NIGHTFIRE ISLAND: LATER HOLOCENE LAKEMARSH ADAPTATION ON THE WESTERN EDGE OF THE GREAT BASIN

by

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with contributions by

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PREFACE

The main purpose of this monograph is to describe as fully as possible the archaeological excavation of a prehistoric hunter-gatherer village on the shores of Lower Klamath Lake in northwest California. Nightfire Island contains the detritus of some 6,000 years of sporadic human occupation and is one of a very small group of deeply stratified archaeological sites known from the Northwest. Conscious that its stratified sequence is likely to remain a subject of debate for some time, I have given over more than the usual amount of space to accurate three-view drawings of several hundred artifacts. A clear and complete record of what was found and where it was recovered should, hopefully, result. The monograph is thus designed chiefly for a readership with interest in the archaeology of California, the Great Basin, and the Northwest.

Naturally I hope, but cannot guarantee, that it will interest readers beyond these regions for its relevance to the general debate over sampling strategies in excavation, for its strenuous, perhaps strained, efforts at a genuine integration of multi-disciplinary results, and for the direct use made of the White Mt. bristlecone pine climatic record in interpreting observed fluctuations in the palaeoecological data.

When I agreed to take over this project from Leroy Johnson, Jr., my wholly unorthodox background as a Cambridge-trained Palaeolithic archaeologist threatened to be a hindrance since I was faced with a quite unfamiliar ecosystem and (to me) a new set of archaeological problems. Although both were (more or less) mastered, my Cambridge-rooted theoretical orientation refused to recede into the background, and this monograph undoubtedly reflects this, particularly in its obsessive concern with catchment and synchronic change. I hasten to add, however, that the interpretations offered are my own responsibility and should not be taken as representative of Palaeolithic archaeologists in general! Likewise, my rather pointed omission of any statistical exegesis in this work should not be taken as typical. While I am well aware that some of the data-sets to be discussed are statistically inadequate samples, I remain impressed by the fact that the fluctuations suggested by such weak lines of evidence are repeated by other data-sets with larger samples. To statistically verify all the correlations put forward here, it will be necessary to reexcavate most of the remaining site. Although this would be an excellent prospect, there is little hope that it will happen in the foreseeable future. Meanwhile, this monograph is offered as a modest stopgap until that happy event.

ACKNOWLEDGEMENTS

This research was funded by the National Science Foundation, Washington, D.C., specifically by Grant No. GS-1413 entitled "Nightfire Island Archaeological Project", by GS-2997 entitled "The Klamath Basin Archaeological Project", and by GS-35181 entitled "Archaeology of the Klamath Basin". Permission to excavate the Nightfire Island site was granted by its owner, Mr. Melvin O. McKay, and we are grateful to the McKay family for their forebearance and cooperation while excavations were under way. To Mr. Carrol B. Howe must go full credit for first drawing our attention to the significance of the site, and we thank him for his constant support and encouragement during the excavations; also for his permission to examine and illustrate specimens from his own excavations at the site, as well as material rescued from earlier bulldozer cuts.

The excavations were planned and directed by Leroy Johnson, Jr., then Curator of Ethnology at the Museum of Natural History, University of Oregon. Those taking part in the excavations were, in alphabetical order: P. Chestnut, C. Clark, G. Clark, E. Detling, G. Eck, E. Frost, J. Frost, J. Hanson, D. Hardesty, R. Howard, K. Johnson, D. Libbey, B. Stuart, J. Wheeler, L. Williams, and P. Young. The field notes also mention the presence of a 'field school' contingent from the University of California, Los Angeles, who must be acknowledged collectively for want of specific names. Dr. L. Kittleman acted as on-site consultant on matters of stratigrapy and sediment sampling, and Dr. J. Gray visited the excavations to procure pollen samples. All the excavated materials were processed and inventoried into the collections of the Museum of Natural History under supervision of Leroy Johnson. This work was done by R. Beach, E. Detling, E. Frost, P. Gonigam, C. Kunz, D. Myers, P. Ryan, J. Wheeler, and R. Wilson. Upon the arrival of the artifacts from this collection at my lab at Southern Methodist University, Dallas, they were checked against the original inventory by W. Singleton.

Those responsible for the specialized studies of various parts of the collection will be acknowledged in the order in which their results appear in this volume. Thanks are due to Dr. K. Kigoshi, Gakushuin Univerity, Japan, who processed all the radiocarbon dates and whose thoughtful advice on the interpretation of the dates is much appreciated. Thin-sections for obsidian-hydration studies were prepared by E. Frost, L. Johnson, K. Kittleman, V. R. Uppuluri, and R. Von Hearne. Obsidian hydration rind measurements were done by J. Ericson, J. Johnson, L. Kittleman, and by myself.

Sedimentary analyses were conducted by Dr. L. Kittleman, and thanks are also due to Dr. D. Pheasant of the Geology Department at SMU for his helpful advice in processing additional samples, and in their interpretation.

The pollen samples quoted in this work were taken under my own supervision with the help of J. Bortch, B. Cameron, J. Volkman, and A. Waibel. Extraction and identification were carried out by L. Vogel at the Department of Botany, University of Washington, Seattle, under the guidance of Dr. M. Tsukada. Phytolith extraction was carried out by L. Kittleman, and wood remains were identified by R. Koeppen at the Center for Wood Anatomy Research USDA Forest Service. Charcoals were extracted by L. Vogel. I am grateful to Dr. R. Hubbard, Northeast London Polytechnic, England, and to Prof. A. Horowitz, University of Tel Aviv, Israel, for their comments on an early draft of Chapter 6.

The mammal and bird bones were analyzed and described by Dr. D. Grayson, Thomas Burke Memorial Washington State Museum, U. W., and I am indebted to him for his critique of early drafts of Chapters 7 and 8.

That the fish remains were studied at all is due entirely to the enterprise of R. Greenspan who, while searching for the (apparently now lost) boxes of fishbones, discovered the sorted components of two microcolumns, including fish bones and scales, one of which forms the basis of her analysis in Chapter 9. This was aided by the advice of M. Aikens and D. E. Dumond, Department of Anthropology, University of Oregon. P. Endzweig assisted in the tedious task of counting the bones. Comparative osteological material and help with identifications were provided by C. E. Bond, Department of Fisheries and Wildlife, Oregon State University.

The locations of obsidian sources around the site were plotted by A. Waibel, and neutron-activation analyses were conducted on most of these at The Reed Institute, Portland, Oregon. Waibel's work was pursued and expanded by R. Hughes, supported by a Frank McArthur Scholarhsip in Anthropology, University of California, Davis. Thanks are due to J. Harpel, Department of Geology, U.C. Berkeley, for commenting on the analytical section of Chapter 11, and to J. Blomberg for discussions which improved clarity and context.

Reduction sequence analyses of projectile points were designed and executed by Dr. B. Bradley, whose experience in stone flaking replication experiments helped greatly to steer my own analyses towards questions answerable in terms of the site's own depositional history.

J. Follansbee and J. Bortch measured and weighed the projectile points, and L. Peters explored the various options for systematic classification. In attempting to fit this collection of points to existing typologies, I was greatly helped by the comments of Prof. M. Aikens and R. Hughes, and by R. Nisbet of the Department of Anthropology, Oregon State University, Corvallis.

The <u>olivella</u> shell beads were studied with partial support (for R. Hughes) again from a Frank McArthur Scholarship; J. Blomberg assisted in measuring the spire-lopped beads.

Travel support to allow me to study the grave goods housed at the U. O. was supplied by the Institute for the Study of Earth and Man, SMU.

Osteological measurements were undertaken by Prof. K. Bennett, Department of Anthropology, University of Wisconsin.

Almost all the artifact drawings were executed by Linda Verrett. The only exceptions are Figs. 10-6a, 10-13a, 13-19b, 13-24n, 17-4a-c, 17-4e, 19-7e, 19-16 which were done by Larry McQueen, and Figs. 16-7, 19-4, 19-7a-1, 19-7k drawn by myself. Drafts of several chapters were typed by Anna Sullivan and the remainder of the manuscript was typed by my wife Beatrix who also helped in its editing, and in caption production.

C. Garth Sampson

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Word-processing of the final master copy used in printing this volume was carried out by Erin E. Mortenson. Dr. Michael J. Moratto and William Singleton provided crucial editorial input.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure		Page

Figure		Page

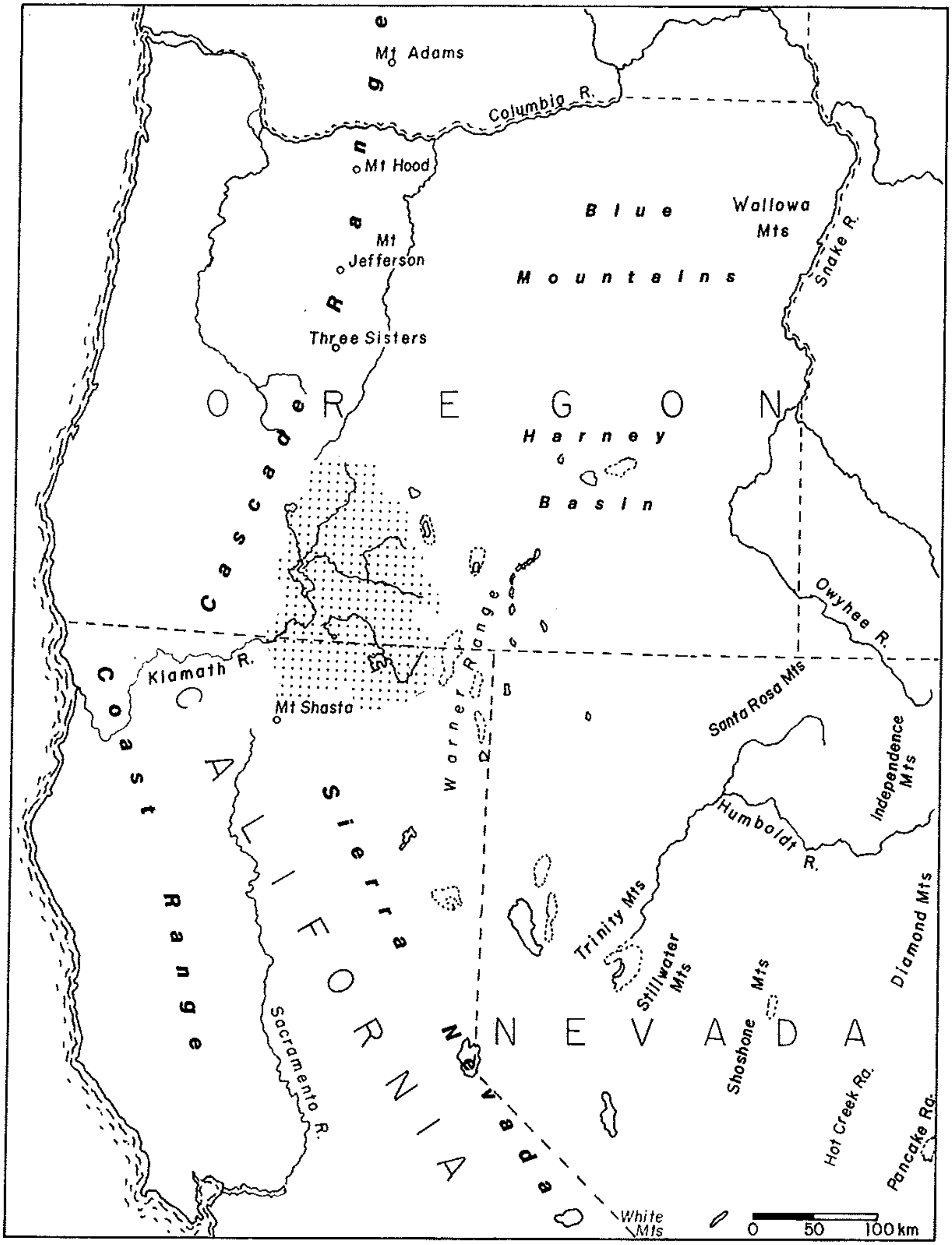

Fig. 1-1 Map showing the position of the Klamath basin (stippled) in relation to state boundaries and major ranges.

CHAPTER 1

INTRODUCTION*

Among the many problems confronting the student of Great Basin prehistory, one of the more durable puzzles has been the nature and timing of human adaptation to lakemarsh econiches--those resource-rich patches around the fringes of shallow lakes known to have covered the valleys and intermontane basins of the Postglacial landscape. From the start it has been assumed that the peoples living in these niches were anomalous--different from their desert-dwelling neighbors in their peculiar wisdom, skills and ingenious equipment developed for the procurement of the marshlands' many riches: fish, waterfowl, eggs, and plant foods. While the lakes lasted, it was argued, their marshes were "the fat of the land" where resident populations could concentrate in relatively large groups, and could live almost all year round in the same places--an enviable contrast to their dispersed and tirelessly mobile desertic neighbors. During the various and much-debated Postglacial dry spells they took to the desert as their marshes disappeared (so the argument runs), while some held on, keeping the traditions alive in places where the lakes were large enough not to desiccate entirely, and turn to alkaline flats.

Since the first really clear archaeological proof of their existence (Loud and Harrington 1929), these denizens of past marshes have managed to retain their autonomy in the collective imagination of Great Basin prehistorians. They have somehow survived all the revisions and name-changes that come with an accelerating pace of archaeological discovery. Thus they were awarded separate status by Jennings and Norbeck (1955:3), even promoted to Specialized Lake Dwellers (Meighan 1959) while their desertic neighbors have drifted from one uncertain archaeological label to the next, as befits their wandering habit: Desert culture, Western Archaic, Great Basin Archaic, and half a dozen or so cultures, complexes, phases, and stages.

The chief reason for the Lake Dwellers' durability as a concept is because a couple of their sites have now been subjected to some of the best archaeology practiced anywhere in the U. S. Yet in spite of this, many gaps in our understanding of this rather special adaptation still yawn wide. A major drawback has been the absence of any really convincing ethnographic model upon which to draw for analogs, ideas for theoretical modelling, and fire for the prehistorian's imagination. By the time of European contact, the so-called Pluvial lakes were gone, and the marsh-dwellers with them. Thus from the very beginning prehistorians were obliged to cast about for living examples of this kind of lifeway in areas outside the Great Basin itself. It did not take very long for their gaze to settle on the Klamath basin just outside the northwest rim of the Great Basin (Fig 1-1). Here the Klamath and Modoc tribes had managed to survive the early onslaught of White contact long enough to have had more than just the rudiments of their culture recorded by early travellers and, later, by professional ethnographers. Both tribes were found to be without horticultural techniques, livestock, ceramics, or metallurgy. Like their great Basin neighbors, they were hunter-gatherers with a basic stoneworking technology. More important still, they were seen to be so intimately entwined with the lakemarsh habitat in (and off) which they lived, that they seemed to offer just the analog needed by Great Basin prehistorians. Soon enough they were being specifically invoked as

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the kind of adaptation presumed to have existed around the Pluvial lakes (e.g., Meighan 1959). Furthermore, because parts of the prehistoric Klamath/Modoc cultural inventory were suspected to derive from older adaptations around ancient lakes inside the northwest rim of the Great Basin (Cressman 1942), the comparison was not thought to be too far-fetched (Fig. 1-1).

When Hopkins (1965) produced linguistic support for a "proto-Sahaptian lake-marsh adaptation" in the Klamath basin during the Altithermal (i.e., mid-Holocene) leading to a Sahaptian lake-marsh adaptation in the Medithermal (upper Holocene), this was not thought to be particularly threatening to the earlier comparison. Yet it poses the first serious challenge to the supposition that the Klamath/Modoc were living fossils of an earlier Great Basin lifeway, for it asserts that their adaptation had local roots quite as early if not earlier than anything in the Great Basin. What Hopkins lacked was any sound archaeological basis for his assertion. Although Cressman (1956) had evidence of waterside occupation at the north end of the basin which stretched back to the mid-Holocene (Aikens and Minor 1978), the necessary organic associations were lacking to demonstrate the dietary range and, therefore, the actual adaptation of these people. Nonetheless, the convergence of linguistic evidence (Wenger 1969), ideological and trait comparisons (Hofmeister 1969) and physical anthropology (Bennet 1972) all pointed to a long in situ development for Klamath/Modoc adaptations. If proven, this will have grave implications for their future use as analogs in Great Basin prehistory: there is no guarantee that the evolution of the Modoc/Klamath adaptation paralleled those of the pluvial lakes. Neither is there any guarantee that the timing, rates of change or progressive stages through which they passed were the same. In short, they may each have emerged in quite different ways and may have ended up looking quite different. Yet the comparison persists because no archaeological evidence of the time-depth of Klamath/Modoc adaptation has been forthcoming.

Not only is the field evidence wanting, but there has been remarkably little discussion of the possible learning pathways which lead to marsh adapted cultures. If the earliest inhabitants of this region were indeed mainly big-game hunters, how did they first approach the marshes? Which resources attracted them first? How much of their hunting skill and equipment was applicable to marshland exploitation? What was the order of discovery of edible resources? Which items went unexploited at first for want of adequate equipment? These and many more questions spring to mind when confronting any specific marshland niche. Still more interesting questions arise when the process of marshland adaptation is considered in broader perspective: Are there general rules for the development of adaptive stages? Which comes first--fishing, waterfowling, seedgathering? Or are they all practiced together from the beginning of the adaptation? None of these questions is easily answered. The modern marshlands vary enormously and are in constant flux, as Weide (1968) has so eloquently shown, and so were the Pluvial lakes, as the paleoecological evidence shows. If the learning pathways of a single marshland adaptation are to be examined in the archaeolgocial record, they must be sought through a haze of fluctuating numbers, caused by vacillations in the prehistoric marsh and its resources. Trends and stages are likely to be masked by other oscillations which must be correctly interpreted (e.g., Rosaire 1963). Yet the attempt must be made if we are to make any headway in the study of lakemarsh adaptation as a long-term process.

The site of Nightfire Island affords an ideal opportunity to address this broader challenge as well as the more specific question of the Klamath/Modoc analog in Pluvial lakes prehistory. Because it is in the heart of Modoc territory, the use of Modoc ethnography as an interpretative tool is less suspect. The site's abundant faunal remains and its clearly demarcated stratigraphy offer excellent opportunities for unravelling the ebb and flow of prehistoric marshland fluctuations and for gauging their impact on the developing Modoc adaptation.

What follows is a summary of that adaptation: the resources, how they were extracted, the seasonal round, and the effect of all this on the settlement pattern and the variety of Modoc site types. The catchment around Nightfire Island is then examined, and the role of the site within a Modoc-like subsistence round is predicted by choosing from a selection of possible site-types drawn from the Modoc record. Next, a predictive model of long-term changes in the composition of the Nightfire Island catchment is derived from regional paleoecological data. The model is then extended to predict changes in the role of the site in the face of these changes. Throughout, the model is designed to fit the original assumption that the lakeshore adaptation arrived here already fully developed, having been brought in from the Pluvial lakes to the east. The archaeological ramifications of the prediction are then explored. A rival model is then set up to compete with the first, based on the opposing assumption that the Modoc took several millennia to perfect their adaptation on the spot. The archaeological implications of the second model are explored with one eye on the possible masking effects of lakeshore fluctuations.

The two competing models will be used as a testing framework within which to analyze the copious and varied materials recovered from the site, with the ultimate goal of deciding which model best fits the facts.

The Modoc Territory and its Resources

The Modoc were surrounded by four other tribes (Fig. 1-2). The Shasta on their western flank they feared and hated as traditional enemies (Ray 1963:xii). To the northwest and north were the Klamath to whom they were more closely related in their lakeshore adaptation, material culture and language than to any other surrounding tribes. So similar were they that several early ethnographers made little attempt to distinguish the two. Their relationship was cooperative, with a modest flow of personnel across the boundary, but it was also one of wary mutual respect. The Yahuskin band of the northern Paiute shared their northeast boundary, and the Kidu band were on their east flank, across Goose Lake. The Modoc thought the Paiute to be inferior and tried to have as little to do with them as possible. Not so the Achomawi to the south with whom they were constantly at war. Their relationship was no doubt more complex and varied than this because the two tribes shared a great many culture traits. The boundary of the Modoc tribal territory was disputed at several points[1]. If we provisionally accept their maximum claims (Ray 1963:206), then they must have occupied 9,412km^2 (3,634 sq. mi.) of which about nine-tenths were undoubtedly under their control in the mid-1800's.

The territory centered on the lakes and marshes of Lower Klamath Lake, Tule Lake, and Clear Lake (Fig. 1-3). The remainder comprised the drainages of these three, of which the Lost River is the main channel, rising in Clear Lake and terminating in Tule Lake. Thus the territory was itself a closed drainage system with the intermittent exception of Lower Klamath Lake which drains into the Klamath River. The rim of this basin is lined with volcanic ridges and occasional peaks, dominated by Mt. Shasta in the southwest (Fig. 1-3). The basin floor stands at about 1225m (4000ft) asl and is dotted with minor volcanic plugs, ridges and fault scarps. A massive lava flow dominates the landscape south of Tule Lake, and the country to the east of this is dominated by hills, plains and alkaline flats. To the west the plains are interspersed with conical buttes, becoming increasingly mountainous as the ground rises to the Cascade Divide.

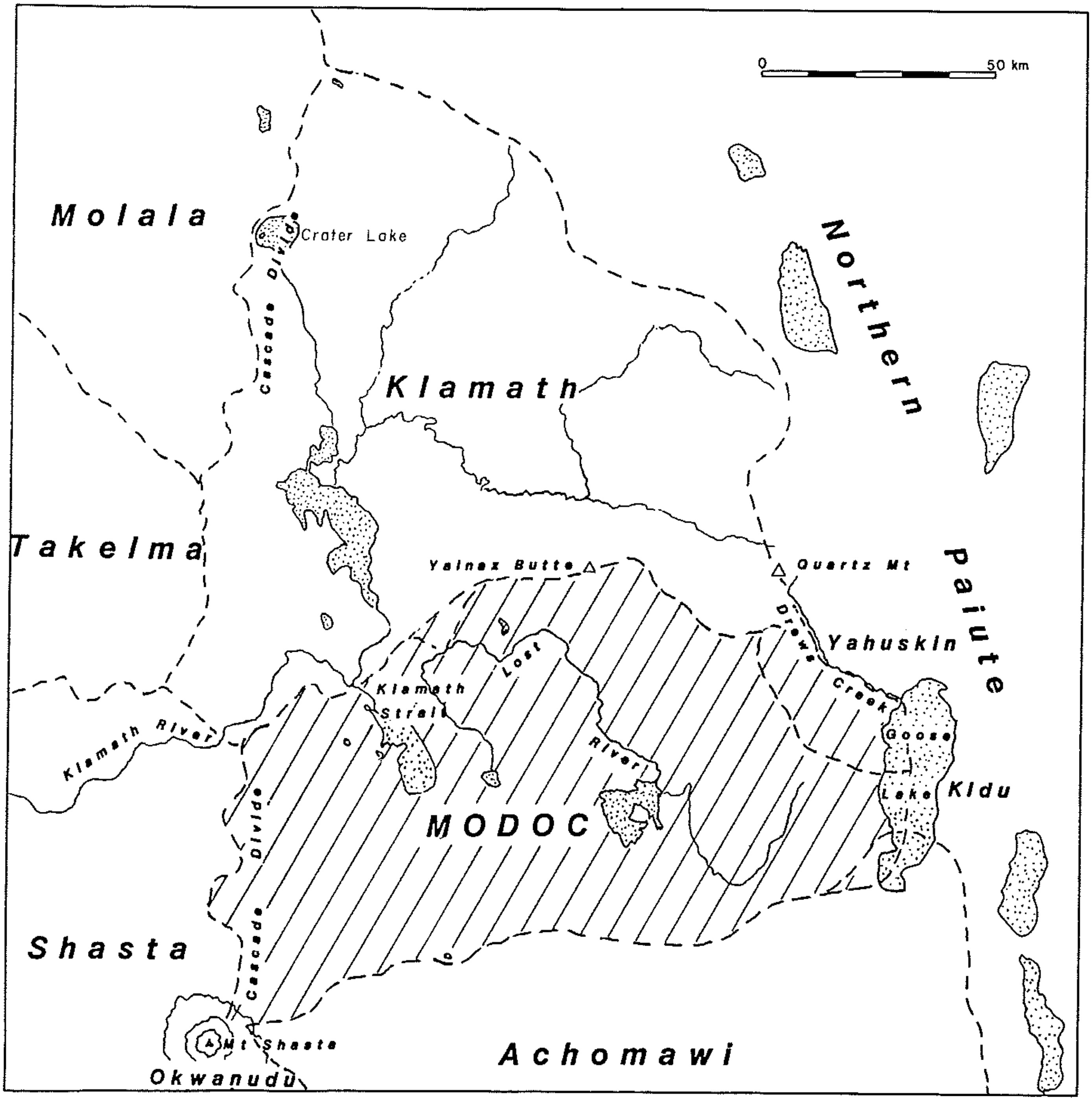

Fig. 1-2 Map of the Modoc territory within the Klamath basin, showing the positions of surrounding tribal territories.

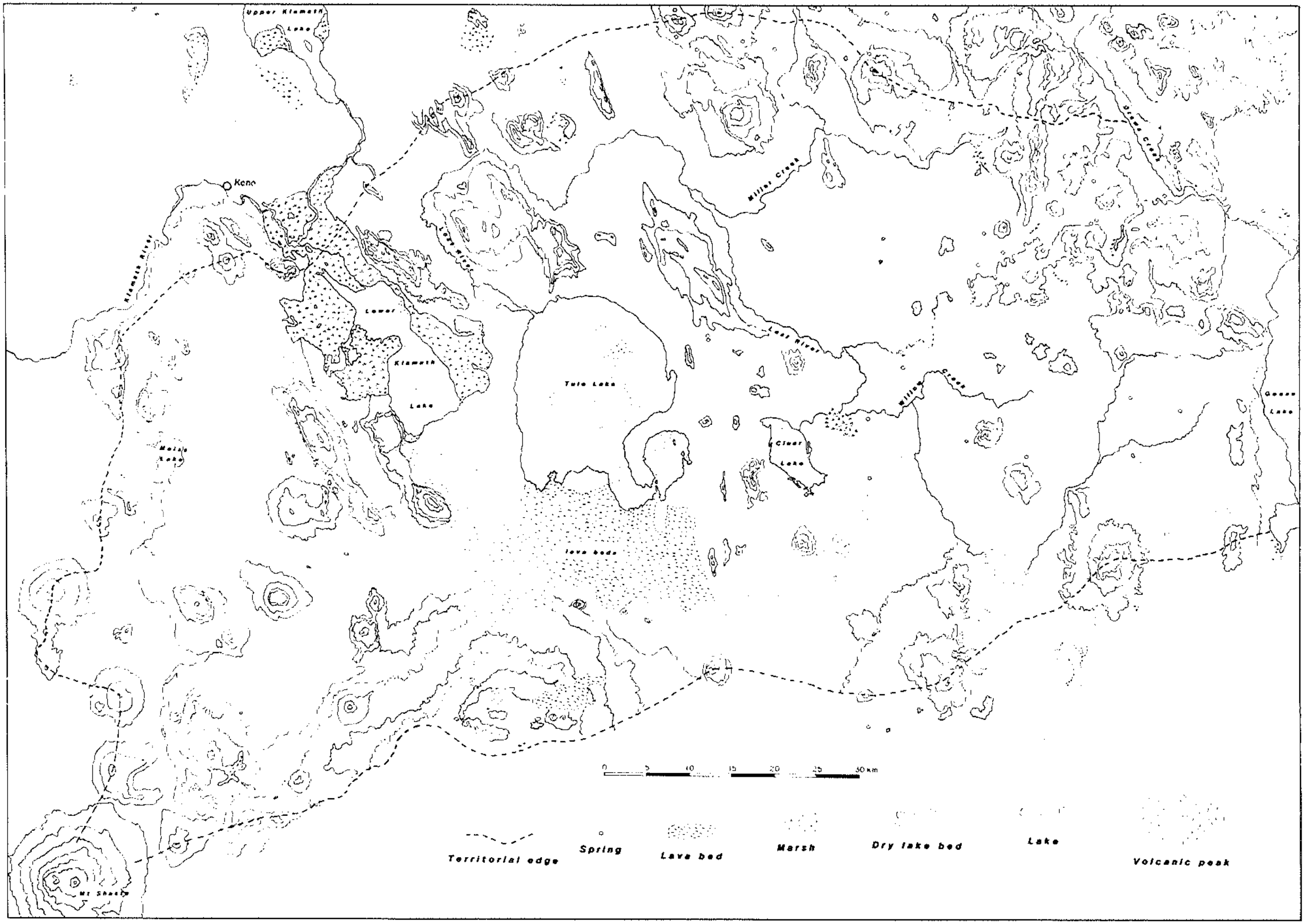

Fig. 1-3 Map of the relief and drainage of the Modoc territory.

Most of this western upland was forested, as was the northern rim--dominated by Ponderosa pine. The lava flow was almost barren and the plain to the east was mainly covered with bunch grass and some juniper. Farther east the plains were covered with sage and juniper with bunch grass more common in the hills, and juniper increasing along the southern rim. The bottom lands along streams supported dense meadow where shallow flooding induced marshy conditions. Marshland also occurred in patches along the lake margins.

In food resources for hunter-gatherer inhabitants, the basin was both extravagant and varied. Among the catalog of food plants collected by the Modoc (Ray 1963:218) are 15 types of edible roots, 26 edible seeds, 17 fruits and berries, 5 edible barks and lichens, and an edible leaf plant. Only a few dominated the Modoc diet, and may reasonably be called staples: The roots of ipos (epos) *Perideridia* spp., the roots of camas *Camassia quamash*, white camas *Zygadenus venenosis* and the seeds of the water lily wocus (wocas) *Nuphar polysepalum*. Game animals also abounded. The larger artiodactyls included pronghorn, elk, mule deer, blacktailed and whitetailed deer, and mountain sheep. There were also several fur-bearing carnivores, plus many small carnivores and rodents which were occasionally taken. The lakes and streams supported species of sucker; also perch, chub, dace, trout, eels, turtles, and mussels. The salmon runs did not reach into Modoc territory, but were traded from the neighboring Klamath in modest amounts[2].

To this already impressive list must be added the fact that the core lakes of this territory are an important waystation on the Pacific waterfowl flyway. Each year millions (Fig. 1-4) of waterfowl pass through on their northbound and return journeys, between the Arctic and California/Mexico. The marshlands swarmed with year-round residents as well: ducks, geese, various diving birds, pelicans, gulls and loons. The sagebrush country also yielded prairie chickens, curlews and sage hens.

Several of these resources will be examined in more detail in the chapters which follow, but this summary list will suffice here to drive home the point that the Klamath/Modoc habitat was an exceptionally abundant and varied one.

The Modoc Subsistence Round

The annual cycle of subsistence, treks, dispersals, and regroupings of Modoc within their territory never seized the interest of any of their early ethnographers. However, Ray (1963:180-3) has presented a generalized account of the Modoc round which has considerable value for this study.

Evidently the Modoc moved about on their landscape in a way which now enjoys various labels: central-based wandering (Beardsley *et al.* 1956) and sedentary seasonal settlement with permanent bases (Chang 1962) are but two of the more commonly used ones[3]. Mobility patterns of this type are quite typical of hunter-gatherer adaptations to areas with abundant resources but also with cruel winter temperatures. The Modoc territory certainly fits that description (Fig. 1-5).

During the sub-zero winter months all Modoc congregated in quasi-permanent villages. These were all but abandoned in the early Spring when either the village moved as a group to a fishing camp along a streambank for the sucker runs or it split and moved to two nearby camps for the same purpose. The Spring fishing lasted 3-4 weeks after which the runs diminished and the village group(s) moved to late-Spring camps situated at places where the women could dig up epos roots and the men could catch the trout which were now beginning to run. If the location of these camps was suitable, waterfowl eggs were also collected. Whenever the epos around a camp were worked out

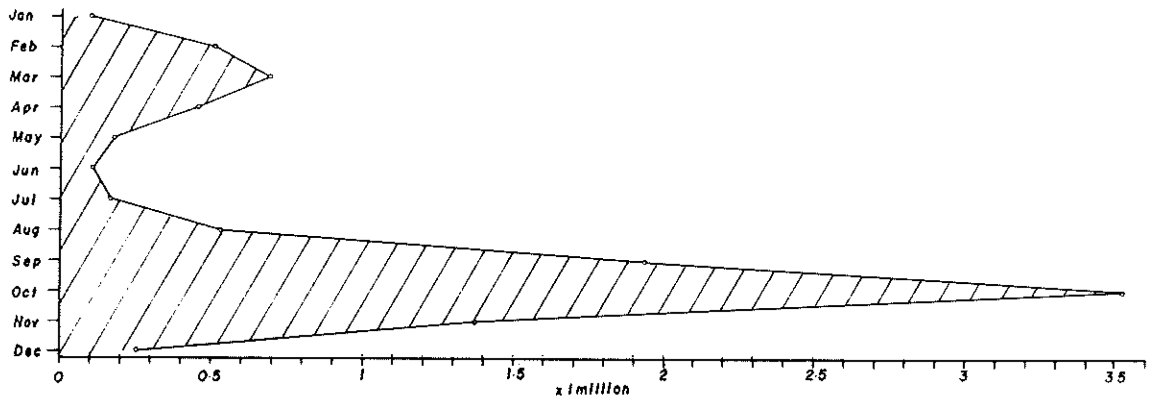

Fig. 1-4 Total monthly birdcounts in the Lower Klamath Wildlife Reserve. Monthly averages derived from Grayson (1973a, Table 3).

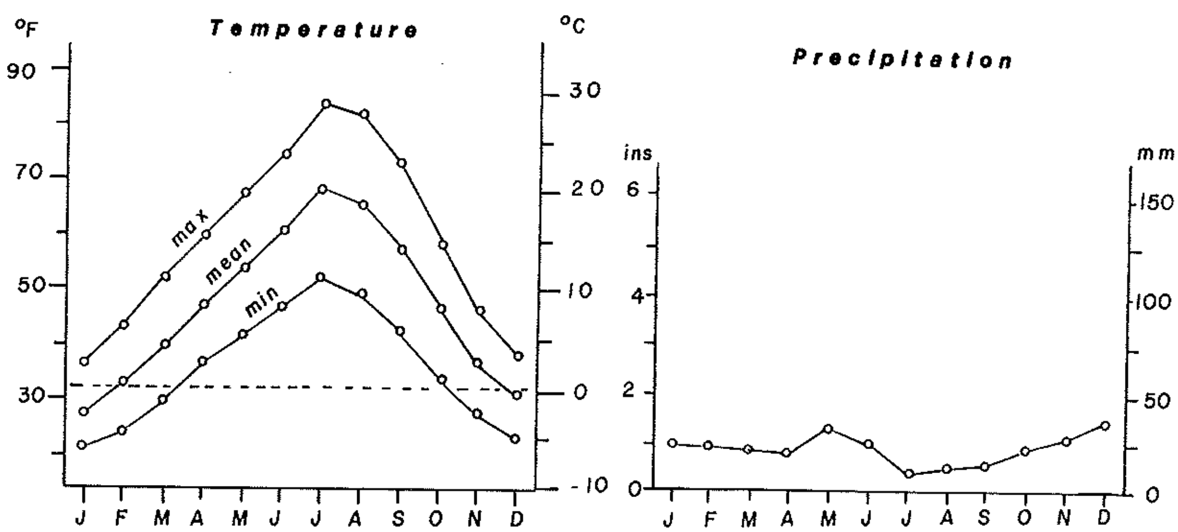

Fig. 1-5 Mean monthly Temperature and Precipitation at Kingsley Field airport, about 22 km N. of Nightfire Island.

before the season was over, the camp would be moved--repeatedly if necessary. In midsummer (late June-early July) camps were shifted again to those areas where camas roots were ripening. These were relatively scarce in Modoc territory, but highly valued, so that the group(s) became widely dispersed and mobile in their quest. Camps could be occupied for as little as a week--just long enough for the camas to be dried and cleaned at the digging site in preparation for winter storage. Trout fishing and waterfowling were conducted by the men where possible. July-August saw another shift to white camas digging, and the men sought mountain sheep in the lava beds, or pronghorn in the eastern plains. Early September started with the second sucker runs, as well as wocus seed gathering, and the harvesting of several lowland berry crops. In late September the groups reconvened at remote camps at high elevations so that the men could hunt deer and elk and the women could gather huckleberries and other fruit. Work slackened and various ceremonial and gambling activities took place, near at least four such camps (Fig. 1-6). During October, groups returned to their winter villages where hunting preoccupied the men until the first snows (December). This was supplemented by some fishing in both the lakes and streams. Throughout winter there was some desultory hunting on an individual basis to supplement the supply of stored foods.

This is of course a generalized overview of the system which omits local variations determined by the relative abundance of seasonally available foods. The round of the Aku'astkni, who exploited the southwest of the territory in which Nightfire Island is located (Fig. 1-7), included a regrouping spell at Stu'ikish on the marshy northeast shore of Lower Klamath Lake to collect wocus lily seed (Ray 1963:208). This would have been between August and late September, after the white camas had been dried and stored. The regrouping was probably not duplicated elsewhere in Modoc territory where wocus were relatively scarce and played a lesser part in the diet.

The Modoc Settlement Pattern

Without doubt the marshland edges of the lakes were at the focal core of these superabundant resources, and it is hardly surprising that the Modoc inhabitants tended to concentrate here in quasi-permanent villages. These were seldom located in the marshes unless some dry promontory was available near potable water. Remarkably, the latter was not always easy to come by because so many springs in this ubiquitously volcanic basin yield water saturated with salts of many kinds. Another consideration was that most streams freeze over in winter, so that fresh, warm-water springs and their streams were a major attraction. We might expect, then, that the larger settlements would be concentrated along the edges of marshland, and on the meadowland banks of certain streams, preferably within reach of marshland.

The only comprehensive map of Modoc villages has been compiled by Ray (1963: Appendix I) from various sources, including some published ones (Gatschet 1890, Farrand 1959, Kroeber 1925). Fig. 1-6 gives the locations of Modoc villages known to have been inhabited in the mid-1800's. Excluded are the more numerous temporary hunting and collecting camps which dotted the countryside between the core area and the territorial boundary. Apparently several villages existed in Langell Valley which were never plotted, and several more are known as archaeological sites (C. B. Howe pers. comm.).

Four "divisions" (Ray's term) were recognized by the Modoc to designate people who came from villages in different parts of the territory. Each division was named for a principle village within the core area of the division (Fig. 1-7). These names were convenient, informal labels and did not represent discrete hunter-gatherer bands. Individuals could and did move their places of residence to villages

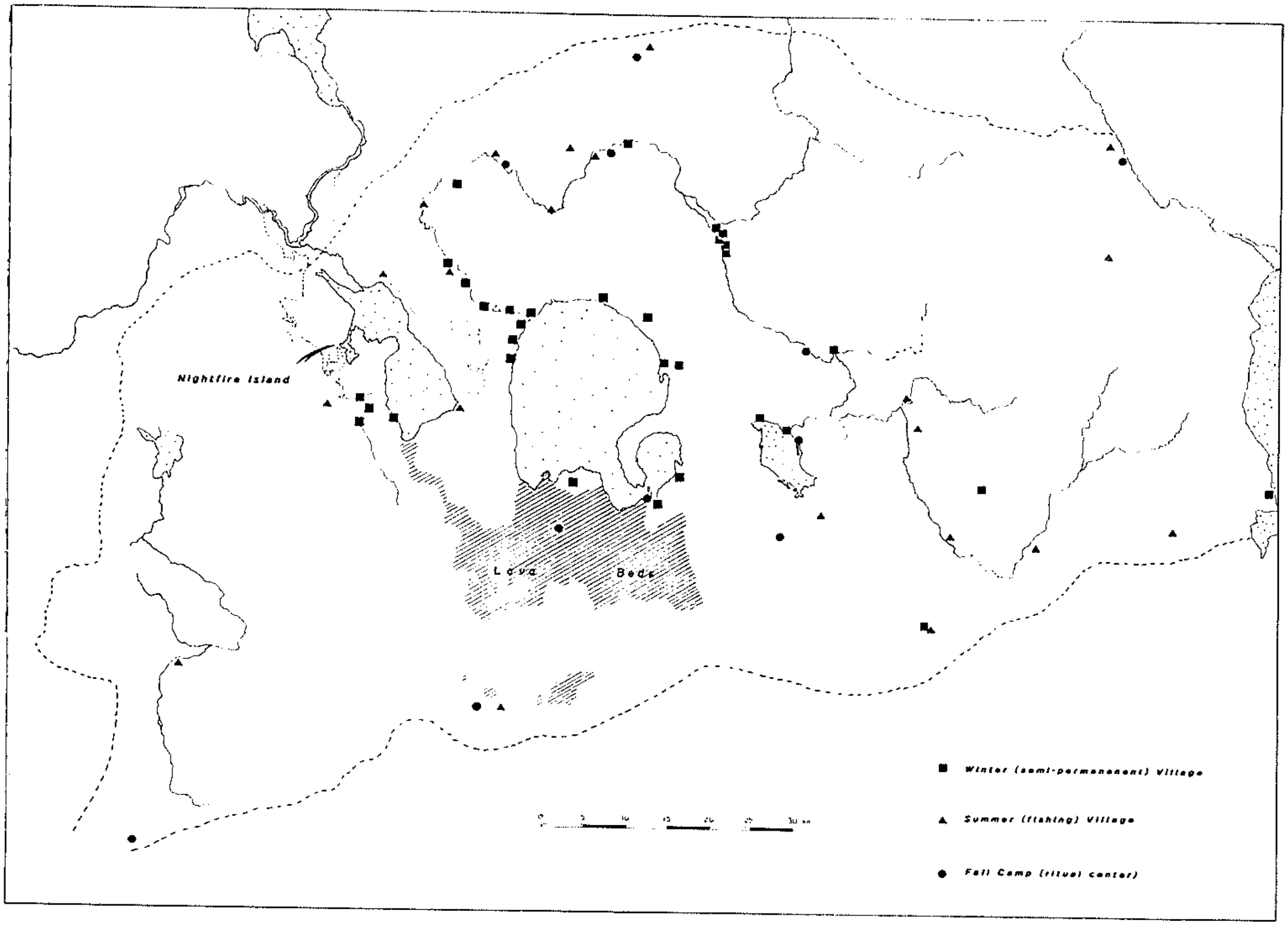

Fig. 1-6 Distribution of site types within the Modoc territory, after Ray (1963, Appendix I).

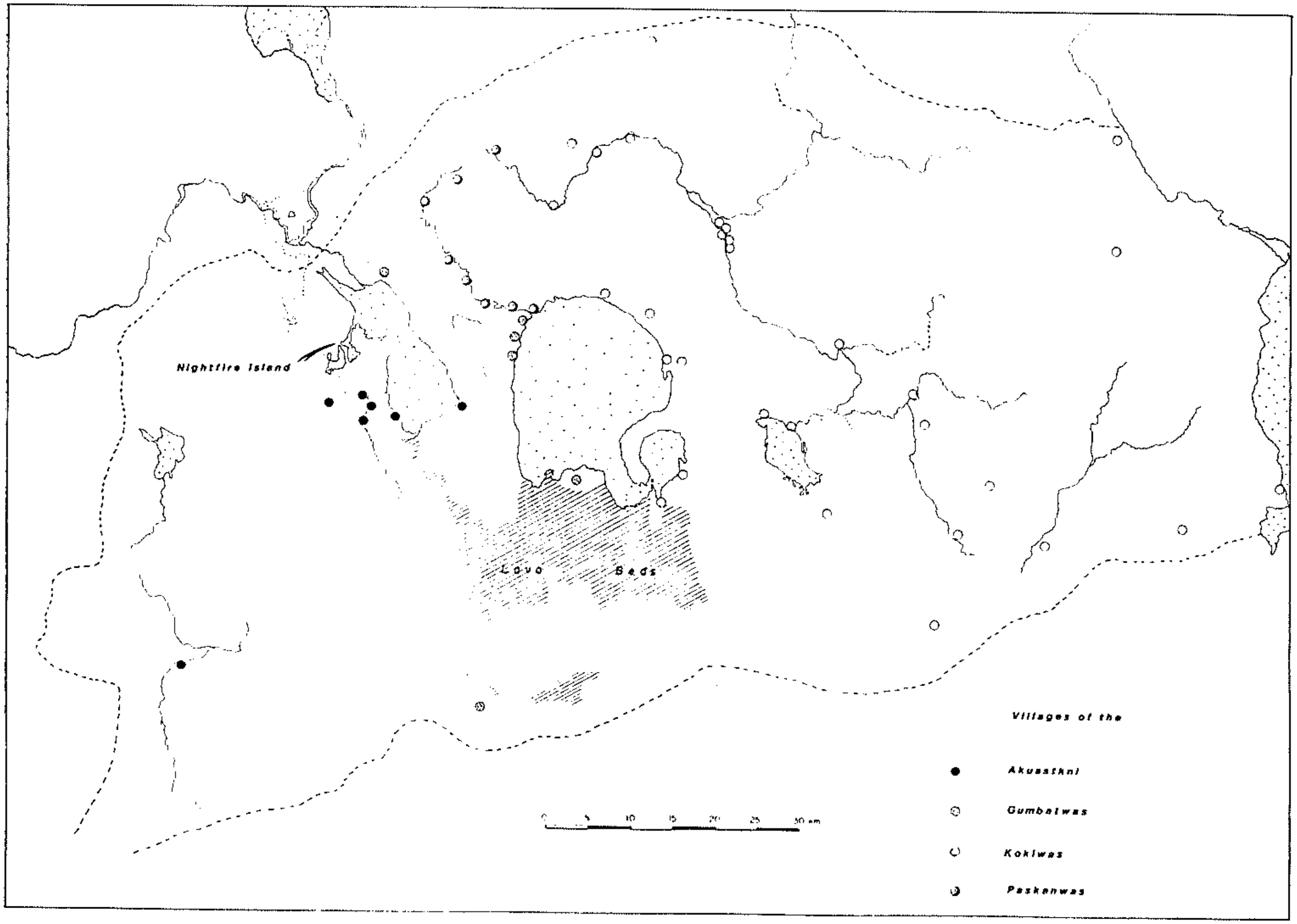

Fig. 1-7 Distribution of Modoc villages and camps within the "divisions", following Ray (1963).

in other divisions and would, with time, become labelled as belonging to them. Although the most influential village head in a division usually had more say over affairs in his own division than elsewhere, the division should not be construed as a polticial unit. It is quite likely that they represented what we should now call "exploitation spheres"--areas which most of the residents used most of the time.

The term village has been used in two senses: the permanent village comprising a small group of semi-subterranean dwellings known variously as pit houses or earth lodges; and the summer village, sometimes composed wholly of above-ground temporary structures (Fig. 1-6). Permanent villages were almost all occupied in winter, but it is far from clear which ones were occupied year round. By permanent, Ray seems to mean permanently maintained rather than permanently occupied. The same applies to the summer villages. There were obviously no clear rules about the scheduling of occupation of a permanent village. Some were truly abandoned in the early Spring when the winter lodges were unroofed and allowed to air and dry. However, the old and infirm were simply rehoused and never left the site. Winter villages located near summer resources were liable to fill up again in late Spring sometimes beyond their winter capacity. Others, less favorably located, might stay empty until October, except for periodic short visits to stash dried camas, meat and fish for the winter. Likewise, certain summer villages could retain a residual winter population if their locations were appropriate.

Apart from "permanent" and "summer" villages, Ray mapped two other site types. Factors controlling the location of cremation grounds will be examined in detail elsewhere (Chapter 19) because they were not influenced much by subsistence concerns. Ceremonial centers were mostly in the uplands because these activities were scheduled to coincide with the hunting and berry-gathering excursions in September-October. Unfortunately, no description of such a site has survived, and its archaeological trace is therefore uncertain.

The same applies to the many unmapped short-term camps set up for a few weeks at a time as bases for epos or camas digging, hunting, waterfowling, wocus gathering, berry gathering and combinations of these. As the literature is bereft of eye-witness accounts of any of these specialized working camps, it will be impossible to reconstruct detailed archaeological analogs for them. Nevertheless, some rough attempt must be made if the role(s) of Nightfire Island in a Modoc-like subsistence round is to be understood. It would be a pointless exercise, however, to try to predict the archaeological composition of all the various site-types. Several can be eliminated without further ado because common sense dictates that they do not qualify as analogs for Nightfire Island as they occur in the wrong setting.

Nightfire Island: Location and Catchment

The position of Nightfire Island in relation to documented villages of the Aku'astkni near the south shore of Lower Klamath Lake is shown in Fig. 1-7. Assuming that the documented list of villages is complete, this implies that Nightfire Island was an abandoned site by the mid-1800's[4].

It was located in the tule marshes on the southwest shore of the lake. At the beginning of the 1900's (prior to drainage and conversion of the lake bed to pasture) it was centered in a marshy embayment surrounded by volcanic ridges. The bay mouth faced north towards a vast stretch of tule marsh. The nearest shore would have been 1/2km to the east on Sheepy Creek Island and about 1/2km to the south where a very low rise of dry land jutted out into the middle of the embayment. Sheepy Creek at that time entered the marsh about 1km south of the site and disappeared into the tule stands. The course of its channel could not be mapped until the lake was drained.

The Nightfire Island catchment is given in Fig. 1-8a. All the usual limitations of this approach (e.g., Dennel 1980) are compounded by our ignorance of travel-times through tule marsh by canoe and raft. Although the 5km (1hr) and 10km (2hrs) radii are not precise reflections of travel time, they nevertheless reveal some of the reasons why this spot was chosen for settlement.

The site's position within the 5km radius placed it within an hour's[5] reach of all the Birds' Nest Islands--the largest and most stable resource in the catchment (waterfowl, eggs). It was also just within reach of Otey and Skull Islands to the north-- a convenient staging ground for working the edge of Miller Lake. On land, an hour's walk brought the inhabitants to the foot of the Mahogany Mountain complex on the west side of the Hot Creek drainage, or to the southern tip of the outlying ridge of which their own Sheepy Creek Island was a part. Significantly, this gave them a ridge-and-flats complex (with a sage/juniper cover) completely free of high relief features. This would have provided some hunting and possibly root gathering on the Hot Creek meadowlands. The shoreline edge of the tules would have provided good trapping for mink, otter, raccoon, beaver and bobcat. The tule marsh itself comprised 56% of the 5km catchment in 1905. The tule (hardstem bullrush) (Scirpus acutus) would have shared the shoreline zone with cattails (Typha) sp. between the mudflat shoreline and about 1m water depth, beyond which tule would have dominated (Green, McNamara and Uhler 1964:563). These gave protection from wave action to submerged plants which were important food sources for waterfowl and humans. Conspicuous among these were sago pondweed (Potamogeton pectinatus) and widgeon grass (Rappia maritima). Like the cattails, these would have been concentrated between the shallows and the 1m water depth contour (H. Duebbert, quoted in Weide 1968:89-90). The tule/cattail stands also gave wind protection to edible floating leaf plants--particularly wocus lilies, arrowhead (Saggitaria sp.), and several others important as feed to waterfowl (Mason 1957). Because the white base of the tule stem is itself fit for human consumption, the marsh affords another exceptional subsistence base. As a support base for waterfowl the marsh would have been of more limited value--especially where dense, solid stands of tule had formed to the exclusion of all else. However, this is offset by the exceptional amount of marsh edge preferred by most waterfowl for nesting (Fig. 1-8c) and feeding--4km of edge on Miller Lake, and 20km on the channel margin, not counting the nest islands (Fig. 1-8a).

All of these advantages would have been within reach of the inhabitants had they settled on dry land at the tip of Sheepy Creek Island. Evidently the disadvantages of camping in the marsh were outweighed by the advantages of locating directly on the edge of the stream. Sheepy Creek water is alkaline, but nevertheless drinkable. Its major advantage is that it is warm at the spring mouth and does not freeze over in winter. Had the village been located at the tip of the dry land promontory instead, then all drinking water would perforce be carried 400m. Furthermore, runs of sucker and trout could not be easily monitored. Finally, there was less protection on the exposed bluff from winter winds than there was in the tules, next to the steaming water of the creek.

The 10km (2hr) catchment sheds yet more light on the strategic wisdom of locating the site here. Although the area of marshland added in the larger catchment is only about 3%, the highly productive marsh edge is increased by 38.5km. Furthermore, the site comes within reach of Zuckerman Island to the north, the entrance to Klamath Straits, the Stu'ikish wocus stands, and the far shore of the lake at the foot of the Klamath Hills. To the southeast it comes within reach of four permanent villages, and to the west it is within reach of a summer village centered on a dense epos patch together with stands of plums and chokecherries (Ray 1963:208). If we accept that there was originally a site on Zuckerman Island, now destroyed (C. B. Howe pers. comm.), Nightfire Island was remarkably central to at least six

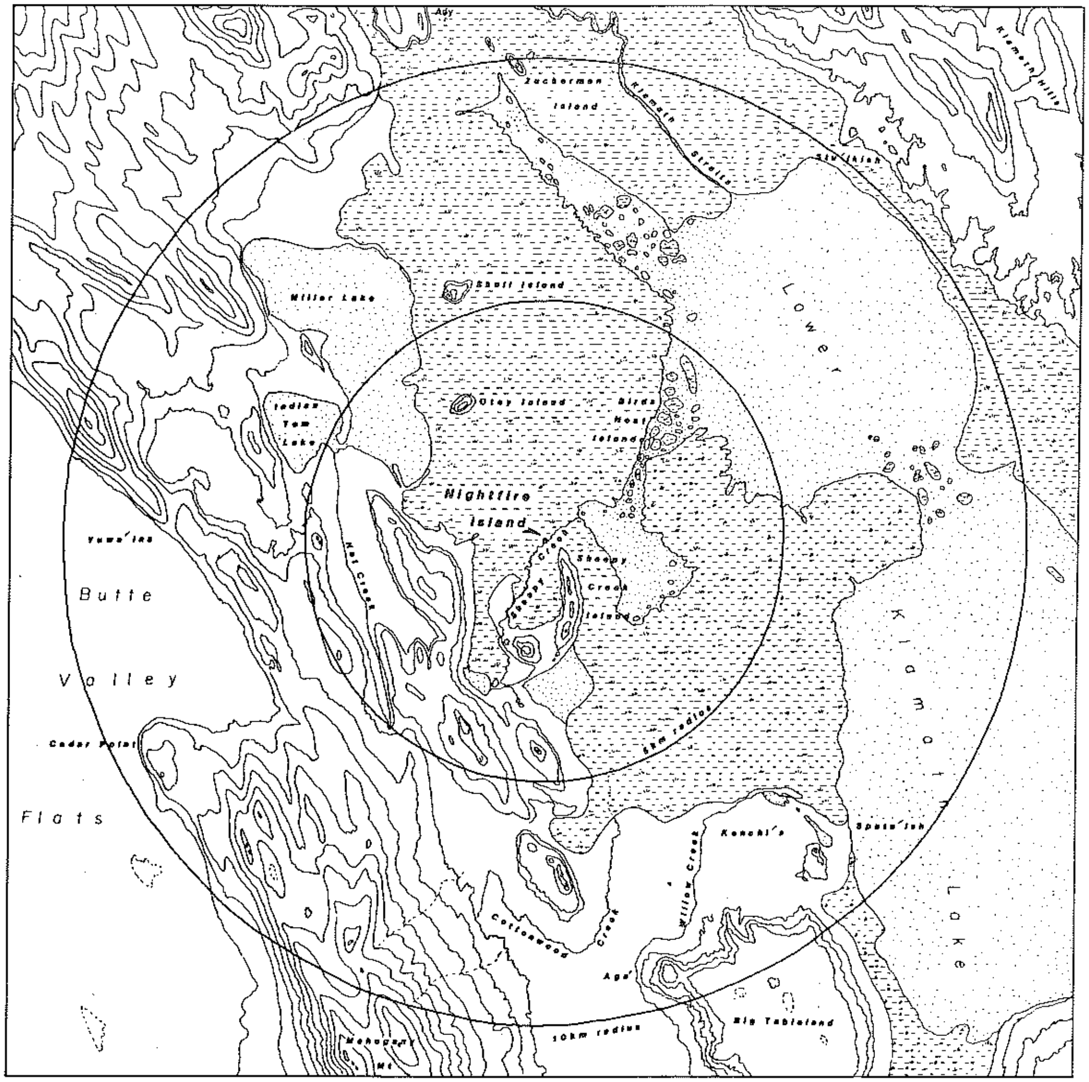

Fig. 1-8a Topography of the 5 km and 10 km radius catchments of Nightfire Island.

known villages, all about 2hrs distant. It was a very similar distance to a ritual rock pile (Ray 1963:xiii) on the shoreline ridge to the west of Zuckerman Island.

The 2hr catchment contains 47% of dry land, a higher proportion than in the 1hr catchment, and it contains a wider diversity of landforms. The Butte Valley Flats and the Oklahoma Flat would have supported rabbits and occasional pronghorn and mule deer. In prehistoric times the odd stray bison would have been found on these settings. The gap north of Yuwa'lna may have been a useful narrows for the ambush of herd animals. The complex of northwest-trending outlier ridges extending from Mahogany Mountain would have supported Mountain Sheep, elk and grizzly in their well forested portions, and they also provided pine nuts as well as several berries.

It is now abundantly clear that Nightfire Island was centrally located to exploit, without much work or trouble, the greatest possible range of foods within two hours' reach of the site. The only really unpredictable resources were the larger artiodactyls which tend to winter along the shores of the lake, but prefer to summer in the uplands (see Chapter 7). With this in mind, we may return now to the search for suitable analogs among the various Modoc site types.

Modoc Analogs for Nightfire Island

Only four analogs need be considered: the permanent village, the spring/fall fishing village, the wocus-gathering camp, and the waterfowling station. Other land-based hunting and/or gathering camps would not have been located here.

The first to merit comparison is the permanent village. Although the site's lakeshore location would strongly favor this analog, its marshy setting would argue against it. Most Modoc villages were sensibly located on dry land where there was no chance of the living area becoming drowned by fluctuating lake levels or, more simply, by settling into the morass underfoot. If Nightfire Island was a permanent village, it would have functioned only if: (a) the lake level was low enough for it to be on dry land, as it is today, in which case the tule marshes would have been a mere fraction of their 1905 extent, and the site would have been that much less attractive; or (b) the villagers were willing to undertake periodic bouts of platform-building to keep the settlement from turning into a quagmire. The archaeological trace of (a) would be ephermeral and easily missed in excavations--perhaps a buried soil horizon marking undisturbed meadowland on the edge of the site. The trace of (b) would be hard to miss--structureless fill composed of sediment and basalt blocks brought from the north slope of Sheepy Creek Island about 1/2km away. Other gross traces would be shallow pit house fills, with central stone-lined hearths, post holes, but no storage cache pits (the Modoc cached their winter supplies outside the village). Foodwaste trash would include the total array of available fauna, but the numerical ranking of species in the trash cannot be predicted from documentary sources. We can predict that the ranking would vary from village to village according to the composition of the catchment area. The chances of plantfood survival cannot be predicted, but there will be numerous pestles, manos and metates of basalt and sometimes bowls and platters of scoriaceous lava (Barrett 1910). Again, the relative abundance of these will be determined by the catchment composition, and by the distances that heavy pieces would have to be carried between the village and surrounding gathering/processing camps. The trash will also contain abundant byproducts of dart and arrowpoint manufacture. Most of the flaked stone will be obsidian from the nearest sources--Glass Mountain, Medicine Lake Highlands and Grasshopper Flats. Obsidian flakes will show plenty of edge damage resulting from work on fibrous plants for twine, matting, netting and basketry (Barrett 1910). Antler wedges and stone mauls should be present indicators of log-splitting activities during house building and annual reroofing (Ray 1963:151) and dug-out canoe adzing (Kroeber 1925:332). Rare fragments of personal ornaments (Ray 1963:178-9) and stone smoking pipes should also occur. Charcoal should be abundant and widespread in the trash.

There may be several problems in distinguishing the archaeological trace of a permanent village from that of a *spring/fall fishing village*. Although we may infer that all the houses in the latter were of the movable dome-shaped type (without an excavated floor) the literature is not explicit. Of the six fishing villages listed by Ray (Fig. 1-6) two were also permanent villages, and would certainly have contained pit houses. Nevertheless, the absence of pit houses will be a frequent feature of the fishing village. Although we can reasonably expect large quantities of fish bone in the trash, we cannot predict the numerical biases of species--chub will probably dominate the count and trout (being more cartilagenous bone) may not survive too well. Of the abundant fishing equipment--canoes, rafts, paddles, punt-poles, triangular nets, hoop nets, seine/gill set-nets, spears, hooks and gorgets--the only items likely to be found are grooved and elliptical stone net sinkers[6] (Barrett 1910:250), and perhaps the detachable bone points of the two-pronged spear (Ray 1963:94). Erratically placed post holes may survive from the tree-like drying racks planted in the camp. However, there is no way to distinguish those used by women who dug and dried desert parsley roots at the end of the sucker runs, before moving camps.

Although this schedule was more common around Tule Lake, it nevertheless indicates that several other activities could have occurred at the fishing village. At best, then, we can expect a 'pure' fishing village to have no pit houses, and abundant fishbone--probably in midden-like lenses in the deposit. Spring or fall migratory birds may occur among the few bird bones present.

Predictions of the archaeological trace for a *wocus-gathering camp* is a matter of pure speculation as the literature offers no usable clues. It may be that there would again be no pit houses and an unusually high frequency of grinding equipment, at a truly specialized camp. Again, many other subsistence activities would have left their mark there also--hunting, fishing, and waterfowling, as well as on-site equipment maintenance. It might prove difficult to distinguish the trash of this site type from the others unless very large samples of each could be analyzed. Obviously, the recovery of copious wocus seeds from the excavated fill would add considerable support to this identification if preservation was possible in the site.

Again the *waterfowling station* must be conjectured for want of any useful traces in the literature. These might be small sites in marshy settings, with no pit houses, and the trash would contain more waterfowl bones than fish or mammal remains. There will be no surviving trace of any waterfowling paraphernalia (bows, wood-tipped arrows, ring-necked skip arrows, set-nets, canoe nets, fish spears) other than a few net sinkers[6] (Barrett 1910:243, 247). According to the generalized Modoc round, most of the birds would have been taken in June-July so that the ranked abundance in the trash might be: coots first, then redheads, mallards, *Branta* spp. geese, teals, ruddy duck, with traces of a few others. Swans and *Anser* spp. geese should be absent (see Chapter 8). Although this might be a fair definition of a 'pure' waterfowling station, local circumstances could change the size, season, and mix of activities from one site to the next.

Thus it emerges that the four most likely candidates among the Modoc site-types for analogs of Nightfire Island will not automatically yield archaeological traces which are as clear cut as their ethnographic descriptions imply. Marker-artifacts typical of one site type were no doubt jettisoned at other places as well. Interpretations will perforce be based on numerical proportions of artifacts and fauna, rather than on sheer presence/absence. In the end, decisions about site function must be derived from the total contents and setting of the particular stratum (i.e., period) under consideration.

It is commonplace that ethnographic analogs deteriorate in value as one pushes back into older prehistoric periods. Comparisons between the hoped-for analog and the much older archaeological assemblage become weakened by two areas of doubt: (a) that the past environment, subsistence round, and site catchment differed from the ethnohistoric cases being compared; and (b) that too many changes in material culture, for whatever reasons, have intervened between the prehistoric assemblage and the ethnographic one. Both areas must be properly understood before the comparison can be made to stick. Each area must be explored in its turn.

Changes in the Prehistoric Catchment: A Predictive Model

Nightfire Island was first occupied at about 5,000BC and remained in sporadic use up to a few centuries before European contact. It is absurd to expect that the configuration of its catchment had always resembled that of 1905AD (Fig. 1-8) throughout the middle and upper Holocene. Even in historic times its composition has altered frequently as lake levels rose and fell in response to short-term fluctuations in rainfall (controlling runoff into the lake), temperature (controlling evapotranspiration) and marsh growth (controlling the rate of flow through the outlet channel). It follows that long-term climatic fluctuations would have influenced lake levels (and catchment configuration) by the same processes. Any reconstruction of past catchment configurations must begin, therefore, with the reconstruction of long-term climatic change at the regional level.

Currently the most widely respected record of temperature changes in this region is the bristlecone pine study from White Mountains about 500km to the southeast (La Marche 1973, 1974). A temperature curve for the period 3,400 BC-1900AD was derived from ring widths taken from the upper (temperature-sensitive) treeline (Fig. 1-9). Four cooler episodes can be identified: 3,100-2,850BC, 1,250-300BC, 200-950AD, and 1350-1850AD. These, and the intervening warmer spikes in the curve, fit at several points with surface sea-water temperature fluctuations for the same period in the Santa Barbara Basin (Pisias 1979), suggesting that the curve is relevant far beyond the confines of the White Mountains. The second cooler episode can be linked to minor glacial advances throughout the North American cordillera (Porter and Denton 1967) and the third and fourth can be correlated with minor readvances in the Sierra Nevada (Birman 1964, Curry 1971) and elsewhere. Fish scale studies from Clear Lake, about 460km SSW of Nightfire Island, provide a less sensitive readout of a warming trend from 4,050BC reaching a peak in the warm interval between the first and second cooling episodes (Casteel et al. 1977). It is not unreasonable to expect that the Nightfire Island catchment would have passed through the same sort of fluctuations. However, the effect of these on rainfall and runoff rates (hence lake level) in the Lower Klamath Basin cannot be evaluated without recourse to other data sets.

Bristlecone ring widths from the lower (moisture-sensitive) treeline on White Mountain have been used to plot fluctuations in effective moisture for the period 4,050BC-1950AD (La Marche et al.

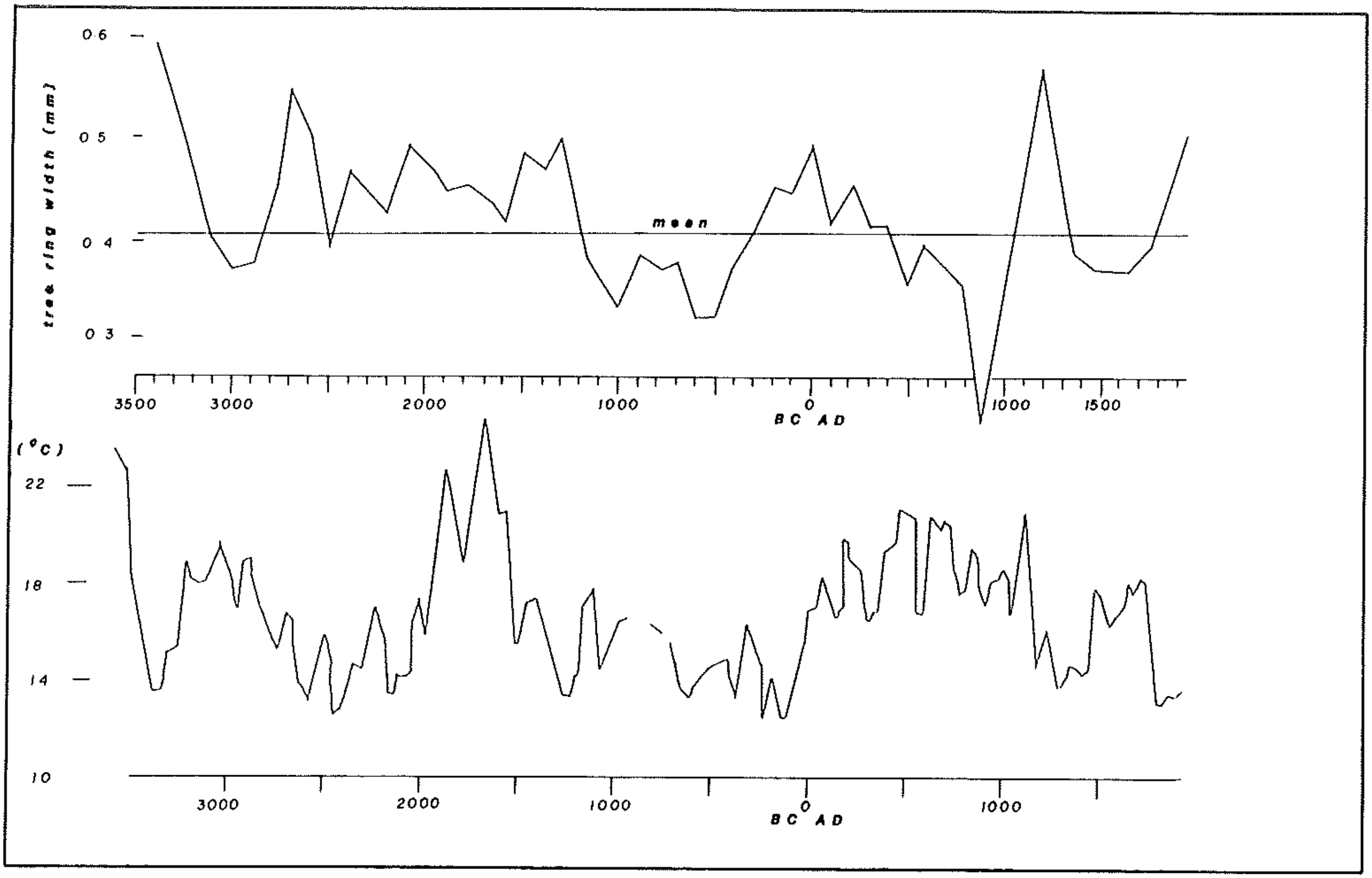

Fig. 1-9 Top: Temperature curve derived from bristlecone ring widths of the upper tree line on White Mountain, after LaMarche (1973, 1974), compared with bottom: the surface sea-water temperature curve for Santa Barbara Basin, recalibrated from Pisias (1979).

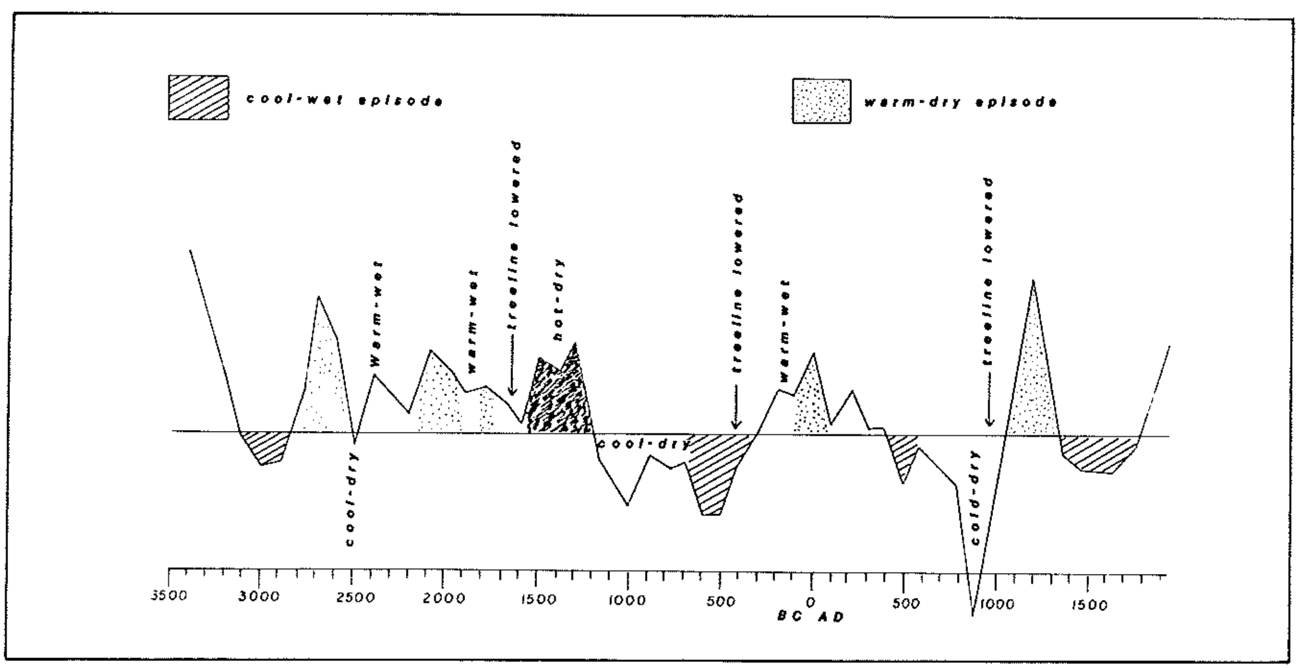

Fig.1-10 Effective moisture curve derived from bristlecone ring width of the lower tree line, fitted to the temperature curve shown in Fig. 1-9, after LaMarche (1973, 1974).

1974). When combined with the temperature curve (Fig. 1-10) a series of climatic regimes emerges in which the first cooling period coincides with a rise in effective moisture. However, the second cooling must be subdivided into an earlier cool-dry episode, followed by a cool-wet interval (with a marked drop in the upper treeline). Also, the third cooling must be subdivided into an earlier cool-wet and a later cold-dry interval. The longer "warm-dry" spell between the first and second cooling also emerges as a fluctuating and variable period. Did the same sequence of dry or wet episodes occur in the Klamath basin? Modern rainfall regimes vary notoriously from one sub-basin to the next and it may be rash, therefore, to assume that the sequence is wholly relevant. In the absence of a radiocarbon-dated raised shoreline sequence from around Lower Klamath Lake[7], we are obliged to seek regional verification for each episode and to surmise that the more widely registered events would have prevailed in the Klamath basin also. Mehringer (1977:38) points out that prior to the bristlecone record (i.e., 3,550BC) there is widespread evidence in the Great Basin of a millennium-long (5,400-4,400BC) increase in effective moisture. This was certainly of long enough duration and of wide enough distribution to have occurred in the Klamath area also. The first minor cool-wet event in the bristlecone sequence is not registered elsewhere in the Great Basin and may have been a localized event, or restricted to the Sierra-Cascade ranges. The long set of drier fluctuations between the first and second cool-wet events is confirmed from pollen records in the Sierra Nevada (Adam 1967, Sercelj and Adam 1975) and appears to be coterminous with the much-debated Altithermal of the Great Basin. There is some reason, therefore, to assume that this was also registered in the Klamath area. Next in sequence, the second cool-wet episode is very widely registered. It is represented by pollen evidence for wet-meadow development in the Sierra Nevada range (Wood 1975), by probable flooding of the Great Salt Desert, by lake formations in Searles Valley and Death Valley, by deepening of existing Pluvial Lakes and by several other lines of evidence (Mehringer 1977). The following warm-dry episode is less widely represented, but the third cool-wet phase and the ensuing cold-dry spike are widely registered in the Great Basin, while the fourth and last cool-wet event is poorly represented. A case may be made, however, for a coterminous rise in lake level in Carson Sink (Morrison 1965).

We may tentatively conclude, therefore, that the White Mountain bristlecone record is relevant at the regional level and that the lower Klamath basin would have shared to some degree in the same sequence of climatic oscillations. What follows is an attempt to reconstruct the catchment under various climatic regimes suggested by the bristlecone record.

During cool-wet episodes, runoff into the lake would increase and evapotranspiration rates would drop. If the basin remained an open system, the lake level would rise very little unless the outlet became blocked. This might happen only if the episode was preceded by a build-up of marsh detritus at the outlet which reduced the flow so that the lake became a natural dam. It is doubtful whether such a mechanism could effectively raise the lake level more than a couple of meters, but even this would have a devastating effect on the lakeshore configuration and consequently on the Nightfire Island catchment. A long-term rise of only 2m above the 1905 level would alter it in the manner shown in Fig. 1-11a. This would be enough to drown and destroy most of the tule marsh and all of the cattail (Green et al 1964; Mason 1967) plus all the submerged plantfoods. The carrying capacity of the catchment would be much reduced, particularly in plantfoods and waterfowl, but fish resources would remain relatively stable as the annual runs would continue. A rise of only 1m would be less devastating to the catchment (Fig. 1-11b) because the amount of marsh edge would not be reduced, even though the marsh would shrink to about half its 1905AD area. The only real loss in carrying capacity might be in plantfoods yields.

During warm-dry episodes, runoff would decrease and evaporation rates would rise so that long-term lowering of the lake level could be expected. A drop of only 2m would change the catchment to something approaching that shown in Fig. 1-11c. The tule marsh would be reduced to sage-covered flats with meadowland near the streams (e.g., Fig. 1-8b). The marsh fringe would be reduced to about 25% of its 1905AD area, with a parallel reduction in its overall yield, but an increase in grazing and potential epos fields. Declines in the subsistence base would occur in waterfowl, eggs, and submerged plantfoods. This would not be balanced by the gains in mammalian carrying capacity or terrestrial plantfoods. The fish yields would not necessarily decrease, if the seasonal sucker and trout runs up the streams could be maintained.

Warm-dry events with further lowering of the lake level would cause drastic changes (Fig. 1-11d). Marshland resources would be wiped out, streams would perforce have sporadic flow, and the lakebed would be reduced to sage covered flats with clump grasses. The catchment would be converted to a mere fraction of its former food yields, now based almost wholly on hunting, trapping and some root gathering.

Of course the exact hydrological budget of the lake is unknown for any given climatic episode in the past so that the precise lake level cannot be calculated. However, the relative level can be estimated (Fig. 1-12b). Five long-term high stands are predicted: before the first cool-wet event, during that event, towards the end of the second cool-wet event, at the beginning of the third, and during the fourth. The lake level between these events fluctuated between something like the 1905AD level and somewhat lower levels. The model predicts exceptionally low levels before 3,500BC before the first wet-cool event, again at 1,500-700BC before the second, another at around 0AD, and one more at 700-1300AD before the fourth cool-wet episode.

The impact of these lake level changes on the gross composition of the 10km catchment of Nightfire Island can now be estimated on a relative basis (Fig. 1-12c). The model predicts gains in open water, and losses in marshland during the five lake level rises. Gains in marshland are at the expense of open water in most of the warm-dry intervals. In the exceptionally warm-dry spells, gains in dry land are predicted at the cost of marsh and open water.

Implications of the Model: Sedimentary Processes

If this model holds water, then the sediments in Nightfire Island should reflect at least some of the major predicted changes. The five cool-wet events could register in the sediments in two ways. The occupants could either abandon the site as the lake level rose and drowned the site, or they could build up the living surface of the surrounding marsh. Abandonment could be detected by significant gaps in dating, and possibly by sedimentary breaks. The best possible field evidence for drowning and abandonment would be a sterile lakebed clay sandwiched between occupational fills--coupled with a dating gap. If, however, the occupants raised the living surface, this response should be visible as a massive structureless fill of earth and basalt chunks fetched from the northern tip of Sheepy Creek Island.

Periodic building and refurbishing events might be separated by occupational fills with hearths, organic staining and living features. Completely sterile earth-and-rubble fills would only occur if great depths were deposited rapidly. Shallower layers of fill would inevitably have occupational litter pressed into them underfoot as they became gradually waterlogged. Brief episodes of neglect might be registered as invasive lenses of organic muck around the fringe of the site, interleafed with fills from refurbishing events.

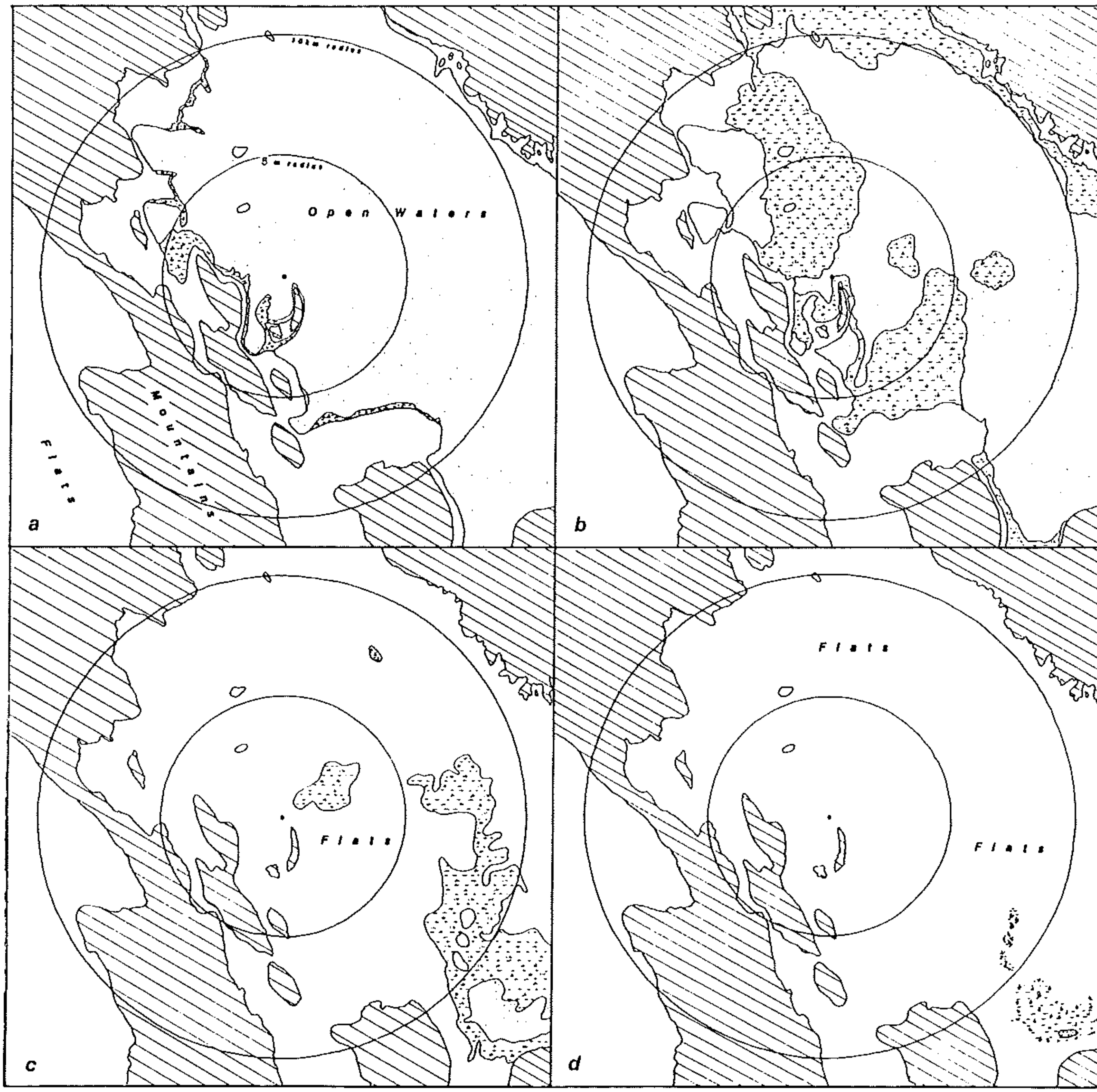

Fig. 1-11 (a) Catchment configuration for a lake stand +2m above the 1905 level shown in Fig. 1-8a; (b) the same for a lake stand +1m above the 1905 level; (c) for a stand at -2m below the 1905 level; and (d) for a stand at -3m below the 1905 level.

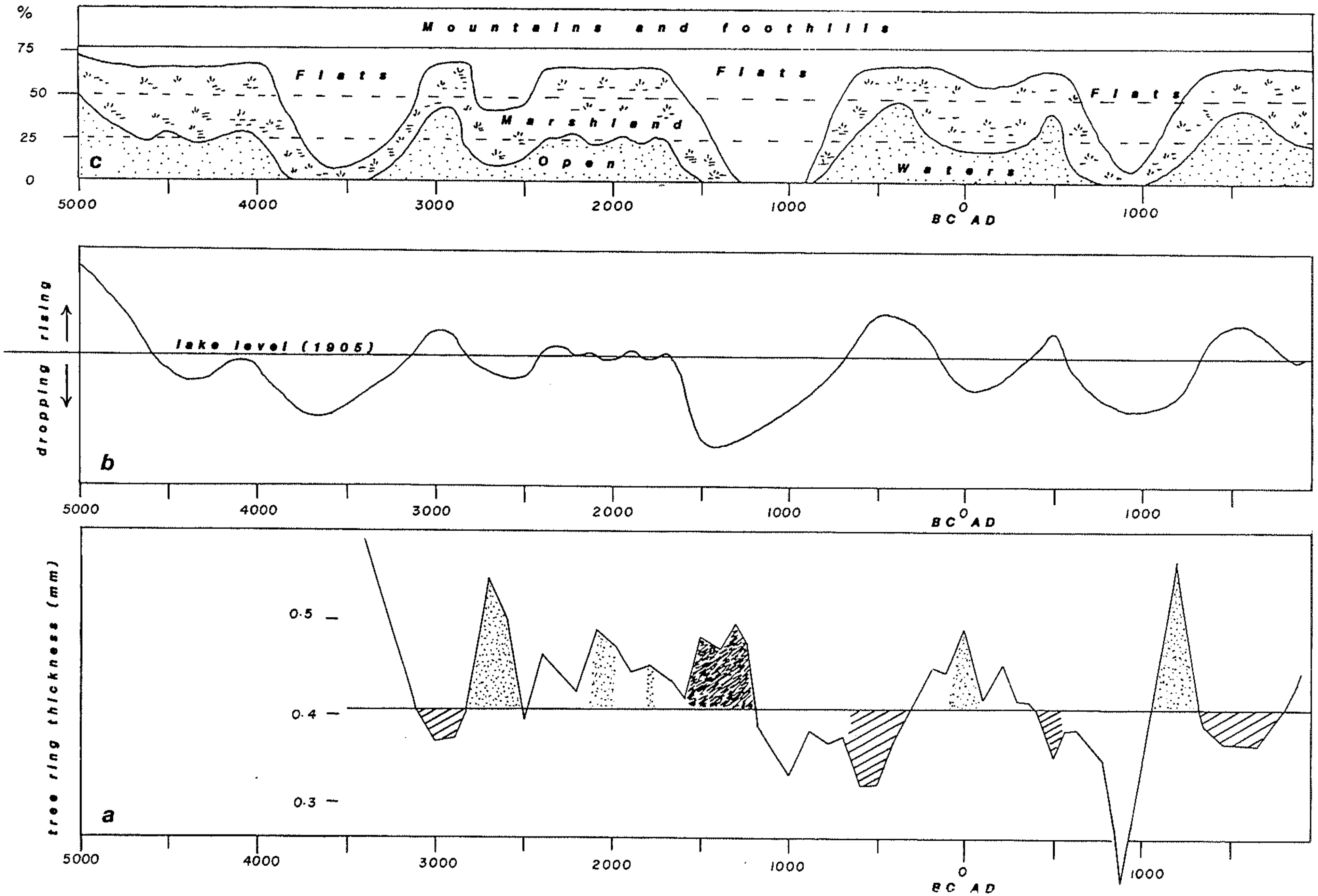

Fig. 1-12 (a) The bristlecone climatic record used to project (b) predicted long-term fluctuations in the lake level of Lower Klamath Lake, and (c) predicted changes in the Nightfire Island catchment. Prior to 3,500BC ancillary paleoclimatic data (see text) are used to project changes.

The warm-dry intervals with lowered lake levels would register in the sediments as dense occupational trash layers with relatively little fill--there being no need to refurbish the living platform. The rate of sedimentation on the site should decline markedly, and radiocarbon dates obtained from such layers may vary by several centuries, and stratigraphically inverted dates can be expected, due to mixing by compression.

It is doubtful whether periods of exceptionally low lake levels could be distinguished from the aforegoing unless the site was abandoned, in which case meadowland soils would develop over the site. It is doubtful whether a soil horizon would survive subsequent reoccupational damage unless it was covered rapidly, however. A more likely consequence of lake desiccation would be downcutting of the Sheepy Creek channel with erosion and/or winnowing of deposits on the east side of the site to a dense lag deposit of rocks, sand and stone artifacts. One other possible consequence of these episodes might be the formation of caliche just below the site surface.

The various depositional pathways implied by the model are shown in Fig. 1-13ab. It is obvious that the correct sequence of deposits in Nightfire Island cannot be predicted because the occupants' decision taken at the start of a lake-level rise (abandon or build) is unknown.

Implications of the Model: the Role of the Site

The decision to abandon or build in the face of a rising lake level would have been determined by the importance of the site to its users. It is likely that a small seasonal camp would have been more readily abandoned than a permanent village. Also, the more effort previously invested in platform building, the less likely that its users would be willing to abandon it. It may be argued, therefore, that abandonment would become less and less likely as the site grew in size and height above the surrounding marshland. Not only was it a sizeable investment, but it was also more likely to survive a lake-level rise. Signs of abandonment and drowning (lakebed clays) are more likely to occur in the lower half, whereas indications of platform raising (earth and rubble fill) are more probable in the upper portions during cool-wet events. This carries with it the implication that the site would have functioned as a small seasonal camp (waterfowling or wocus-gathering) in its earliest stages simply because it was neither large nor dry enough to serve as a fishing camp or permanent village.

Unfortunately, the bristlecone record does not reach back to the first thousand years of the site's use, and the behavior of the lake for this period cannot be predicted. Moratto et al (1978) have opted for a "cool-wet" event covering 7,000-6,000BP, based mainly on the pollen record from the Sierra Nevada. If this is provisionally admitted to the model, then we should expect that lake levels were high, the site was frequently drowned and abandoned, and any efforts to stabilize the surface would not have been very successful.

It would be a mistake to assume that the role of the site passed through a simple linear evolution (seasonal camp to fishing village to permanent village). Such a scenario fails to take into account those periods of exceptionally low lake level vwhen the catchment was so altered that the site could not function as a permanent village. During such episodes it would either have reverted to a fishing village or (if desiccation was extreme) abandoned altogether. Caliche formation would be more likely in the later intervals because they stand a better chance of survival. Incipient calcification during earlier warm-dry abandonments would be dissolved by subsequent waterlogging.

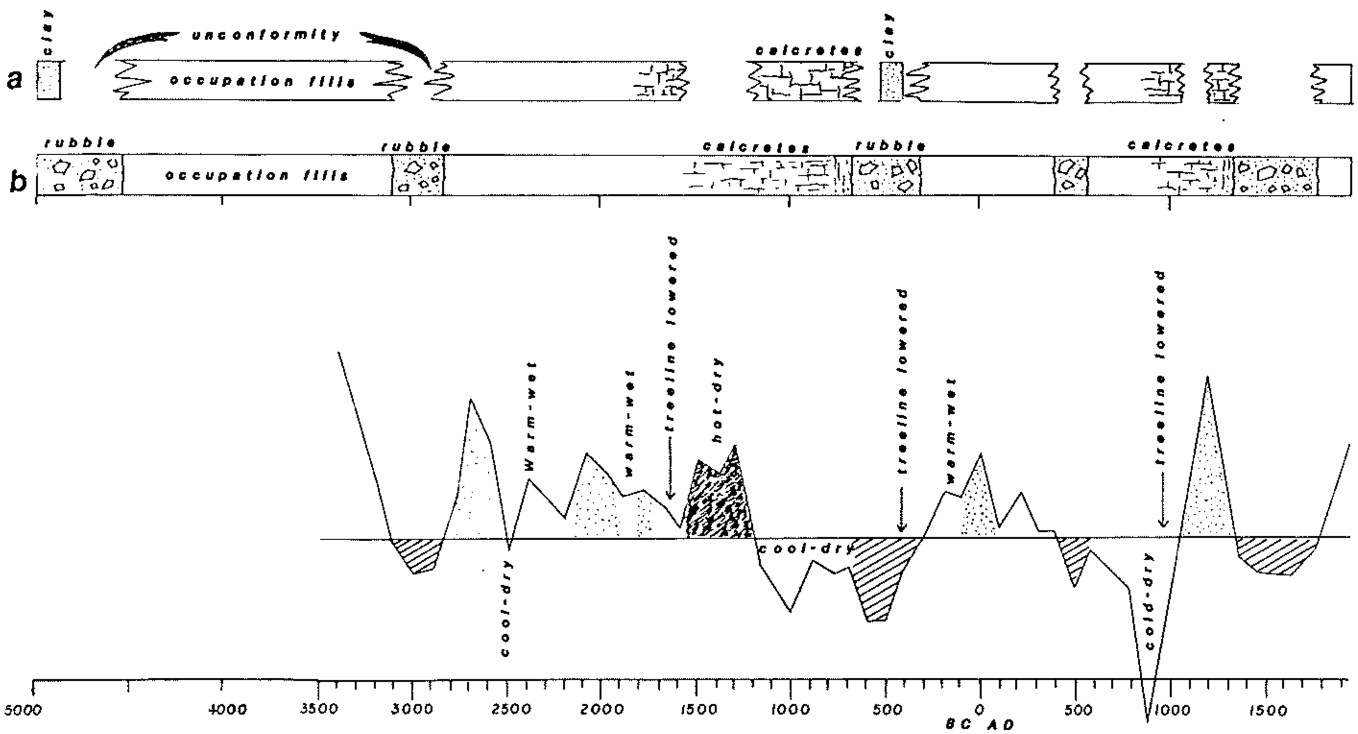

Fig. 1-13 (a) Predicted sedimentary sequences if the site was abandoned during very high and very low lake stands; (b) the same if artificial platform-building was the response to very high lake stands.

In summary, the model predicts a changing role for the site through time: first, a seasonal camp frequently drowned and abandoned for long periods, then a seasonal camp with some attempt at platform stabilizing. Once this reaches successful dimensions, it is used more frequently, is added to and may emerge as a fishing village, abandoned only when the lake recedes too far. Further building brings it to the size appropriate for a permanent village, which reverts to a fishing village when the lake recedes too far. If this scenario is built into the model, then the more likely decision pathway can be predicted in a general way (Fig. 1-14).

Implications of the Model: Faunal Remains

The predicted changes in the composition of the 10km catchment given in Fig. 1-12c imply parallel changes in faunal carrying capacity. If the model holds (and the plethora of assumptions on which it is based are valid) then the site should yield faunal remains in ratios which should be a gross reflection of the carrying capacity. Thus, the strata equated with cool-wet, high-stand events should yield relatively more waterfowl and fish than mammals, and the waterfowl should include more deep-water divers than shallow-water dabblers. Warm-dry intervals with lake levels comparable to the 1905 AD configuration should have similar ratios, but there should be more dabblers than divers. Extreme warm-dry events with a very low lake should show an increase in mammals over fish and birds, and marsh-dwelling mammals should decline. Fig. 1-15a attempts to show the predicted fluctuations in these gross categories while also making allowances for the changes in site function predicted in the previous section. The diagram is designed with few abandonment episodes as these cannot be predicted exactly.

Implications of the Model: Material Culture

The Modoc analogs reviewed in an earlier section suggest that the material culture surviving at the four most likely site types to occur at Nightfire Island will vary in composition. Permanent villages will yield the widest variety of artifacts, whereas small camps will have the narrowest range. Plantfood processing camps will have exceptionally high yields of pounding and grinding equipment, while fishing or waterfowling stations will yield more stone net sinkers. Changes in site type through time can be predicted only as broad probabilities (Fig. 1-14), and changes in artifactual content can only be predicted in the same general terms (Fig. 1-15b). The earliest levels, predicted as seasonal camps, will yield a narrow range of equipment but should include net sinkers. Equipment should become more varied by the middle levels, with net sinkers still present. The ratio of pounding/grinding equipment will fluctuate throughout the period, declining during exceptionally low lake stands. Hunting equipment (obsidian projectile points) will increase proportionally during such episodes. Pit house floors are likely to appear somewhere between the middle and upper levels, as the platform becomes large enough to accommodate a permanent village. These too will be abandoned during low-stand episodes when the site reverts to a seasonal fishing camp.

Stylistic changes in the artifacts themselves will not be connected with the model because there is no reason to suppose that fluctuations in microhabitats around the site would have any effect on style. Some tentative predictions of stylistic changes are proposed in a later section, based on our knowledge of the archaeology of the surrounding region.

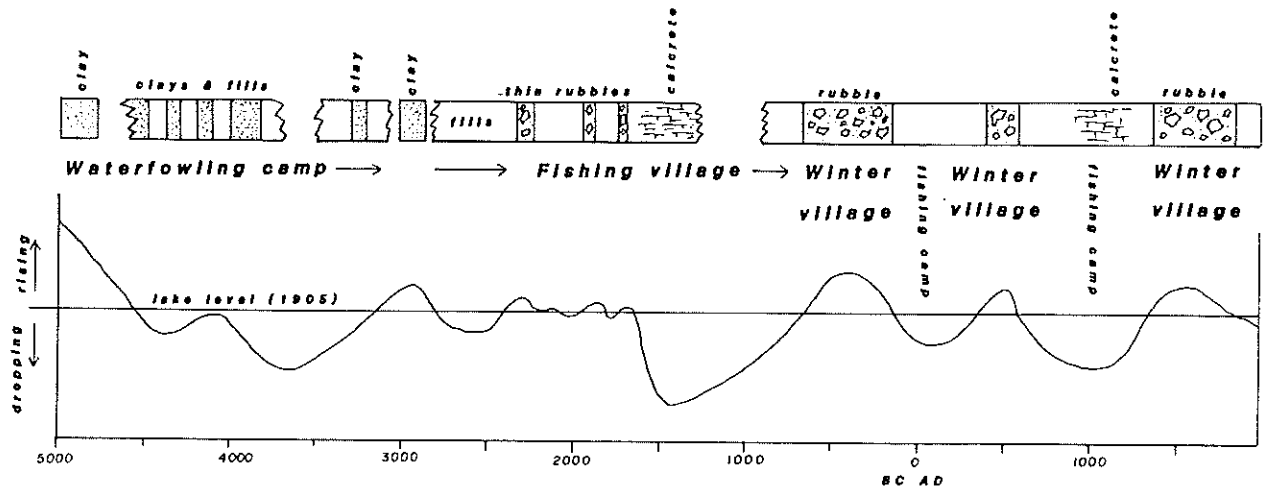

Fig. 1-14 Predicted changes in the sedimentary sequence fitted to predicted changes in the role of Nightfire Island in the prehistoric subsistence round.

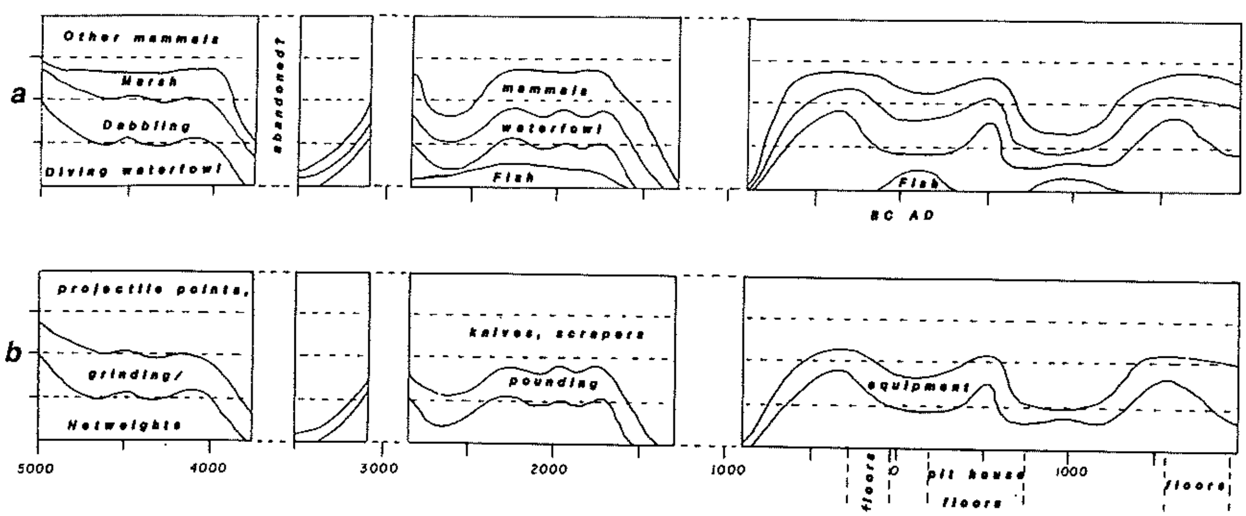

Fig. 1-15 (a) Predicted changes in the ratios of fauna, derived from the Know-it-all Model, and (b) predicted changes in artifact content derived from the Know-it-all Model.

A Rival Model: Adaptation in Progress

All of the aforegoing presupposes that a Modoc-like marshland adaptation had already been perfected by 7,000BP: the first inhabitants were acquainted with the timetables of all edible species of plant, fish, bird and animal found in the marshes and lake, and they had the skills and equipment to take them. With nothing else to learn, their adaptation was essentially stable. The aforegoing model was designed to deal with the "noise" of fluctuating catchment composition, and with the proper responses (dictated by the rules of a Modoc-like settlement system) in the face of various lakeshore scenarios.

But what if the first inhabitants were beginners? In this case the contents of Nightfire Island will reflect various stages along the learning trajectory from an incipient to a Modoc adaptation. If a predictive model of this trajectory (Learner Model) can be constructed, this will serve as a useful rival to the aforegoing one (Know-it-all Model). The real contents of Nightfire Island can then be compared with each model in the hope that it will resemble one more closely than the other.

The Learner Model is based on the following set of assumptions: (a) the adaptation started from a terrestrial hunter/trapper/forager base with a mobility type something like the Shoshonean pattern or one of restricted wandering with transient bases; (b) marshland exploitation began with the most visible and easily obtainable resources requiring the least equipment and effort; (c) early forays into the marshland were infrequent, brief and exploratory in nature; (d) half-hearted attempts to stabilize living platforms in the marshland followed (c), and probably failed at first; (e) grinding/pounding equipment used for terrestrial plantfoods were swiftly adjusted to cope with aquatic ones; (f) permanent living platforms became worthwhile only when the full scope of the plantfood yield was realized; (g) raft and dugout design was perfected in response to (f)--at this point the adaptation took on its basic character--other refinements followed; (h) waterfowling with set-nets was refined to take more elusive birds; (i) set-netting led to the procurement of the last untapped resource--fishes.

The archaeological implications of the model are easier to predict if, in the first step, the catchment is held steady, i.e., no lake level changes or microhabitat shifts. Once the archaeological contents of each stage have been predicted, the whole model can be fitted to the dynamic framework of a fluctuating catchment, and modified accordingly.

In a static catchment, then, the Learner Model predicts Stage 1 as a basal series of thin occupation layers (assumption c) interbedded with lakebed clays (d) and with little or no rubble fill. Artifacts will include mainly hunting/trapping equipment (a), and little or no grinding/pounding equipment (c). The faunal material will include plenty of mammal species (a) with some marshland species. There will also be plenty of the most vulnerable birds - coots which were simply chased onto dry ground and clubbed. Neither fish nor waterfowl with fast-rising escape patterns will be well represented (b).

Stage 2 will involve the establishment of small permanent platforms of earth and rubble fill, less frequently drowned. The artifacts and fauna will remain the same except for slight increases in the number and variety of grinding equipment and birds; the proportion of mammals in the fauna should decline slightly.

Stage 3 will see the expansion of the earth fill platform and a marked increase in the amount of grinding equipment (f) and antler wedges for shaping dugout canoes (g). The number and variety of waterfowl bones will continue to increase at the expense of mammals.

Stage 4 sees the platform now large enough to support a permanent village, and pit house bases will appear. The amount of grinding equipment will increase further, then level off. The ratio of waterfowl bones to mammals will also level off, but the variety of waterfowl species will display a trend towards larger, better-tasting ducks and geese which require some skill and equipment to catch: grooved net sinkers will appear in numbers (h). Fishbones, which have occurred only as a trace up to now, begin to appear in numbers.

Stage 5 sees a persistence of the permanent village. Larger quantities of fishbone will occur in the deposits (i) and the number of set sinkers will also increase. Waterfowl bones will continue to dominate mammals; there will be more ducks and geese than coots and other more vulnerable birds.

In the following construction step this simple linear version of the Learner Model is converted to fit the framework of catchment fluctuations predicted in the Know-it-all Model. Modifications to each stage are discussed in turn.

A linear trend from Stage 1 to Stage 2 is improbable. This may have continued for a couple of millennia, and fluctuations in bird/mammal ratios and grinding/hunting equipment are to be expected. Specifically, mammals and hunting gear will dominate in periods of very low lake stands. High lake stand episodes will be represented by sterile lakebed clays. Once Stage 2 is reached, similar fluctuations are to be expected, with drownings more likely in earlier lake rises and outbursts of platform building more likely in later ones. Complete drowning and abandonment is improbable by the end of this stage. Lake level fluctuations in Stage 3 will induce appropriate changes in the role of the platform: waterfowling station or plantfood processing station during high stands; hunting camp during very low stands; and permanent village during medium stands, particularly towards the end of the stage. There will be considerable "noise" in the bird/mammal ratios and hunting/grinding equipment ratios through this stage, but the long-term trends should still be detectable. By the time Stage 4 is reached, the permanent village will survive most lake level fluctuations except extreme desiccation periods at which point it may be abandoned or converted to a hunting/root foraging camp (with appropriate shifts in fauna and equipment). By Stage 5 the platform will be high enough to survive all but the most extreme, short-lived lake rises. It will convert from permanent village to fishing village during low stands, and will be abandoned or converted to a hunting camp during extreme low stands.

Thus the effect of fitting catchment fluctuations to the Learner Model is to introduce oscillations to the linear trends in predicted foodbone ratios and equipment ratios. If the Learner Model is to be detected at all, it must be viewed through the noise of percentage fluctuations. Rare elements will appear and disappear from one layer to the next, and the ratios of better represented items will change back and forth. Nevertheless, the broad pattern of the Model should still be visible through all this (Fig. 1-16).

The Learner Model is of course a work of the imagination founded on a mix of common-sense, assumptions and inspired guesses, particularly in the early stages. Other scenarios could be introduced (early adaptation of rabbit nets to waterfowling is but one example). However, the early stages are not necessarily weaker than those of the Know-it-all Model which are based on the very shaky assumption that the Modoc analog is valid all the way back to the mid-Holocene.

Socio-economic Noise in the Models

Neither model attempts to accommodate the fact that Modoc villagers were (a) involved in intensive trade networks of

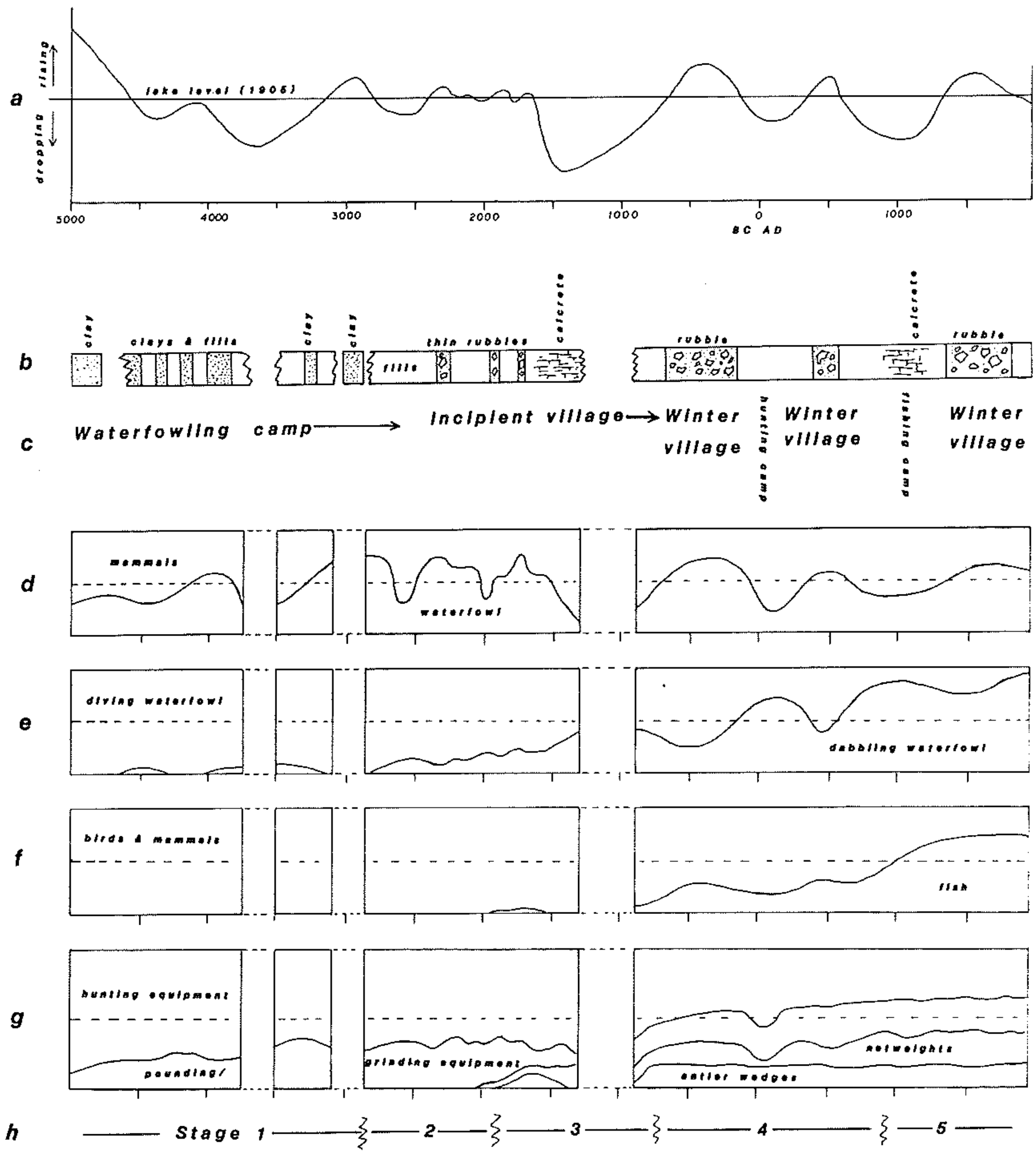

Fig. 1-16 The Learner Model: (a) predicted changes in lake level, (b) predicted changes in the sedimentary sequence, (c) predicted changes in site role, (d) predicted changes in the mammal/waterfowl ratio, (e) predicted changes in the diver/dabbler ratio, (f) predicted changes in the ratio of fish to other faunal categories, (g) predicted changes in artifact content, and (h) purported schedule of Stages in the Learner Model.

status-related objects, and (b) at constant war with at least three of their neighbors. The ebb and flow of these activities around Nightfire Island would not have been influenced much by changes in catchment yields, and they represent entirely independent systems. Both would have left their archaeological mark on the site.

The villages on the south shore of Lower Klamath Lake were well positioned to control the traffic in obsidian from Medicine Lake Highlands down the Klamath River, and in marine shell beads and ornaments back up the same route. Any of these, including Nightfire Island, could have acquired middle-man status as a distribution center for these items. The villagers themselves were not traders in the commercial sense, but were in a postion to accumulate status objects at a faster rate than less well positioned villages. The effect of this would be to draw in more permanent villagers to the community, attracted by the social possibilities of the place. The archaeological implications of this would be fairly obvious: status objects would appear in the trash and with burials at the time that the exchange network was established, and then would proliferate as time passed.

This situation would induce the same distortion in both models. Village expansion (with platform extensions and pit house proliferation) might be triggered off at any point in the upper part of the site without much concern for ecological factors. In the Know-it-all Model, platform expansion will not be a steady growth trend, but will experience a sudden burst of infilling resembling that predicted for Stage 3 in the Learner Model. If such a growth spurt is seen to coincide with the appearance of status objects, then it can be assumed to represent noise in the model, through which the long-term adaptive trends must be perceived.

The distorting effects of warfare on the models would be to cause unscheduled abandonments of the village or camp. Short term abandonments resulting from unsuccessful raids will register as widespread burning of structures, and property damage. Long-term abandonments might arise from successful raids in which the villagers were surprised and massacred. Such episodes should be identifiable if they are associated with mass graves and obvious signs of violence. If the graves were not on site, however, this explanation of an abandonment episode (dating gap) can only be invoked as a last resort if there is no obvious link-up with ecological factors. Unscheduled abandonments are therefore another noise hazard to be expected when trying to compare the models with the excavated data. They could occur anywhere along the time frame--Modoc camps were just as likely to be attacked as villages. Actually, they may be more likely to occur in the upper part of the site's stratigraphy: Moratto et al (1978) equate the intensely dry interval between the third and fourth cool-wet events with widespread violence and village abandonment in the southern Sierra foothills, and further north (e.g. Ritter 1970).

Archaeological Background of the Modoc Territory

Obviously, Nightfire Island cannot be studied as the entirely closed system suggested by the two models against which it is to be tested. The preceding section has already hinted that the site did not exist in a socio-economic vacuum. Neither does it exist in an archaeolgoical void. Figures 1-17 and 1-18 show the distribution of archaeological studies conducted within a 200km radius and a little beyond.

It is already well known that human occupation of the region extends back from the historic period into late glacial times. Excavations at Fort Rock Cave have revealed some of the earliest traces currently known: a small assemblage of two projectile points, a grinding stone, and a number of flakes lying on gravels left by Pluvial Fort Rock Lake as it receded from a late glacial beachline,

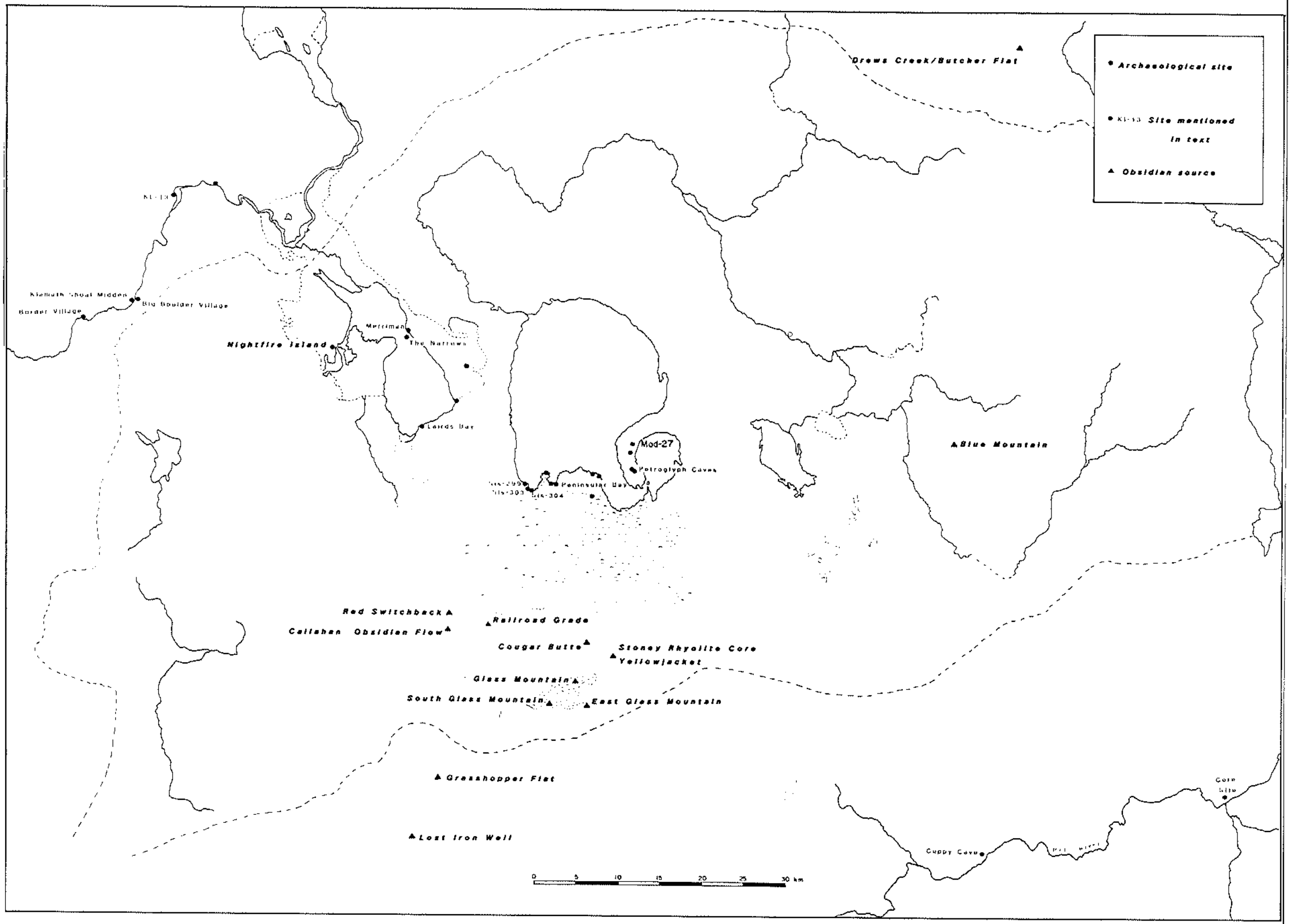

Fig. 1-17 Map of archaeological sites in the Modoc territory and the immediate surrounds.

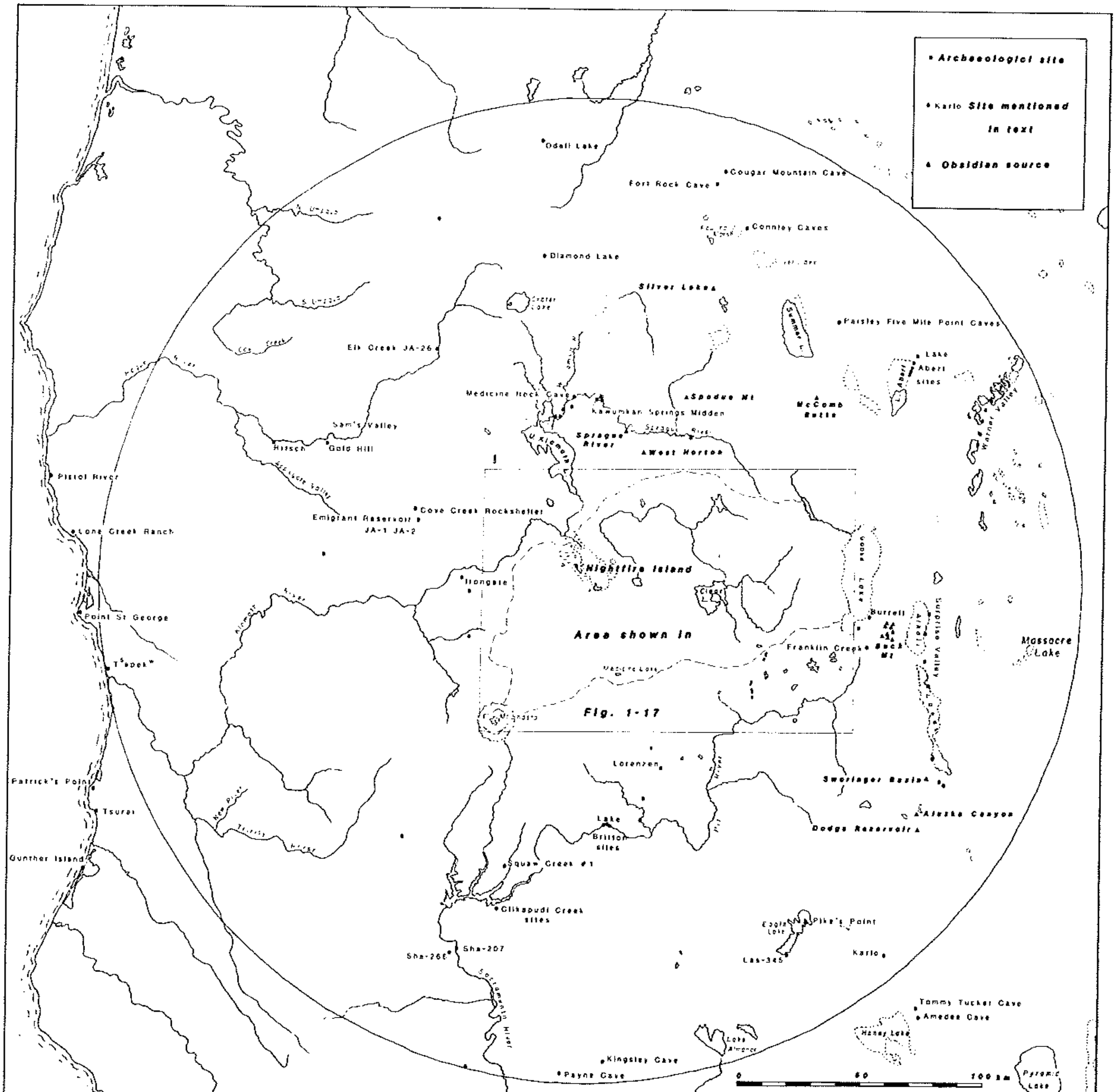

Fig. 1-18 Map of archaeological sites within 200 km radius of Nightfire Island, and slightly beyond.

opening Fort Rock Cave for occupation. A radiocarbon determination on charcoal found with these specimens yielded an age of 11,200bc[8]. At the nearby Connley Caves and Cougar Mountain Cave, all within the Fort Rock area, stone tools have been C-14 dated to about 9,000BC and later. The Paisley Five Mile Point caves along the eastern shore of Summer Lake, not far to the south, have produced a comparably early record, in one site a few stone tools having been found with the bones of horse and camel, Pleistocene species which became extinct in early postglacial times (Cressman, Williams, and Krieger 1940; Cressman and others 1942; Bedwell 1973).

The archaeological record within the Modoc territory almost certainly begins during these times and develops into an increasingly complex data-set. Test excavations and surface collections at two sites, the Narrows (Sis-257) and Laird's Bay (Sis-230) combined with studies of collections from the modern shoreline, led Cressman (1940, 1942) tentatively to propose three cultural horizons for Lower Klamath Lake. The oldest horizon, not all of which was in situ, came mainly from the Narrows. The artifacts seemed to be associated with fossilized mammal bones found on the lakebed including elephant, horse, and camel. The artifacts included fossilized bone points, heavily weathered manos, utilized flakes and projectile points. The most common projectile point type was a crude willow-leaf shape. Other types in this assemblage included several large side-notched points, which could be considered Northern Side-Notched and Elko Side-Notched, and a few Lake Mojave and Humboldt types. This horizon was believed to date to roughly 5,500bc, an estimate which remains plausible based on radiocarbon dates for comparable Fort Rock Valley specimens (Bedwell 1973).

The second horizon came primarily from Laird's Bay where rather more was found in situ, with an estimated date of about 2,000bc. Artifacts included bone awls, a bone flesher, worked antler, manos (including a few which may represent a developmental stage of the two-handled wocus muller so characteristic of the ethno-historic Klamath), a drilled human skull cap, a drilled tuffaceous disk, and several projectile points, most of which were large side- and corner-notched points of the Northern Side-Notched and Elko types.

The most recent horizon, considered to be "Historic," probably dates within the last 1000 to 1500 years. The projectile points were all small side- and corner-notched varieties, which could be classified as Rose Spring Series, Cottonwood Series, Desert Side-Notched and Gunther Series points. The sites contained groundstone pipes, special wocus mullers and grinding slabs, mortars and pestles, shell beads and a variety of other artifacts.

Nearby, Heizer (1942) reported two sites along the southeast shore of Tule Lake which contained eight burials and five cremations. Petroglyph Cave One (Mod 2) had a thick layer of occupational debris. The artifacts included small projectile points, mammal bone beads, shell beads and basketry. Petroglyph Cave Two (Mod 3) did not show evidence of intensive occupation. In its upper layers, it contained small projectile points, bird bone beads, seed beads and basketry. The burials and cremation also contained a few artifacts. All of the artifact material seemed to be from the late prehistoric period, and Heizer attributed it to Modoc occupation. However, Cressman's analysis of the basketry from these sites casts doubt on a Modoc origin for the cave materials and the burials.

Also nearby, a surface reconnaissance and excavations at eight archaeological sites around Lower Klamath Lake and Tule Lake by R. J. Squier and G. L. Grosscup (1952, 1954) led Squier (1956) to subdivide Cressman's "Historic" horizon into three phases.

The Tule Lake Phase was most recent. It was characterized by small projectile points, including the Desert Side-Notched type, large obsidian blades, twined basketry, bone awls, bone flaking tools, mammal and bird bone beads, shell and pine nut beads, hopper slab mortars, thin grinding slabs, few portable bowl mortars, and cremations.

Stratigraphically below the Tule Lake Phase in the rockshelters was the Gillem Bluff Phase. The sparse artifact inventory for this phase is characterized by medium to large projectile points, large obsidian blades, mammal bone awls, stone mauls, thin grinding slabs and crevice burials.

Oldest was the Indian Bank Phase, found only at open sites on Lower Klamath Lake. Squier considered it possible that the Gillem Bluff inventory was simply a restricted assemblage of the Indian Bank Phase. The Indian Bank Phase is characterized by large projectile points, flexed burials, stone mauls, antler wedges and flaking tools, mammal bone awls, olivella shell beads, bird bone whistles, bone pins and pendants, tubular stone pipes, portable bowls, mortars and a few thin grinding slabs. Squier noted a strong Californian influence on this phase.

Swartz (1964) excavated the Peninsula Bay Site, Sis-101, a large village site in the Tule Lake area. Three small rockshelters, Sis-299, 303, and 304 were also examined. Though there was no physical stratigraphy in the Peninsula Bay midden or within its housepits, Swartz was able to divide the occupations of the site into four major components. The most recent, Component IV, was historic and included rock fortifications and artifacts from the Modoc War.

Component III was represented by the housepits, which were believed to be the remains of the historic Modoc village of Gumbat (ibid:191). However, a house beam dated to 803 $\pm$ 160 ad suggests that the site was several centuries older than the historic Gumbat. Component III was distinguished by the presence of small triangular projectile points, including some Desert Side-Notched types, grinding slabs, hopper mortar bases, palettes, circular rubbing stones, flanged tubular pipes, bone whistles and dice, twined basketry, housepits and cremations.

The midden deposits were divided into Components I and II, both assumed to be earlier than the housepit materials. Component II was represented by Humboldt Concave-Base projectile points and by corner and side-notched projectile points. This component also included bowl mortars, deep-basined mortars, hopper mortar bases and grinding slabs. The primary method of disposal of the dead was secondary burial in cairns. The only distinguishing artifacts of Component I were large, thick lanceolate projectile points.

Swartz organized the components into three phases which he compared to those of Cressman (1940) and Squier (1956). His earliest components were, he felt, both comparable to Cressman's Second (Laird's Bay) horizon and he split them into Laird's Bay phases I and II. He felt they also corresponded to Squier's Indian Bank Phase. Swartz's Component III was placed (in spite of its anomalous C-14 date) in Squier's Tule Lake Phase, which corresponded to the top of Cressman's "Historic Horizon." He had no material which corresponded to Cressman's Narrows Horizon or Squier's Gillem Bluff Phase.

Another large midden, the Merriman Site (Sis-253) on Lower Klamath Lake, yielded both cremations and flexed burials, localized in different areas of the site. Both of these may be assigned to the early Tule Lake Phase on the basis of associated Rose Spring and Gunther Island projectile points and a complete lack of historic debris and Desert Side-Notched points (J. Johnson 1966). Both inhumations and cremations were accompanied by olivella shell beads. The most abundant faunal remains were fish bones, followed by the bones of large mammals and waterfowl. Plant processing equipment, including mullers, pestles, mortars, and grinding slabs, was also present.

The only systematic areal study inside Modoc territory is an archaeological survey of the Lava Beds (outside of the National Monument boundary) which yielded 166 prehistoric and historic sites, most of which were chipping stations (Fox and Hardesty 1972; Hardesty and Fox 1974). However, the interior of the Lava Beds may not have been much used until the recent prehistoric period. Although they fall within historic Modoc territory, there are clues that they may have been frequented by neighboring Achomawi until the 1700's. Besides the chipping stations there were also three seasonal composites, two hunting blinds and two fortifictions. Hunting sites were associated with those parts of the sagebrush zone adjacent to areas of either bunchgrass or bitterbush and mountain mahogany, while butchering sites were in, or adjacent to, the rushes zone. There were very few implements associated with seed processing in the Lava Beds area except near the margins of Tule Lake.

The cultural-stratigraphic correlation of all these sites (Fig. 1-19) is far from secure because of a chronic shortage of absolute dates with which to verify any particular scheme. This situation is not helped by the small number of adequately stratified sites, nor by the small sample sizes of some of the critical assemblages. The lack of standardized terminology, particularly for the description of projectile points, does nothing to encourage our belief that the scheme in Fig. 1-19 is essentially correct or complete. What then can be salvaged from this rather inadequate record? Tentatively, we may anticipate a sequence of at least four different projectile-point assemblages at Nightfire Island: (1) large crude points with some large Northern Side-Notched types, then (2) augmented by Elko and Humboldt types, followed by (3) Gunther, Rose Spring and Cottonwood Series, augmented by (4) Desert Side-Notched types. Large blades may be expected to appear in (3), while non-flaked stone items, boneworking, and ornaments can be expected to proliferate in (2). The dates at which these events should occur, however, cannot be predicted. Consequently they cannot be fitted to the predictive scheme in Fig. 1-16.

Archaeological Background within 200 km Radius

This situation can be but little improved by looking farther afield in the Klamath basin. Several sites have been excavated or tested along the Sprague and Williamson Rivers just to the northeast of Upper Klamath Lake: Medicine Rock Cave (KL-8), Kawumkan Springs Midden and housepits (KL-9), and Housepit sites KL-1, 7, 10, 11, and 12 (Cressman 1956). Medicine Rock Cave was used intermittently from an unknown date before the eruption of Mt. Mazama (at about 5,000bc) until historic times. It was not, however, used by the historic Klamath, who avoided it because of religious beliefs. It apparently was used seasonally during fish runs as there was a great deal of fish bone and mussel shell in the debris. Cressman estimated a 5,500bc date for the oldest level of Kawumkan Springs Midden, but more recent work, which dated projectile points from the site by the obsidian hydration method (Aikens and Minor 1978), indicated that the lowest levels were better dated to about 3,000bc. The housepits at Kawumkan Springs, and other housepit sites, were assigned to the proto-historic and historic Klamath occupation of the area.

From areas immediately peripheral to the Klamath Basin, several archaeological investigations shed light on prehistoric Klamath and neighboring cultures. These areas include the Upper Klamath River, the Southern Cascades, the Pit River-Modoc Plateau area, the Goose Lake Basin, and the Abert basin. The concentration of large occupation sites and rockshelters along the Upper Klamath river is not necessarily an accurate reflection of aboriginal settlement patterns, however, since the surveyors only examined areas which were scheduled to be directly affected by proposed power projects and were *a priori* thought likely to contain archaeological sites. One rockshelter,

<table>
<tr><th>Cressman (1940, 1942)</th><th>Squier (1956)</th><th>Swartz (1964)</th><th>J.Johnson (1966)</th><th>Hardesty & Fox (1974)</th></tr>
<tr><td rowspan="2">Historic horizon</td><td></td><td>Peninsular Bay site Component IV</td><td></td><td>Lava Beds</td></tr>
<tr><td>Tule Lake Phase</td><td>Component III</td><td>Merriman</td><td></td></tr>
<tr><td></td><td>Gillem Bluff Phase</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Lairds Bay horizon</td><td rowspan="2">Indian Bank Phase</td><td>Component II</td><td></td><td></td></tr>
<tr><td>Component I</td><td></td><td></td></tr>
<tr><td>Narrows horizon</td><td></td><td></td><td></td><td></td></tr>
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Fig. 1-19 Tentative correlation of sites in the Lower Klamath Basin.

KL-13, was used seasonally by hunters and gatherers between 1000ad and 1800ad. Both hunting and plant processing activities were indicated by the artifact assemblage, but there were no historical artifacts or trade goods. Newman and Cressman (1959) attributed the occupation to people of the Klamath tradition, acknowledging some influences from the west and south.

Further downstream, the Irongate Site (Sis-326) had thirteen housepits visible on the surface, of which one was tested and three were completely excavated. Leonhardy (1967) concluded that the village had been occupied between 400ad and 1600ad, by people with primarily north-central California cultural affiliations, probably the Shasta.

The Salt Cave Locality (Cressman and Wells 1961; Cressman and Olien 1962; Anderson and Cole 1964; Mack 1982) includes two housepit sites, Big Boulder Village (KL-18) and Border Village (KL-16) both C-14 dated to about 1400ad. Both village sites had midden components which dated from approximately 3,000bc to 1000ad, based on projectile point cross-dating. Mack (1982) concluded that Big Boulder Village may have been occupied within recent prehistory by the Klamath, Modoc and/or Achomawi, and Border Village was probably occupied by Takelma, but also possibly by Shasta. A large non-housepit site, Klamath Shoal Midden (KL-21), was dated between 7,000bc and 1000ad, and a final occupation dating to about 1600ad was recognized on the basis of late projectile points recovered in the upper level. Klamath Shoal Midden may have been used by the Klamath, Shasta and Takelma. Throughout all these occupations fishing, hunting, and gathering had been of about equal importance, with the exception of the earliest period which appeared to stress hunting. However, the excavated sample was small and bias cannot be ruled out. The sites in this area showed cultural links from the Klamath Basin, Northwest California, and the Rogue River in Oregon.

In the southern Cascades, the Sis-13 rockshelter on the western flank was used seasonally by small groups of hunters and gatherers within the recent prehistoric period. Their cultural affiliations were either Achomawi, Modoc, or Shasta (Wallace and Taylor 1952).

Along the middle Pit River in the Lake Britton, Big Bend and Pit River Canyon localities, a total of 94 historic and recent prehistoric sites are known, of which 12 have limited test excavations (Johnson 1982). These studies were primarily concerned with settlement patterns and site locations mainly on the lowest terrace. Most of the sites are fairly large middens, and there were also 28 housepit sites with between one and 33 housepits. Sites in this area are well located for the exploitation of salmon runs, which end at Pit River Falls. There are also mussels within the Pit River at these localities, as well as oak and digger pine.

The Lorenzen Site (Mod-250), in Little Hot Springs Valley, is a large housepit village with an associated deep midden. Baumhoff and Olmsted (1964) interpreted the projectile point sequence as indicating that it had been used from Early Horizon times (ca 3,000bc) to the late prehistoric period by people who had cultural ties to northern and central California.

Within the area of the northern Modoc Plateau and the Upper Pit River, Cuppy Cave, a much disturbed site, yielded an artifact inventory indicating use between 500ad and historic times as a seasonal site occupied for hunting, fishing and plant processing. The large number of deer bones and the small number of fish bones found there may indicate use primarily in the fall (Hughes 1973). Because the site is within Achomawi territory, the cave is assumed to pertain to that tribe (Hughes 1977). The Core Site, a shallow lithic scatter near Warm Springs Valley, revealed only tool manufacturing debris associated with hunting activities, roughly dated between 1500-1800ad (Johnson 1977).

The Burrell Site (Mod-293), a shore occupation at Goose Lake, yielded abundant artifacts and faunal remains, and though somewhat disturbed, exhibited notable changes through time. There were two radiocarbon dates, one of 110ad at the bottom and one of 1610ad from a feature near the surface. Hughes (1977) noted cultural influences from the Columbia Plateau in the earliest occupation, and influences from the northern Great Basin in the latest.

Throughout the occupation, subsistence was based on hunting and seed processing, with fishing being much less important. The few fish remains found were of Tui chub and not trout as had been expected. The projectile point assemblage from the most recent occupation included Desert Side-Notched and Cottonwood Triangular types. Hughes associated these points with cultural groups from the northern Great Basin and concluded that the latest occupants were Paiutes rather than Achomawi, whom he associated with Gunther Series projectile points. Additional support for this idea came from two other sites which were test excavated in the southern Goose Lake Basin. The projectile points from the Franklin Creek Site (Mod-305) and from Mod-301 indicated that they had been occupied from about 4,000bc to 1500ad. The projectile points from the most recent period of occupation were almost exclusively of the Gunther Series, and there were no Cottonwood Triangular nor Desert Side-Notched points in either site. Indications are that a "central based" wandering pattern of settlement was in use throughout the past 6,000 years in the Goose Lake Basin, with less specialized subsistence adaptation to lakeside resources than was anticipated before these excavations.

Within the High Cascades of southern Oregon and northern California, archaeological studies are rare. The Odell Lake Site produced lithic tools, projectile points, used flakes, and scrapers in a glacial till overlaid by a deposit of Mazama ash. Cressman (1948) suggested that the site represented a hunting camp for peoples occupying the Deschutes drainage or the Klamath Basin, and felt that the tools closely resembled specimens from the Narrows Period at Lower Klamath Lake. The Mazama ash which overlay the artifacts implies an age of at least 5,000bc for the assemblage. Snyder (1979) has reported a similar site of comparable age, also associated with Mazama ash, from Diamond Lake.

Across the Cascades, the Gold Hill site included thirty-nine burials and over twenty-five occupation and workshop areas (Cressman 1933). Many of the burials contained large obsidian blades, while others held shell beads and pine nut beads, indicating relationships between the people of the Rogue River and others to the east (obsidian), south (pine nut beads), and west (shell beads).

Other more recent studies in the Rogue River basin have not changed the impressions about cultural affiliation made by the work at Gold Hill, but have added pithouses and other artifacts to the cultural inventory. At the Ritsch Site (JO-4), three circular housepits were excavated, representing two components. The most recent component was C-14 dated to 1500ad, the older to approximately 500ad (Wilson 1979). Occupation of the Applegate River area, as cross-dated on the basis of projectile point typology, spans at least the last 6,000 years (Brauner and Honey 1978 a, b). Other sites in Southwest Oregon, such as Emigrant Reservoir (JA-1,2) (Newman 1959), Sam's Valley (Cressman 1933), and Cove Creek Rockshelter (Deich 1978), show artifact assemblages similar to those recent occupations which included both Desert Side-Notched and Gunther Barbed types. Earlier occupations are attested by Gunther Series, Siskiyou Side-Notched, and Gold Hill Leaf points.

Archaeological studies in the Western Cascades indicate close cultural ties with Southwest Oregon. The testing of several sites allowed Davis (1974) to propose a tentative cultural chronology for the Lost Creek area. The earliest occupation, Phase I, was found above a presumed Mazama Ash deposit and on this basis dated to about

4,000bc. The Gold Hill Leaf point was associated with this phase. Phase II was associated with side-notched points, keeled end scrapers, and milling stones. Phase III, with a conjectural beginning date of 1,000bc, was characterized by mortars and pestles, micropoints and triangular stemmed points. Phase IV, the most recent prehistoric occupation, was dated from 1400ad to 1850ad. It is associated with hopper mortars and Gunther Barbed Points. Throughout the sequence, hunting and seed processing were important subsistence activities and fishing is assumed to have been important as well.

Another large project on Elk Creek (Brauner and Honey 1981) fits the same tentative cultural chronology. One site, JA-26, has a radiocarbon date of 700ad from its major occupation level. The strongest cultural influence on these areas comes from Southwest Oregon, while a lesser influence seems to come from the Willamette Valley. Lithic artifacts from farther north, along the Umpqua River, also show affinities with the Rogue Valley materials (Marchiando 1965, Newman and Scheans 1966, Brauner and Honey 1978a, b).

The materials from the Western Cascades generally indicate a cultural similarity shared among all the major drainages from the Umpqua in the north to the Klamath River in the south. The peoples of this interior region had strong ties to those living on the lower courses of the rivers of Southwest Oregon and Northwest California. They also had some cultural relationships, probably through trade, with the northern Great Basin, the Klamath Basin, and the Willamette Valley, and it is probable that movements from the northern Great Basin and the Klamath Basin brought people into this area from time to time (Honey and Hogg 1980).

The oldest occupation currently known from the Northern California-Southern Oregon coast is the Point St. George Site (DNO-11); the lower component is dated by radiocarbon to 310bc, while the upper component represented a protohistoric Tolowa village. The lower component contained Gunther Stemmed points, while the Gunther Barbed type was common in the upper levels. Both components represented specialized coastal adaptations (Gould 1966, 1972).

The other known coastal sites all date to either late prehistoric or protohistoric times. Gunther Island (Hum-67), where the Gunther Barbed point was first noted and described (Loud 1918), has radiocarbon dates of 900ad and 1600ad (Heizer and Elsasser 1964). The tool assemblages from Gunther Island and the Point St. George Site are similar to one another and to the other recent prehistoric and historic villages excavated on the coast: Tsurai (Hum-169), Patrick's Point Site (Hum-118), and $T^{s}apek^{w}$ (Hum-129) in California (Heizer and Elsasser 1964; Benson 1977), and the Lone Creek Ranch Site and the Pistol River Site in Oregon (Berreman 1944; Heflin 1966). Some researchers hypothesize that the coast was settled rather late by people moving down from the interior (Elsasser 1965; Cressman 1953).

In the interior northwest California, a number of housepit village sites on the upper Trinity River (Treganza 1958, 1959) all yielded similar assemblages and were attributed to Wintu occupation of the area, starting no earlier than 900ad. Fishing for steelhead and salmon was apparently the subsistence activity which most influenced village location. All the sites contained mortars and pestles as well, indicating the importance of acorn processing in the economy. The Gunther Barbed projectile point type was defined in these reports; the many points recovered indicated the importance of hunting.

Two other river valley studies illustrate the same relationship between village locations and good fishing locations. Along the New River (Chartkoff and Kona 1969), the steep-sided canyons and poor oak forests led the investigators to speculate that fishing might be even more important here than on the Trinity River. Along the middle Klamath River, the location of good fishing spots also seemed to determine Karok village locations. This study further showed that late prehistoric Karok villages had circular houses covered with bark and wood. The wooden plank houses which were the major Karok residence at contact seem to be quite recent. Within recent prehistory the circular, semi-subterranean house found in north-central and northeast California was also used along the Klamath River (Chartkoff and Chartkoff 1975).

Within the Southern Klamath Mountain, Squaw Creek #1 (SHA-475), a deep stratified site has produced three radiocarbon dates placing its occupation between 4,580bc and 850ad (Clewett 1977). Squaw Creek is a campsite with a large complex of tools, showing heaviest occupation around 2,000bc. Mullers and milling stones were common in the early levels, and large projectile points associated with the atlatl were common until sometime after 2,000bc. The excavator perceived connections with the Borax Lake Pattern of the North Coast Range of California, as well as occasional contact with the northern Great Basin (Clewett 1977; Meighan 1955; Fredrickson 1973).

Kingsley Cave (Teh-1) and Payne Cave (Teh-193) in the western foothills of the Southern Cascades have yielded a tentative reconstruction of Yana prehistory (Baumhoff 1955, 1957). The excavator saw early connections in lithic tool assemblages between this area and the North Coast ranges, Klamath Mountains, and northeastern California.

The first work in the northern Sacramento Valley and its surrounding foothills was a survey and test excavations of the Shasta Dam area (Smith and Weymouth 1952). The results indicated use of the area by peoples subsisting on hunting and gathering as well as some fishing. Recent influence from the Northern Great Basin was indicated by many Desert Side-Notched points. However, the most common point types were those of the Gunther series.

Recent work on Clikapudi Creek in the Shasta Lake area suggests a tentative cultural sequence for the area (Clewett and Sundahl 1981a). The projectile point assemblage of the earliest occupation, perhaps as early as 4,000bc, is similar to the Borax Lake Pattern. Between 2,000bc and 1000ad the area was used more intensively by hunters and gatherers. The processing of seeds was done with mullers and grinding slabs, but hunting was still very important. Recent use of the area was by the historic Wintu, whose sites are characterized by housepit villages, Gunther Barbed and Desert Side-Notched projectile points, and mortars and pestles.

Along the Sacramento River near Redding, Site Sha-266 was a protohistoric Wintu housepit village, which showed evidence of use throughout the late prehistoric period (Clewett and Sundahl 1981 b). There was also an earlier component at the site, showing evidence of its use as a fishing camp. The occupation of sites along the Sacramento River as seasonal fishing camps by people living in the foothills is also documented for recent prehistoric and protohistoric times at Sha-207 (Dotta and Hollinger 1963).

Archaeological investigations further south but still within the northern Sacramento Valley led to a cultural sequence proposed by Edwards (1969) in which the earliest occupation, the Northern Millingstone Phase, is dated roughly by radiocarbon and obsidian hydration dates between 6,000 and 300bc. As the name indicates, the use of millingstones is one of the most important characteristics of the phase. Evidence from Teh-256, Teh-258, Teh-261, and Teh-262 supports the description of a group of people who did not exploit the acorn, but for whom hard seeds were an important staple, while hunting and fishing were probably of equal importance. In the succeeding Tehama Phase, the exploitation of acorns became important, as shown by the fact that Tehama Phase assemblages all contain mortars and pestles. Most recent is the Shasta Complex, a prehistoric Wintu phase which begins around 1000ad. The use of the clam shell disc bead is the major distinguishing characteristic of this recent phase, which totally lacked milling stones (Treganza 1954, Edwards and King 1968).

One of the most interesting things noted by Clewett and Sundahl (1981a, b) is the use of obsidian throughout the Northern Sacramento Valley region. In early periods the obsidian comes mainly from either the Medicine Lake Highlands of northeastern California, or a more local "Source X." However, in the more recent Shasta Complex, representing the prehistoric Wintu, almost all the obsidian comes from "Source X." As noted by Clewett and Sundahl, this may indicate some restriction during the late period to access or trade in the Medicine Lake Highlands area. This change in access may in turn be related to changes noted in cultural relationships around Lower Klamath Lake approximately 700 years ago (Chapter 21, this volume).

Archaeological investigations on the Southern Modoc Plateau and in the Northern Sierra Nevada have included excavations in the basins of Eagle Lake, Honey Lake, and Lake Almanor. The dates from Lake Almanor have not yet been published (Kowta, pers. comm.), but the studies from Honey Lake and Eagle Lake have both generated cultural phases and speculations on cultural ties between northeast California and the Great Basin. Three sites have been excavated in the Honey Lake area: Amedee Cave is a protohistoric site (Riddell 1958), while Tommy Tucker Cave has been defined as a late prehistoric site with cultural ties to the Lovelock Cave area (Riddell 1956). It may also have a sparse earlier component equated with the Middle Lovelock Period. The multi-component Karlo Site, which dates as early as 3,000bc, shows cultural relations to both Central California and the Great Basin. The faunal remains indicate a much moister climate during the early period of occupation than in late prehistoric times (Riddell 1958, 1960). Generally, the subsistence economy of the Honey Lake basin is perceived as more similar to the desert lakeside adaption of western Nevada's Lovelock Culture than to that of Lower Klamath Lake, as attested at Nightfire Island.

The archaeological data from Eagle Lake indicate a sequence similar to that of Honey Lake. Two sites have been excavated, Las-345 (Wohlgemuth 1978) and the Pike's Point Site (Las-537) (Pippin et al. 1979). Radiocarbon dates for the Pike's Point Site indicate it was occupied from 2,500bc to 1850ad. Thus, the archaeological data from Honey and Eagle Lakes indicate that the Southern Modoc Plateau was occupied throughout the last 6,000 years by hunters and gatherers who exploited large and small game, seeds, and roots, in a subsistence pattern very similar to that of the Western Great Basin.

Finally, to complete the circular tour of archaeological sites surrounding the Nightfire Island region, Great Basin manifestations in Surprise Valley, northeastern California, Warner Valley, south-central Oregon, and the Lake Abert Basin, not far northwest of Warner Valley, may be briefly mentioned. These areas are of interest in relation to Nightfire Island because all appear to represent, at certain periods in their prehistory, cultural patterns somewhat comparable to those discovered at Nightfire Island.

The Menlo Phase of Surprise Valley, dated between 4,500 and 2,500bc, revealed evidence of large pithouses reminiscent of those known from the Klamath country, associated with Northern Side-Notched and other points, mortars, and pestles. Large ungulates (mule deer, mountain sheep, pronghorn antelope) dominated the faunal assemblage, and small game and waterfowl were conspicuously absent. In succeeding phases, from 2,500bc down to historic times, the picture was quite different. The large substantial pithouses were replaced by flimsy brush wickiups, while ungulates conspicuously decreased in the faunal assemblages and waterfowl, jackrabbits, cottontails, and marmots increased. It was suggested by the excavator that this shift might represent a replacement of an early people culturally related to the Klamath historically known farther west, by the predecessors of the Northern Paiute who occupied Surprise Valley in ethnographic times. A shift in the ranges of these peoples, it was suggested, may have been induced by environmental changes taking place near the end of the Menlo Phase (O'Connell 1975).

Not far to the north of Surprise Valley is Warner Valley, where a lifeway closely adapted to lakemarsh resources is believed to have persisted from at least 1,500bc to 500ad (Weide 1968, 1974). Evidence is based entirely on archaeological surface survey rather than excavation, but the concentration of occupational remains in an area of dunes and sloughs, and the occurrence of several large midden sites at waterside locations, supports the interpretation of a heavily lacustrine orientation. The lifeway implied is again similar to that of the ethnohistoric Klamath, who occupied the country west of Warner Valley in historic times.

At Abert Lake, northwest of Warner Valley, archaeological surveys and limited test excavations have revealed additional evidence of a settled lakeside occupation, dated between about 2,500bc and 1200ad (Pettigrew 1980). Approximately 20 sites with surface depressions interpreted as housepits have been identified along the eastern shore of Lake Abert. This body of water is now virtually an aquatic desert due to high mineral concentrations, but formerly was a much more productive locale, to judge from the rather abundant cultural remains.

In both the Warner Valley and Lake Abert cases, it has been suggested that Klamath peoples may have been replaced by Northern Paiutes as climatic and aquatic conditions worsened. As noted above, a similar replacement has been postulated for Surprise Valley. In each case, the interpretation seems plausible, but large discrepancies in the dates attributed to these events remain to be resolved. It is conceivable, of course, that these sites lay in a tension zone between better and less well-watered regions, and that a Paiute-Klamath ethnic boundary corresponded to the ecological division. If so, the ranges of different cultural groups may have fluctuated across this boundary zone in response to changes in local environmental conditions. The topographic and hydrographic controls on effective moisture operating in the three different localities may well have been sufficiently different that critical environmental thresholds in each were reached at quite different times.

Nightfire Island Models in Broader Perspective

For about one millennium before Nightfire Island was occupied (5,500-4,500bc), the region's sparsely distributed inhabitants were already practicing a diversified economy that included fishing (Medicine Rock Cave, Klamath Shoal Midden, Northern Millingstone Phase) and, at least locally were making projectile points in shapes that foreshadowed the Northern Side-Notched/Elko Side-Notched/Mojave/Humboldt range (Narrows, Odell Lake, Diamond Lake). A chronic shortage of dates from these sites still blurs our vision of this period, however. During the ensuing episode of increased effective moisture (4,500-3,500bc) that is coeval with Nightfire Island's earliest occupation, pit house architecture appeared to the east (Menlo Phase in Surprise Valley) but there is no evidence of a lakeshore adaptation to go with this innovation, which seems to have belonged to a central-based wandering mobility pattern involved mainly with hunting large mammals. To the south (Squaw Creek), mullers and grinding slabs came increasingly into use. Furthermore, if the typological correlations are to be believed, there is an increase in the number of discovered sites ascribed to this period (Franklin Creek sites, Applegate sites, Lost Creek I, Elk Creek sites, and Clikapudi Creek sites to the south). The range of point types seen in the earlier episode now take on their standardized forms, and the Gold Hill Leaf Point appears in the western half of the region (Lost Creek I). The warming trend at the beginning of the bristlecone record (3,500-2,400bc) correlates with the end of the Menlo Phase in Surprise Valley (2,500bc) and the onset of a more dispersed settlement pattern there. To the west, other sites come into use for the first time, however (Kawumkan Springs, Big Boulder midden, Border midden), and in the southeast (Lorenzen, Karlo). Again, dating is too dependent on point typologies for this grouping to be considered more than tentatively. In the first cool-wet episode of the bristlecone record (2,400-2,200bc), settlement of the Abert lakeshore began, and Pike's Point, with its Lovelock cultural affinities, was first occupied. In Surprise Valley, however, the economy began to diversify, with a notable increase in waterfowling. At the start of the long and variable warm-dry phase in the bristlecone record (2,200-2,000bc), both Laird's Bay and Peninsular Bay I and II suggest an increase in the use of Elko Point types, and there seems to have been an upsurge in the use of stone mortars used in plantfood processing. However, the dating of both is a typological estimate only. The next segment of this long oscillating phase (2,000-1,350bc) saw the beginnings of the Warner Valley lakeshore adaptation, and further south the Squaw Creek settlement seems to have reached its most intense level of occupation. The following hot-dry spike in the record (1,350-925bc) has remarkably little associated prehistoric settlement although Lost Creek III--with its increase in mortar and pestle technology--is claimed to be the same age. Finally, there is no evidence of any new site coming into use during the cool-dry spike at the close of this long episode (925-525bc).

In the second cool-wet episode of the bristlecone sequence (525-225bc) the Gunther Stemmed Point makes its first appearance (Point St. George), but there are no other sites of comparable date.

Associated with the drier, variable phase following this (225 bc-350ad) is the end of the Northern Millingstone Phase in the North Sacramento Valley. The Burrell Site at Goose Lake is occupied for the first time.

The third cool-wet phase (350-550ad) witnessed the start of the Tehama Phase in the North Sacramento Valley with its increased emphasis on mortar and pestle technology for processing acorns. It also saw the foundation of Irongate village, the Ritsch Site with its housepits, and the first occupation of Cuppy Cave.

The ensuing dry phase--first cold-dry (550-1100ad), then warm-dry (1100-1300ad)--is associated with a number of related events. Foremost is the abandonment of a series of locations (Kawumkan Springs midden, Squaw Creek, the Warner valley settlements, and the Lake Abert settlements). Although it appears that Big Boulder midden, Border midden, and Klamath Shoal midden were also abandoned at this time, the case is too poorly documented for these to be included. In the North Sacramento Valley, the Tehama gives way to the Shasta Phase when the obsidian traffic from Medicine Lake Highlands was evidently cut off. In the light of these events, the estimated starting date for a number of housepit villages in the Upper Trinity at 900ad is in urgent need of verification. Other confirmed first occupations are the KL-13 rockshelter in the upper Klamath River and the JA-26 in Elk Creek. Closer by Nightfire Island were the Tule Lake Phase settlements including Peninsular Bay III, the Merriman Site, and some of Cressman's Historic Horizon sites on the shores of Lower Klamath Lake. Although abandonment does not seem to be a conspicuous pattern around these lakes, it should be remembered that there is only one radiocarbon date associated with all these sites. Gunther Island Points make their first appearance here in this phase, along with Desert Side-Notched Points, and there is a proliferation of materials, particularly boneworking, stone pipes, basketry and marine shell jewelry. Cremation burials also proliferate during this phase.

It is only in the fourth and final cool-wet episode of the bristlecone sequence (1300-1800ad) that the widespread village-based settlement patterns of the ethnohistoric record began to take shape. In the Lower Klamath basin, these include some of Cressman's Historic Phase sites and the Lava Beds occupation. In Upper Klamath Basin there were the Kawumkan Springs housepits, and the Sprague River housepits. In the Klamath River valley, Big Boulder village and Border village were founded and Klamath Shoal midden was reoccupied. In the upper Pit River, the Core site dates to this episode. In the western Cascades, most of Lost Creek IV is ascribed to this period, as are the many village sites along the coast: Point St. George, Tsurai, Patrick's Point, T^{s}apek^{w}, Lone Creek Ranch, the Pistol River sites. Inland in Northwest California, there was the Wintu occupation of the Upper Trinity River and the Karok settlement of the middle Klamath River. In the southern Klamath mountains, there were the Yana occupations of the Kingsley and Payne Caves. Wintu settlement patterns emerged in Clikapudi Creek, and in the Sacramento valley.

To the east, however, Paiute incursions inhibited the development of such village-based settlements where more fluid mobility patterns were practised in Surprise and Warner Valleys and in the Abert basin.

This chronological rearrangement of the region's archaeology within the bristlecone climatic framework allows a reevaluation of certain aspects of the Rival model proposed for analyzing Nightfire Island. It also provides a few useful hints about the schedule of appearances of certain key artifacts expected to occur in the site.

First, the sedimentary models with their *build* or *abandon* alternatives should be reassessed. It now seems more probable that the site would be abandoned during the dry-spikes of the record, particularly the cool-dry spike between 925-525bc when no new sites appear in the region, and the spikes between 500-1300ad when there is evidence of widespread site abandonment.

Next, the predicted sequences of site roles in the Learner and Know-it-All models need a second look. If the purported date for Medicine Rock Cave is accepted, then intensive fishing was already an intrinsic part of the local economy before Nightfire Island was inhabited. It could, therefore, have started out as a fishing camp, not a waterfowling camp as both models assume. Furthermore, the presence of pithouses in Surprise Valley at this time implies that platform-building could start earlier than either model predicts. Somewhat more encouraging to the Learner Model is the fact that fishing activities apparently dominated the upper levels of the Kawumkan Springs sequence. However, the faunal data are not sufficient to test the earlier parts of the model.

Socio-economic noise in the models may be addressed next. There is strong evidence from surrounding sites that Nightfire Island will prove to become involved in a status-object trade network by at least 800ad, but probably a few centuries earlier since it is likely to be abandoned at that precise date (see above). The objects involved will be tubular stone pipes, large bifacial knives, and marine shells. There is no evidence of systematic or institutionalized violence in the region, but disruptions to obsidian traffic could occur during that final intensive cold-dry spike around 1000ad.

The schedule of artifact-type appearances can be predicted a little more accurately than was possible in the preceding section. Projectile points from the earliest levels covering the waterfowling stage on Nightfire Island's supposed development should include Northern Side-Notched, Elko Side-Notched, Mojave, Humboldt and Gold Hill Leaf points. Elko Corner-Notched types and Siskiyou Side-Notched points should proliferate during the long variable dry episode of 2,200-525bc. Gunther points could appear as early as 500-300bc, but are more likely to occur at ca. 500ad if the site is not immediately abandoned with the onset of cold-dry conditions. Gunther Barbed points will appear during the final cool-wet phase of the bristlecone sequence.

Mullers and grinding slabs can be expected in the earliest levels and will persist throughout. Mortar and pestle technology is not known in the region before the onset of the long variable dry spell starting at 2,200bc. Locally, flat round grinding slabs appear after 500ad, as do hopper mortars.

It is expected that these changes in artifact design, as well as the switch to cremation burials at about 500ad, will not have an impact on the proposed models since they were part of large-scale systems of culture change taking place beyond the site itself.

ENDNOTES: CHAPTER 1

1. The eastern boundary is usually claimed to have started at Mt. Shasta, although Kroeber (1925:318) points out that the north slope was uninhabited but may have been hunted by the Okwanudu from the south flank. The boundary then ran north along the Cascade Divide (Ray 1963:xii) to the watershed rim of the Klamath River (Spier, 1930: Fig. 1), then northeast on this rim; it crossed the Klamath Strait and on to Yainax Butte. From here it followed the north rim of the Lost River drainage (although Spier indicates some Klamath tribal ownership along this stretch), to somewhere south of Quartz Mountain. Ray and Stewart (1939:136) indicate that the line ran down Drew's Creek to the Goose Lake shoreline, but Kroeber and Spier ascribe this portion to the northern Paiute (Yahuskin). Ray states that the Modoc shared the north end of Western Goose Lake shore with the Yahuskin, owned the central part, and shared the southern end with the Achomawi. Olmstead and Stewart (1978: Fig. 1) show all the land at the southwest end of the lake in Achomawi hands, however. Kroeber also points out that the southern rim of the territory was uninhabited and not precisely defined.

2. Dog salmon were sighted in Sheepy Creek recently (Howe, 1979:145).

3. All sorts of differences between these types and Steward's (1955) mobility types have been strenuously argued. See Weide (1968:26-39) for a thorough survey of the question. I suspect that there was enough variability in the Modoc round to accommodate most of these nuances.

4. Although the superficial deposits yielded no recent carbon-14 dates, several iron and wire fragments came from the top few inches of the excavations. These were recent intrusions from 20th century farming activities and do not support an early post-Contact occupation of the site. Howe (1979:11) has built a case for historic occupation on the grounds that Nightfire Island is actually the village of Shapa'sh. As this conflicts with Ray's location (Fig. 1-7) its basis should be examined. Gatschet's (1890) informants used the word Shapasheni (Shapash/xpni) meaning "where the sun and the moon live" to describe a curved ridge at the south end of the lake. While it is reasonable to assume that Sheepy is the modern cartographic equivalent, it is applied both to Sheepy Creek Island (Howe's choice) and the Sheepy Peak overlooking the southeast shore, closer to Ray's location. Similar names were given to different villages and it is quite possible that Shapa'sh was indeed the original name for Nightfire Island--before it was abandoned.

5. Of course there is no guarantee that the Birds' Nest Island channel had an identical configuration during the upper Holocene. However, it survives today as Sheepy Creek Lake, and many of the original nesting islands are still preserved within the Lower Klamath National Wildlife Refuge. The contouring of this channel is fairly permanent, therefore, and is related to the scouring of the Sheepy Creek draingage. As a middle-to-upper Holocene Sheepy Creek can be demonstrated (Chapter 5), ergo this channel must have been in place.

6. The local name for the small obsidian arrowpoint of Gunther Island type (Chapter 13) is "duck point" (C. B. Howe pers. comm.). I have been unable to find any confirmation for their use in duck-hunting by the Modoc in the ethnographic record, however. It is definitely not a reliable marker for a waterfowling station.

7. Prospects for a detailed chronology of lake level fluctuations exist for the closed system of Lake Abert, only 130km NW of Lower Klamath Lake (R. Pettigrew pers. comm).

8. Radiocarbon years, designated ad/bc rather than Calendar years (AD/BC), are used hereafter to allow comparisons between published dates.

CHAPTER TWO

THE EXCAVATIONS

The Nightfire Island Site before Excavation

The site catchment as it was mapped in 1905 (Fig. 1-8a) is no more. During the construction of the Southern Pacific railroad embankment across the marshland at the outlet of Lower Klamath Lake, a drainage conduit was cut in the vicinity of Ady which accidentally drained most of the lake, exposing large areas of lake bed and forming peat mounds out of former islands. Sparks from passing locomotives ignited fields of drying peat which burned intermittently for years. Much of the exposed bed was converted to farmland and many of the islands were bulldozed away.

Before the drainage, Nightfire Island would have been obscured from vision by reeds and inaccessible except by boat. Today, the surface configuration of the site is unspectacular at ground level, presenting little more than a low irregular rise in the pasture on the left bank of Sheepy Creek[1]. The hump-and-hollow appearance of the surface (Fig. 2-1) is due partly to its depositional history and partly to recent damage. The farm track running through it is little more than a minor rut which has caused minimal damage. Far more severe are the bulldozer cuts from which deposit was taken for use as road fill on farm tracks through waterlogged pasture and for the fill of an irrigation dam. Narrow irrigation ditches have been cut into the lake bed on either side of the site, one of which cut through a related cemetery (see Chapter 19). In 1960, the site was first visited by Mr. C. B. Howe, who subsequently dug another large trench across the center of the site. Very little archaeological material survived the bulldozer cuts, but a considerable collection of artifacts was amassed by Howe who has described these in his two books <u>Ancient Tribes of the Klamath Country</u> (1968) and <u>Ancient Modocs of California and Oregon</u> (1979). In spite of these disruptions, about 89% of the site's surface area remained intact at the time that the controlled excavations began.

The Test Pits

A total of 25 pits, each 2x2m in area, was excavated completely down to the sterile basal clays beneath the site (Fig. 2-2). This chapter will describe the original justification for such a sampling procedure, as well as the organization and recording system used while excavations were under way. The correlation of field records for each pit is in the appropriate figure caption, and the section concludes with a brief discussion of the pros and cons of these particular field methods.

The original sampling design was based on results from two test pits (O and part of P in Fig. 2-2) excavated in June 1966 (L. Johnson 1966, 1969a). Following these trial cuttings, it became apparent that several stratified layers of cultural debris had accumulated to a maximum height of about 3m. At the base of Pit O was a gray, sterile diatom-rich argillite interpreted as a lakebed surface. Above this, six "zones" (strata) were recognized. From bottom to top these were seen as: Zone 6--a black organic clayey, sandy silt densely packed

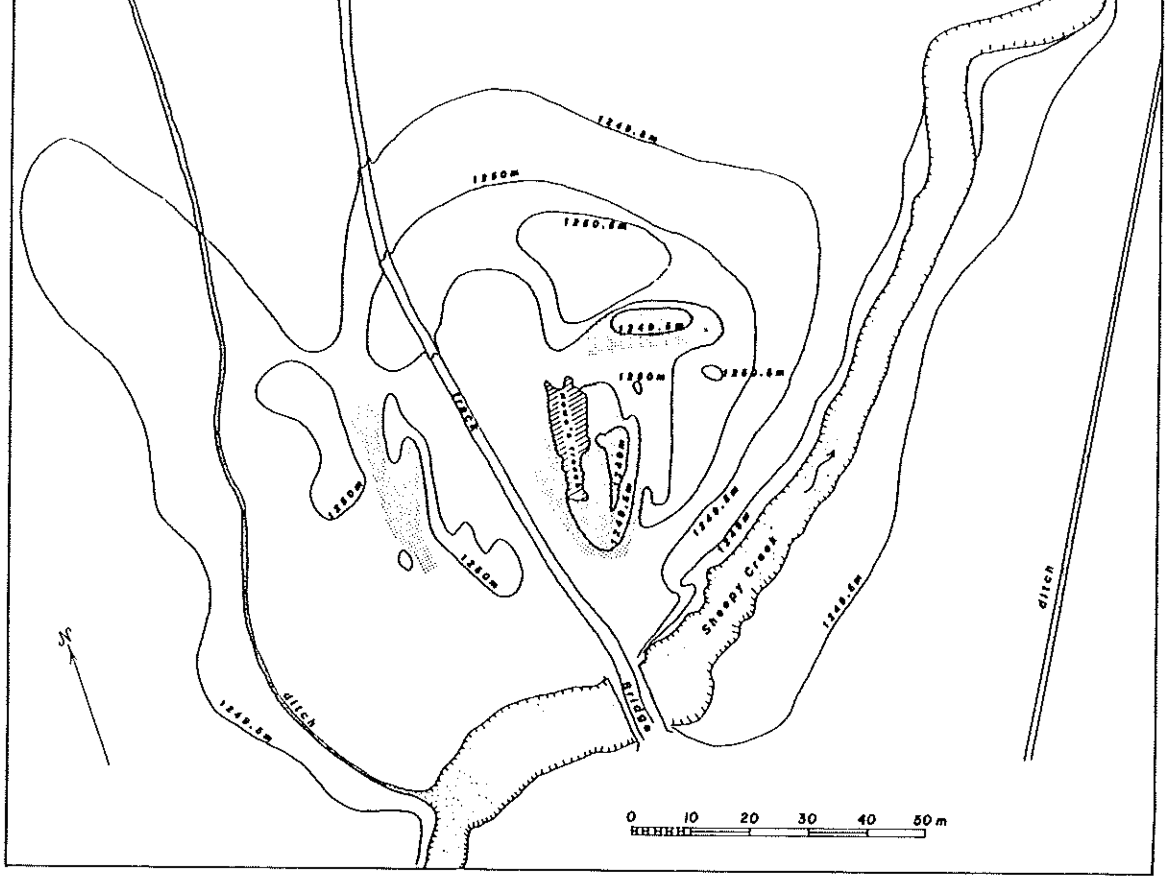


Fig. 2-1 Surface configuration of the Nightfire Island Site, showing areas of pre-excavation damage.

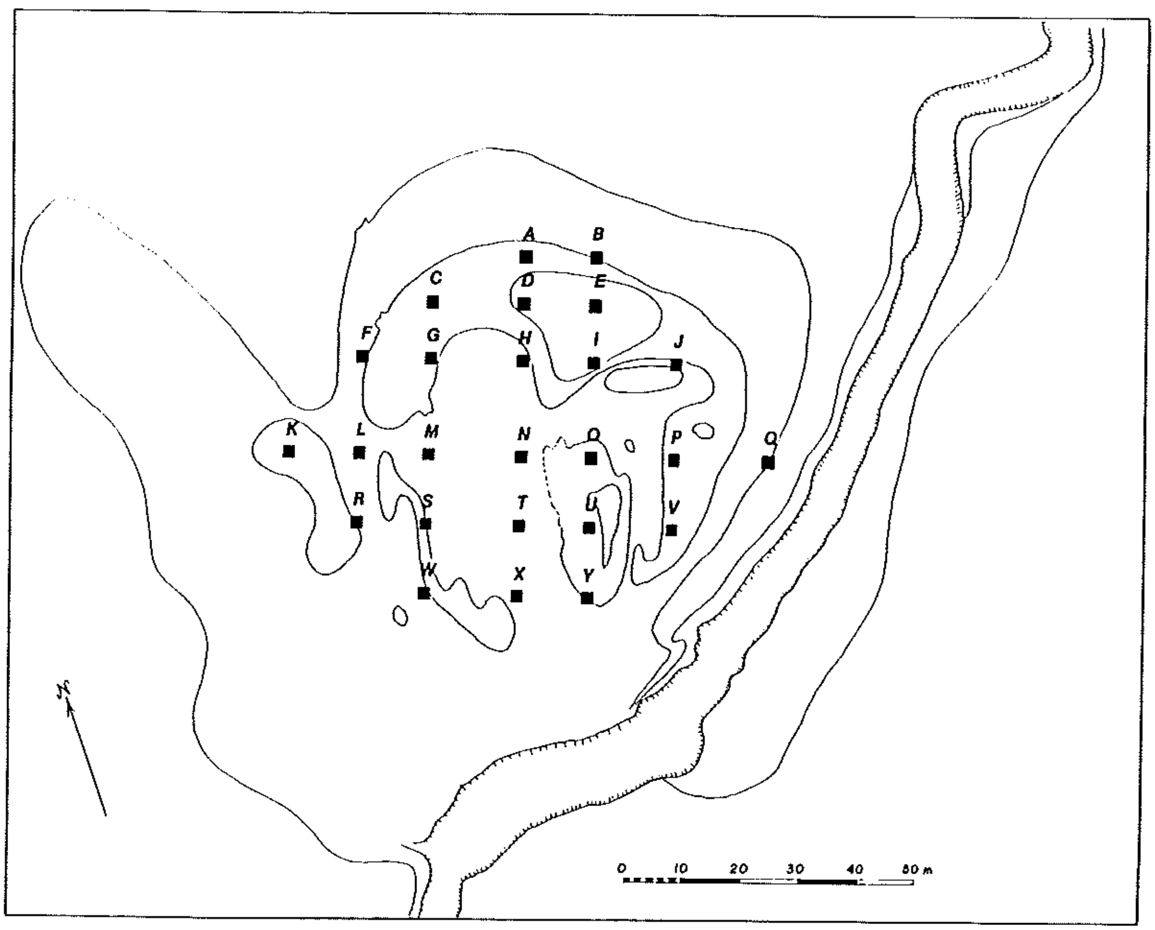


Fig. 2-2 Locations of the 25 pits.

with waterfowl bones (in O); Zone 5--a deliberately constructed pavement of basalt fragments on the underlying muck, probably to provide a dry working surface or living surface (in O); Zone 4--a thin layer of friable limonitic sandy silt (O and P); Zone 3--a near-sterile silty clay (P); Zone 2--a sandy silt rich in cultural debris (O and P); Zone 1--almost 1m of calcareous silty clay with abundant fish (P). Not only were strata interfaces sharply defined, but characteristic projectile points were also tightly associated with individual sediments: Zone 6 dominated by long lanceolate forms with side notches and parallel/oblique pressure flaking; Zones 5 and 4--dominated by long lanceolate, bipointed or triangular forms without notching; Zone 3--uncertain; Zone 2--abundant large corner-notched forms; Zone 1--large numbers of small (protohistoric Modoc/Klamath) forms.

Although intended only as a provisional statement on the site's stratigraphy, much of the terminology and some of the zone-concepts became permanently entrenched in the subsequent research. These preliminary test results came to have a far-reaching influence upon the way strata in other pits were excavated, and especially on the way that they were described in the field records. Because the stratigraphic separations in the test pits were so clear, and because the sediments (and their artifact contents) were so distinctive in each zone, it was anticipated that strata with equally sharp boundary-definitions would be encountered in most other parts of the site. Given these conditions, it would be possible to trace the horizontal distribution of any stratum within the site by noting its presence or absence in a series of pits scattered about the site. This confident prediction underpins the excavation strategy devised for the site.

The Sampling Strategy

The major objectives of the excavation were to (a) outline the depositional history of all parts of the site, (b) determine the sedimentary processes which caused the observed strata to accumulate, (c) outline the sequence of cultural events expressed in the artifact-content of each stratum, (d) determine the economic pursuits of the prehistoric occupants expressed in the faunal content of each stratum, (e) reconstruct the local environmental history through (d) and through pollen analysis, (f) date each stratum, and (g) determine the horizontal variability in artifact- and faunal-content of each stratum.

Near total excavation would, no doubt, have safely achieved all these objectives, but the cost of such a task was prohibitive. The need for a sampling strategy was obvious. By using the man-hour data derived from the test pit excavations, it was estimated that 100sq^{m} of the site's surface area could be excavated at a cost deemed to be currently realistic in the late sixties. Although artifact- and faunal-yields per volume of sediments for each test-pit stratum were not given, it was asserted that 100sq^{m} of excavations would most likely yield large enough samples to provide an adequate data-base for each stratum in the site (L. Johnson 1966).

The problem remained of how best to distribute the excavations about the site so that there would be a reasonable chance that each objective would be achieved. The decision to excavate according to an interval sampling technique was prompted mainly by the need to reach all parts of the site. It was also encouraged by the optimistic prediction that pit correlations would pose few problems. This choice was further influenced by the current climate of thought on sampling theory (L. Johnson 1966)--particularly by the recommendations of Binford (1964), Rootenberg (1964) and Vescelius (1960), none of which addressed the many practical problems created by interval sampling.

Consequently, the decision was made to impose a rectangular grid system over the site plan, composed of 2x2m squares oriented on magnetic north and aligned with the two test pits. Although linear alignments of pits were maintained, spacing between alignments was varied in such a way that most pits would avoid the farm track and the areas disrupted by bulldozer cuts and by amateur digging (Fig. 2-2).

Precise estimates of the proportion of the site ultimately sampled by this approach are difficult to calculate because the outer edges of the site are poorly defined and its true area and volume cannot be accurately assessed. Although the original intention was to sample 12% of the surface area (L. Johnson 1966), a considerably smaller fraction was actually excavated. If the site circumference is arbitrarily depicted as a circle of 42m radius (Fig. 2-3), then the area sampled is 1.8%, and the volume sampled ($164.4m^3$) is less than 1%. Ultimately, these gross volumes are of little importance because it is the sample-size of each individual layer of deposit which determines whether the yield will suffice to make valid statements about its content. Various attempts to make such estimates have not met with success.

Excavating Procedures

A standardized recovery procedure was used in all the pits. Wherever possible, each stratum was removed and processed as a discrete unit. If the stratum was thicker than 20cm, then the excavation was halted and leveled off at 20cm depth and the deposit thus far removed was treated as a discrete spit within the stratum. This procedure would be repeated until the bottom boundary of the stratum was reached. Thus any deep stratum was recovered as two or more arbitrarily subdivided spits. In a few pits, very deep loams with much rubble lacked any microstratigraphic clues to their dip and strike. It is therefore impossible to tell whether the 20cm spit subdivisions reflect their true depositional history. However, the generally horizontal position of most strata encountered in the site must greatly increase the probability that the spits are valid chronological subdivisions of such loams (Fig. 2-4).

A $1sq^m$ area of each new stratum (or spit) encountered was first shovelled into a portable 5mm mesh sieve. This was carried to the creek and wet-sieved (Fig. 2-4). The occupational debris in the residue was then bagged and labelled as a separate unit. The remaining $3sq^m$ area of the same stratum was then shovelled directly into a 5mm mesh rocker-sieve standing at the pit edge. The bottom of the stratum was then trowelled clean and dry-screened as well. All dry-screened material was bagged and labelled separately. Thus, for every recovered stratum or spit, a wet-screened control sample was recovered as a monitoring device to check the loss rate from dry-screening.

Three features encountered during excavations required special treatment. Burials were treated as discrete depositional units--wherever possible burial-pit outlines were plotted and the fill was processed separately from the surrounding deposits. Storage and other pits were treated in a like manner. Pit house floors were (except in one pit) trowelled clean and the surface artifacts exposed by the pit were plotted in place. House floors were otherwise not

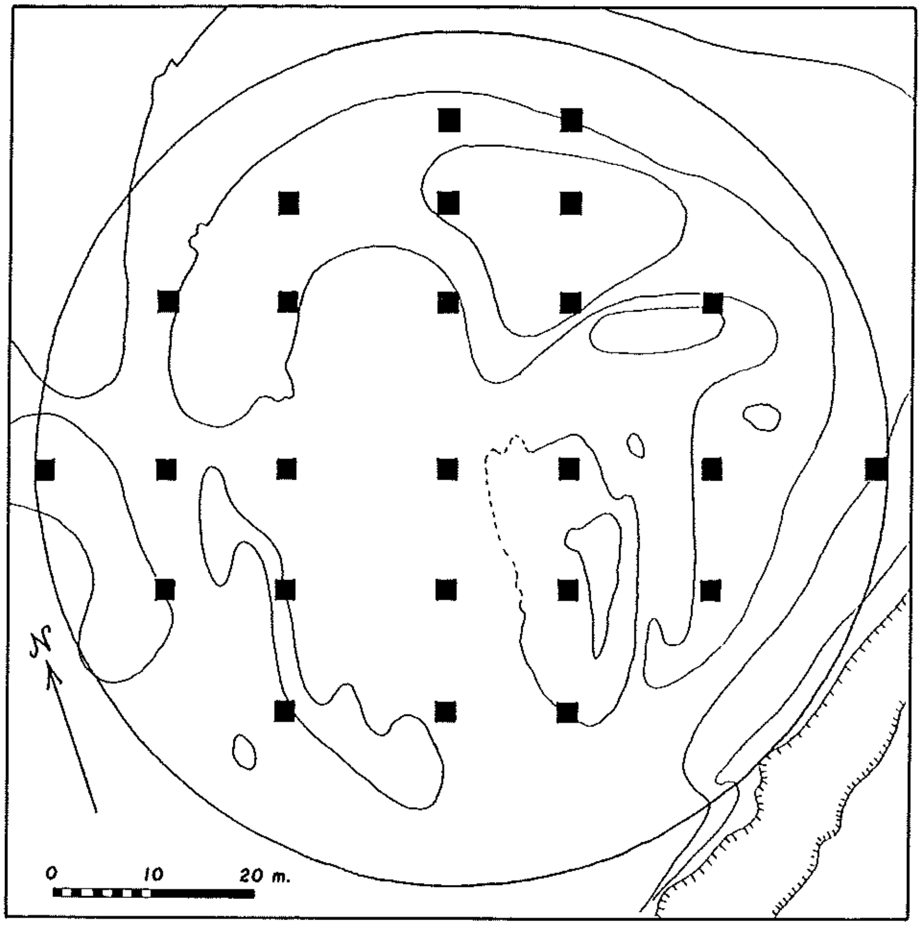


Fig. 2-3 The site contained within a 42m radius circle. The 25 pits represent 1.8% of the surface area.

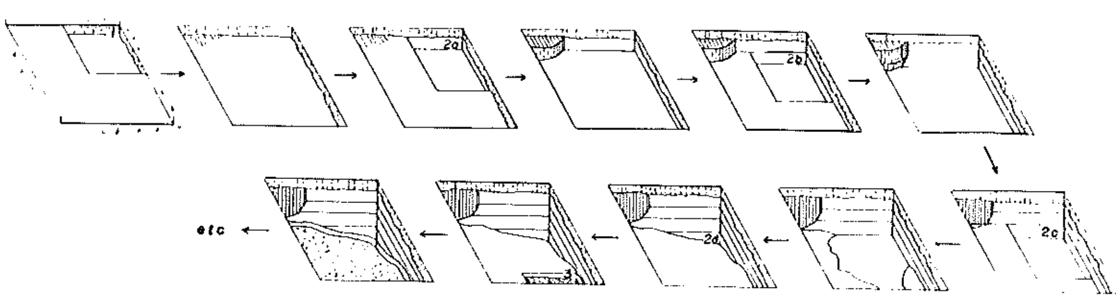


Fig. 2-4 Isometric diagram showing excavation procedure. A 1m square of each spit or layer was water-screened.

LEVEL
REPORT FORM

Date 8-1-67 The Nightfire Island Site (4SK4)

Recorded by ____________ Record No. 472

Square N72-E74 Level 49.2-49.4 m.

Stratum (if determined) ____________ Screened? ________ Mesh size ________

Floor troweled? yes Floor cleaned with shovel? ____________

Observed occupational features:

possible living surface (discontinuous in spots) → with thickness of 2-3cm

Record Nos. for features ____________

Observed natural features (root holes, animal burows, recent pits, etc

none

Description of soil and inclusions

Possible occupational surface in the form of white clay separating dark humic soil (above) from light-colored friable sand (below), the latter beginning at 49.2 m

Artifacts recovered:

3 proj. points, 1 stone pipe frag., 5 carnivore teeth

Other material collected (wood, charcoal, soil samples, etc.):

carbon sample

Photos of floor? no Photo Nos. ________ Plan of floor drawn? no

Record No of Drawing ____________ Excavated by ____________

see Record Nos. ____________ for additional data

Fig. 2-5 A Level Report Form (LRF) with typical entry.

opened up to their full extent. Instead, the pit was allowed to continue downwards through the floor in the interest of maintaining the original sampling.

Accidental mixing of strata was held to a tolerable minimum throughout and individual cases will be itemized in the figure captions.

The Field Records

Following the removal of one 20cm depth of deposit, the pit supervisor filled in a Level Report Form (Fig. 2-5) in which a field description of the sediment(s) was recorded together with a listing of types of occupational debris observed during screening and bagging. If the 20cm deep level was part of a still deeper stratum, the entry was straightforward. If the removed level was composed of two or more strata, then each was given an arabic numeral--starting with (1) for the uppermost stratum--and described separately. Strata were not numbered sequentially from the top of the pit downwards in the Level Report Forms--thus each 20cm deep unit starts with (1).

Although space was provided for the supervisor to make a provisional correlation with one of the six zones established in the test pits, this was often used for more localized correlations with immediately adjacent pits. The Level Report Form is chiefly useful for the field description of the sediments encountered. However, descriptive procedures were not prearranged, nor was a Munsell color code used. Thus, each of the 10 supervisors used his own descriptive procedures and no calibrated terminology for sediment descriptions was developed for universal use. It follows that pits supervised by the same recorder are easier to compare than pits supervised by different overseers.

A second and independent description of each stratum was recorded by another crew member on a specimen inventory sheet. Here, a separate sheet was prepared for each stratum within the 20cm spit, this time numbered with Roman numerals starting with (Stratum I) from the top of the spit in each case. The sediment description given was generally shorter than that in the Level Report Form and seldom replicated it. However, it remains a relatively simple task to match the two records, thanks to the standardized depths used in both systems.

A third independent description of each stratum occurs in the pit profile records. All four sections exposed in the walls of each pit were drawn onto graph paper at a scale of 2ins to 1m. Strata were again described in these drawings, usually by a third crew member whose descriptive terminology frequently differed from the keepers of the other two records. Furthermore, this third observation took place some time after the previous two when deposits had invariably begun to dry out with inevitable changes in shade, color, and hardness. The correlation of pit sections with the other two sets of records sometimes poses problems, particularly in pits with severely disrupted stratigraphy and in those where pit walls were dismantled before recording so that graves or house floors could be expanded.

Records of such features (graves, house floors, pits) can be readily tied into the first two records, but some difficulties arise when pits or graves were in the center of the excavations and were not sectioned by the wall profile.

Record Correlations for Individual Pits

For clarity's sake, each of the pits has been labelled A through Y (Fig. 2-2)[2]. Discrete sedimentary units recorded in the four sections of each pit have been numbered, starting with 1 for the topmost layer. Where a particularly thick layer has been subdivided into arbitrary 20cm spits, each spit has an additional lower-case letter starting with a. Thus, B4c is the third spit down taken from the fourth layer down in Pit B (Fig. 2-4).

What follows is a summary of the way each pit was excavated and recorded. Original descriptions of strata are given verbatim in the captions in the following order: pit sections (PS), level report form (LRF) and inventory (I), followed by brief notes on discrepancies. Supplementary descriptions from the Radiocarbon records (RR) are added where available.

Some Observations on the Procedures

This section contains a few remarks--based on the wisdom of hindsight--on the sampling, excavating, and recording procedures. The sampling strategy probably reached about two-thirds of the site and was therefore fairly successful in attaining its main objective. Although the pit layout must have approached the natural rim of the site in the west (Pits K and L yielded relatively little cultural debris), all other perimeter pits are both deep, rich and of complex stratigraphy. It can be fairly stated that the layout reached the larger part of the site's interior, but less of its rim--particularly to the north. Exactly how much of each stratum in the site was sampled is, of course, unknown.

The excavations tended to concentrate too rigidly on the maintenance of a 20cm spit system. Less experienced pit supervisors and/or excavators tended to fall back on arbitrary levels when the stratigarphy became more complex. However, actual cases of accidental mixing were reltively few and were concentrated in the complex sand and basalts with intercalated brown loam lenses. Firmer stratigraphic control could have been maintained by following individual strata in a trenching or stripping procedure. Instead, each crew was forced repeatedly to come down "blind" on the underlying layer without forewarning of its dip and strike. Consequently, some layers such as V3 or Y7 were split horizontally when they were later seen (in section) to be foreset beds. Broad areal coverage of the site was achieved therefore, at the cost of some stratigraphic control.

Lack of standardized terminology for color and texture of sediments has impaired geological correlations of pits. Terms such as fill, soil and loam were used interchangeably and color definitions vary widely. Given the crucial importance of the pit correlations to the rest of the analysis, literally everything depends on the precision of the terms used and the extent to which different recorders and supervisors are calibrated to see the same sediments. If sampling strategies of this type are to be repeated elsewhere, it is recommended that descriptive procedures be planned in advance and rigidly maintained during excavations.

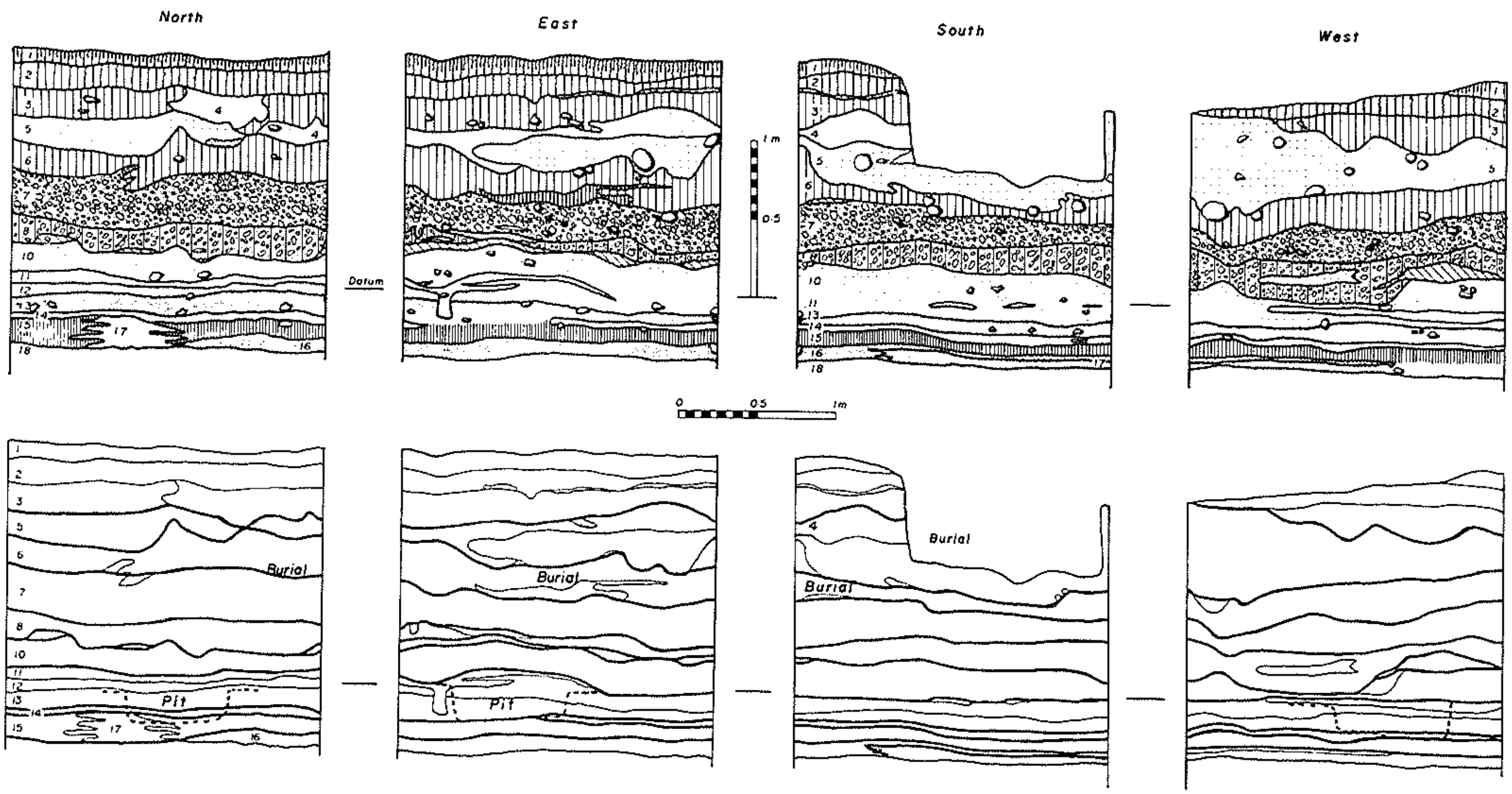


Fig. 2-6 Pit A: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. sod (PS), heavy sod (LRF), surface level (I)

2. brown humic, many roots - thin gray layer in SE at base (PS, LRF), surface level (I).

3. brown humic (PS,LRF), surface level (I). 1-3 excavated as one unit.

4. white (PS) no record (LRF, I).

5. gray (PS), gray loam (LRF), brown humus (I).

6. tan humic filled & light lenses (PS), brown loam (LRF), no record (I).

7. dark sand - some fused (PS), black gravel - some rocks (LRF), soil: black gravel (I).

8. mottled brown clayey (PS), black gravel and brown sandy gravel mixed (LRF, I).

9. yellow silty clay (PS), while clay floor (LRF, I).

10. gray organic clay (PS) dark gray clay & rock - friable white clay lenses (LRF, I).

11. silty clay (PS) white clay living surface (LRF,I).

12. gray organic clay (PS), darker soil (LRF) no record (I).

13. dark gravelly yellow-mottled clay, gray organic clay (PS) no record (LRF,I).

14. silty clay floor (PS) clay living surface (LRF) no record (I).

15. dark clay, gray organic clay (PS) dark gray sandy clayey with rocks (LRF) no record (I).

16. line of dark gray (PS) dark gray clayey sand (LRF,I).

17. dark gravelly yellow-mottled clay, gray organic clay (PS) no record (LRF,I)

18. sterile clay (PS), light gray clay (LRF,I).

Color discrepancies in records for 5 through 9 all show lighter shades in the pit sections (PS). Drying of exposed sediments before sections were drawn probably explains this.

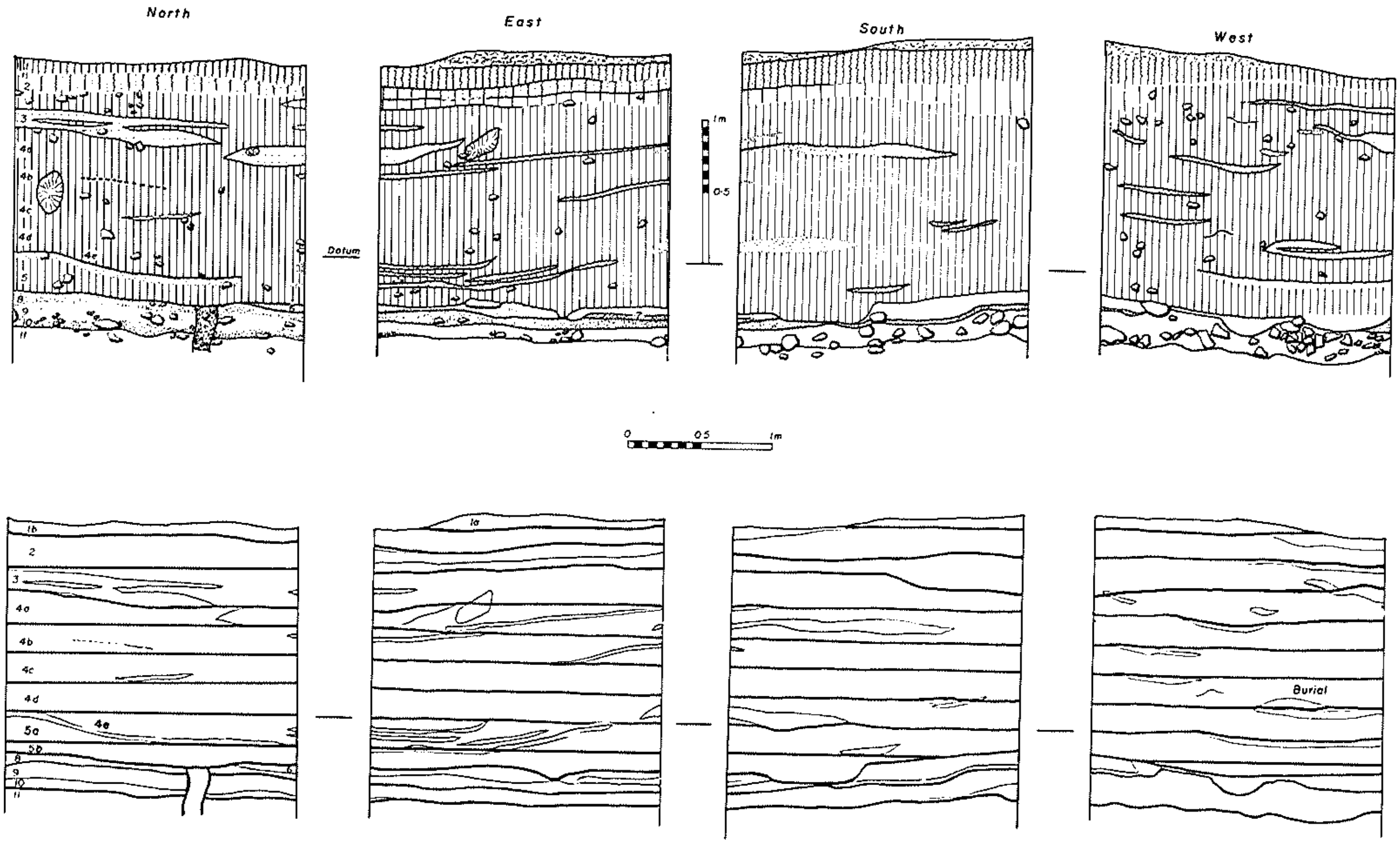


Fig. 2-7 Pit B: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1a. loose topsoil (LRF, I) no record (PS).

1b. grass roots over gray sod or brown-gray sod (PS) dark brown sod (LRF) sod (I).

2. gray sod, brown-gray sod with lenses of light tan or tan-brown mottled sand (PS) dark humic soil (LRF) sod (I).

3. brown-gray sod with lens of friable white sand in north face (PS) dark humic soil (LRF, I).

4ab. brown humus-stained soil with lens of gray sand in northeast (PS) dark humic soil (LRF, I).

4cd brown humus-stained soil with lenses of gray sand (PS) dark humic soil with several small lenses of ash (LRF, I).

4e. lenses of gray sand (PS) dark humic soil (LRF, I).

5. no record (PS) dark humic soil above floor (LRF, I).

6. duck muck (PS) hard-packed clay floor (LRF) habitation floor (I). Two postholes - fill not described.

7. white sandy clay (PS) in and below hardpacked clay (LRF, I).

8. gray clay (PS) no record (LRF, I).

9. duck muck (PS) duck muck with rock inclusions - very little duck bone (LRF) duck muck in and above clay (I).

10. blue-gray clay in north face only (PS) no record (LRF, I).

11. gray clay (PS) sterile clay (LRF) no record (I).

Layer 4 was removed in arbitrary 20cm spits. Separation between layers 4e and 5 is also arbitrary. Layers 6-8 removed as one unit. The posthole fills were removed as separate units. The large rodent burrows lacked any fill. The term "duck muck" elsewhere denotes a black organic sandy clay with yellow mottle and abundant waterfowl bones.

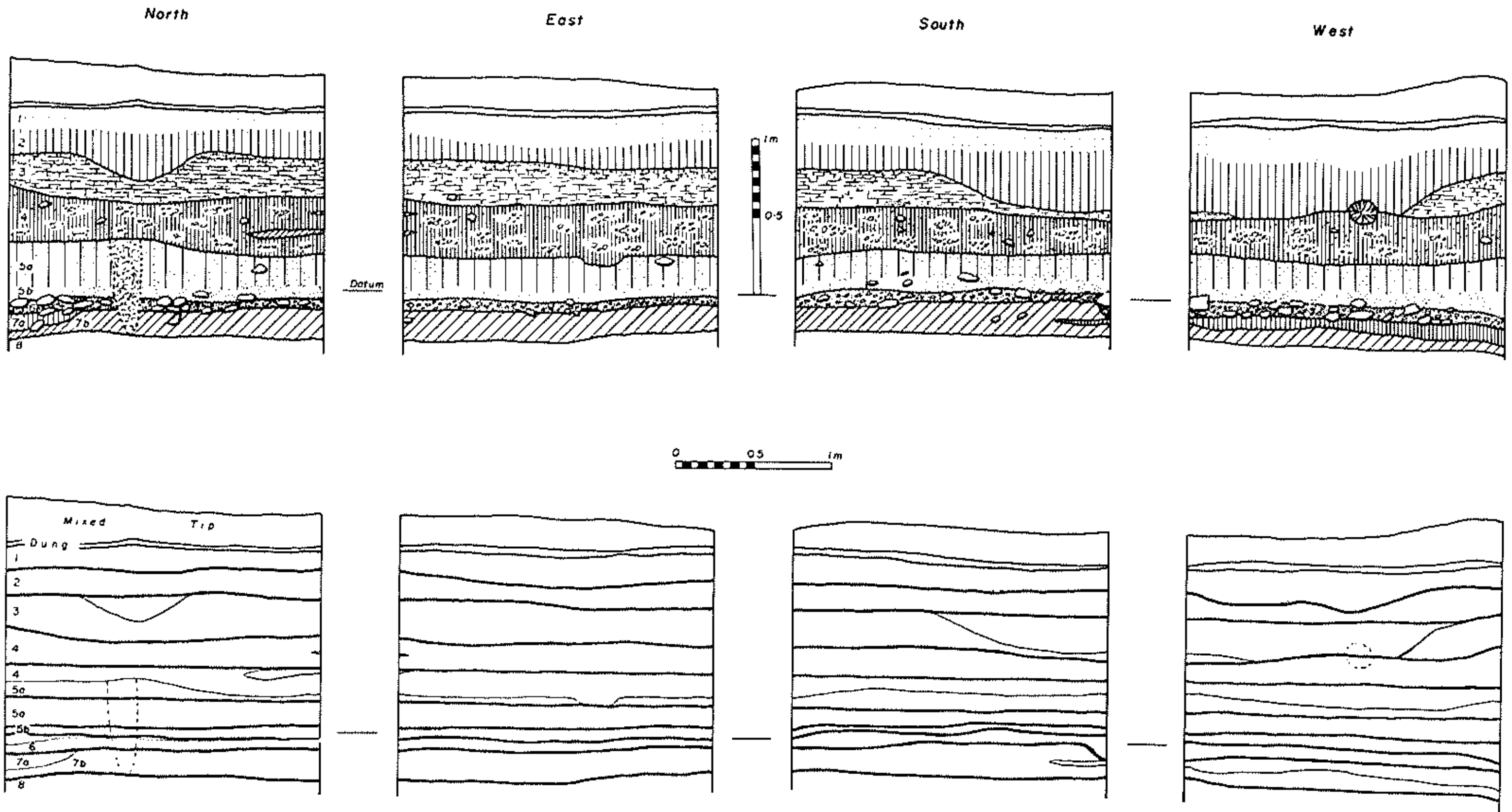


Fig. 2-8 Pit C: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. gray loam (PS) light gray friable material (LRF, I).

2. brown-loams, dark brown organic loam (PS) light-gray friable material (LRF, I).

3. platy hardpan (PS) black sandy gravel (LRF, I).

4ab laminated brown very hard clay tan lenses in northeast (PS) black sandy rocky soil partly cemented (LRF, I). Old surface at 4b/5a with posthole in north face - dark fill.

5a. brown-gray silty organic clay (PS) brown and rock rubble (LRF, I).

5b. ditto (PS) gray sand and rock rubble (LRF, I).

6. friable sand and basalt (PS) gray sand, very rocky - rocks get bigger as stratum goes down, top few centimeters generally rockless (LRF, I).

7a. brown clay (PS) dark gray clay (LRF, I).

7b. tan clay (PS) dark gray clay (LRF, I).

8. gray clay (PS) dark gray clay (LRF, I).

Although stratum descriptions match up by recorded levels, some of the discrepancies in descriptions are not easily explained. Layer 2 presumably darkened as it dried out. Layers 3 and 4 probably calcified after exposure - "the gravel" recorded during excavation may have been caliche chunks. Desiccation probably also caused the color changes in 7. There was accidental mixing of Layers 4-5a and 5b-6 during excavation. The original surface of Layer 1 is overlain by cattle dung and fine brown soil and roots - probably sod from a nearby bulldozer cut.

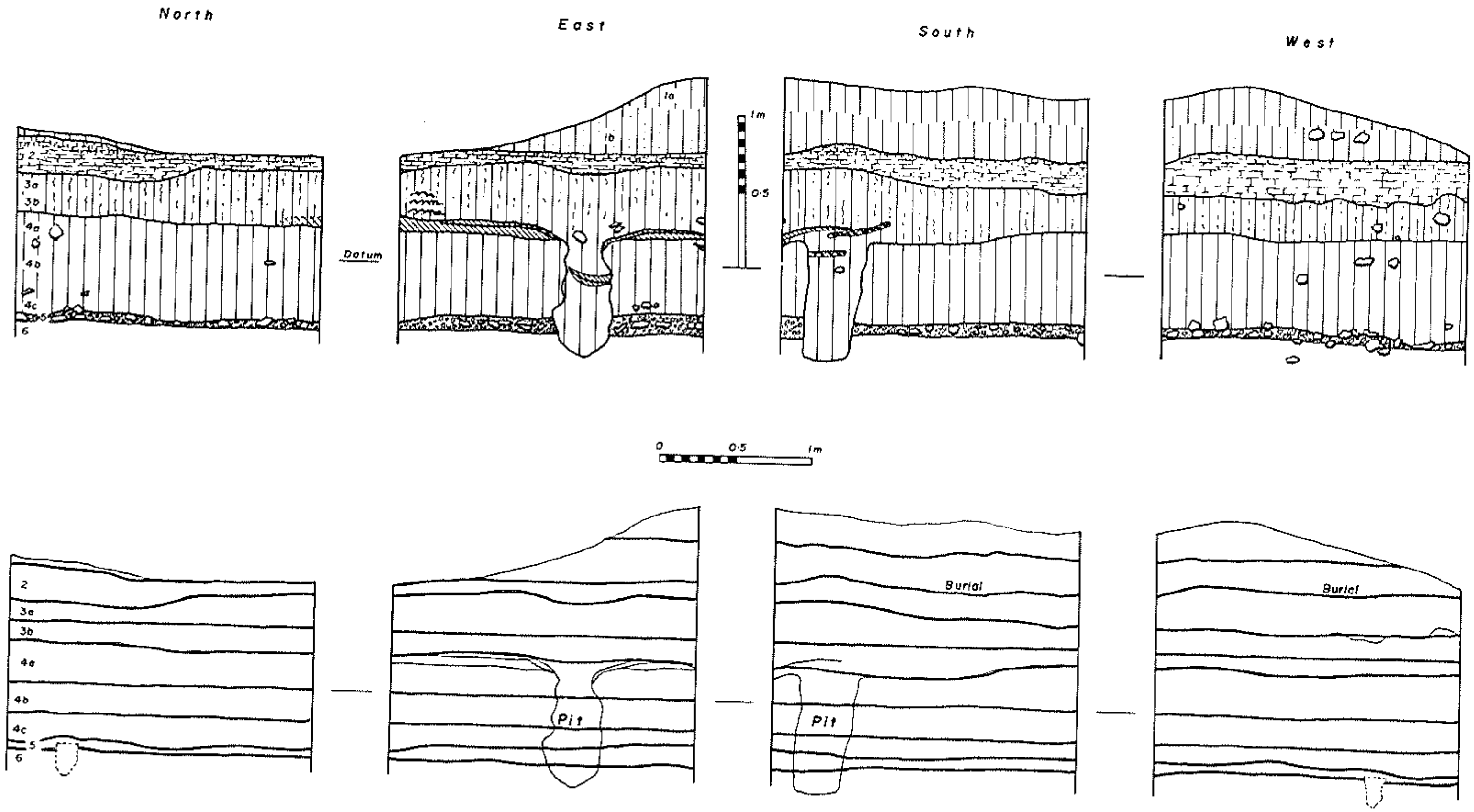


Fig. 2-9 Pit D: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1a. brown younger loam (PS) very fine light brown dusty soil with very little intermixed basalt (LRF,I).

1b. gray younger loam (PS) same as 1a (LRF, I). Northeast cut by bulldozer.

2. platy duripan, drawn as pisolitic at top (PS), platy hardpan (LRF). Penetrated by burial pit.

3a. no record (PS) dark humus-stained soil with intermixed basalt, rust colored mottled intrusions oriented vertically (LRF,I).

3b. no record (PS) dark humus-stained sandy soil with charcoal staining and rust colored vertical inclusions - shell concentrations (LRF), same as 3a - two shell concentrations (I).

4a. sandy loam capped by orange layer in east face (PS) dark sandy loam with intermixed grass roots and some basalt (LRF,I).

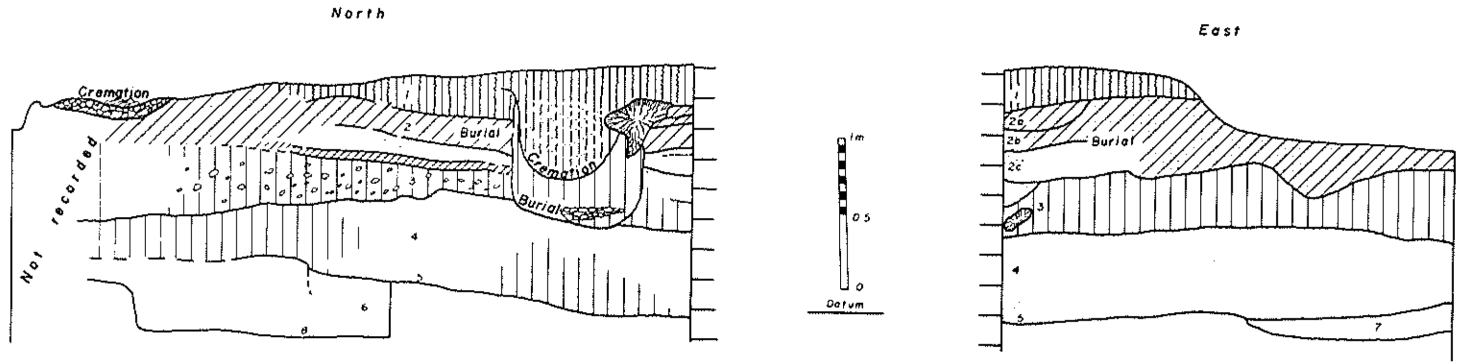
4b. sandy loam (PS) dark humus-stained sandy soil with less basalt and carbon than previous level; intermixed with grayish clay (LRF, I).

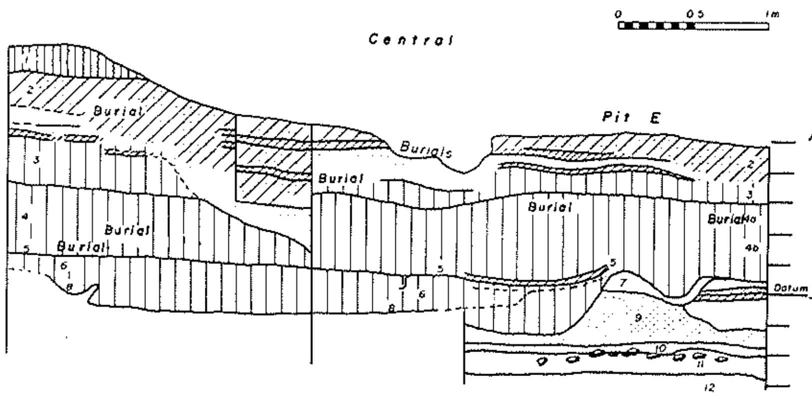
4c. no record (PS) dark humus-stained clayey soil with increasing basalt (LRF), gray clay and intermixed sand and increasing basalt (I).

5. friable sand and basalt (PS) very rocky friable limonite stained sand (LRF) very rocky yellowish sand with some carbon (I).

6. no record (PS) gray clay and carbon penetrated by posthole (LRF) light gray clay (I).

The large pit sectioned in the north and east faces was excavated as a separate unit. It has orange laminations, possibly derived from the capping of Layers 4a. The posthole in Layer 6 was likewise excavated separately.





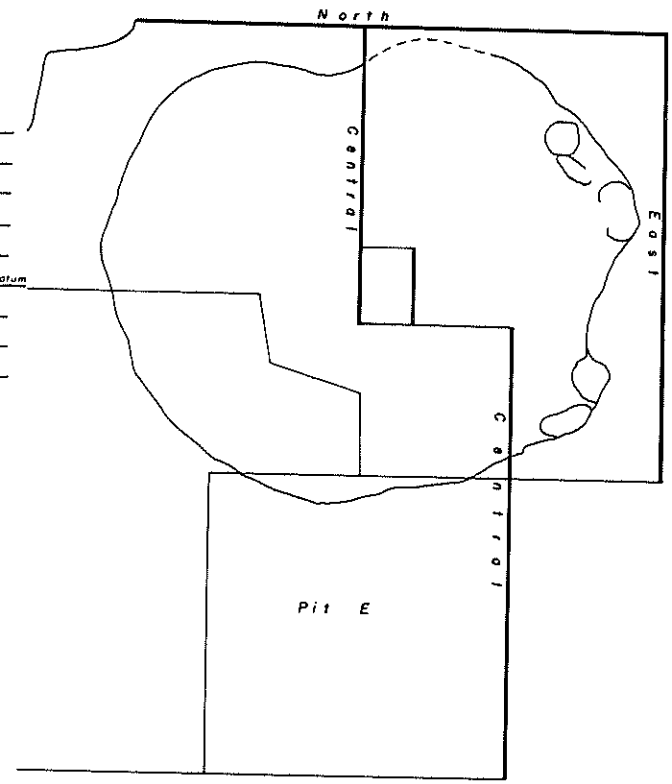


Fig. 2-10 Pit E: only the east face of the original pit was recorded. Bottom right plan shows the position of recorded sections in relation to the original Pit E after extended excavations to expose the circular pit house floor (5 on sections). Geological sections include north and east faces of the extension cuttings with the pit house floors (5 and 8) projected on each face. The central face (bottom left) is a composite section including the Pit E east face. Only the burials and cremations actually sectioned are included in these diagrams, but several others were recovered during excavation. 1 Brown-black loam truncated by bulldozer cut, 2a light tan loam, 2b tan-gray sandy loam, 2c off-white or gray loam with tan silty clay lenses, 3 brown or brown-black loam, rocky in north face, 4 brown-black silty clay, with yellow mottled "duck muck" in northeast area, separated from 3 in central area by compact floor, 5 rim of large circular pit house, 7 white, yellow and gray clay lining of lower pit house floor and margin, projected on to north section, 8 pithouse floor - dark gray charcoal - and white clay-flecked sandy clay, 9 dark gray-black clay, 10 gray clay, 11 black silty clay with yellow sand and basalt rocks in upper part, 12 basal light gray clay.

All descriptions (PS) no record (LRF, I).

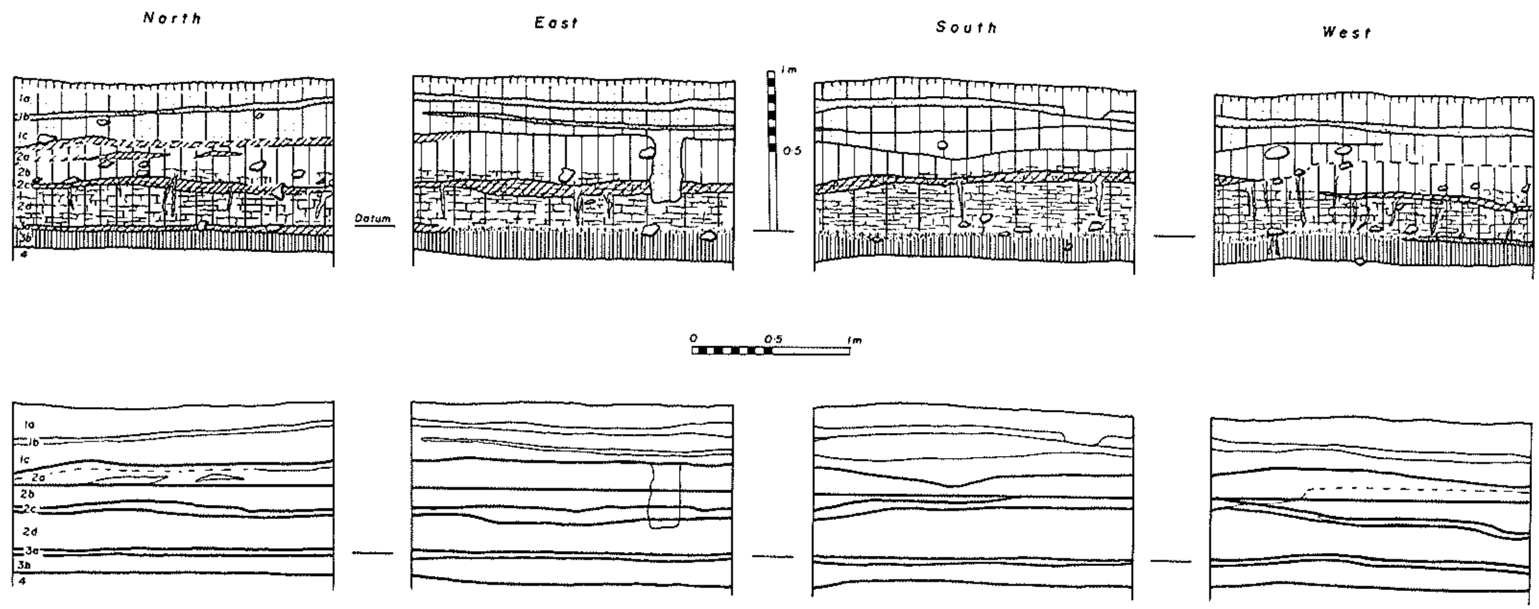


Fig. 2-11 Pit F: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1abc. gray loam with light and dark laminations (PS) surface (LRF, I)

2a. same as 1 (PS) light brown very fine soil (LRF, I).

2b. brown sandy silty clay with tan laminations (PS) rocky light brown soil, some hardpan (LRF,I).

2c. same as 2b (PS) tan clayish (LRF) no record (I).

2d. same as 2b (PS) light tan clayey duripan (LRF) tan soft duripan (I) base cleared as a sandy surface with some basalt.

3a. dark brown laminated clay (PS) dark humus-stained sandy soil (LRF,I).

3b. same as 3a (PS) dark brown humus-stained clayish soil (LRF, I).

4. gray clay (PS) gray clay with carbon (LRF) gray clay (I).

The post-hole was not excavated as a separate unit.

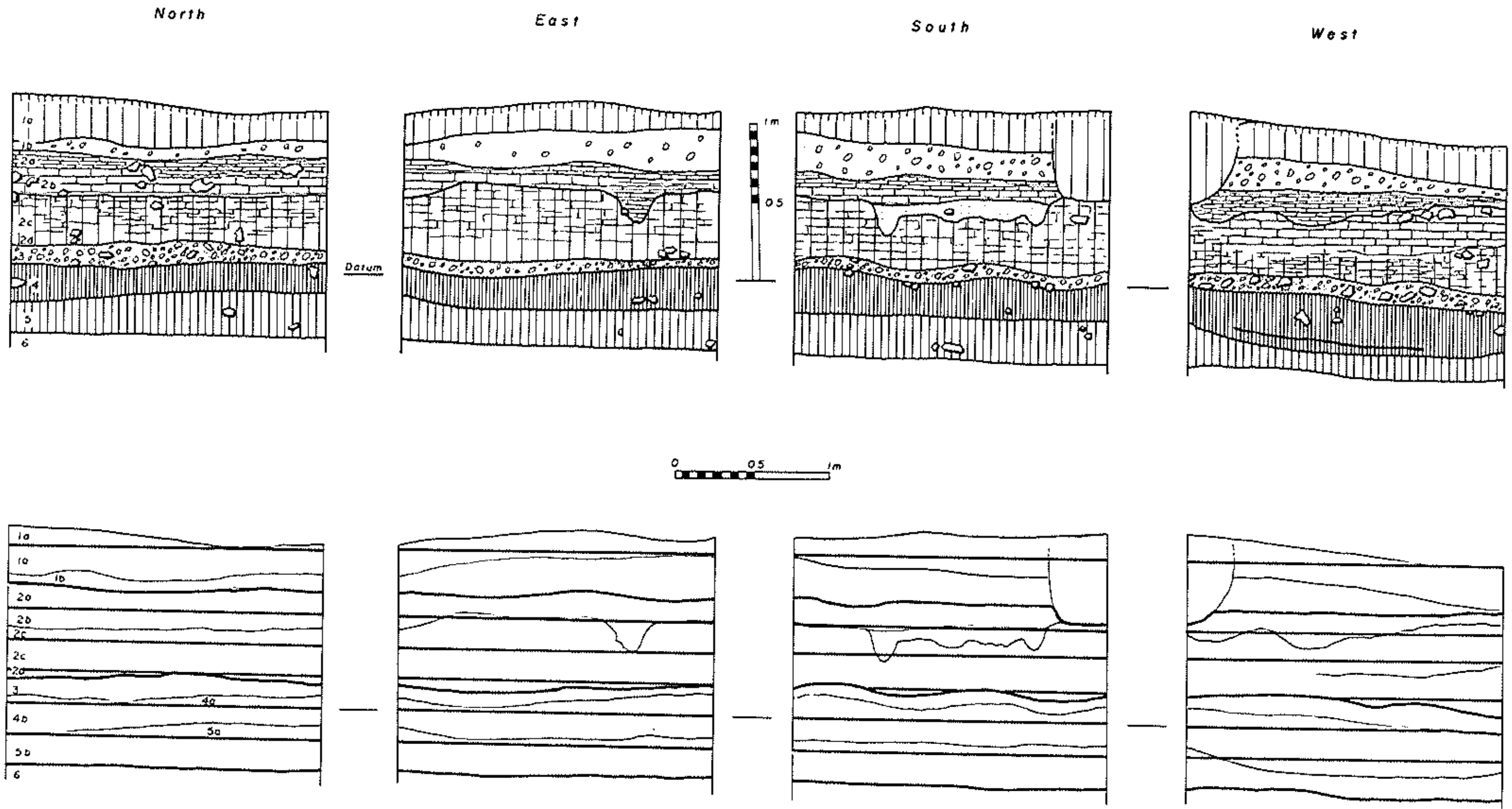


Fig. 2-12 Pit G: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1a. brown loam (PS) fine brown loam (LRF, I) excavated in two spits.

1b. gray loam (PS) silty tan-brown sandy soil and small basalt rocks (LRF,I).

2a. platy duripan, drawn as pisolitic (PS) intensely hard dark brown hardpan and basalt rocks (LRF) brown very hard hardpan (I).

2c. duripan (PS) hardpan softens to mottled brown hardpacked soil (LRF, I).

2d. duripan (PS) brown silty soil (LRF) brown soil (I).

3. friable sand and basalt (PS) black/upper friable sand and basalt (LRF) brown friable sand and basalt and charcoal (I).

4a. dark brown silty organic clay (PS) black sandy clayey soil (LRF,I).

4b. same as 4a (PS) dark black clay (some sand) charcoal, humic stained (LRF), dark brown humus stained clayey (I). A thin black lens was sectioned in the west face.

5ab. light brown silty organic clay (PS) tan charcoal-flecked clay (LRF) no record (I).

6. gray sterile clay (PS, LRF) gray clay (I).

Color-differences reported for 3-5 probably caused by drying out of exposed deposits. Rigid adherance to 20cm spits may have caused slight mixing of lab. 2bc and 4b-5a.

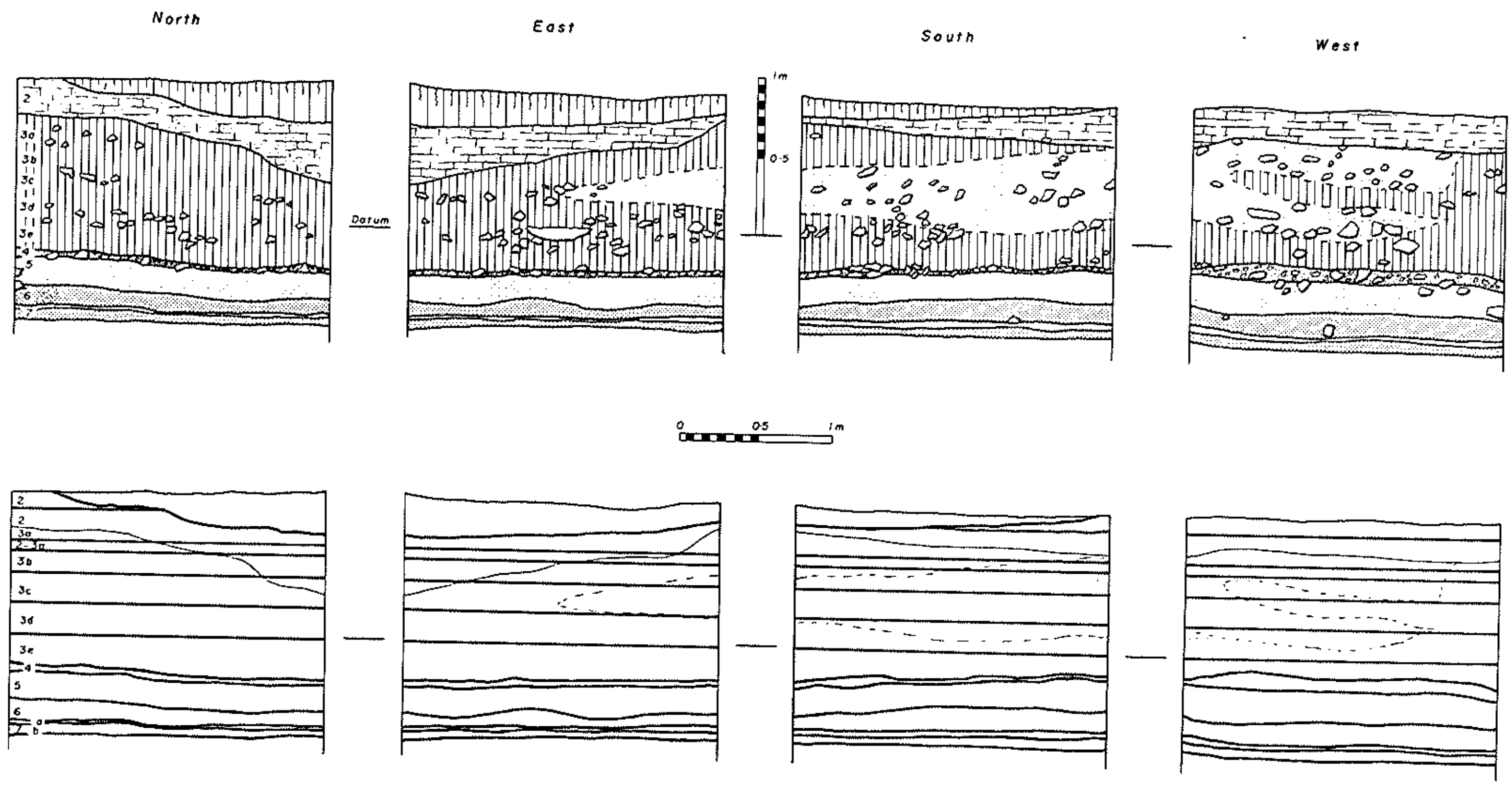


Fig. 2-13 Pit H: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. brown fine silty soil (PS) brown organic topsoil (LRF) brown surface dust (I).

2. gray "soft" hardpan (PS) gray blue clay (LRF) blue-gray clay (I).

3a. brown humic loam, gray friable sandy silt in southwest faces (PS) friable brown clay and high rock content (LRF) no record (I).

3b. same as 3a (PS) friable brown soil and high rock content in northwest quarter and indurated soil in south half - asphalt (LRF) no record (I).

3c. same as 3a (PS) black soil and basalt, over yellow clayey soil, over sandy black soil and basalt chunks (LRF), basalt chunks and lumps of hardpanish soil in black soil, over yellow hard clayey, over black rocky sand (I).

3d. same as 3a (PS) sandy black soil and numerous basalt inclusions (LRF,I).

3e. brown humic loam (PS) no record (LRF, I).

4. friable sand and basalt (PS) duckless muck and numerous basalt inclusions (LRF, I).

5a. light gray silty clay (PS) no record (LRF) medium brown clay over medium gray clay (I).

5b. sandy light gray clay (PS) no record (LRF) light gray clay with waterfowl and charcoal (I) thin lens of organic staining (PS) no record (LRF, I).

6. dark gray clay (PS) medium brown clay (LRF) same as 5b (I).

7a. thin lens of gray clay (PS) light sterile clay (LRF) same as 5b (I).

7b. dark gray organic clay (PS) brown sterile clay (LRF, I).

The yellow clay lens in 3c was not recovered in any of the pit sections. Contradictions in the descriptions below Layer 4 cannot be reconciled. The excavation did not reach the gray basal clay in this pit.

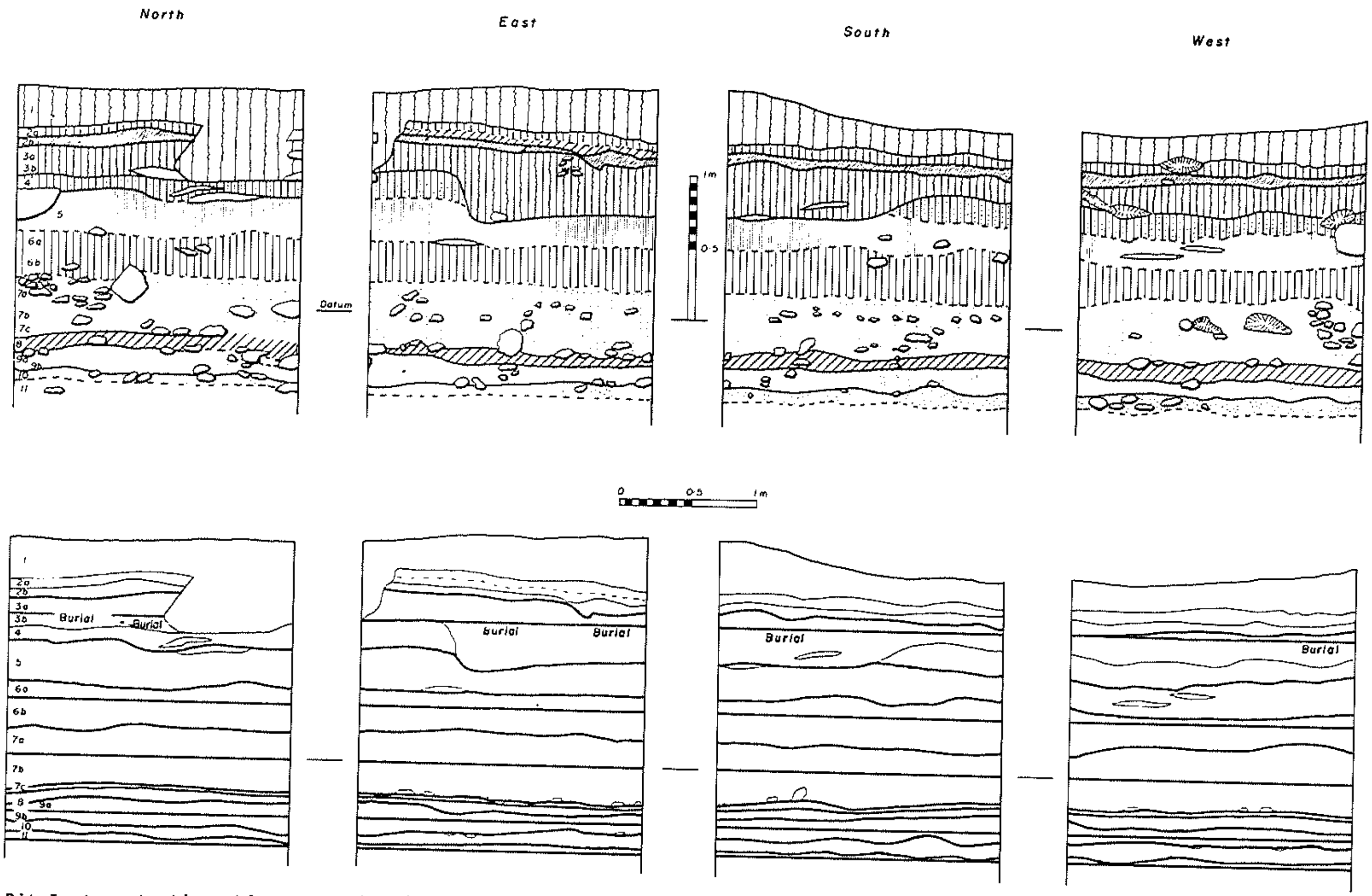


Fig. 2-14 Pit I: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. disturbed brown sand with wooden fence post fragments in cutting in northeast corner (PS) no record (LRF, I).

2a. hard brown fibrous sand (PS) no record (LRF, I).

2b. compressed organic matter (PS) no record (LRF, I).

3a. dark brown humus soil with tan sandy laminations (PS) dark humus-stained soil (LRF) no record (I).

3b. same as 3a with white fibrous lenses in southeast (PS) friable with carbon, some sand (LRF) no record (I).

4. light gray-brown very hard chunky laminated clay (PS) very hard compact carbonized soil (LRF) no record (I). Penetrated by burial pits in southeast.

5. black-brown laminated clay - very hard (PS) very hard, with interspersed carbon chunks (LRF) no record (I).

6ab. black-brown humus and charcoal-stained sand and clay (PS) dark friable sand, much carbon, few rocks (LRF) no record (I).

7abc. dark gray sand with charcoal flecks (PS) dark humus-stained sand with basalt (LRF) no record (I).

9. mottled clay with waterfowl bone (PS) duck muck, few duck bones (LRF) duck muck (I) organic brown clay with waterfowl bones (RR).

10. gray clay with debris (PS) gray clay with intermixed basalt (LRF) gray clay (I,RR).

11. gray clay (PS, LRF,I).

Layers 3b and 4 were not excavated as separate units.

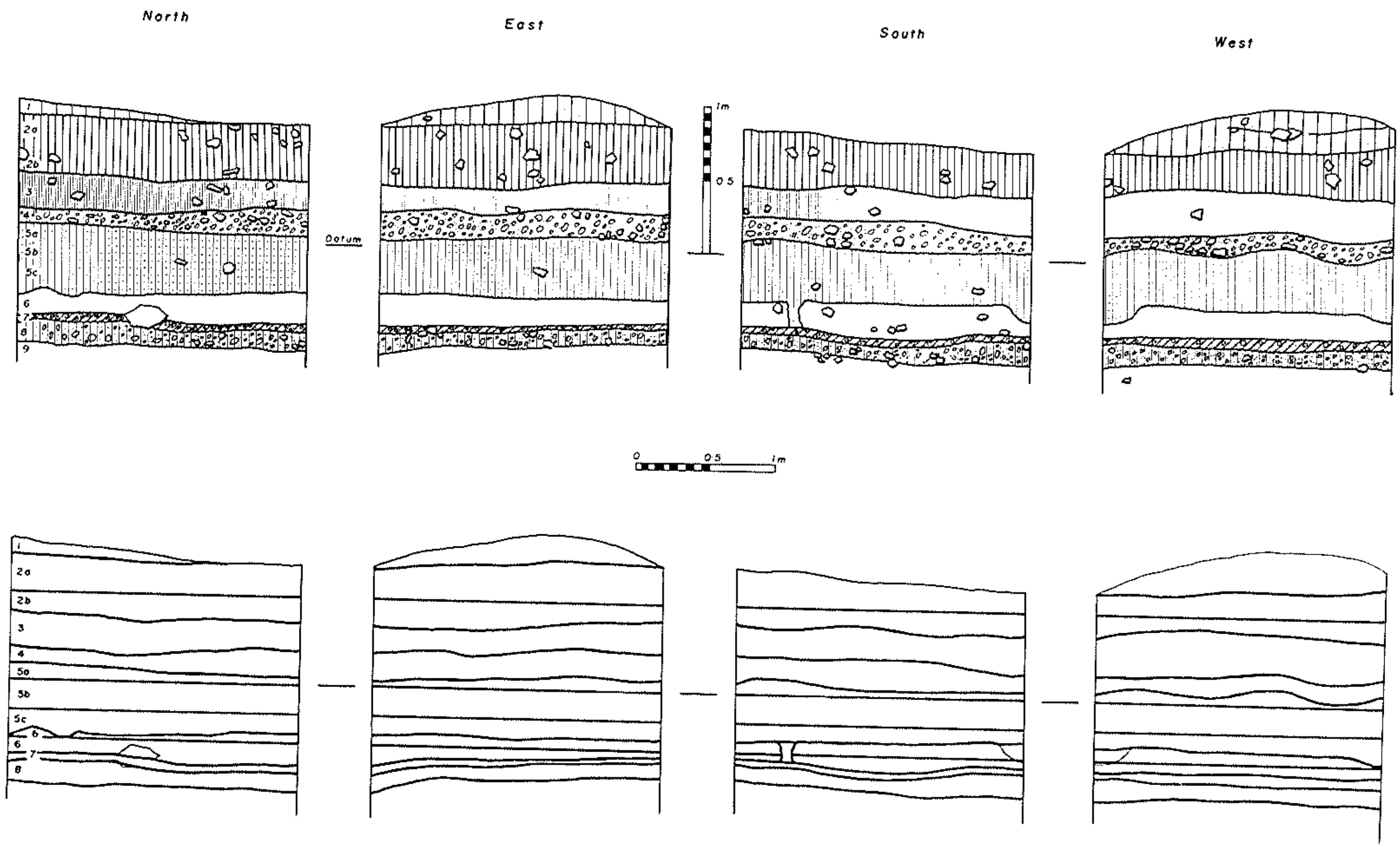


Fig. 2-15 Pit J: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. light brown sandy loam with black lens in west section (PS) dark humic soil, many rocks, several patches of orange-brown stained soil, large patch of concentrated fish remains (LRF) no record (I).

2a. brown loam (PS) dark humus-stained soil with lenses of sand and fish debris and inclusions of rocks (LRF) dark brown humic soil (I).

2b. same as 2a (PS) black-brown highly humus-stained soil, pea-size gravel abundant and many angular cobbles (LRF) dark humic stained soil (I).

3. brown silty clay with tan laminations (PS) blackish sandy fill with pea size gravel and angular cobbles (LRF) dark humic-stained (I).

4. gray silty friable sand and basalt (PS) very sandy black gray fill with many angular cobbles (LRF) rocky black earth (I).

5ab. brown sandy silty clay (PS) dark gray clayey sandy fill and lenses of light gray sand, white and yellow sand patches (LRF) grayish-black charcoal-flecked compact clayey fill with occasional golden-yellow sand (I).

5c. same as 5ab (PS) black clayey sandy fill with lenses of light and dark gray sandy fill and small pockets of yellow material (LRF) black and gray sandy fill (I).

6. white fibrous organic clay with some yellow stain (PS) white clayey floor with red flecks and golden to brassy yellow patches, over white clay (LRF) white clay with yellow staining (I).

7. yellow stained friable sand (PS) golden sandy and very rocky fill (LRF) yellow stained sand with rocks (I).

8. brown organic silty clay (PS) rocky black sandy soil with areas of yellow stained sand (LRF) charcoal filled spit (I).

9. gray silty clay (PS) dark gray clay over light gray clay (LRF) gray clay over light medium gray clay (I)

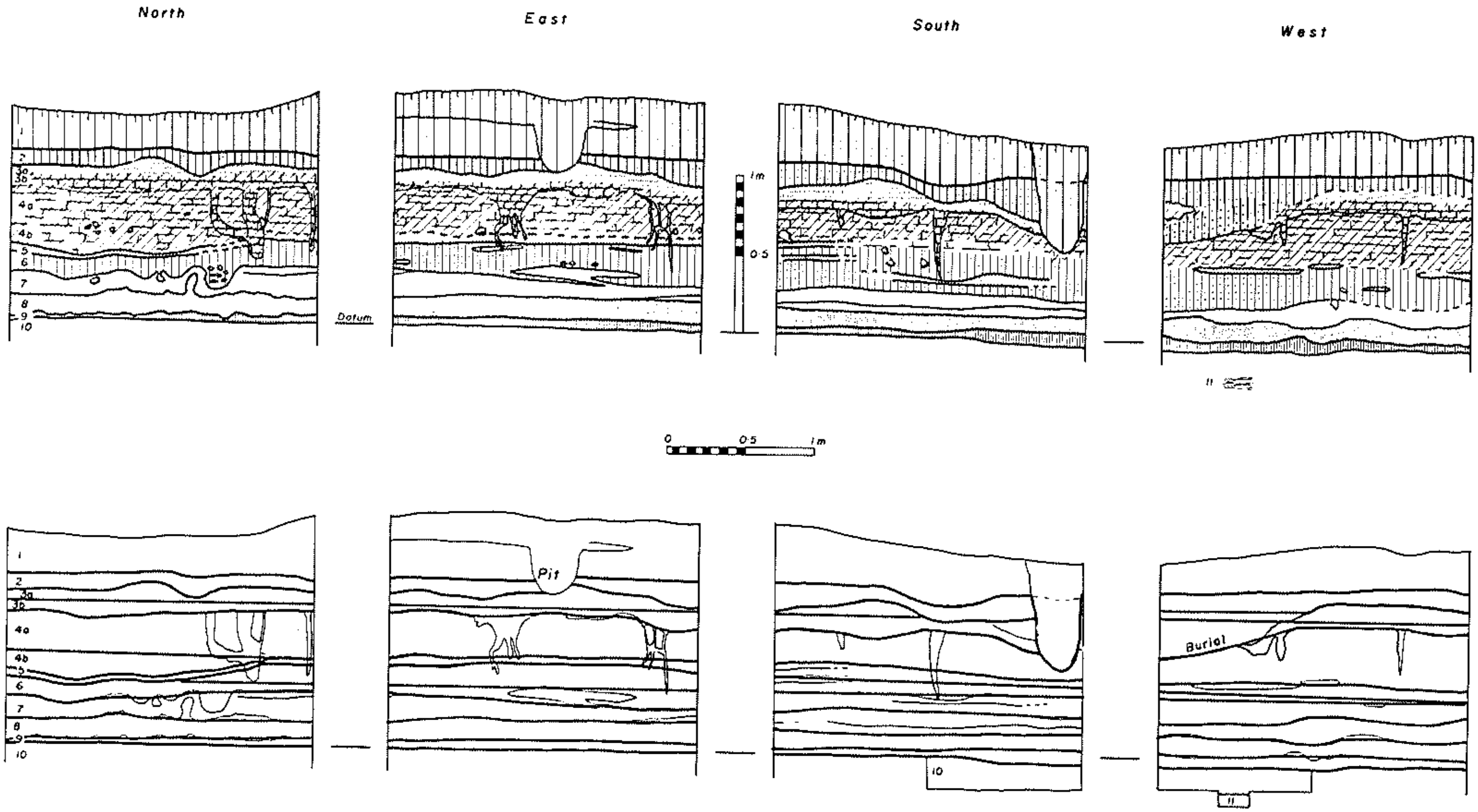


Fig. 2-16 Pit K: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. loam (PS) very fine dusty brown-gray soil (LRF, I).

2. same as 1 (PS) very dry fine dusty soil (LRF, I). Penetrated by pits in east and southwest.

3a. platy structure - represents lowest extent of rootlets (PS) very concentrated pea-size gravel over hardpan (LRF, I).

3b. same as 3a (PS) very hard tan hardpan and little basalt (LRF, I).

4ab. tan silty clay with organic matter (PS) tan hardpan and some basalt, slightly softer near bottom (LRF, I).

5. light colored silty clay lens (PS) no record (LRF, I).

6. brown fine silty clay (PS) dark brown-gray humus-stained clay soil (LRF, I).

7. tan silty clay (PS) yellowish white sandy clay (LRF) yellow peat (I).

8. brown fine silty clay (PS) gray-brown clay and no basalt, mottled yellowish discolorations, some duck bones (LRF) brown-gray mottled clay (I).

9. light colored silty clay (PS) no record (LRF, I).

10. brown laminated organic clay (PS) gray-brown, no basalt (LRF) organic laminated clay (I).

11. thinly laminated sterile silty clay (PS) no record (LRF) gray sterile clay (I).

It is not clear from the records that Layers 4b and 5 were in fact excavated separately as shown.
The surface of Layer 11 was reached in a small pit in the west section only. The burial was not removed as a separate unit.

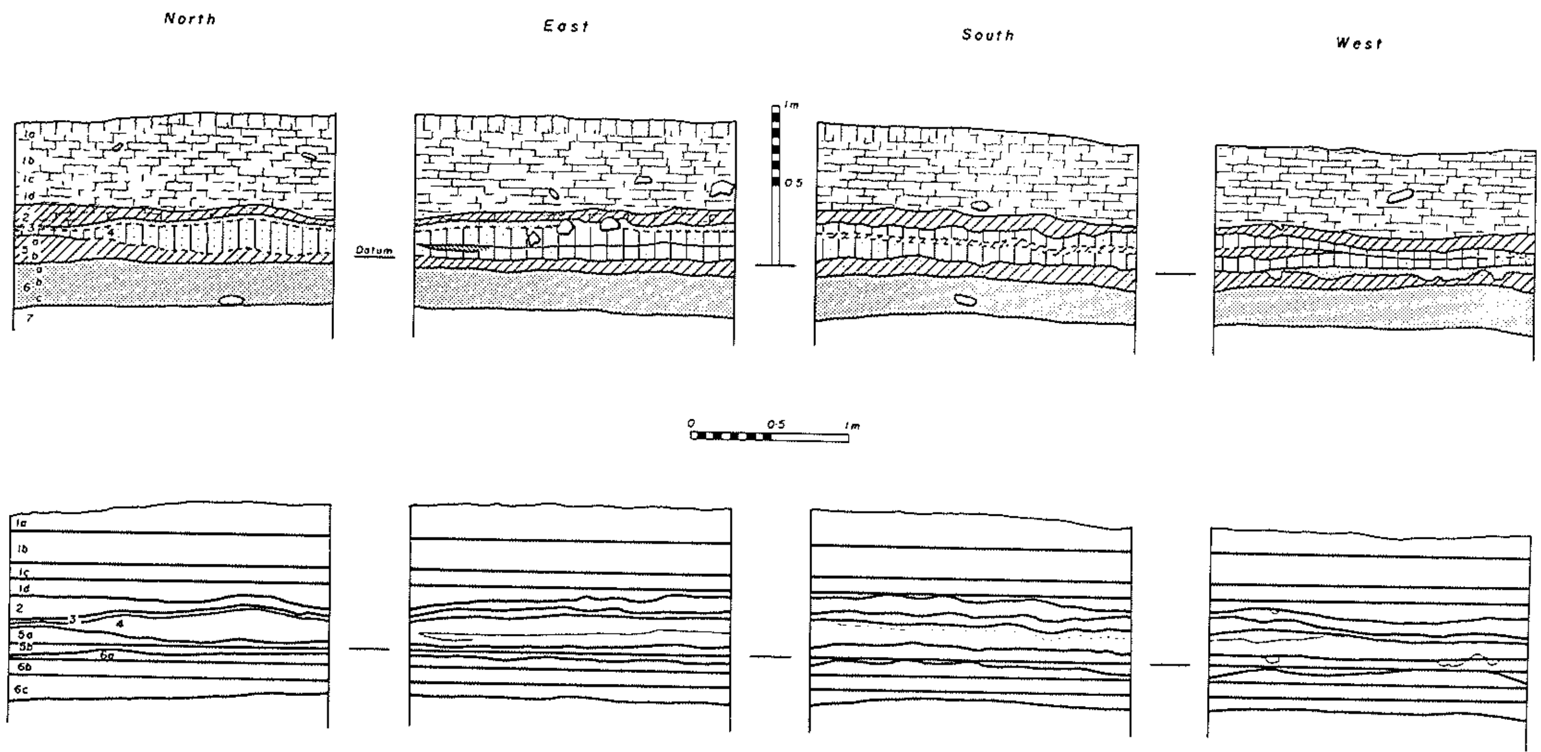


Fig. 2-17. Pit L: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1a. Surface of gray hardpan (PS) dark brown to black hardpan (LRF) hardpan (I).

1b. gray hardpan (PS) hardpan, variegated gray, brown, black, orange (LRF) hardpan (I).

1c. same as 1b (PS, I) hardpan dark brown mottled black and gray, grayer with depth (LRF).

1d. same as 1b (PS) brown-black gray mottled fill (LRF) hardpan mottled gray (I).

2. friable tan sandy clay (PS) tan fill (LRF) tan hardpan (I).

3. black band in gray brown soil (PS) black-brown fill (LRF) black-brown fill (I).

4. brown-black soil with thin red sand lens in east face (PS) black-brown fill grading into grayish (LRF) black brown grayish hardpan fill (I).

5ab. tan clay, gray in west face (PS) mottled grayish tan fill clayey (LRF, I).

6ab. laminated brown-black soil with tan lenses (PS) dark gray clayey fill, mottled, charcoal flecks, pea-size stones, bird and fish bone (LRF) dark gray clay (I).

6c. tan and black laminated (PS) banded gray clay grading from dark to light gray (LRF) mottled and banded dark and light gray clay fill (I).

7. gray clay (PS) no record (LRF, I).

Arbitrary excavated spits subdivided Layers 2,5 and 6.

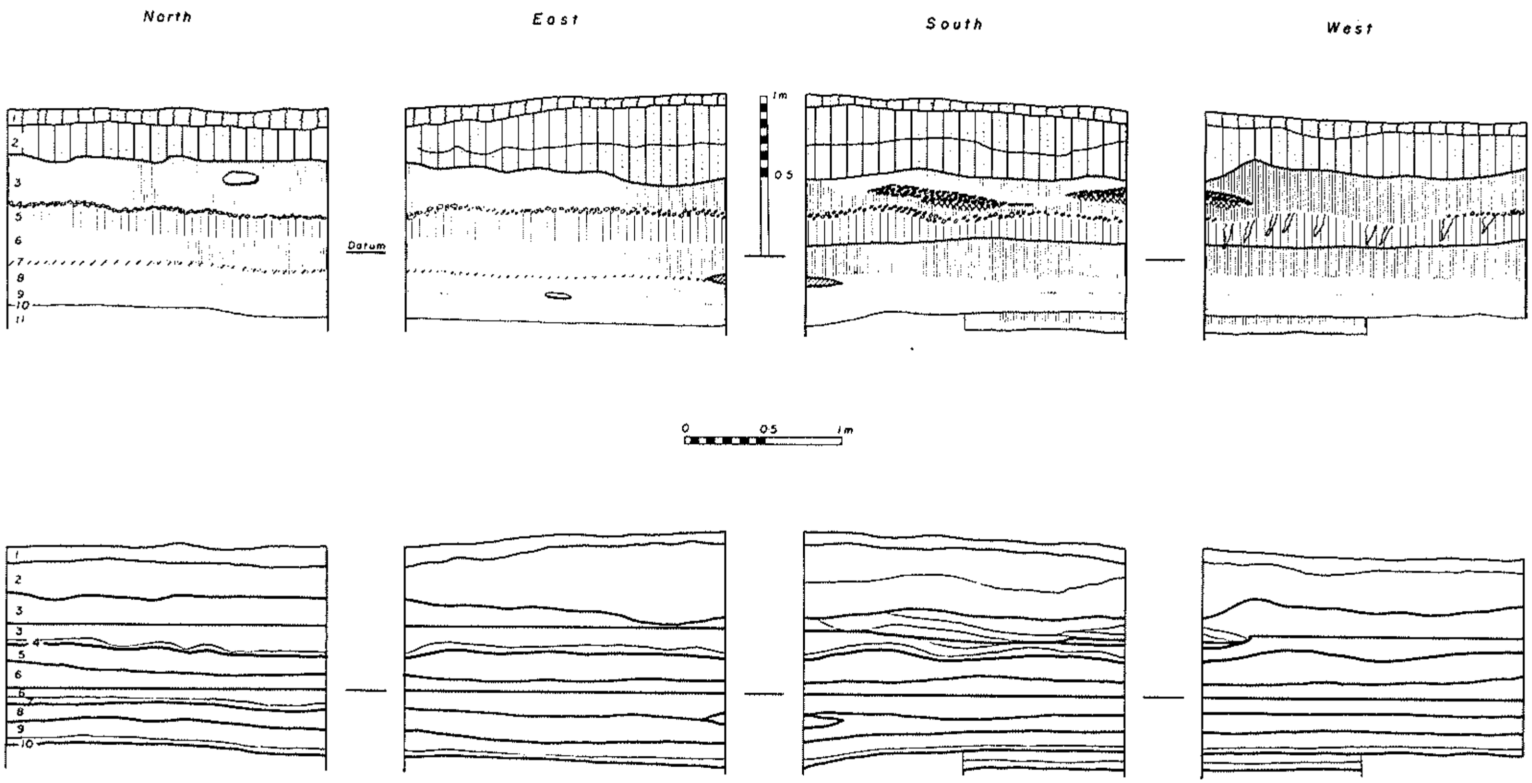


Fig. 2-18 Pit M : top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. topsoil-brown (PS) sod with tan-gray soil, ashy (PS) extremely hard dark brown cemented layer and few egg-size angular rocks (LRF) no record (I).

3a. brown very hard laminated clay with lenses of charcoal stained soil over very hard pink clay in southwest (PS) dark brown cemented soil over dark brown clayey soil, very hard, with cream-colored pea-size clay nuggets and lenses of tan burned soil (LRF) charcoal over possible occupation surface (I).

3b. brown very hard laminated clay (PS) very hard matrix of brown clays with nuggets of cream-colored soil, charcoal and gray clay (LRF) no record (I).

4. concretions (PS) no record (LRF, I).

5. light brown very hard clay (PS) tan-brown soil, very hard (LRF) dark brown very hard soil with snails (I).

6a. dark brown very hard clay (PS) brown-gray clay and charcoal with small white lines (roots?) in broken chunks (LRF, I).

6b. same as 6a (PS) very hard compact brown clay (LRF) brown gray clay with charcoal (I).

7. yellow sand, very scarce basalt (PS thin yellow sandy layer (LRF) yellow sandy stain (I).

8. black-brown charcoal flecked clayey sand with waterfowl bones, very hard yellow sand/clay lens in southeast (PS) black brown clay with waterfowl bones, southeast corner rocky with clay lump (LRF) dark brown clay with heavy charcoal and some light sandy areas. Dark gray clay in southeast (I).

9. tan clay with charcoal lenses at top, inorganic (PS) duck muck, black brown clay and waterfowl bones (LRF) duck muck (I).

10. coarse cream-colored sand (PS) coarse creamy sand (LRF) no record (I).

11. brown clay over tan clay (PS) tan clay (LRF) light tan clay over sterile clay (I).

Layer 4 incorporated with Layer 3b. The charcoal and pink clay lenses in Layer 3 were excavated separately. Layer 7 was incorporated in Layer 6b. The clay lens in the southeast corner of 7-8 was excavated as a separate unit. Layers 9 and 10 were combined in excavation. The basal gray clay was not reached in this pit.

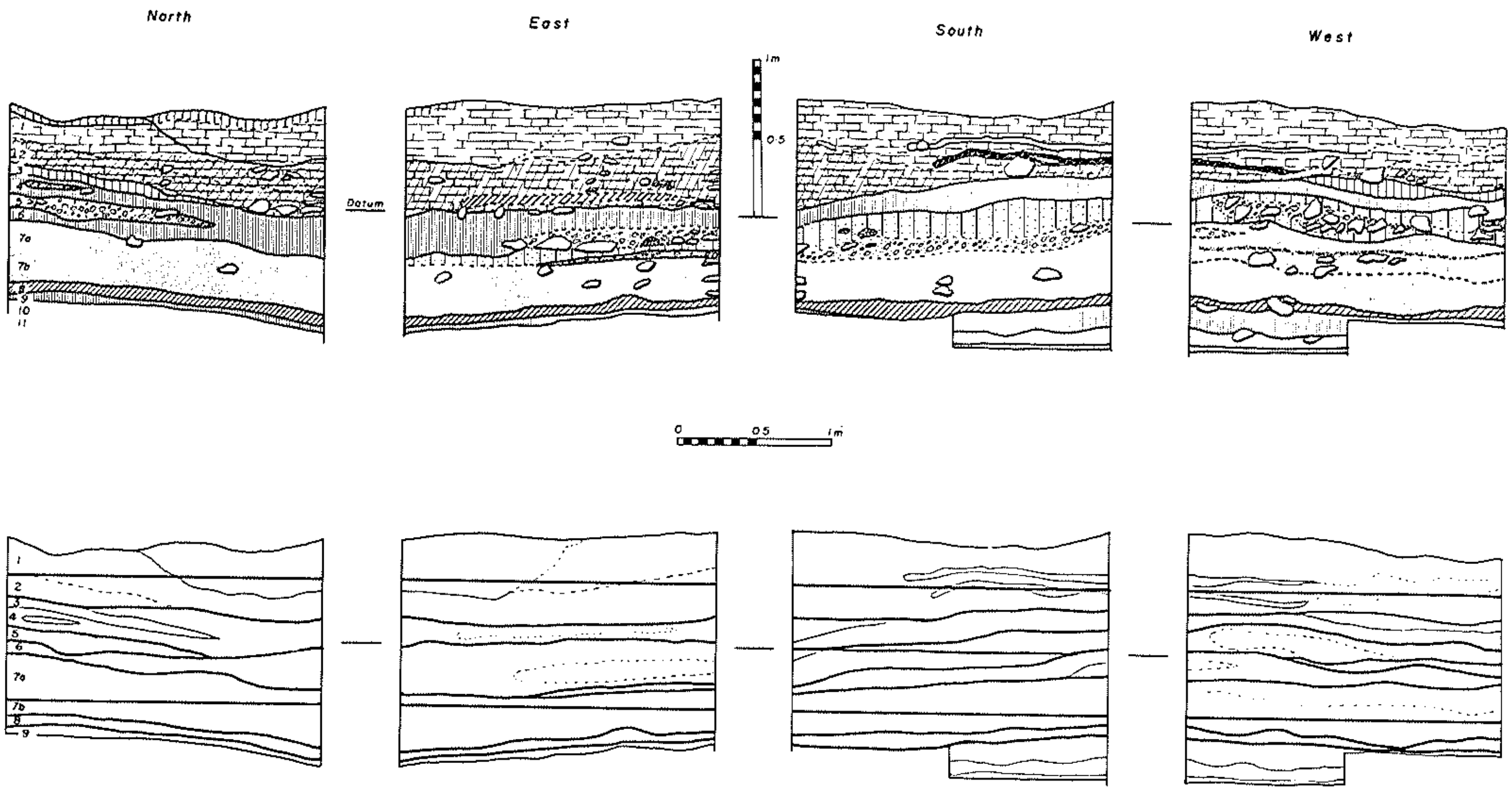


Fig. 2-19 Pit N: <u>top</u> stratigraphic profiles of the four pit faces; <u>bottom</u> the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. brown hard with white very hard layer in southwest sections (PS) highly cemented sandy gravel ?burned (LRF) dark humic soil (I).

2. tan hardpan with charcoal lens in southwest (PS) humus stained sand with numerous rock inclusions, extremely hard and compact (LRF) humic stained soil or sand with rock inclusions (I)

3. light brown very hard clay - yellow stain in east face (PS) no record (LRF, I).

4. dark brown very hard clay (PS) brown sandy clay with charcoal and rocks, more clay towards bottom (LRF) dark humic stained sand over sandy clay and charcoal (I).

5. basalt with gray friable sand (PS) light friable sand (LRF, I).

6. brown clayey soil with charcoal in north and west (PS) no record (LRF, I).

7a. black or brown muck with charcoal and sand lenses in west face (PS) sandy duck muck with numerous waterfowl bones (LRF) sandy duck muck (I).

7b. same as 7a (PS) sandy duck muck (LRF) no record (I).

8. tan clay (PS) light gray clay (LRF, I).

9. brown clay with charcoal (PS) dark gray clay (LRF) lighe brown clay in sandy lens (I).

10. cream clay (PS) gray clay (LRF) light gray clay (I).

11. brown clay (PS) sterile brown clay (LRF, I).

Too rigid adherence to 20cm spits has caused some mixing of 2 through 6, not all of which can be resolved. Layers 9-11 were excavated as a single unit. The basal gray clay was not recorded in this pit.

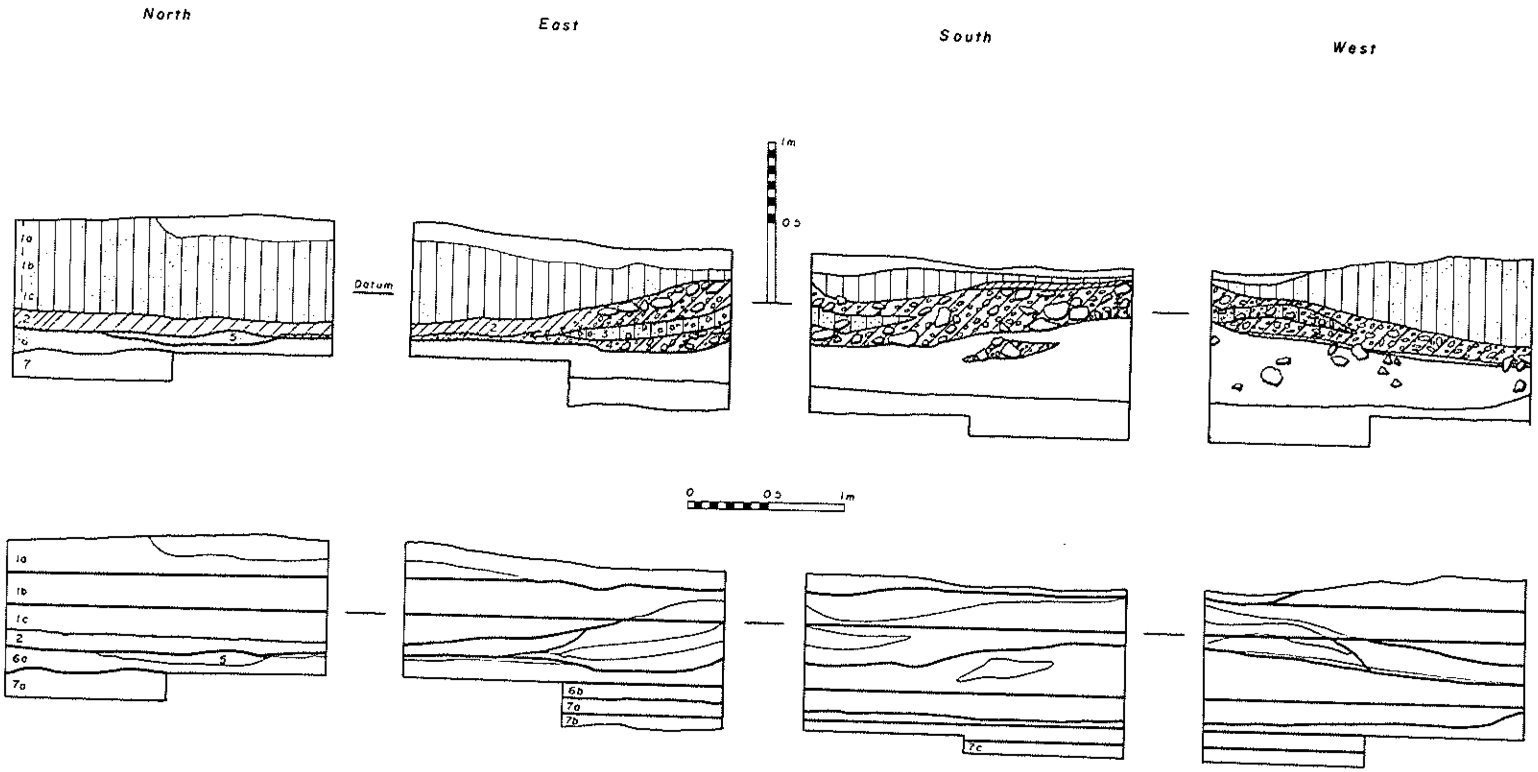


Fig. 2-20 Pit O: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1a. gray brown soil, dark brown sand covered by recent fill (PS) gray or brownish black soil with mottled charcoal areas and some basalt (LRF, I).

1b. gray-brown soil (PS) mottled black soil very compact with much fist-sized burned rock (LRF) mottled black soil (I).

1c. same as 1b (PS) blackish compact soil (LRF) dark grayish black compact soil (I).

2. sandy yellowish black in north and east, tan sand and gravel south (PS) tan or gray rock and sand concentration, sandy and rocky friable soil (LRF) light gray sand and rock (I).

3. gray brown soil lens (PS) no record (LRF, I) friable sand and rock stratum with peat (RR).

4. tan sand and gravel (PS) no record (LRF) rock stratum (I).

5. thin lens not anotated, but colored yellow on original sheet (PS) no record (LRF, I) Yellow-black zone of sand and pea gravel (RR)

6a. gray-black muck charcoal-flecked (PS) black compact "marly" soil interbedded with friable sandy soil, very abundant bird bone (LRF, I).

6b. same as 6a (PS) heavy compact medium gray peaty soil, bird bones decrease towards bottom black soil with duck bones and gray clay (I).

7. gray clay (PS, LRF) clay (I).

Pit O was one of the original test pits, hence the absence of photographic records and the very abbreviated section annotations. The records are not sufficently clear to determine which parts of 2 through 5 were mixed during excavations.

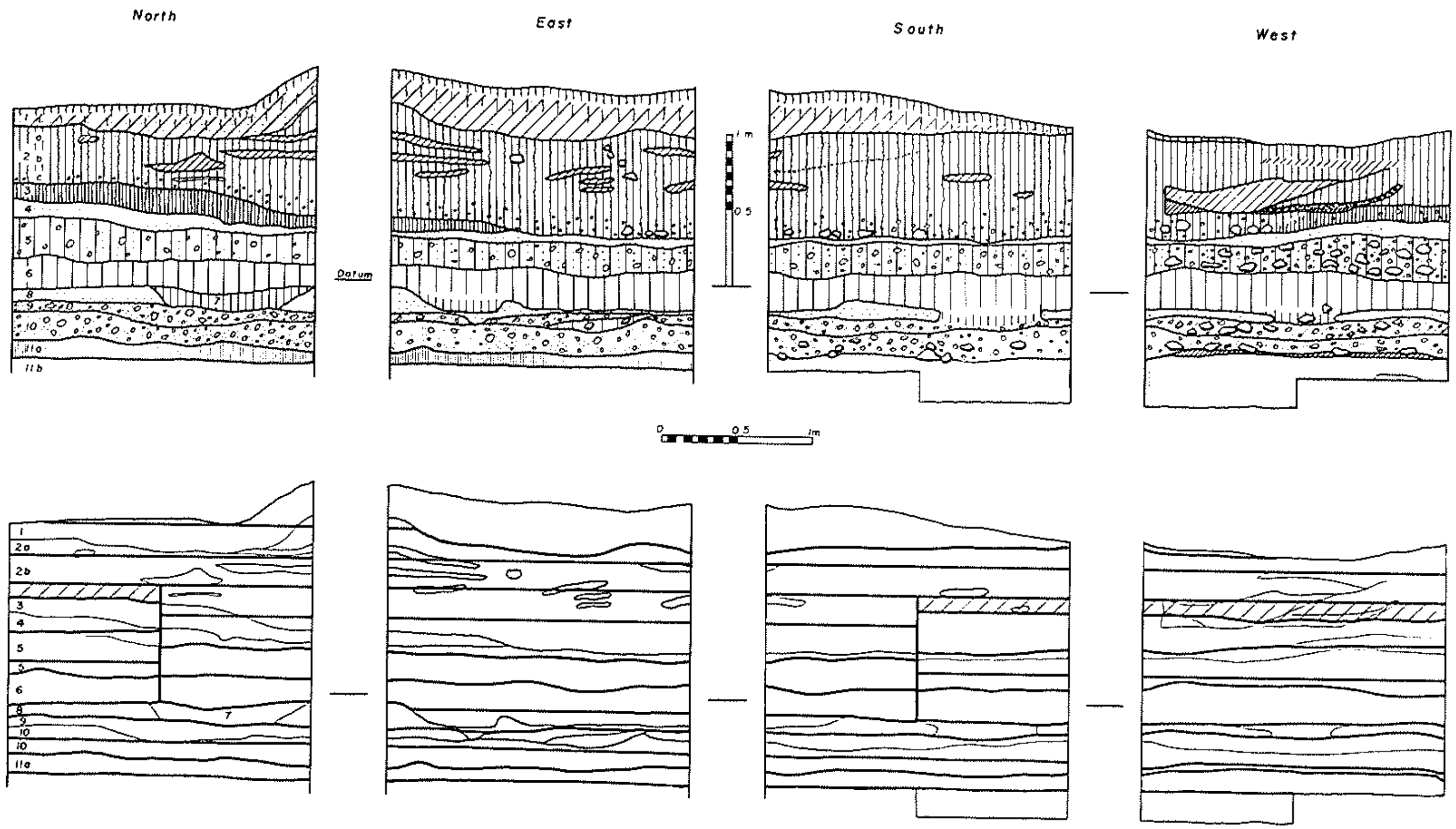


Fig. 2-21 Pit P: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. disturbed tan-gray surface peaty soil (PS) soft, mixed with grass roots, many charcoal flecks and small fire-cracked rocks (LRF). below grass, many charcoal flecks (I).

2a. brown humic soil with lenses of tan silty soil (PS) dark humic soil with charcoal flecks, certain areas mottled with lighter soil, cracked rock (LRF) dark humic soil with charcoal flecks (I).

2b. same as 2a (PS) dark black brown generally friable (LRF, I).

2c. same as 2a (PS) dark brown homogenous friable soil, no fire-cracked rock, but pea-size gravel (LRF) dark brown friable soil, much pea gravel (:

3. brown charcoal flecked soil (PS) dark humic soil with charcoal and concentration of fire-cracked rock at bottom (LRF) dark humic soil with charcoal (I).

4. gray clay, charcoal flecked (PS) light gray clay, crushed rock (LRF) possibly gray habitation level (I).

5ab. brown charcoal flecked soil (PS) increasingly sandy and ashy with few rocks, extremely friable (LRF) sandy

6. brown sandy soil (PS) brown sand and stones, black-gray compact less friable soil with charcoal and small rocks (LRF) friable black-gray sand (I).

7. brown sandy clayey soil, tan silty at top in pits and hollows of underlying floor (PS) no record (LRF, I).

8. gray clay (PS), white brown clay (LRF) no record (I).

9. fused yellow sand and basalt (PS) light colored friable sand with basalt fragments, crusted yellow sand in spots (LRF) yellow crusted sand (I).

10. black soil with yellow sand and basalt over fused yellow sand in west face only (PS) same as 9 (LRF, I).

11a. brown clay (PS) dark clay, some basalt (LRF) clay (I).

11b. gray clay with sand lenses at top (PS) clay with very thin sand (LRF) gray clay below sand (I).

In the first test pit, only half the square was dug to Layer 6. By the following season when the pit was completed, part of Layer 2c had been destroyed presumably through prolonged exposure. Records are not clear whether 7 was recovered separately from the floor of Layer 8. Layer 9 was partly mixed with the top of Layer 10.

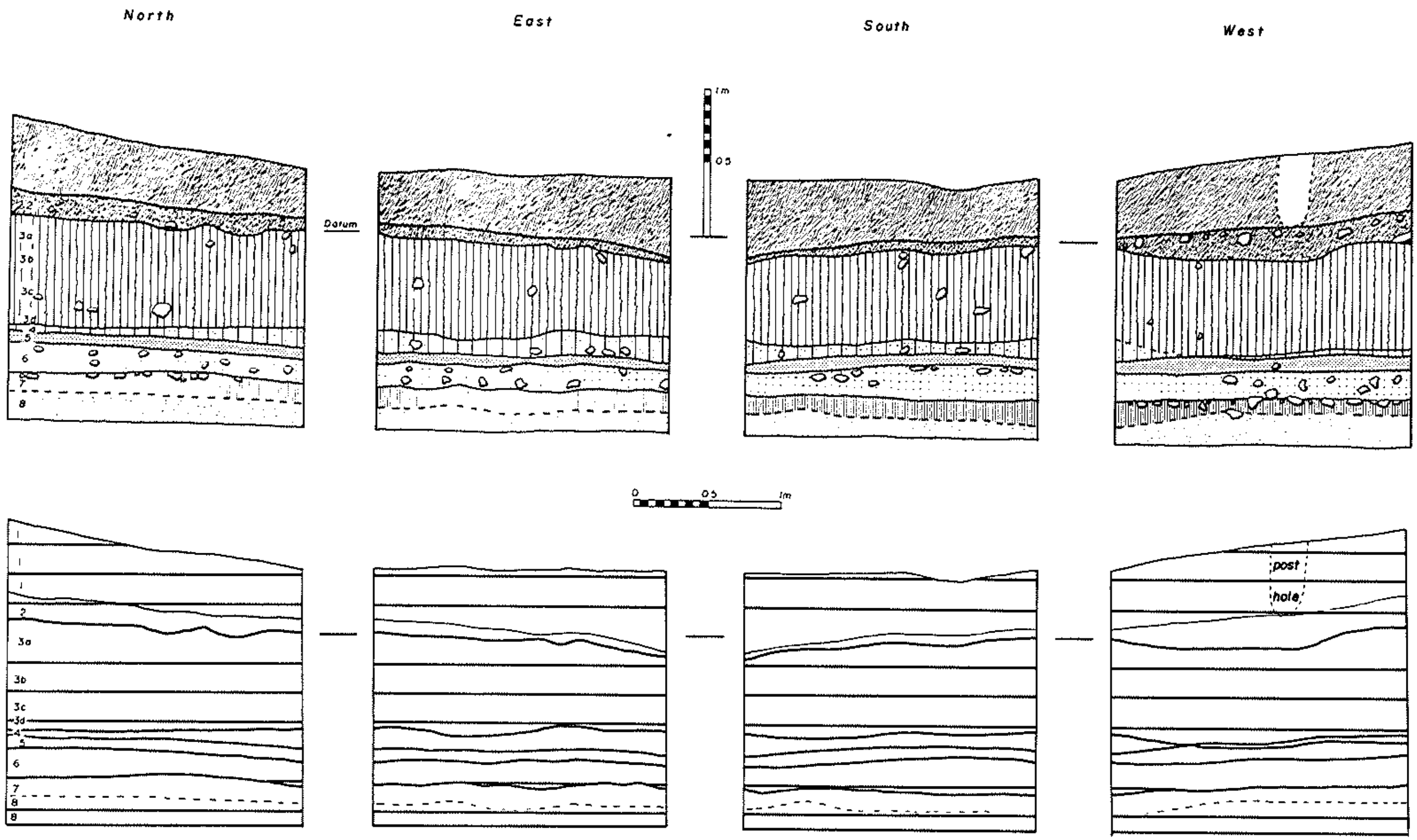


Fig. 2-22 Pit Q: stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. light gray peat with dense mat of rootlets at base (PS) friable gray peat with friable brown sand and some basalt towards bottom (LRF) no record (I).

2. gray sandy peat (PS) old surface (beneath peat) with friable humus-stained sand and basalt inclusions (LRF) no record (I).

3a. brown humus-stained sand (PS) brown friable soil with peat, and sand towards top (LRF) no record

3b. same as 3a (PS) brown friable soil, peaty, golfball to fistsize angular rocks throughout (LRF) no record (I).

3c. same as 3a (PS) brown sandy soil with high concentration of roots and angular rocks (LRF) no record (I).

3d. same as 3c (PS, LRF) brown sandy soil (I).

4. gray-brown sand (PS) a sandy possible living surface with high concentrations of rocks and roots throughout. The sand is large grained and lacks fine debris suggesting it was river- rather than lake-deposited (LRF) sand living surface (I).

5. black sand (PS) sand (LRF, I).

6. gray sand (PS) sand (LRF, I).

7. brown clay (PS) gray clay soil with laminations of sand at top (LRF) gray clay (I).

8. gray clay (PS) dark gray clay with organic material (LRF) dark gray clay (I).

Layer 1 is penetrated by a fence-post hole. Layer 2 was combined with the bottom of Layer 1. Layer 3 excavated in arbitrary spits. Surface of Layer 7 excavated as a separate unit. Layers 7 combined with the top of 8.

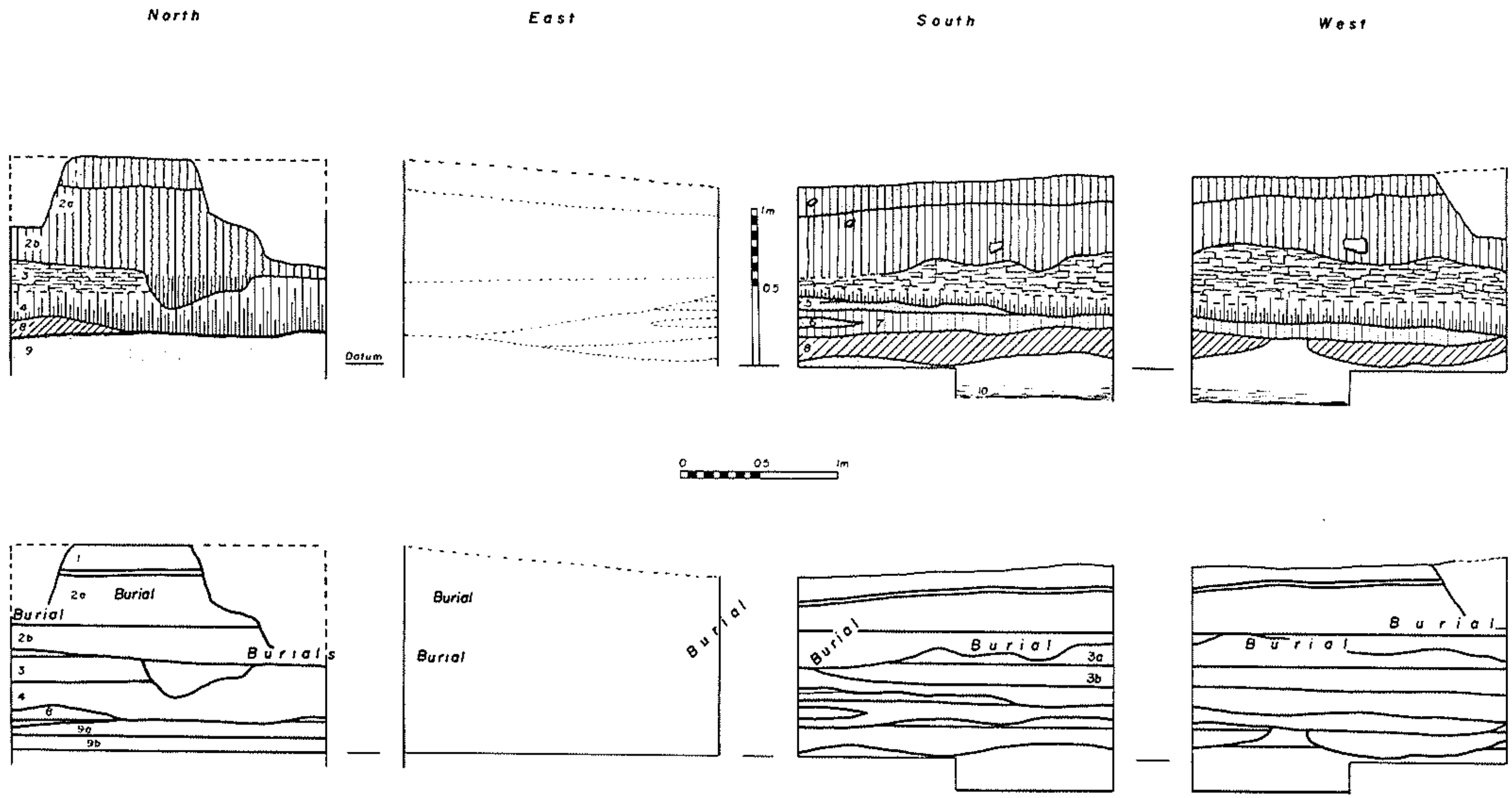


Fig. 2-23 Pit R: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. brown-gray sod (PS) brown sod, highly organic friable (LRF) no record (I)

2a. light brown humic soil (PS) dark brown gray soil, grass roots (LRF) dark brown humic soil (I).

2b. same as 2a (PS, I) dark brown humic soil and pea-size gravel (LRF).

3a. gray hardpan (PS) medium gray-brown hardpan (LRF) medium gray-brown fishbone-impregnated hardpan.

3b. light brown charcoal-flecked soil (PS) softer with depth (LRF) dark humic highly organic fill (I).

4. dark brown soil (PS) darker gray-black softer fill (LRF) very dark gray blackish fill (I).

5. dark gray charcoal-flecked clay (PS) no record (LRF) mottled medium to dark gray clayey fill (I).

6. gray clay (PS) black, fish-bone, little rock (LRF) very dark gray blackish fill (I).

7. dark brown charcoal-flecked soil (PS) gray loose, mottled, with fishbone and some rock (LRF) upper soil and mottled soil, light-medium gray very soft (I).

8. tan cream clay, peaty (PS) tan mottle fill, stones rare (LRF) mottled very light tan fill (I).

9a. black capped gray clay (PS) gray mottled, rare angular basalt (LRF) brown capped gray clay fill (I).

9b. gray clay changing downwards to black clay (PS) gray clay mottled fill over black homogenous muck (LRF) gray mottled clay (I).

The east face was removed during burial recovery without recording the stratigraphy, as were parts of the north and west sections. The "floor" between Layers 1 and 2a was excavated as a separate unit. Layer 2 was excavated in two arbitrary spits. All burials in Layer 2 were excavated as separate units. Layer 3 was subdivided into two spits, as was Layer 8. Parts of Layer 9 where it penetrates up between Layer 8 lenses were excavated as separate units in the north, northeast and west.

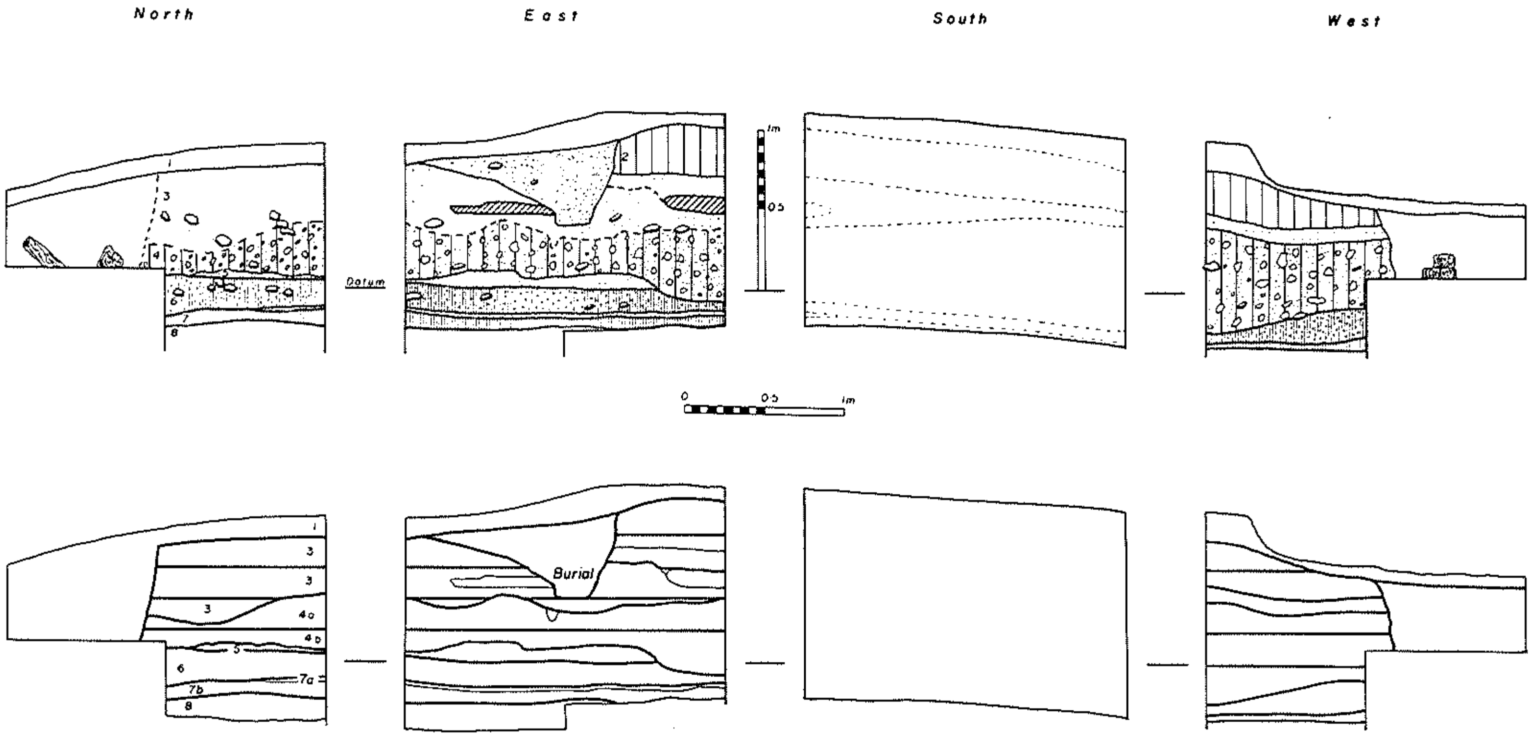


Fig. 2-24 Pit S: top stratigraphic profiles of the four pit faces; bottom the same faces sho ing excavated spits (thick lines) overlaid on the stratigraphy.

1. brown surface disturbed soil and fill of recent bulldozer cut with plank fragments (PS) no record (LRF, I).

2. brown loam, brown silty loam with tan laminations (PS) fine brown dusty soil with grass roots (LRF) no record (I).

3abc. gray loam, gray sandy clayey soil with tan sandy clayey soil lens in 3b (PS) dark brown humic soil (LRF) dark brown humic stained (I).

4ab. brown-clayey rubble-filled soil (PS) dark brown humus stained (LRF) dark brown humic stained (I).

5. not anotated (PS) gray clay (LRF) dark gray clay (I).

6. gray-brown clay, laminated (PS) dark gray clay (LRF) gray clay (I).

7. black-brown clay (PS) dark colored clay capped by thin light-colored lens (LRF) dark clay beneath whitish clay lens (I).

8. gray clay (PS) light colored "sterile" clay - light brown to light gray (LRF) light colored sterile clay (I).

Burial removed as separate unit. Lower 2 and upper 3 mixed. Layer 3 divided into two arbitrary spits. Layer 5 mixed with bottom of 4 at west end. South section not recorded.

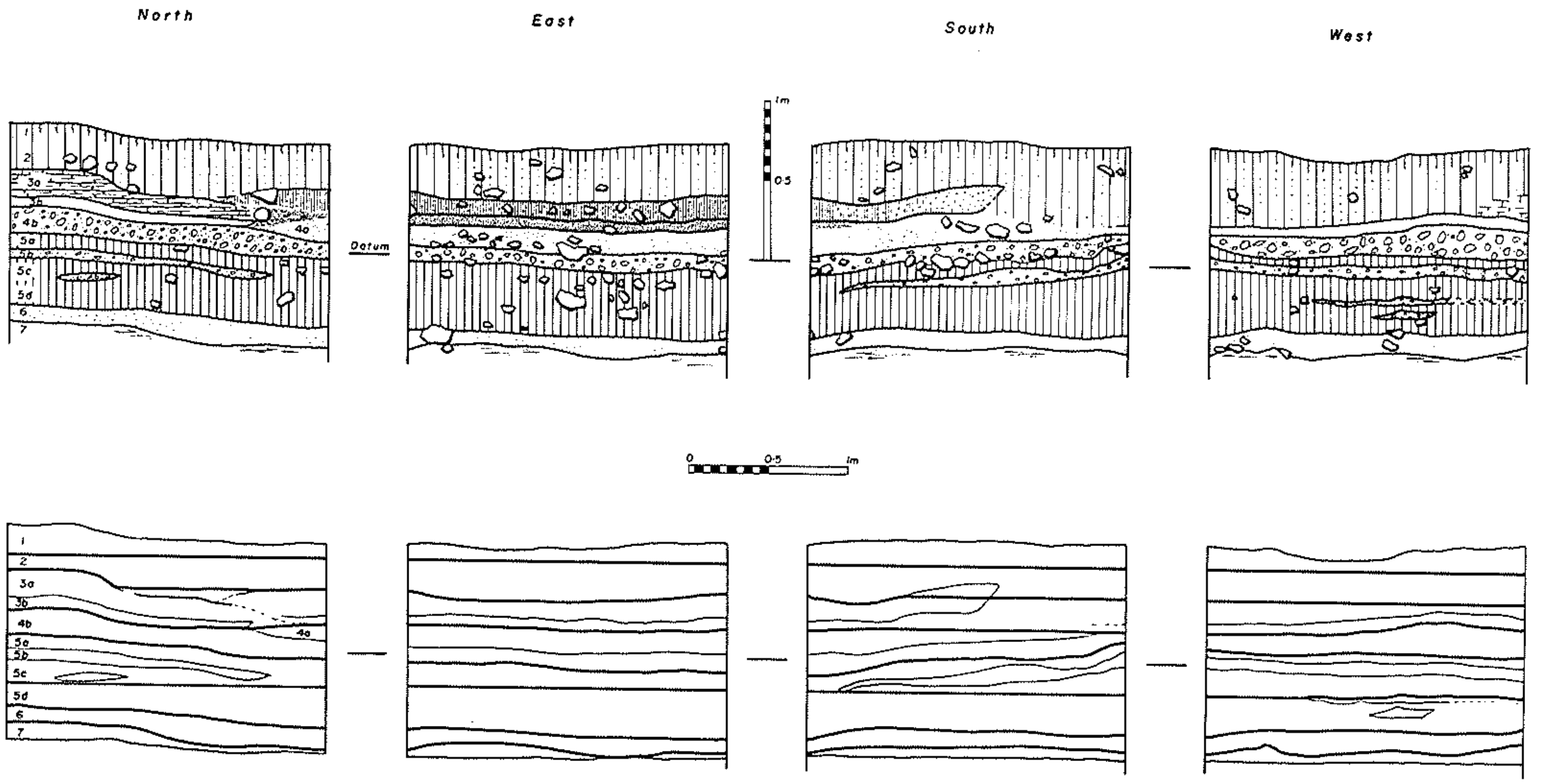


Fig.2-25 Pit T: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. surface (PS) dark humus stained (LRF,I).

2. dark brown hard loam, gray brown loam (PS) same as 1 (LRF, I).

3a. brown and gray silty clay with black lens at base grading to platy duripan (PS) no record (LRF) dark humic-stained semi-hardened (I).

3b. white clay lens (PS) possible occupational surface in the form of white clay (LRF) no record (I).

4a. brown silty clay (PS) no record (LRF, I).

4b. friable sand and basalt (PS) light colored friable sand with basalt fragments (LRF, I).

5abc. brown sandy silty clay with friable sand lenses (PS) rust colored friable sand with numerous inclusions of angular basalt fragments (LRF, I).

5d. brown sandy silty clay (PS) duck muck (LRF, I).

6. gunmetal gray silty clay (PS) light gray clay (LRF, I).

7. white organic clay, brown in some areas (PS) sterile white clay (LRF) whitish clay (I).

Layers 3ab were combined, as were 5abc. It was assumed that Layer 7 is the same as the basal gray clay elsewhere.

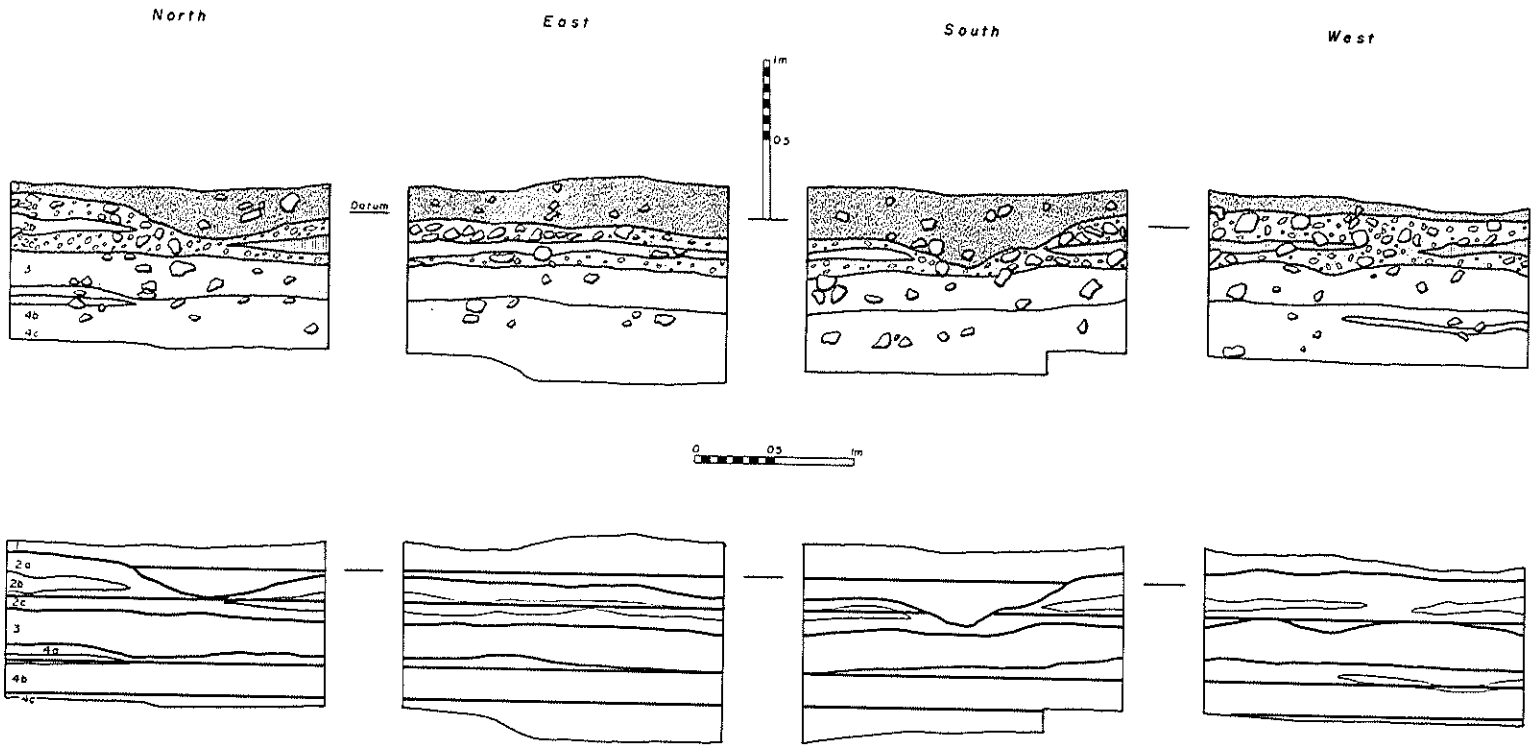


Fig. 2-26 Pit U: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. dark soil, black soil, recent fill (PS) dark black soil (LRF) soil (I).

2a. sand and basalt (PS) light friable sand and basalt (LRF, I).

2b. dark brown lens (PS) no record (LRF, I).

2c. same as 2a (PS, LRF, I).

3. black muck and duck bones (PS) black sandy clay with abundant charcoal, sections of small limbs and twigs, brush, extremely numerous waterfowl bones.

4a. lens of black muck and duck bones in diatom clay (PS) dark gray clay diatomite (LRF) gray diatomite clay.

4bc. diatom clay (PS) light gray clay diatomite, finer texture (LRF) clay diatomite (I).

Layers 1, 2 and 4 were subdivided into arbitrary horizontal spits.

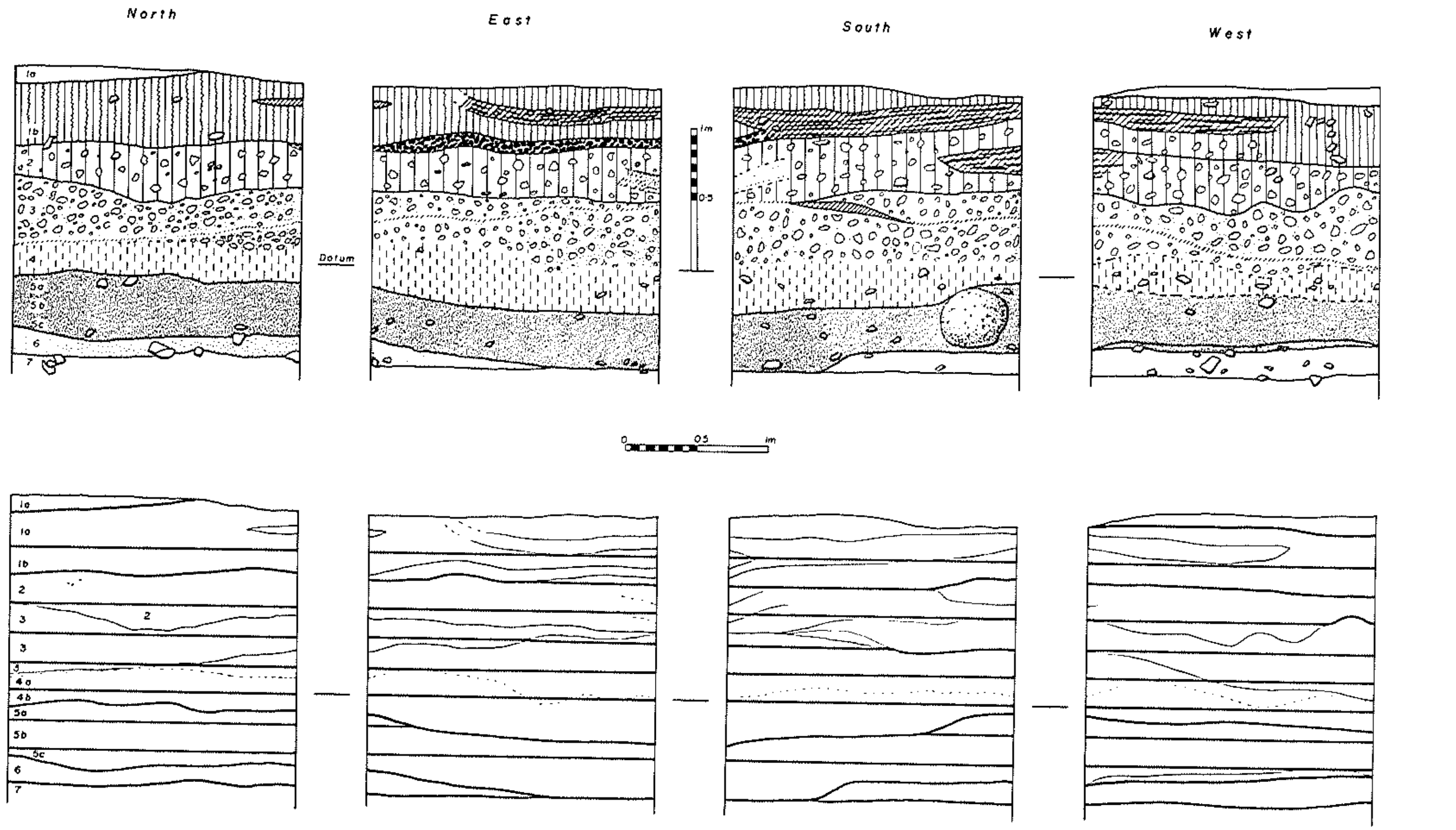


Fig. 2-27 Pit V: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1a. loam with tan lens, tan and black laminated lenses and rocks (PS) surface grass and cattle dung over very fine brown soil with light tan soil (LRF) dark brown fine soil (I).

1b. loam with charcoal lens and tan-black laminated lens (PS) dark highly organic soil with much basalt fragments and fish-bones (LRF) brown, highly organic (I).

2ab. loam with tan-gray laminations (PS) fine brown humus-stained soil with rocks (LRF,I).

3a. coarse rubble with sand, divided by sloping line of limonite stain (PS) very hard compact fine brown soil with concentrated rock and leached limonite - yellow sand? (LRF) rock concentration on top of asphalt (I).

3b. same as 3a (PS) light brown soil with heavy rock concentration (LRF, I).

4. less rubble with sand (PS) brown friable sand (LRF, I).

5a. black clayey sand (PS) black friable sand (LRF, I). Basalt mortar in section.

5b. same as 5a (PS) sandy gravelly black friable soil with basalt chunks (LRF) no record (I).

5c. same as 5a (PS) black gravelly charcoal-stained friable sand with basalt chunks (LRF, I).

6. dark gray silty clay (PS) gray clay (LRF, I).

7. light brown silty sterile clay (PS) brown clay (LRF, I).

Layer 1b subdivided into two arbitrary spits. Lower level of Layer 2 mixed with upper Layer 3. Bottom of Layer 3 mixed with upper Layer 4. Layer 5 subdivided into three arbitrary levels. It was assumed that Layer 7 was equivalent to the basal gray clay elsewhere.

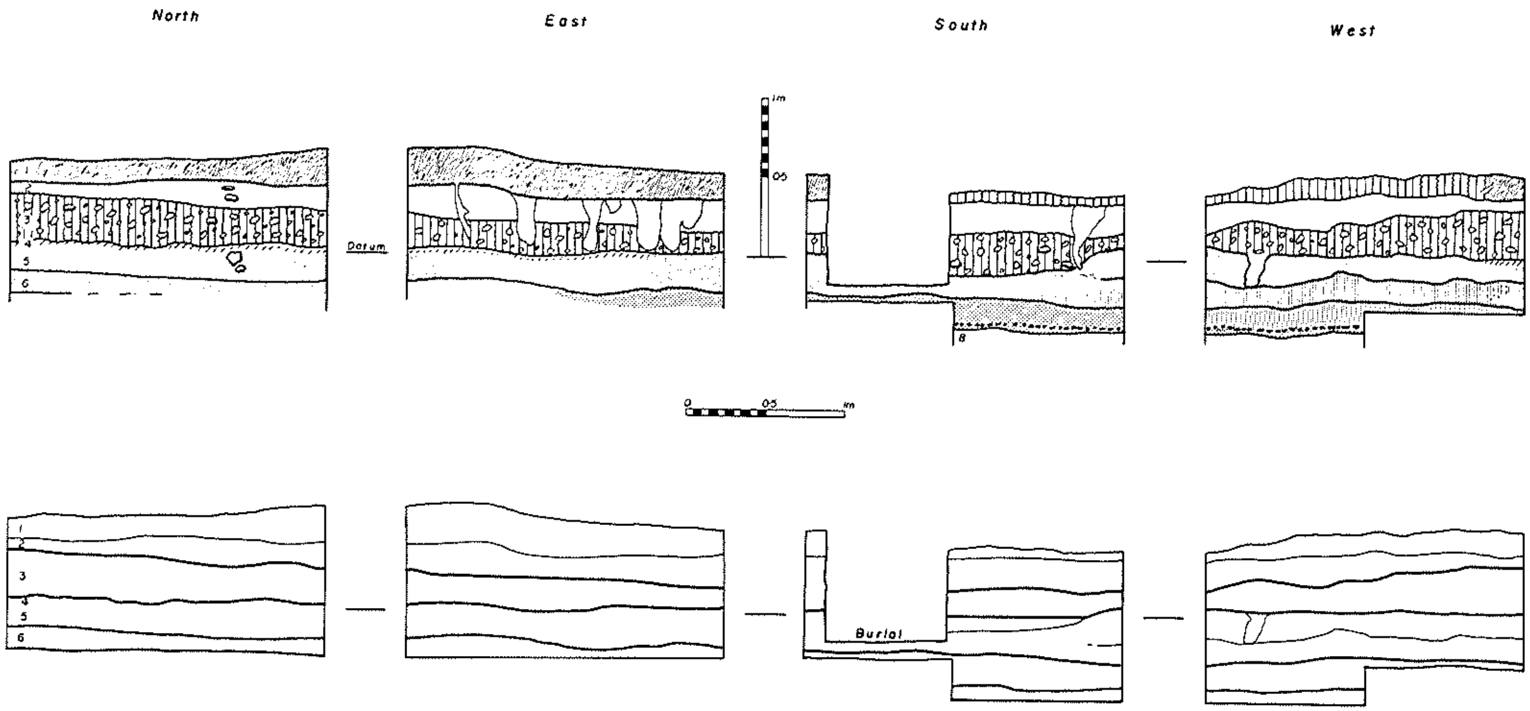


Fig. 2-28 Pit W: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. peat, loam (PS) very fine (I). Brown silt (LRF) sod (I).

2. white sterile clay penetrated by pedotubules (PS) hardpannish light colored soil (LRF) no record (I).

3. rubble and loam (PS) dark humus stained sandy soil with some intermixed basalt (LRF, I).

4. yellow lens (PS) no record (LRF, I).

5. duck muck (PS) sandy duck muck (LRF, I).

6. silty clay (PS) dark gray clay (LRF, I).

7. high pumice concentration (PS) no record (LRF, I).

8. white clay (PS) light gray clay (LRF) sterile clay (I).

Layers 1 and 2 combined. Layers 6 and 7 mixed in east end. Layers 5 and 6 mixed in west end. Part of south section destroyed before excavation. Layer 8 taken to represent basal gray clay of other pits.

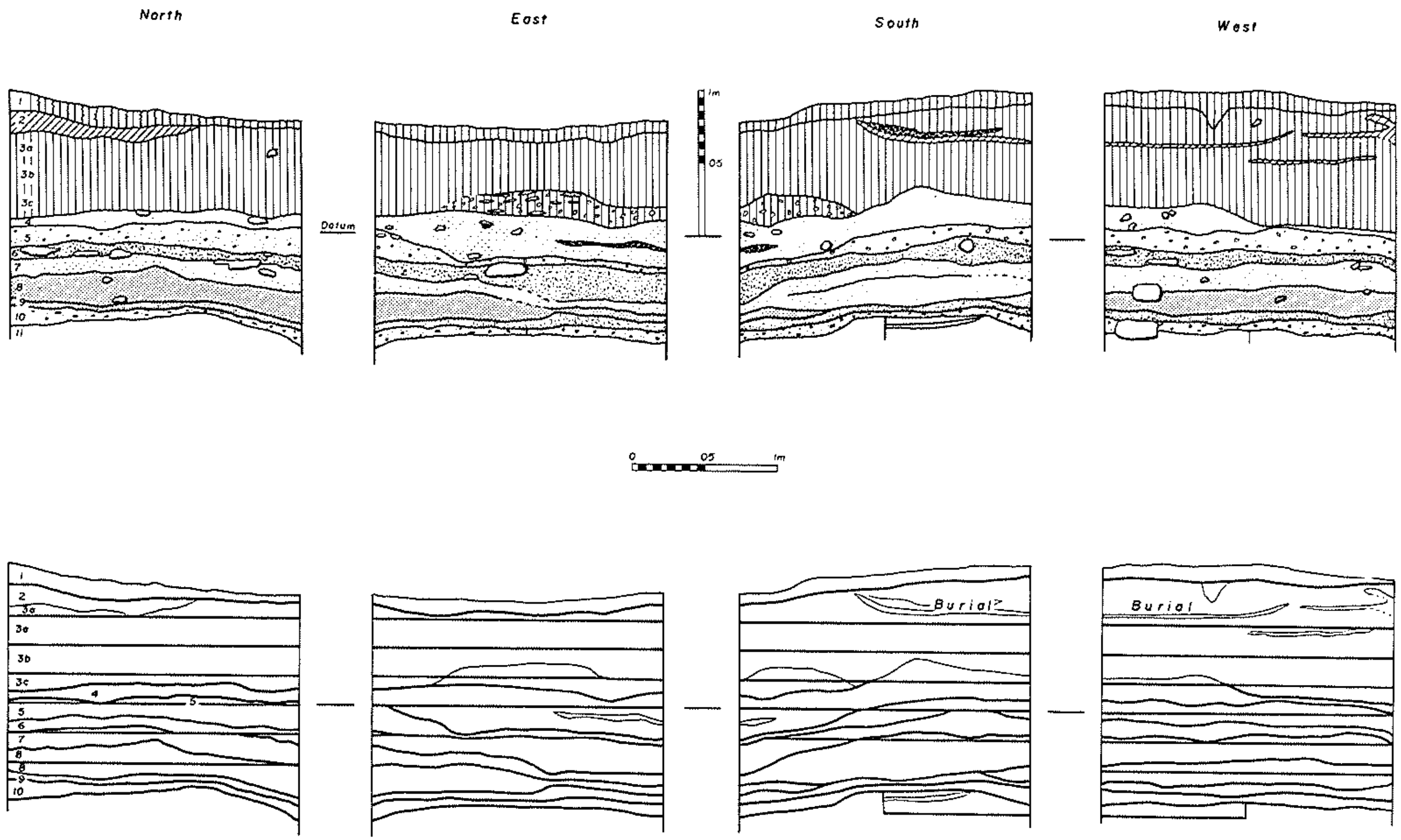


Fig. 2-29 Pit X: top stratigraphic profiles of the four pit faces; bottom the same faces showing the excavated spits (thick lines) overlaid on the stratigraphy.

1. topsoil (PS) medium dark brown humic soil (LRF) top cover and soil (I).

2. brown humic loam and light tan lens with charcoal lens (PS) dark brown humic fill (LRF) brown soil (I).

3a. brown humic loam with tan lens (PS) dark brown humus stained fine soil (LRF) brown humic fill (I).

3b. same as 3a (PS) very dark brown nearly black fill (LRF) humic stained dark brown soil (I).

3c. loose gravelly fill (PS) nearly black sandy cobbly fill when moist - drying to gray (LRF) light gray (when dry) sandy soil (I).

4. gray clayey, gray clay with charcoal (PS) humic gray, clayey, sandy cobbly fill (LRF) gray sandy clay with rocks (I).

5. basalt sand (PS) light gray, golden-flecked friable sand (LRF) light gray sand with some gold color (I).

6. gray sand (PS) light gray clayey sand (LRF, I).

7. golden brown sand (PS) golden brown clayey sand (LRF, I).

8. gray clayey sand (PS, LRF, I).

9. gray clay (PS) battleship gray clay (LRF, I).

10. gray clay and carbon (PS,LRF,I).

11. white clay (PS) white, slightly brown clay (LRF), no record (I).

Layer 3 subdivided into three arbitrary spits. Layer 4 subdivided into two arbitrary spits in the southeast corner. Layer 5 subdivided into two arbitrary spits in the northwest. Layer 6 subdivided horizontally in the south. Layer 7 subdivided into two arbitrary spits in the southern end. Layer 8 arbitrarily subdivided in the northwest. Layers 3c and 4 were accidentally mixed in the southwest corner.

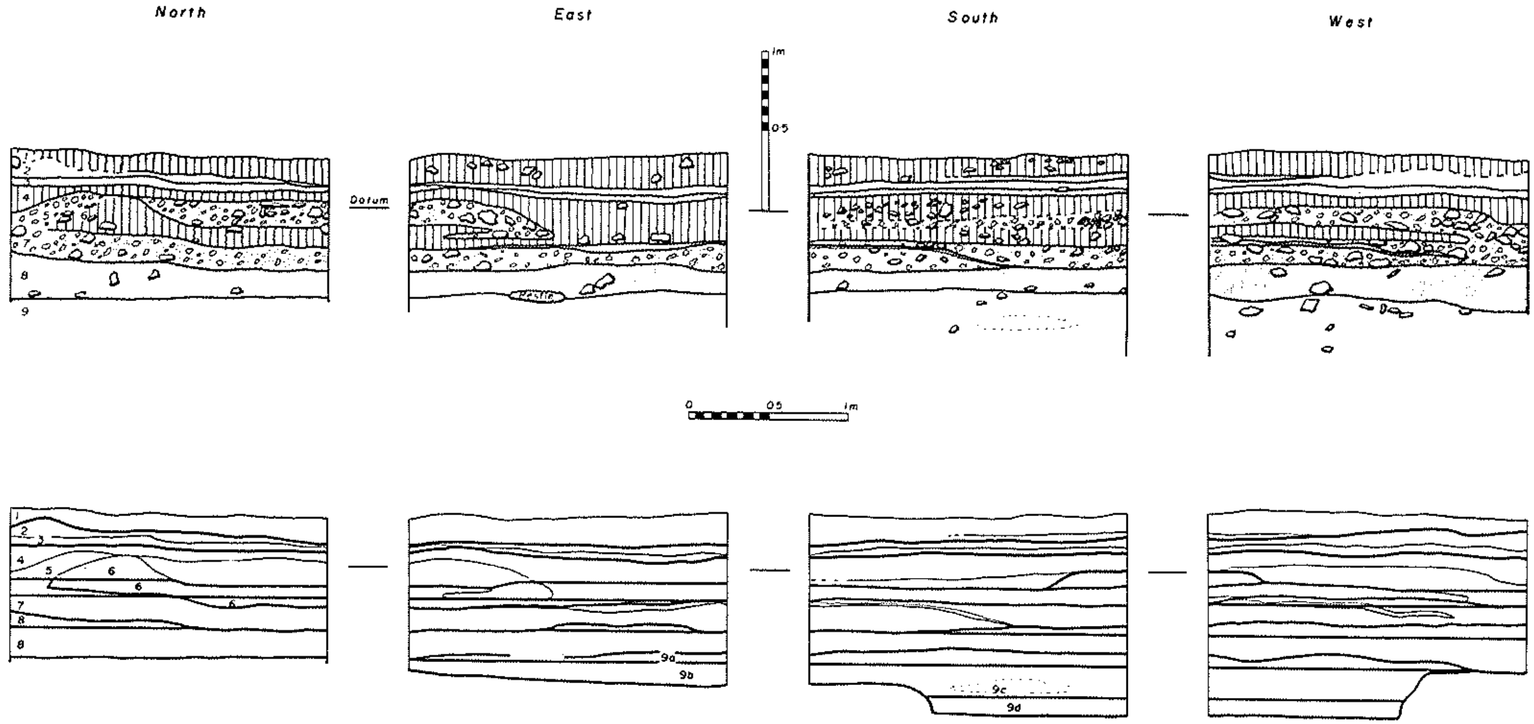


Fig. 2-30 Pit Y: top stratigraphic profiles of the four pit faces; bottom the same faces showing excavated spits (thick lines) overlaid on the stratigraphy.

1. brown humus soil with dark brown clay lens in southeast (PS) sod (LRF) turf mixed and disturbed (I).

2. cream clay (PS) no record (LRF,I).

3. white sand (PS) light friable sand (LRF, I).

4. brown humus-stained soil (PS) black material with no rocks (LRF) black lens (I).

5. friable sand and basalt (PS) rock layer in sandy matrix (LRF) rock concentration (I).

6. brown humus-stained soil (PS) rock in black organic matrix (LRF) black layer (I).

7. friable sand and basalt with yellow sand lens (PS) an irregular fused green layer over a green sandy gravel in east half of pit; brown green sandy gravel in north area (LRF, I).

8a. brown black sandy clay with waterfowl bones (PS) black layer (LRF) black clay (I).

8b. same as 8a (PS) brown clay with organic material - much wood over sandy clay with duck bone and carbon (LRF) brown clay with bones in sandy matrix (I).

9ab. gray clay (PS) sterile gray clay (LRF) no record (I).

9c. no record (PS, LRF) clay layer (I).

9d. same as 9ab (PS, LRF) clay layer (I).

Layers 2 and 3 combined. Layers 4 and 5 combined, with rock concentration in southwest corner excavated as a separate unit. Layer 6 subdivided in northeast into two arbitrary levels. Layer 8 subdivided into two arbitrary levels at the western end. Layer 9 subdivided into three arbitrary levels.

ENDNOTES: CHAPTER 2

1. The exact locality of this site within its modern cartographic setting has been deliberately omitted in the (perhaps vain) hope that this will slow down the rate of future looting of Nightfire Island.

2. All field records use a cumbersome labelling system generated from each pit's position within the original sampling grid. Thus, pit A appears in the records as N118-E74 which designates the midpoint of that square on the grid. Apart from the length of this label, it is readily confused with, for example N84-E116 (Pit Q), and many others.

CHAPTER THREE

THE CORRELATION

The next task is to correlate the 25 pits so that individual strata[1] can be traced from pit to pit throughout the site. After similar-looking layers in individual pits have been joined up to form strata, their history and contents can be analyzed. Obviously, all analytical tasks which follow depend on the correctness of the correlations. Should any errors inadvertently be built into the correlations, they will distort the results of every analysis which follows. Correct correlation is therefore of paramount importance, and it is appropriate to devote a chapter to describing the steps taken to accomplish this.

Support for the correlation is derived from several sources: sedimentary descriptions of layers (color, grain-size, texture, rock-content, thickness, elevation, and angle of dip); dates (radiocarbon and obsidian hydration); avifaunal contents of layers (particularly grebe, coot, and scaup); and lithic artifact content of layers (particularly flake length and projectile point type). Each of these groups of data varies in value as a correlating tool from one part of the site to the next.

First, the site will be subdivided into three gross stratigraphic zones based on lithic technology: a large-flake zone at the base, a small-flake zone in the middle and an arrowhead zone at the top of the sequence. Each zone will then be further subdivided into strata based on sedimentary, avifaunal and dating criteria.

The First Marker-horizon

In all 25 pits, there is an abrupt decrease in the size of obsidian debitage at some point in the sequence of layers. This is the only event which is clearly registered in every pit and it is therefore a vital marker-horizon running through the entire site. This was established in the following manner: first, the unbroken obsidian flakes were extracted from the artifact sample of every layer in each pit; then, the maximum length of each flake was measured and recorded; finally, the average length of whole flakes for each layer was calculated. Results are shown in Fig. 3-1.

The horizon is demarcated by a drop in mean flake length of between 10 and 5mm. Samples below the line cluster around 30mm average and those above it cluster around 23mm average. The exact position of the horizon in Pits H and I is ambiguous, but can be determined on other criteria. Several pits show an increase in flake length again towards the top of the sequence where samples tend to contain one or two very large flakes, and means are thus skewed with very large standard deviations.

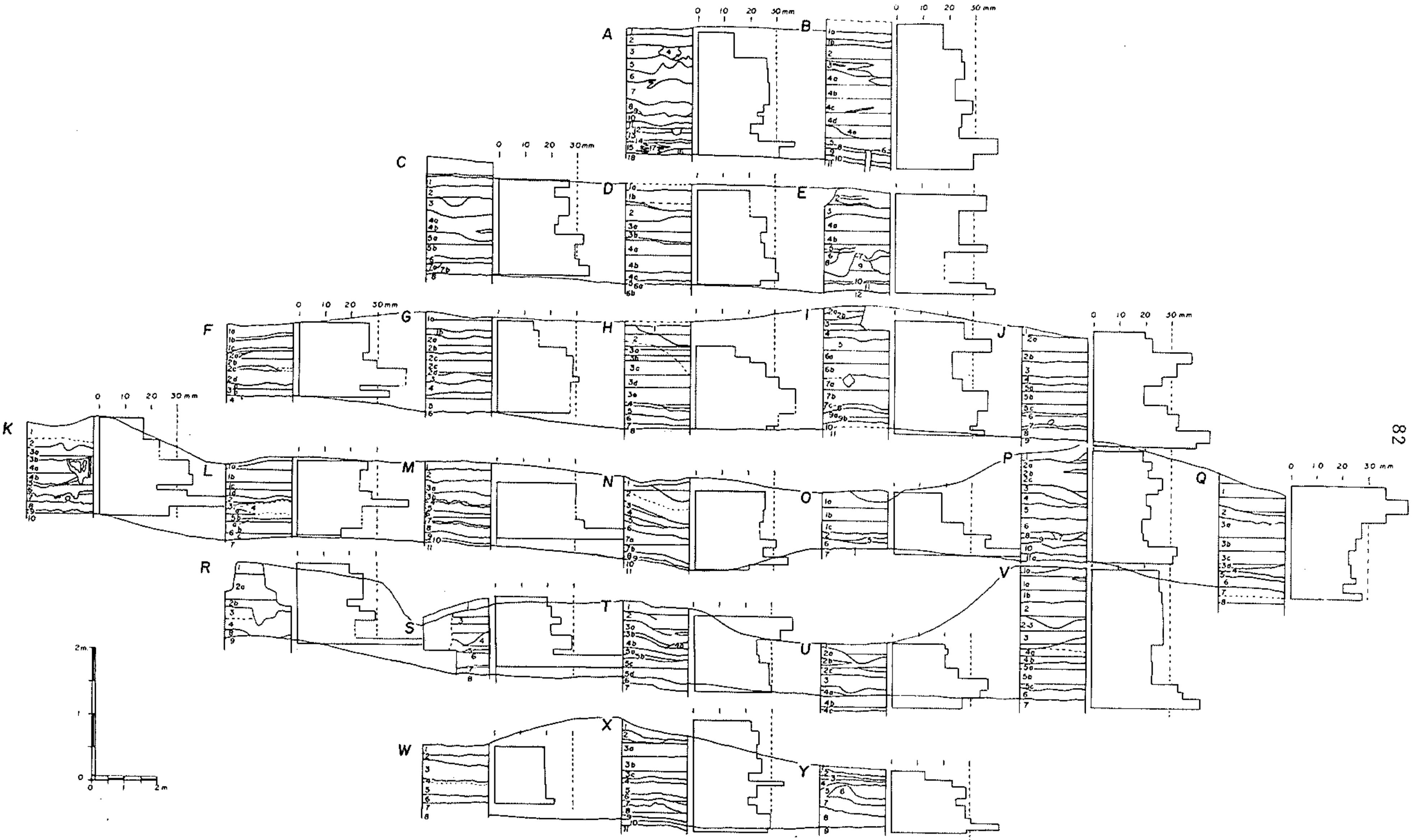


Fig. 3-1 Stratigraphic profiles of the north faces of the 25 pits. Bar graphs to the right of each profile show the mean lenghts of whole flakes from the layer or spit at the equivalent depth.

The Second Marker-horizon

The upper layers of almost every pit contain small projectile points (2-3cm long) which are easily distinguished from all other points in the site by overall length and/or weight. They are traditionally designated as arrow armatures. The second marker-horizon is therefore immediately below the layer in each pit where these specimens first appear. Although absent from Pits K, L, F, R and S on the western edge of the site, this second horizon is distributed widely enough to provide another valuable benchmark for the correlation.

The site can be subdivided, therefore, into three gross zones: lowermost is the large-flake zone bounded by the lakebed surface at its base and the first marker-horizon at the top; above this are the Small-flake Loams bounded by the two marker-horizons; uppermost are the Arrowhead Loams between the second marker-horizon and the site surface (Fig. 3-2). The further subdivision and correlation of each zone will be treated separately.

The Large-flake Zone: Geological Subdivisons

The recorded descriptions of layers (Chapter 2) allows a coarse, provisional correlation of the zone. Five superimposed units can be recognized (Fig. 3-3).

The lowest unit is the Basal Clays, followed by clays with waterfowl bones (usually designated "duck muck" in the field records), followed by Sand and Basalt, which is covered by thin Gray Clays in the north. The northwest of the site is covered by loams with basalt rubble, partly calcified and capped by clay house floors in the north and northeast. These will be called the Large-flake Loams.

The Large-flake Zone: Avifaunal Subdivisions

Element-counts of waterfowl bones from the layers of the Large-flake zone in each pit are shown in Fig. 3-4. It is immediately apparent that the unit designated as "duck muck" in the previous section may be further subdivided into subzones, each characterized by a dominant waterfowl species (Fig. 3-5). The Coot Clays cover the Basal Clays. The Grebe Clays overlie this subzone in Pits N and X, but in M they are separated by two layers of sterile clay. A third subzone of mixed waterfowl (with coots again dominant) overlies the Grebe Clays in pit N, and is also present in Pits S and R. To the east of this group of three stratified subzones is the Scaup Muck of pits I, O, U, and Y. Unfortunately, the stratigraphic relationship between the Scaup Muck and the other three has not been captured in any of the pits, although the earlier amateur diggings must have encountered this interface repeatedly (see Fig. 2-1).

It may be inferred that the Scaup Muck is later in sequence than either of the other three subzones on the following grounds. The angle of dip of the Basal Clays, Coot Clays and Grebe Clays tends to

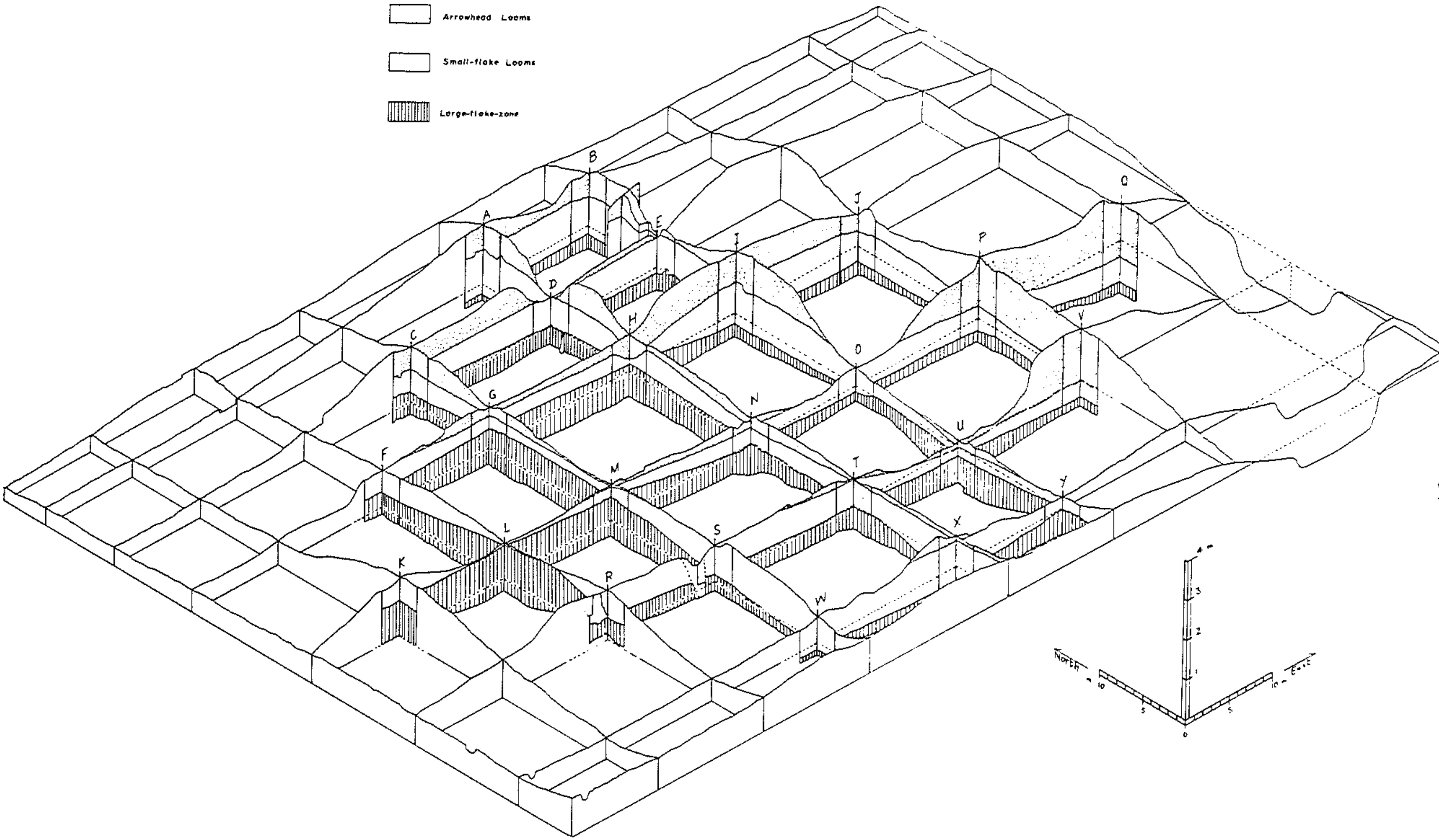


Fig. 3-2 Isometric diagram showing the north and east faces of the 25 pits, with the depths of the two marker horizons and the three zones used to correlate the pits.

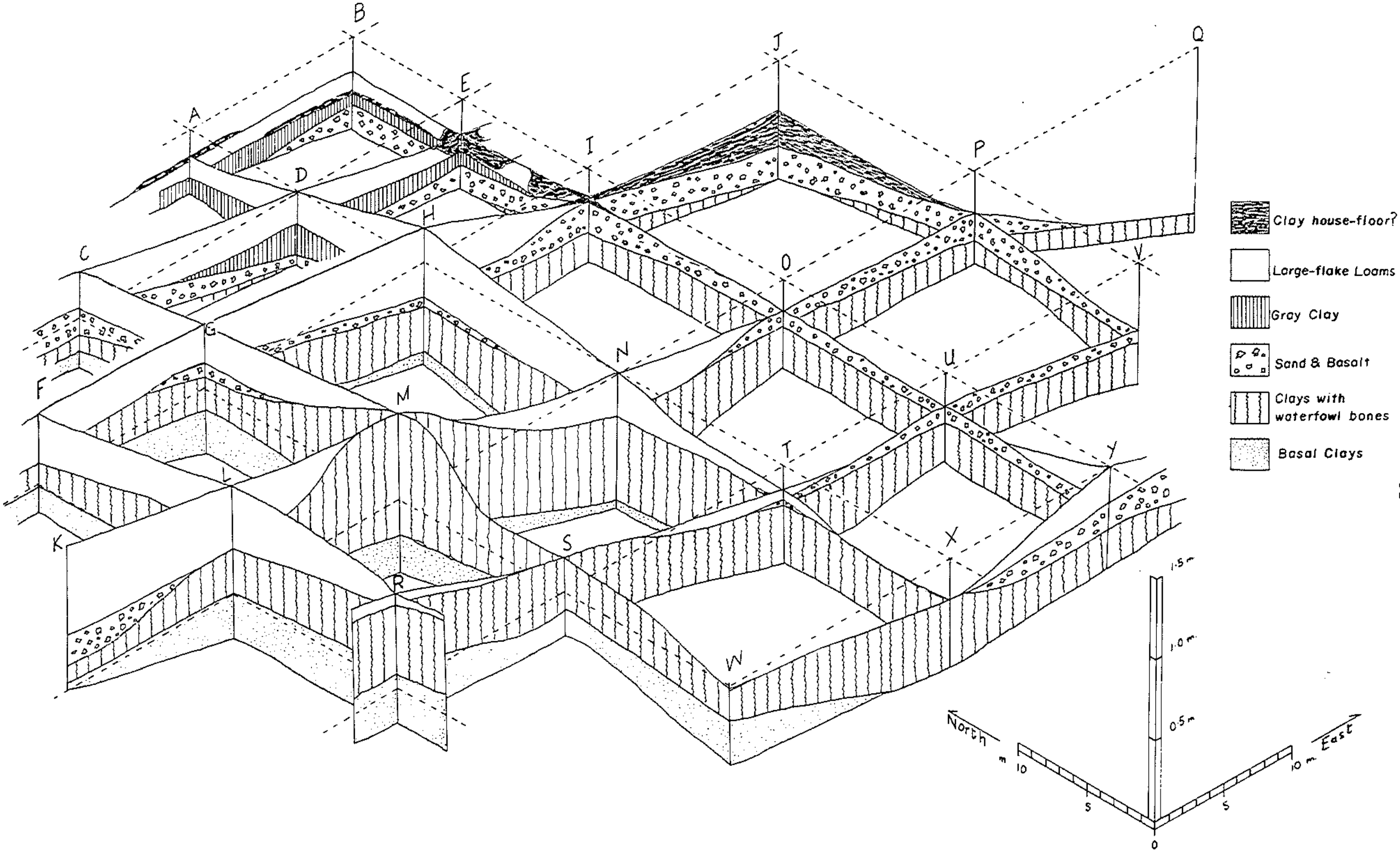


Fig. 3-3   Isometric diagram showing the geological correlation of the Large-flake zone.

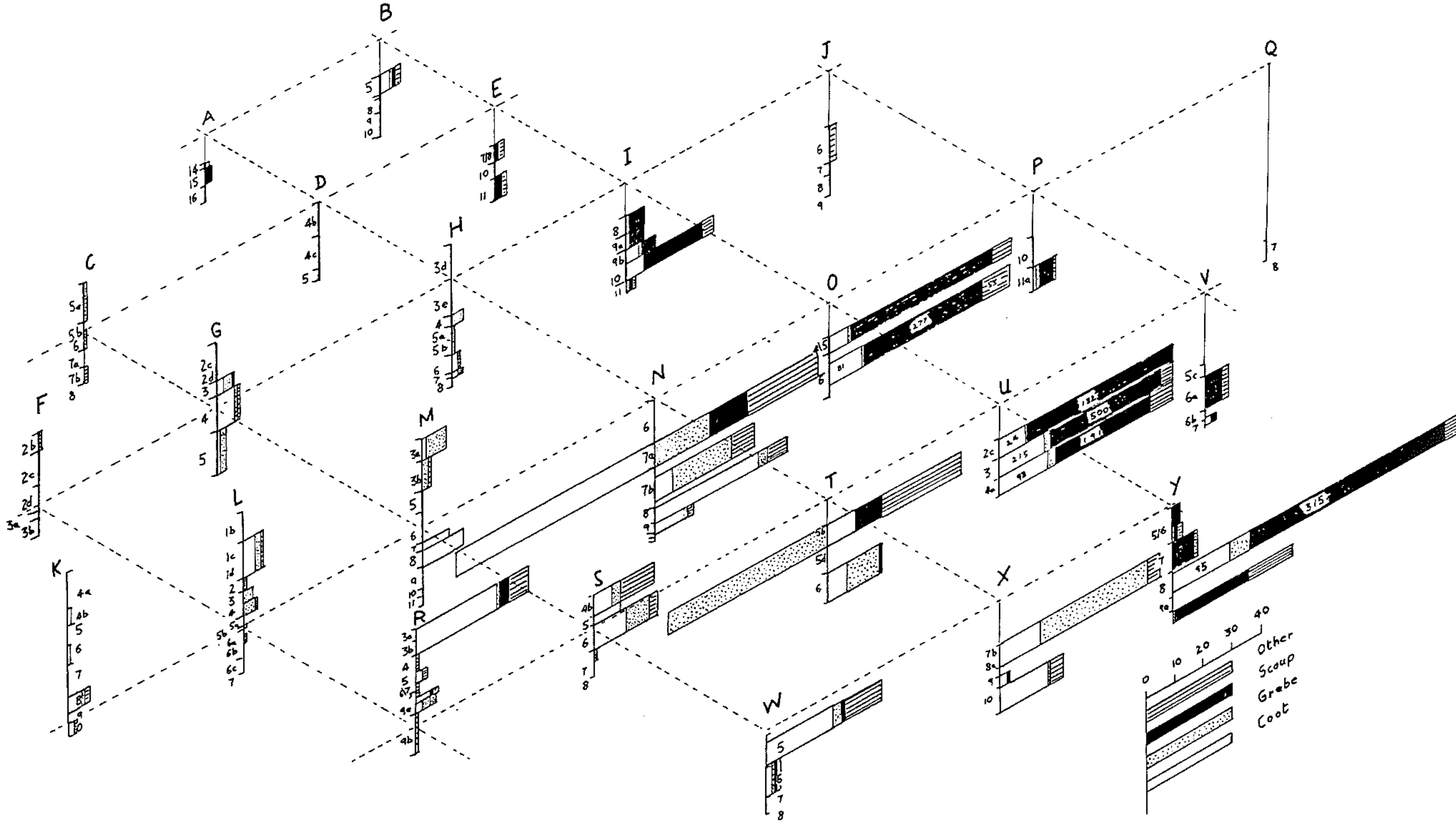


Fig. 3-4 Isometric diagram of the 25 pits. The bar graphs represent counts of waterfowl bones from the layers ascribed to the Large-flake zone.

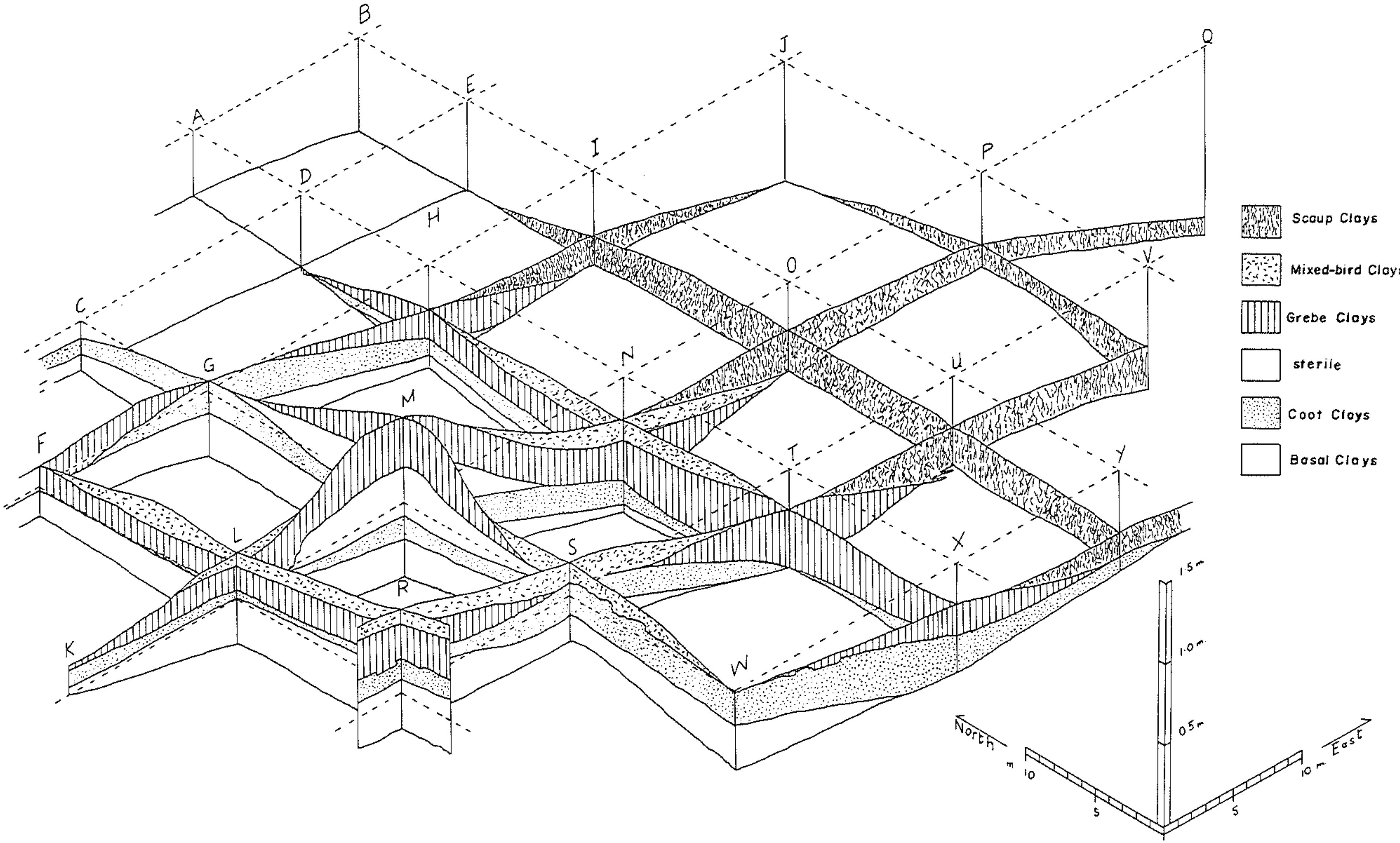


Fig. 3-5 Isometric diagram showing the final subdivision and correlation of the Clays with waterfowl bones in Fig. 3-3.

be eastwards, with a general north-south strike (Pit M excepted). The Scaup Muck also dips eastward where it thins out to a mere trace at the bottom of Pits P and V. The strike of the Scaup Muck is also roughly north-south, suggesting that it was banked up against the eastern flank of the other three clays. A small but important feature in support of this interpretation comes from the base of Pit U (Fig. 2-26) where a lens of Scaup Muck is intercalated with the lake bed and lenses out from west to east. The Scaup Muck in all four pits has been arbitrarily subdivided into upper and lower units, but it cannot be demonstrated that these subdivisions are contemporary accumulations in every pit. The overlying Sand & Basalt, Gray Clays, and Large-flake Loams are virtually devoid of waterfowl bones.

The Large-flake Zone: Dating

Radiocarbon and Obsidian hydration (OH) dates are available from all the proposed strata within this zone (see Chapter 4 for details). The OH dates from the 1-Basal Clays and 2-Coot clays overlap, indicating that rare obsidian flakes (and other material) may have been washed down from the same upstream locality into both strata. The very wide range of OH rind-thickness from within the 2-Coot Clays indicates frequent intrusions of flakes from sediments overlying this stratum. Clearly, the OH readings are not at all helpful in separating the strata. Not so the C-14 readings which show that the 2-Coot Clays are indeed older than the 3-Grebe Clays which are in turn older than the 5-Scaup Muck. In fact, the C-14 dates hint at a possible unconformity, as there is a gap of at least eight centuries between the best 3-Grebe Clay date and the oldest of the 5-Scaup Muck dates. As there are no C-14 readings for the 4-Mixed-bird Clays, we are obliged to assume that they were laid down at some time during this interval. The OH dates from the 4-Mixed-bird Clays overlap so completely with those from lower strata that we may suspect that they are indeed a mixture from both the 2-Coot and 3-Grebe Clays combined. They do appear to predate the 5-Scaup Muck, however, as there is minimal overlap in the OH dates from these two. Within the 5-Scaup Muck the five C-14 dates cluster into older and younger sets, but there has been much obvious churning within the muck itself, as the OH dates suggest. Evidently, the soft and malleable muck has been extensively penetrated by the heavier overlying 6-Sand & Basalt and even by the 8-Large-flake Loams so that even the C-14 dates of these three strata overlap. Not surprisingly, the OH dates display similar admixture, albeit less noticeably so. In summary, the C-14 dates support only the stratigraphic units of: 1-Basal Clays and 2-Coot Clays followed by; 3-Grebe and 4-Mixed-bird Clays followed by; 5-Scaup Muck and 6-Sand & Basalt and 7-Gray Clay and 8-Large-flake Loams. The OH dates add no convincing support to any part of the subdivision. It should be stressed that these results do not invalidate the subdivisions, but they provide an early warning that the lower four strata may have been reworked in places and partially mixed, while the upper four strata have also been churned in parts due to downthrusting of the heavier rubble-laden strata into the underlying 5-Scaup Muck.

The Large-flake Zone: Final Correlation

Finer subdivisions beyond the eight strata already correlated can be achieved only between a few adjacent pits. Criteria for such microstratigraphic linkages of localized lenses are strictly sedimentary, and based mainly on shared color and texture. For example, the 1-Basal Clays can be further subdivided into a brown-black lens at the base with a gray-brown clay banked against its eastern surface. This in turn has a tan clay banked against it. To the south, the gray-brown clay has a dark-gray-black clay capping, fragments of which also cover the tan clay in pit M.

The 2-Coot clays are brown in the north, becoming grayer in the south where they are capped by thin, eroded, dark-gray clay. At pit M, they are capped by thin yellow sand which grades to tan clay in pit N only. The 3-Grebe Clays separate into a gray clay at the bottom, capped in pits T and X by a brown clayey sand with some rubble. In other exposures, they can only be arbitrarily subdivided. The 4-Mixed-bird Clays cannot be subdivided. Arbitrary subdivisions of the 5-Scaup Muck and of the 8-Large-flake Loams are possible, but need not reflect true stratigraphic correlations. The final correlation of the Large-flake Zone is shown in Fig. 3-6.

The Small-flake Loams: Avifaunal Subdivisions

Fig. 3-7 gives the element-counts for waterfowl by pit and layer for the Small-flake Loams. It is immediately apparent that a bird-poor subzone occurs in the lower parts of the northern pits and extends into the middle parts of the eastern and southern pits. Three subzones emerge: the lowest has waterfowl, the middle is bird-poor and the upper contains waterfowl once more. The upper and lower subzones both retain mixtures of species, usually dominated by coot, but there is no clear-cut distinction to be made between them on species-content.

The Small-flake Loams: Geological Subdivisons

Stratigraphic correlation of the lower subzone is apparently straightforward (Fig. 3-8). A thin sheet of brown clayey loam-with-rubble is intercalated with a gray sand and basalt lobe--thicker in the south and thinning northwards, where it is overlain in places by more brown clayey loam and rubble. A clay house floor appears in Pit P above the sand and basalt.

The bird-poor subzone has a wider distribution, and more complex stratigraphy. Pits Q and V to the southeast have deep accumulations of sands which probably relate to stream channel activity. Another deep accumulation of gray sand and basalt occurs in Pit I and can be traced in the surrounding pits of H, J, and P where it overlies a brown or black sandy loam with rubble. To the north of Pit I is a complex of clay pit house floors and loam-with-rubble fills. The northward spread of the gray sand and basalt has been obscured by the extensive pit house excavations, but a trace of it may occur in Pit B. Pit house floor fragments have also been penetrated in Pits I and H. Clay floor fragments are also common in the southern part of the site in this subzone, at pits N, T, Y, and W. Charcoal hearth lines also occur in Pits N, T, and X. The western portion of the site does not appear to contain fragments of this subzone.

The upper subzone has its deepest accumulation at the north end of the site, as well as the western portion where it has become heavily calcified. These are loams-with-rubble somewhat variable in color and also changeable in sand and clay content. Tan lenses are visible in several westerly pits in this subzone. In the southern part of the site, it is no more than a thin sheet of brown-gray loam-with-rubble. The tan lenses extend to Pits S and X. Further stratigraphic subdivision of this subzone is possible for the

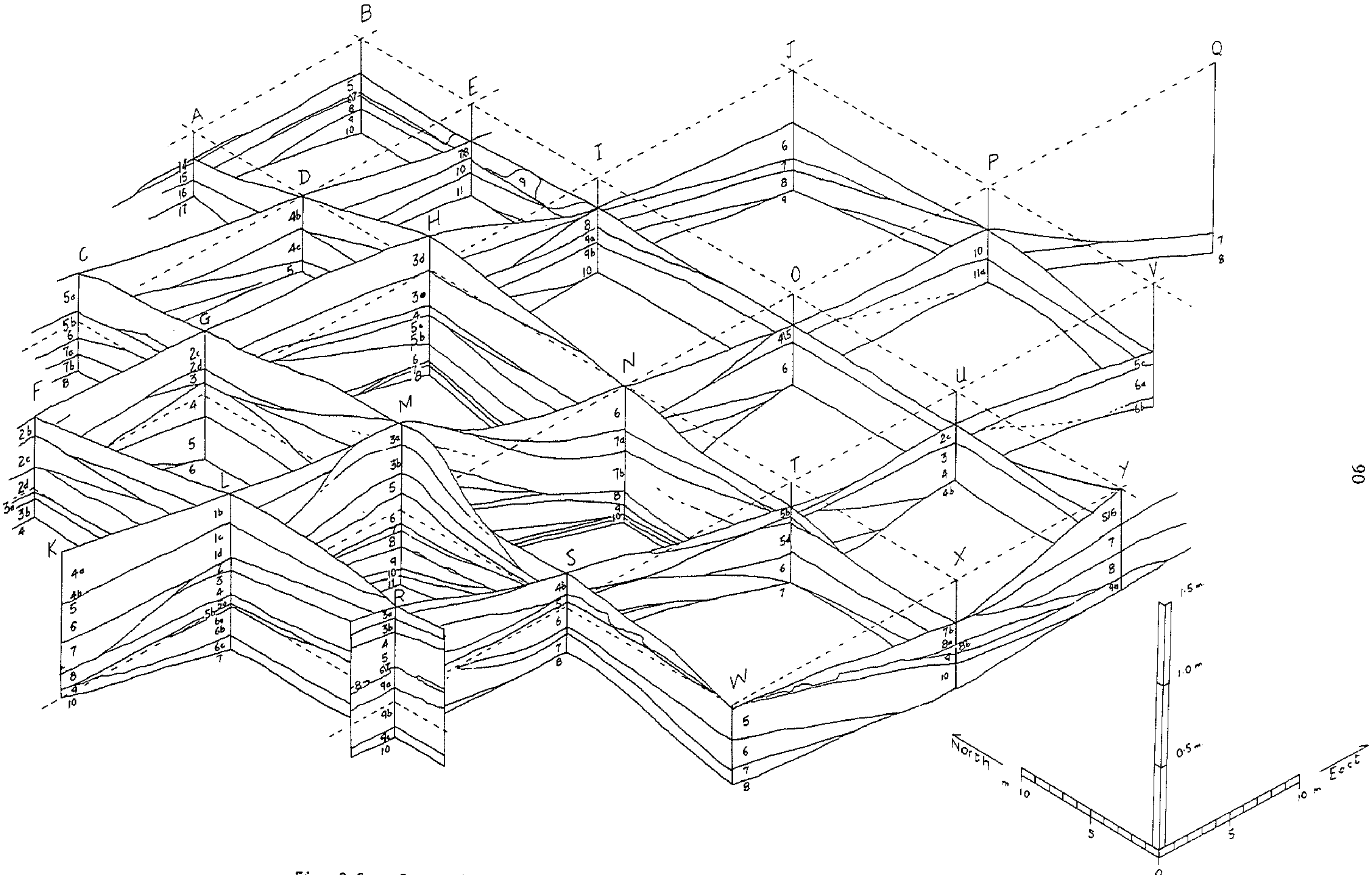


Fig. 3-6 Isometric diagram showing the final correlation of layers within the Large-flake zone.

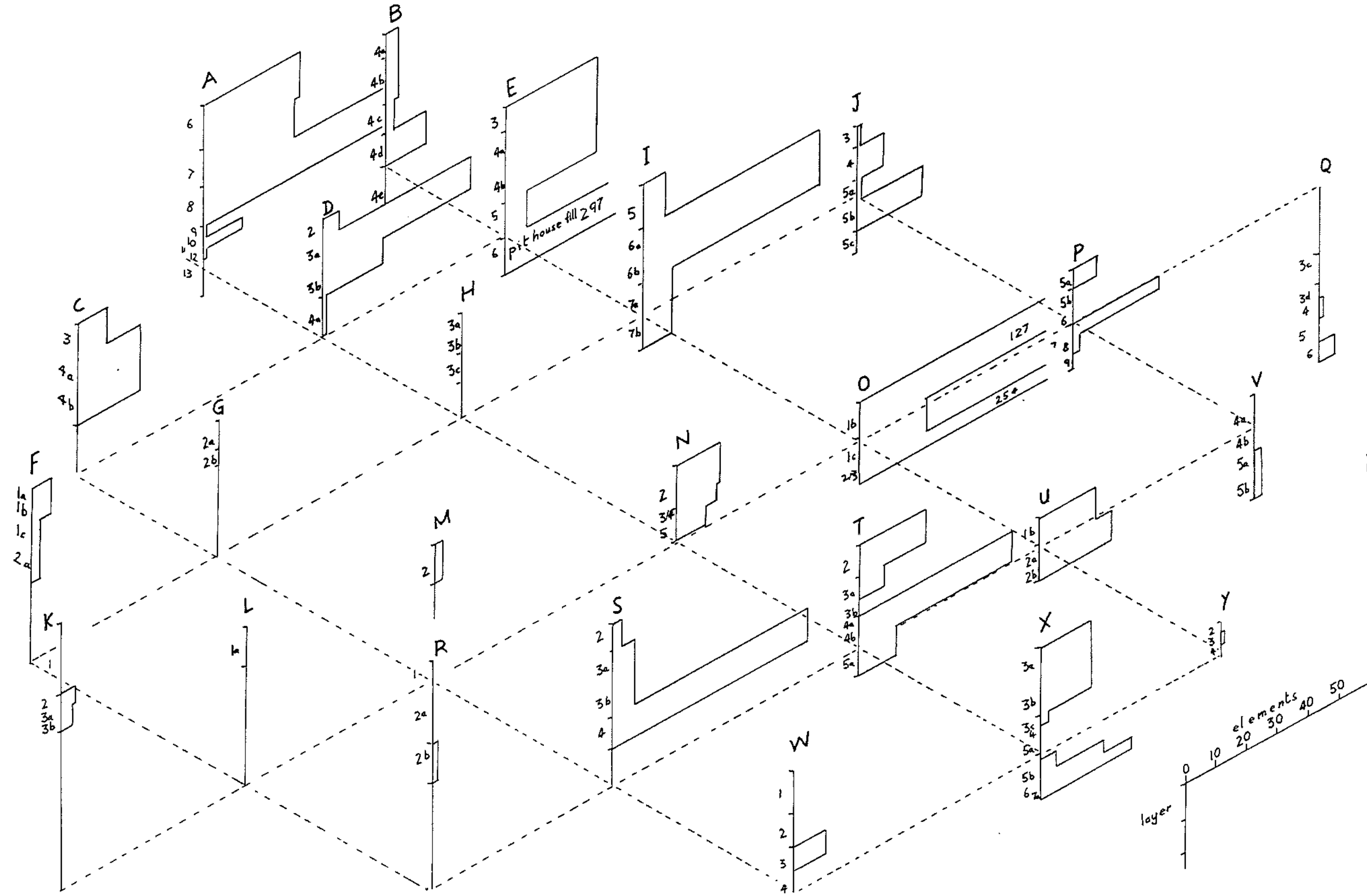


Fig. 3-7 Isometric diagram of the 25 pits. The bar graphs depict the waterfowl counts for layers ascribed to the Small-flake zone.

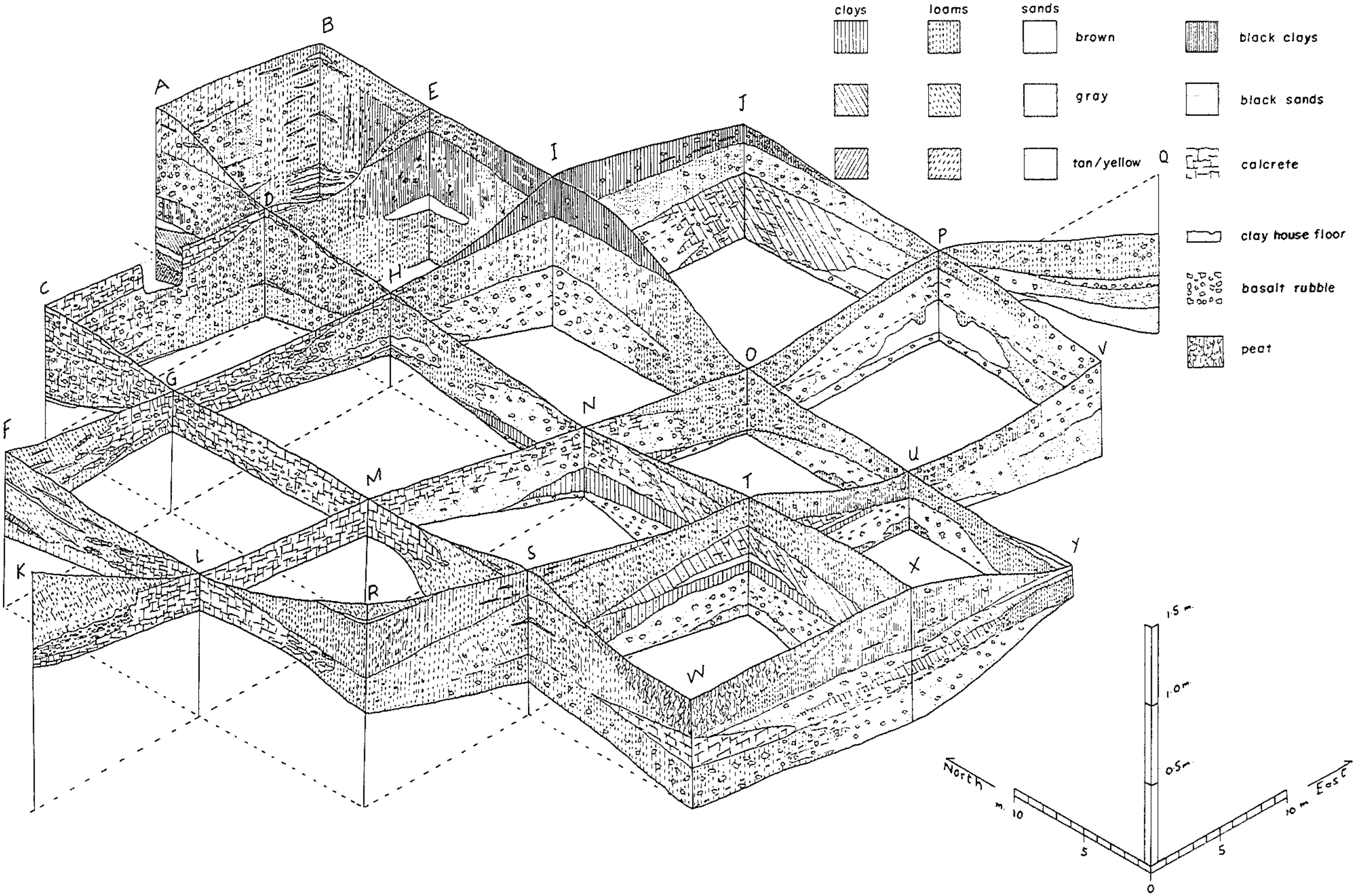


Fig. 3-8 Isometric diagram showing the geological correlation of the Small-flake zone.

northeast and west only. In the north and northeast, the loam-with-rubble is capped by a relatively rock-free loam in Pits A, B, and E, which grades to laminated silty clays in pits I and J. In the westerly pits, the loams-with-rubble are also capped by stone-free gray loams in Pits F, K, R, and S. Below this cap, the subzone can be arbitrarily subdivided into upper and lower units in some of the northern pits, but these do not correlate as discrete sedimentary units.

Overall, the stratigraphy of the Small-flake zone is highly complex, having intercalated loam-with-rubble and sand-and-basalt sheets. The avifaunal subzones are not clearly reflected as sedimentary facies, therefore. However, the concentration of clay pit house floors in the middle bird-poor zone and the recurrence of tan lenses in the upper subzone lend some support to the original subdivision.

The Small-flake Zone: Dating

Unfortunately, neither C-14 nor reliable OH dates have been obtained for the lower subzone (see Chapter 4, Tables 4-1 and 4-3). The oldest C-14 date from the bird-poor subzone indicates that at least six centuries had elapsed since the 8-Large-flake Loams, so presumably the lower subzone must have accumulated during this interval. Within the bird-poor subzone there are two pairs of C-14 dates separated by two centuries. The younger pair comes from the stream channel sands in Pit V which nevertheless reflects a later occupational phase of the same subzone. One of the two OH dates from this same subzone suggests admixture with underlying deposits. The dates from the upper subzone suggest a major break in the depositional sequence at Nightfire Island. At least seven centuries separate the youngest C-14 date in the bird-poor subzone from the oldest date in the upper subzone. This break is confirmed dramatically by the OH dates[2]. The break is all the more interesting as the bird-poor subzone is capped by clay pit house floors (Chapter 5). The proposed geological division of the upper subzone into two strata is not supported by either the C-14 reading or the OH dates from the upper stone-free stratum as they overlap with those from lower down in the deposit. Presumably they were laid down as two parts of a continuous, rapid build-up without much time elapsing between the earlier and later deposits. In summary, the dates confirm the stratigraphic position of the Small-flake Loams above the 8-Large-flake Loams; they strongly confirm the separation of the bird-poor subzone from the upper subzone, but they fail to support the subdivision of the latter.

The Small-flake Zone: Final Correlation

Correlation of the zone depends mainly on the stratigraphic presence and/or absence of waterfowl and less on subdivisions by sedimentary units. Only the localized cappings at the end of the sequence can be separated on lithological grounds alone. Thus it is impossible to isolate true strata within this zone. Instead, four subzones will be designated: the 9-Lower, 10-Middle, 11-Upper and 12-Terminal Small-flake Loams (Fig. 3-9).

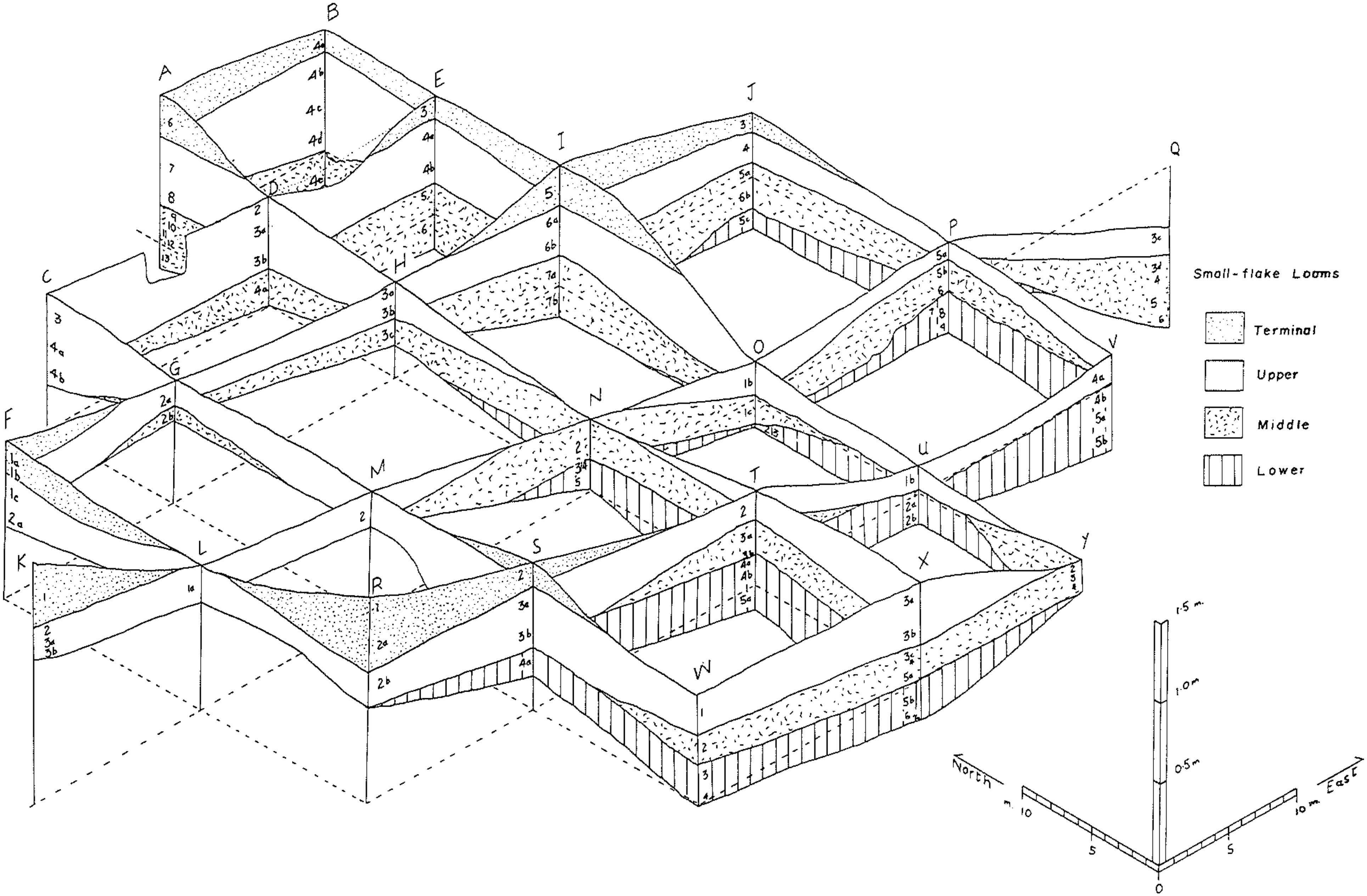


Fig. 3-9 Isometric diagram showing the final correlation of the Small-flake zone.

The Arrowhead Loams: Geological Subdivisions

These loose sandy loams with rubble have their deepest accumulations in the northernmost pits, and again in the easternmost pits. Elsewhere, there is little more than a thin spread of sandy loam over the surface of the site.

Stratigraphic correlation of the northern pits is quite straightforward. At the base of the sequence is a gray loam which can be traced in all Pits A through I with minor local variations (tan lenses, white sand lenses, brown mottling) usually shared by two adjacent pits. The clay content increases in Pits H and I.

Above the gray loam is a loose brown loam in Pits E, G, H, and I, which cannot be discerned in the other northern pits where the two strata may be intercalated. The white sand in layer A4 may be part of this complex.

Overlying the loose brown loam is a localized sheet of tan loam in Pit E which lenses out in layers B2 and A3. Finally, there is a surface sheet or brown organic loam covering all the northern pits except G and H (Fig. 3-10).

The stratigraphy of the eastern pits is far more complex and difficult to correlate with the preceding group. The only trace of the basal gray loam is a gray clay in layer P4 which may be an extension of the clay facies of Pits H and I. Above this in layer P3 is a loose brown loam which also equates well with the sequence in Pits H and I. However, neither of these strata is traceable in Pits V and Q which contain deep accumulations of brown sands at the base of the zone. These are presumably lag deposits of a stream channel cut into the basal strata of this zone. Next in sequence is a brown rubbly loam with pea-size gravels traceable in Pits P, V, Q, and J. It is impossible to equate this horizon with one or other of the two topmost loams in the northern pits. Next, in Pits J, P, and V, there is a sheet of brown rocky loam with tan sand lenses and abundant fish bone. This is probably traceable in the peat in Pit Q where rock concentrations occur in spit Q1c.

Finally, Pits J, P, and V are covered by a surface sheet of loose tan on tan-gray loam which merges into the peat at the surface of Pit Q. Neither this, nor the preceding fish-rich horizon is represented in the northern pits.

The Arrowhead Loams: Typological Subdivisions

In order to tie together the north and east sequences and to correctly tie in the top levels of the south and central pits, three stylistic subzones have to be exploited.

In the northern group, the basal gray loams and the overlying loose loams consistently yield more arrowheads with convex blades, whereas the overlying layers contain higher frequencies of specimens with concave blades. This separation is fortunately repeated in the

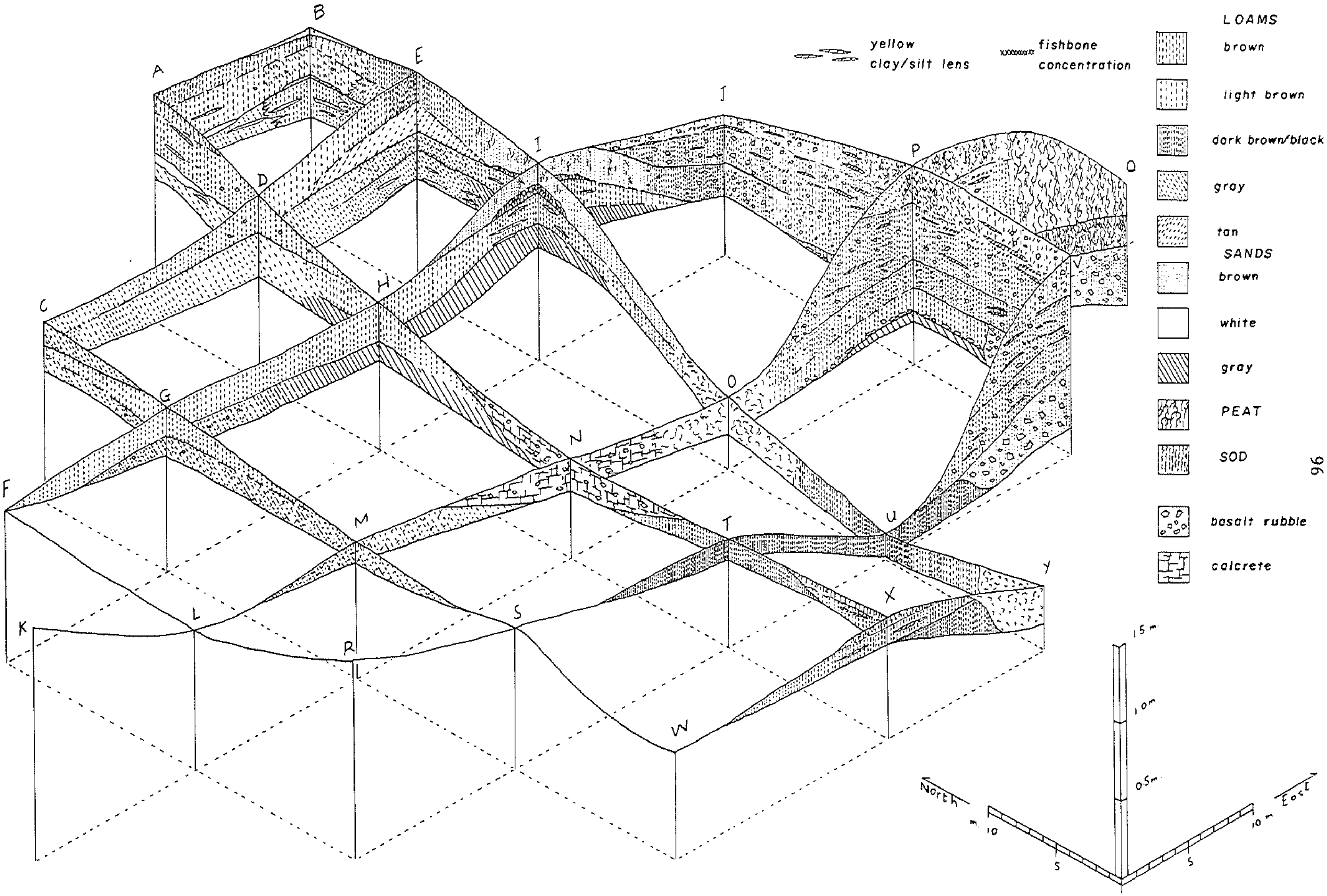


Fig. 3-10 Isometric diagram showing the geological correlation of the Arrowhead zone.

eastern pits--including the stream channel sands in Pits Q and V. The absence of gray loams from the intermediate Pit J is supported.

The upper levels of Pits P, V, and Q also contain Gunther Island winged points which do not occur at all in the north pits. It is apparent therefore, that the topmost beds in the eastern flank of the site were the last to be deposited on the entire site and were of a very localized nature along the streambank edge. During the time that these deposits were accumulating, the north end of the site had already been abandoned, or it was subsequently stripped of deposits belonging to this subzone.

Placement of the remaining top layers from central and southern pits becomes possible, using the typology of the contained arrowheads. Pits O, U, and T have a closer affinity with the gray loam and the convex-blade subzone. The tops of pits M and N fit best with the concave-blade subzone. Finally, pit X has more in common with the Gunther subzone. Pit Y is unfortunately disturbed and cannot be fitted into any part of this closing sequence. The three subzones are designated 13-Lower, 14-Middle, and 15-Upper Arrowhead Loams.

It is regrettable that typological criteria should be drawn into the correlation, but the avifauna provide no adequate subzonation of these upper loams. The final correlation of layers is given in Fig. 3-11.

The Arrowhead Loams: Dating

There was evidently too much churning for these deposits to yield properly stratified dates. The four C-14 readings in no way support the stylistic/stratigraphic subdivisions, and two of the four OH dates from the 14-Middle Arrowhead Loams overlap with the younger readings from the underlying 13-Lower Arrowhead Loams. However, OH dates in the 14-Middle Arrowhead Loams support a stratigraphic separation from the 11-Upper Small-flake Loams. At least one charcoal sample from the 14-Middle Arrowhead Loams had been brought up to the surface from the underlying 11-Upper Small-flake Loams, probably due to storage pit excavations (Chapter 5). Unfortunately, the only reliable OH rind from the 15-Upper Arrowhead Loams is from a derived flake. Thus, the dates partly support the stratigraphic placement of the Arrowhead Loams above the Small-flake Loams, but add no support whatever to the internal subdivisions of the last suite of loams, and they do not help to strengthen the correlation between the northern and eastern pits.

Brief Commentary on the Correlation

Without continuous trenching through the site, it is simply impossible to be sure that every aspect of the correlation is correct. This exercise has aimed to achieve a best approximation which is subject to modification by future researchers (Table 3-1).

Given the lack of standardized descriptive procedures for layers (Chapter 2), a strict geological correlation cannot be achieved with any certainty. Furthermore, those strata which can be confidently linked up have limited horizontal distribution within the site and serve only to correlate small groups of pits. In fact, no single stratum occurs in every pit except possibly the lakebed on which the

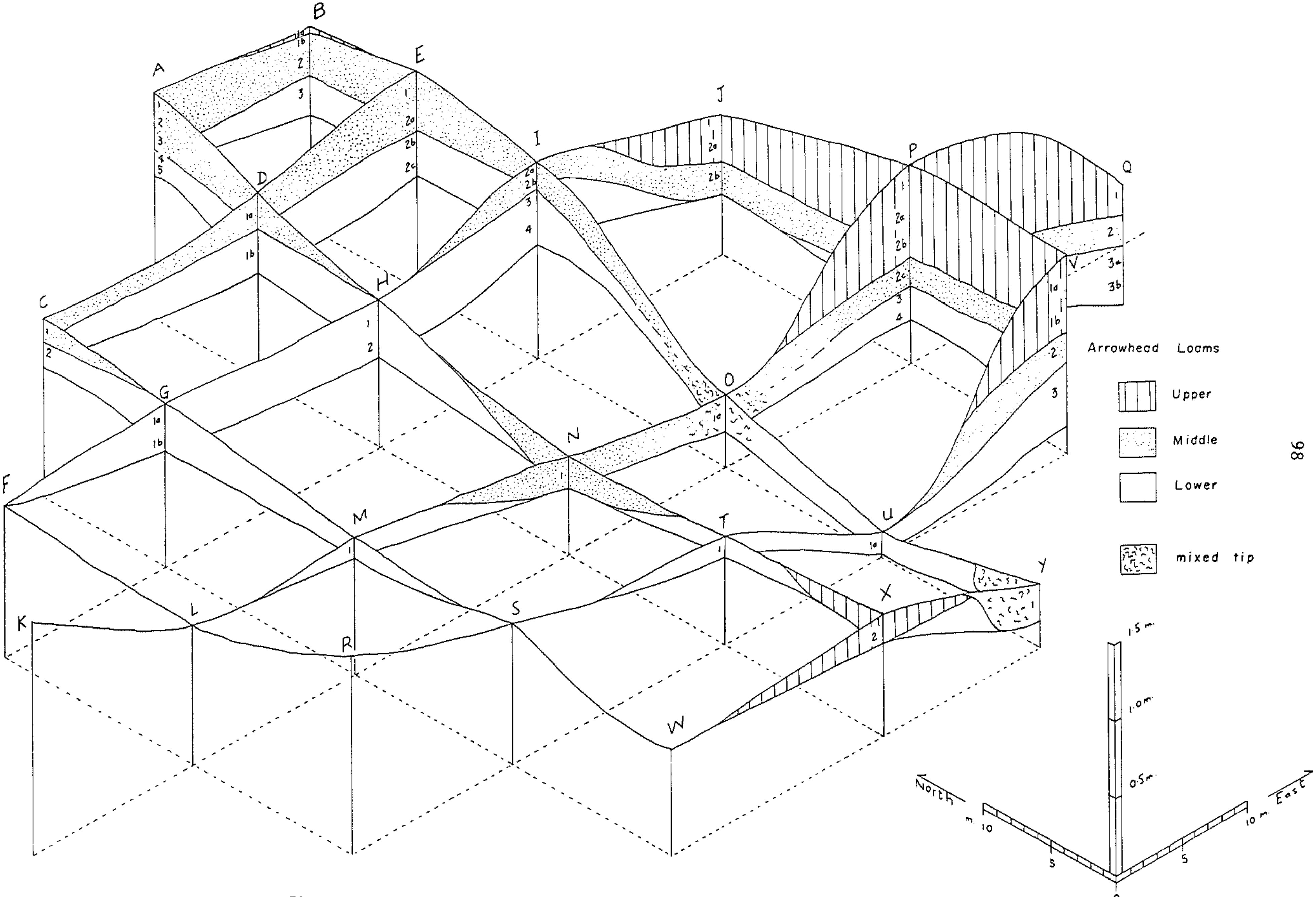


Fig. 3-11 Isometric diagram showing the typological correlation of the Arrowhead zone.

site has accumulated. Correlation attempts based on layer-descriptions alone yield groups of "floating" strata in various parts of the site. In several cases, their stratigraphic relationships to each other cannot be demonstrated. Because many of these floating strata either accumulated too rapidly, were reworked, or were churned by the inhabitants, radiocarbon and obsidian hydration dates are not always sensitive enough to show the chronological order in which they were laid down[3].

It is necessary, therefore, to use selected aspects of the artifact and avifaunal content of the deposits to achieve a few site-wide correlations. This procedure breaks a fundamental rule in the correlating of archaeological sites because it threatens to build circular reasoning into the conclusions drawn from analysis: artifacts and waterfowl appear to change from one stratum to the next because they were correlated to do so; also, the correlation must be valid _because_ the artifacts and birds in each stratum are distinctive.

The 15 strata which form the analytical framework of this site will be mentioned repeatedly in the following chapters. For brevity's sake, each stratum will be referred to by its number followed by an acronym (Table 3-2).

ENDNOTES: CHAPTER 3

1. The term _stratum_ denotes the larger sedimentary unit exposed in several pits. _Layer_ will be used to denote a particular exposure in a single pit.

2. One C-14 reading and one OH date from the _upper subzone_ appear to have been brought up from the 2-Coot Clays to this surface during grave digging operations nearby (see Chapter 4).

3. A provisional correlation based on geological descriptions and dates alone was generated by the author and used as a framework for analyzing the mammalian fauna and birds (Grayson 1972, 1974) and for preliminary presentation of the artifactual contents of the site (Sampson and Verrett 1975). That correlation is now replaced by the final approximation presented in this chapter.

Table 3-1. <u>Correlation of Pits and Layers</u>

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
15-Upper Arrowhead Loams		1a								1 2a						1 2a 2b	1a 1b 1c					1a 1b		1 2	
14-Middle Arrowhead Loams	1 2 3	1b 2	1	1a	1 2a				2ab	2b				1		2c	2					2			
13-Lower Arrowhead Loams	4 5	3	2	1b	2b 2c		1a 1b	1 2	3ab 4				1			3 4	3a 3b			1	1a	2/3 3			
12-Terminal Small-flake Loams	6	4a			3				5	3	1						3c	1 2a	2						
11-Upper Small-flake Loams	7 8	4b 4c 4d	3 4a 4b	2 3a 3b	4a 4b	1c 2a	2a	3a 3b	6a 6b	4	2 3a 3b	1a	2		1b	5a		2b	3a 3bc	2	1b	4a	1	3a 3b	
10-Middle Small-flake Loams	9 10 11-12 13	4e		4a	5 6		2b	3c	7a 7b	5a 5b				2	1c	5b 6	3d 4 5 6			3a			2	3c 4 5a	2 3 4
9-Lower Small-flake Loams										5c				3 4 5	2 3	7 8 9			4a	3b 4a 4b 5a	2a 2b	4b 5a 5b	3 4 5top	5b 6 7a	
8-Large-flake Loams	14 15	5 6/7	5a	4b	7/8 9	2b 2c	2c 2d	3d 3e	7c	6	4a 4b 5 6	1b 1c 1d		6						5b					5 6
7-Gray Clay	16	8		4c	10																				
6-Sand & Basalt		9 10	5b 6	5	11		3	4	8 9a	7 8	7				4 5	10				5c	2c	5c			7
5-Scaup Muck	17								9b 10	9					6a 6b	11a	7/8				3 4a	6			8a 8b
4-Mixed-bird clays												2		7a				3ab	4b						
3-Grebe Clays				6a		2d		5	11			3 4	3a 3b 4/5 6	7b				4 5 6 7		5d 6				7b 8a 8b	
2-Coot Clays			7a				4	6			8	5a	7 8	8 9				8 9a	5 6				5bottom	9 10	9a
1-Basal Clays			7b			3a 3b	5	7 8			9 10	5b 6a 6bc	9 10 11	10 11				9b	7a 7b				6 7		
Lake Bed	18	11	8	6b	12	4	6	?	12	–	11	7	?	?	7	11b	8	10	8	7	4bc	7	8	11	9b

Table 3-2

Acronyms for Strata

Stratum Name	Acronym
Upper Arrowhead Loams	15-UAL
Middle Arrowhead Loams	14-MAL
Lower Arrowhead Loams	13-LAL
Terminal Small-flake Loams	12-TSFL
Upper Small-flake Loams	11-USFL
Middle Small-flake Loams	10-MSFL
Lower Small-flake Loams	9-LSFL
Large-flake Loams	8-LFL
Gray Clays	7-Gracl
Sand and Basalt	6-S&B
Scaup Muck	5-Scaup
Mixed-bird Clays	4-Mix
Grebe Clays	3-Grebe
Coot Clays	2-Coot
Basal Clays	1-Basal
Lake Bed	----

CHAPTER FOUR

DATING

Although briefly discussed in the preceding chapter, the dates obtained from the deposits have been given only cursory attention. They will be treated in more detail here so that each stratum may be fitted to the chronological framework shared by the rival models proposed in Chapter 1. The radiocarbon dates, being altogether more reliable indicators of age, will be evaluated first.

Radiocarbon Dates

A total of 150 carbonized wood samples was collected from almost all of the layers encountered during excavations. Most of the samples were recovered during the dry-sieving process, although a few were taken from prominent concentrations in pit walls or from exposed clay floor surfaces. Altogether, 28 samples were selected for processing at the Gakushuin University laboratory, Tokyo (Johnson 1969)[1].

The selection was determined by three factors. First, a continuous column of stratified samples was needed from a deep pit as a control-sequence for calibrating the obsidian hydration-rate at the site (Johnson 1969b). Pit I was chosen for its depth and relatively undisturbed stratigraphy. This also served to evaluate the apparent lack of disturbance, mixing or turnover of the site's sediments.

A second factor was the obvious conflict between the stratigraphic sequences of the few eastern pits and the rest of the site. Consequently, a second column of samples was taken from pit V as the deepest of this group. The influence of stream-action in mixing deposits in this part of the site could also be evaluated.

The third group of samples was selected to verify the stratigraphic positions of specific features such as pit house floors and enigmatic layers.

The dates were processed between 1967 and 1969 and were reported originally with the Libby half-life of 5,570 years (Kigoshi 1967-69). The readings are therefore listed in Table 4-1 as originally reported, together with recalculated values based on the half-life of 5,730 years recommended by the Sixth International Radiocarbon Dating Conference (1965). Each recalculated date is then calibrated against the White Mountains bristlecone pine tree-ring dates obtained by Ralph (1971) for these radiocarbon ages. The last column gives the tree-ring calibrated date for each reading, as recommended by Clark (1975), using the original Libby half-life.

The readings are listed in Table 4-1 in the stratigraphic order proposed in Chapter 3. Although there are minor dating inversions in pits I and V, none of these is large enough to raise serious doubts about mixing in the deposits. The only outstanding anomaly is sample L1ab in the 11-USFL[2] and 8-LFL. This sample comes from only a few inches above the surface and predates the underlying sample L4 by a millennium. Given the near-surface context of the sample, plus the

Table 4-1

Radiocarbon Dates from Nightfire Island

Stratum	Provenience	Lab. No.	Libby half-life (5568+30)	Revised half-life (5730+40)	Mean Calendric (after Ralph 1971)	Mean Calendric (after Clark 1975)
15-UAL	V1b	Gak-1841	1540±100 bp	1585±100 bp (365±100 ad)	415 AD	438 AD
14-MAL	V2	Gak-2418	930± 90 bp	957± 90 bp (993± 90 ad)	1020 AD	1000 AD
	A2-3	Gak-1842	2080± 90 bp	2140± 90 bp (190± 90 bc)	212 BC	134 BC
13-LAL	V3b	Gak-2419	1420± 90 bp	1461± 90 bp (489± 90 ad)	540 AD	619 AD
12-TSFL	I5	Gak-1831	2180± 80 bp	2243± 80 bp (293± 80 bc)	328 BC	240, 300, 355 BC
11-USFL	I6a	Gak-1832	2340±100 bp	2408±100 bp (458±100 bc)	506 BC	445 BC
	I6b	Gak-1833	2180± 90 bp	2243± 90 bp (293± 90 bc)	328 BC	240, 300, 355 BC
	C4ab	Gak-2428	2210±110 bp	2274±110 bp (324±110 bc)	361 BC	376 BC
	E4a	Gak-2425	1790±110 bp	1842±110 bp (108±110 ad)	165 AD	221 AD
	E4b	Gak-1844	2220± 90 bp	2284± 90 bp (334± 90 bc)	367 BC	382 BC
	L1ab	Gak-2424	6160±130 bp	6339±130 bp (4389±130 bc)	5200 BC	5094 BC
10-MSFL	I7a	Gak-1834	3470± 80 bp	3571± 80 bp (1621± 80 bc)	1840 BC	1861 BC
	I7b	Gak-1835	3450± 90 bp	3550± 90 bp (1600± 90 bc)	1812 BC	1835 BC
	V5b	Gak-2420	3040±100 bp	3128±100 bp (1178±100 bc)	1314 BC	1372 BC
	V5c	Gak-2421	3110±110 bp	3200±110 bp (1250±110 bc)	1406 BC	1451 BC
8-LFL	E8	Gak-1834	4070±100 bp	4188±100 bp (2238±100 bc)	2764 BC	2704 BC
	O3	Gak-1123	3940±130 bp	4054±130 bp (2104±130 bc)	2590 BC	2507 BC
6-S&B	I8	Gak-1836	4260±100 bp	4383±100 bp (2433±100 bc)	2985 BC	2982 BC
	O5	Gak-1122	4410± 80 bp	4538± 80 bp (2588± 80 bc)	3166 BC	3189 BC
	I9a	Gak-1837	4750±110 bp	4888±110 bp (2938±110 bc)	3637 BC	2580 BC
5-Upper Scaup Muck	I9b	Gak-1838	4030± 90 bp	4147± 90 bp (2197± 90 bc)	2715 BC	2640 BC
	I9b	Gak-1839	4500±110 bp	4630±110 bp (2680±110 bc)	3285 BC	3310 BC
	V6	Gak-2422	3960±120 bp	4074±120 bp (2124±120 bc)	2621 BC	2535 BC
	V7	Gak-2423	4140±110 bp	4260±110 bp (2310±110 bc)	2840 BC	2831 BC
5-Lower Scaup Muck	O6b	Gak-1121	4380± 90 bp	4507± 90 bp (2557± 90 bc)	3130 BC	3134 BC
3-Grebe	I11	Gak-1840	5750±130 bp	5917±130 bp (3967±130 bc)	4045 BC	3990 BC
2-Coot	M8	Gak-2427	6080±140 bp	6256±140 bp (4306±140 bc)	5100 BC	5008 BC

fact that Pit R just to the south of it is a mass grave, the most reasonable explanation is that the charcoal from sample Llab is derived probably from the 2-Coot, and thrown up by grave diggings to become incorporated in the surrounding topsoil.

Table 4-1 shows that even the uncalibrated readings tend to cluster, and this is enhanced in the two calibrated columns[5] where the clusters are more widely separated in time. Such patterning suggests intermittent abandonment of the site beteween intensive episodes, but this is not necessarily proven.

Calibrated Radiocarbon Ages of Individual Strata

Given the relatively short distance from the White Mountains in California to Nightfire Island (Fig. 1-1), acceptance of the White Mountains bristlecone pine tree ring-calibrated C-14 dates is justifiable. It follows, then, that the individual strata of the site can be fitted to the bristlecone tree ring-dated framework of climatic fluctuations described in Chapter 1 (Fig. 1-10). Only slightly different matches between the two are obtained when either the Ralph (1971) or the Clark (1975) calibration curves are applied (Fig. 4-1).

On either curve, the 2-Coot was deposited at some time between 5,300 and 4,900BC if the sample Llab date is admitted as derived from adjacent 2-Coot sediments. The means of these readings bracket 5,200-5,000BC. Again, on either curve the 3-Grebe must have been laid down between 4,800 and 4,450BC if the sample L4 date is rejected as suspect. Its very wide standard deviation is anomalous in this sequence so that its intermediate position straddling 4,000BC is called into question. The original charcoal sample is certainly too small and is probably mixed. Thus, the 2-Coot and 3-Grebe strata coincide with Mehringer's (1977) episode of increased effective moisture in the Great Basin. At some time between 4,450 and 3,750BC, the 4-Mix was accumulating, but there remains the distinct possibility that deposition ceased during some part of this interval.

The 5-Scaup began to bank up against the earlier suite of clays at about 3,750BC according to the Ralph curve (or 3,700BC on the Clark curve)[4]. The buildup was slow and possibly erratic until some time before 2,850BC (or 2,800BC) when the 6-S&B was dumped on to its surface. The exact date of this event cannot be ascertained, but it probably took place during the century following 3,000BC. Thus, the 5-Scaup and 6-S&B depositional event straddles the entire first cool-wet episode of the bristlecone-based climatic record, and began during the warm spike that precedes it. The 8-LFL at Nightfire Island dates to 2,850-2,450BC (2,800-2,400BC) and spans the following warm-dry event and the ensuing brief cool-dry spike.

Exactly when the 9-LSFL fits into the bristlecone sequence remains uncertain, but there are grounds for believing that it accumulated during the earlier (warm-wet) part of the period 2,450-1,900BC (2,400-1,950BC). The first deposition of the 10-MSFL coincides with the ensuing warm-dry episode of 1,900-1,750BC. The later accumulation of the 10-MSFL straddles the hot-dry interval of 1,500-1,300BC. The apparent break in deposition between the end of the 10-MSFL and the lowest levels of the 11-USFL coincides exactly with the cool-dry half of the second major cooling episode in the bristlecone record, namely 1,200-600BC.

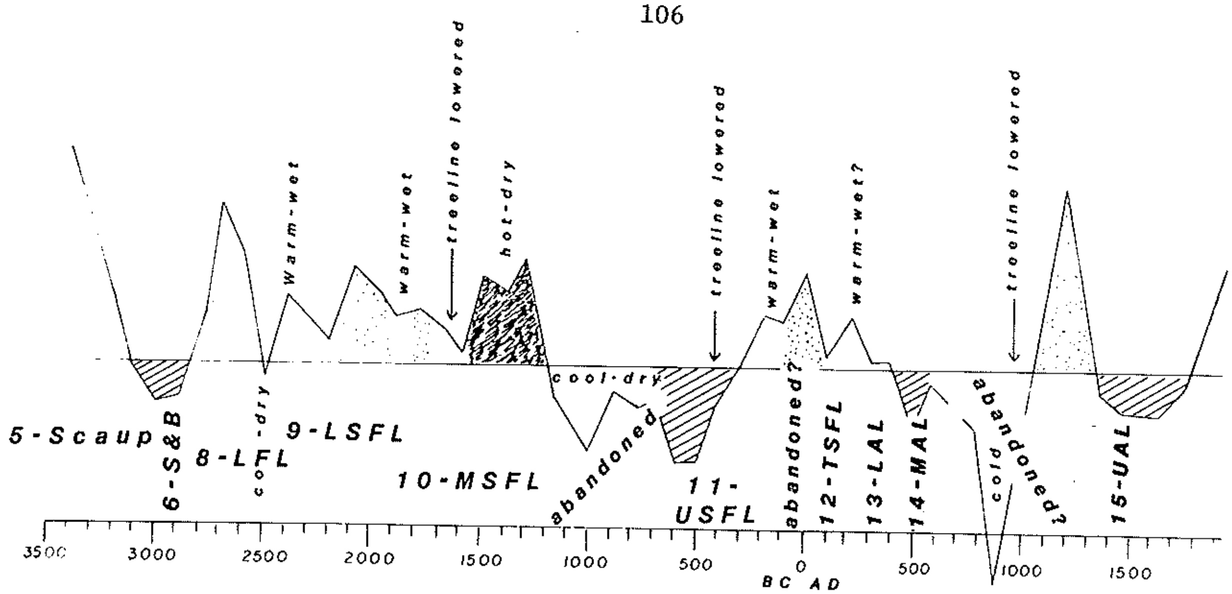


Fig. 4-1 The bristlecone climatic curve fitted to those Nightfire Island strata with appropriate calibrated radiocarbon dates.

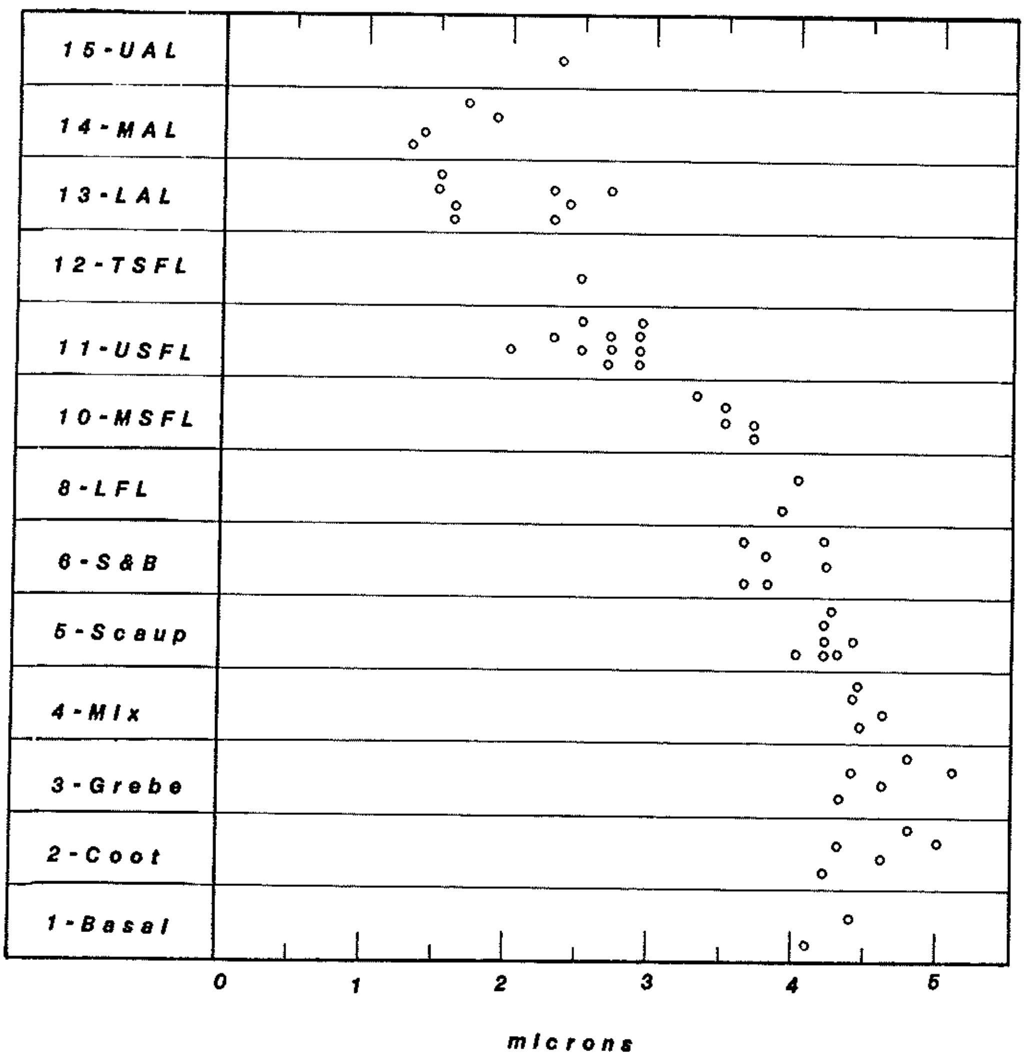


Fig. 4-2 Obsidian Hydration rind thickness in microns of selected flakes from Nightfire Island strata. Based on the specimens listed in Table 4-3.

The first appearance of the 11-USFL fits well with the pronounced cool-wet half of the second major cooling episode. The 12-TSFL may fit into the second ensuing warm-wet event, and there are grounds for suspecting that deposition may have halted during the time of the warm-dry spike around 0 AD. The solitary date from spit E4a spanning 50-250AD (or 100-330AD) comes from the top of the 11-USFL and could be derived from the 12-TSFL above.

The Arrowhead Loams began building up at around 300AD before the onset of the third cool-wet episode in the bristlecone record. It is suspected that deposition may have halted again during the most prominent cold-dry spike of 700-900AD, and during part of the ensuing warm-dry spike. On typological grounds, the 15-UAL cannot be much older than 1,400AD (see Chapter 13) and it therefore fits into the earlier part of the fourth cool-wet episode. The exact date of abandonment is unknown, but was certainly pre-Contact.

Obsidian Hydration Dates

Obsidian flakes were taken from the same layers as the radiocarbon samples in Pit I and used as a control sample to establish the local hydration rate. Johnson (1969b) has already described this calculation which need not be repeated here. However, some aspects of the laboratory procedures and unprocessed results require discussion before the dates are presented.

The standardized procedure for acquiring a rind measurement was as follows: 10 thin-sections were made from each flake. The rind (if visible) was then measured at three loci on each thin-section; and each locus was measured three times. The nine measurements for each thin-section were then averaged and this value was recorded in microns. Under ideal conditions, 10 values for each flake could be obtained, and these could then be averaged to give a mean rind thickness with standard deviation for each flake.

However, the condition of the thin-sectioned rind on a field specimen is seldom, if ever, ideal. Most of the studied flakes yielded some thin-sections without any visible rind at all, and these had to be discarded. Among the remainder, no final calculation was based on all ten measurements. No doubt some of the rind was lost from such specimens during preparation, but the possibility of rind loss while the flake was undergoing burial cannot be discounted--although this is still poorly understood.

On those thin-sections with visible rinds, other problems arose. Most thin-sections reveal rind fragments of more than one thickness. Often, the fragments were too short to measure more than single loci. Consequently, the locus could be measured three times only, and these measurements had to be averaged to obtain a mean thickness for the rind fragment. The same procedure would be used on the next rind fragment, and so on. After all ten thin-sections had been searched, it was not uncommon for a flake to yield two, three, or even four groups of rind measurements, each based on limited numbers of readings from isolated small fragments of rind (Table 4-2). The analyst was then obliged to select a preferred rind-thickness value as the one most likely to date the layer in which the flake was found (cf. Evans and Meggers 1960).

Table 4-2

Obsidian Hydration rind thicknesses (in microns)

Stratum	Pit & Layer	Number of sections per measurement								
		9	8	7	6	5	4	3	2	1
15-Upper Arrowhead Loams	P1	-	-	-	-	-	-	-	5.7	-
	V1b	-	-	-	-	-	2.2	-	-	1.2,2.9
14-Middle Arrowhead Loams	A1-4	-	-	-	-	-	-	-	2.2	3.0
	E1-2	-	-	-	-	-	-	1.7	-	-
	E1-2	-	-	1.9	-	-	-	-	4.7	3.6
	C1	-	-	-	-	1.3	-	-	-	-
	C1	-	-	-	-	-	-	1.4	-	2.0
13-Lower Arrowhead Loams	B3	-	-	3.0	-	-	-	-	3.6	-
	B3	-	-	-	-	-	-	-	2.8,3.4	-
	C2	-	-	-	-	2.7	-	-	-	3.3
	C2	-	-	-	-	2.4	-	-	-	1.8,3.4
	D1-2	-	-	-	-	-	-	-	3.2	-
	D1-2	-	-	-	-	-	-	2.2	-	2.9,3.6
	G1a	-	-	-	-	-	-	-	-	2.4
	H1	-	-	-	-	-	-	-	-	1.0
	H1	-	-	-	-	-	-	-	5.1	-
	I3	-	-	-	1.6	-	-	-	-	-
	I3-4	-	-	-	-	-	-	1.6	-	2.4
	I3-4	-	-	-	-	-	2.3	-	-	1.8
	P4-5	-	-	-	-	-	-	1.5	-	2.5
	V3-4	-	-	-	2.4	-	-	-	-	1.5,3.1 5.0
12-Terminal Small-flake Loams	I5	-	-	-	-	-	-	-	-	2.8
	I5	-	-	-	-	-	-	-	-	1.4,2.1 2.8
11-Upper Small-flake Loams	A7b	-	-	-	-	-	-	-	-	4.0
	A7b	-	-	-	-	-	-	-	4.2	-
	C3	-	-	-	2.5	-	-	1.2	3.5	-
	C3	-	-	-	-	-	-	-	2.5,4.3	1.8,3.1
	C4b	-	-	-	-	-	3.0	-	-	2.3,3.6
	E3-4	-	-	-	-	-	-	-	2.2	1.5
	H3a	-	-	-	-	-	-	-	-	2.3
	H3B	-	-	-	-	-	-	-	-	2.4,3.9
	H3b	-	-	-	-	-	-	-	2.3,3.3	4.2
	I6	-	-	-	-	-	2.9	-	-	6.5
	I6	-	-	-	-	-	-	2.9	-	1.5
	I6	-	-	-	-	-	3.4	-	1.9	-
	P4-5?	-	-	-	-	-	-	1.5	-	2.5
	Q3c	-	-	-	-	-	3.2	-	4.3	-
	S2-3	-	-	-	-	-	-	-	5.6	4.4

Table 4-2 (continued)

Stratum	Pit & Layer	9	8	7	6	5	4	3	2	1
	S2-3	-	-	-	-	-	2.3	-	-	1.9
	S3	-	-	-	-	-	-	-	-	2.8
	S3	-	-	-	-	2.5	-	-	-	-
	S3	-	-	-	-	-	5.5	-	-	3.3
	T2	-	-	-	-	-	-	-	3.2	4.5,5.4
	V3-4?	-	-	-	2.4	-	-	-	-	1.5,3.1 5.0
	W1-2	-	-	-	-	-	2.4	-	-	-
	W1-2	-	-	-	-	-	-	2.0	-	-
10-Middle Small-flake Loams	D4a	-	-	-	-	-	-	-	3.3	2.5,4.2
	D4a	-	-	-	-	-	-	-	3.3	5.0
	H3c	-	-	-	-	-	-	-	4.0	3.4
	H3c	-	-	-	-	-	-	3.8	2.5	1.1
	H3c	-	-	-	-	-	-	-	3.8	2.3,4.7
	I7a	-	-	-	3.3	-	-	-	-	2.6
	I7a	-	-	-	-	-	-	-	3.3	5.6
	I7b	-	-	-	-	-	3.2	2.5,4.3	4.9	-
	I7b	-	-	-	-	4.3	-	-	-	2.2,6.7
	J5a	-	-	-	-	-	-	-	-	1.0,2.0
	J5a	-	-	-	-	-	-	-	4.0	2.7,5.2
	P5	-	-	-	-	-	-	-	3.2	1.1,2.0
9-Lower Small-flake Loams	S4a	-	-	-	-	-	3.7	-	4.7	-
	W3	-	-	-	-	-	-	-	2.1,3.4	1.0,4.0
	W3	-	-	-	-	-	-	-	3.1,4.3	2.3
8-Large-flake Loams	C5a	-	-	-	-	-	3.2,3.8	-	-	-
	C5a	-	-	-	-	-	3.6	-	2.9	-
	F2b	-	-	-	4.0	-	-	-	-	5.4
	F2b	-	3.9	-	-	-	-	-	-	2.9
	I7c	-	-	-	-	-	-	-	3.4,4.4	-
	I7c	-	-	-	-	-	3.8	-	2.3	5.5
6-Sand and Basalt	C5b	-	-	-	-	-	3.4	-	2.9	5.2
	C5b	-	-	-	-	3.8	-	-	-	3.0
	C6	-	-	-	-	-	-	3.7,3.1 2.1	-	-
	C6	-	-	-	-	-	-	3.8	-	3.1
	I8	-	-	-	-	-	3.8	-	3.2,4.8	-
	I8	-	-	-	4.4	-	-	3.5	3.0	-
	I9a	-	-	4.2	-	-	-	-	-	3.3
5-Upper Scaup Clays	I9b	-	-	-	-	4.2	-	-	-	3.5,5.9
	I9b	-	4.2	-	-	-	-	-	-	5.0
	I9b	-	-	-	-	-	3.8	-	2.7,5.1	6.4
	J9	-	-	-	-	4.6	-	-	-	-
	J9	-	-	-	-	-	-	4.0	-	5.9

Table 4-2 (continued)

Stratum	Layer	9	8	7	6	5	4	3	2	1
5-Lower Scaup Clays	I10	-	-	4.4	-	-	-	-	3.4,5.2	6.9
	I10	-	-	-	4.2	-	-	-	-	3.3,5.1
	I10	-	4.3	-	-	-	-	-	-	5.0
	Y8b	-	-	-	-	-	-	4.2	4.7	3.6
4-Mixed-bird Clays	L2	-	-	-	-	-	-	4.4	-	6.2
	L2	-	-	-	-	-	-	4.4	5.1	6.2
	R3b	4.6	-	-	-	-	-	-	-	-
	S4b	-	-	-	-	5.1	-	-	-	-
3-Grebe Clays	D6a	-	-	-	-	-	-	-	-	4.2
	D6a	-	-	-	-	-	-	-	3.8	-
	D6a	-	-	-	-	-	-	-	4.2	-
	I11	-	-	-	-	-	-	-	4.2	-
	T5d	-	-	-	-	-	4.6,5.1	-	-	-
	T6	-	-	-	4.4	-	-	-	-	6.0(1)
	X8	-	-	-	-	-	-	4.3	-	4.9(1)
	X8	-	-	-	-	-	4.8	-	-	-
2-Coot Clays	G4	-	-	-	-	4.3	-	3.7	-	2.5
	S5	-	-	-	-	-	5.0	-	-	-
	S5	-	-	-	-	4.2	-	-	-	2.3,3.3
	W5	-	-	-	-	-	-	4.5	2.5	-
	W5	-	-	-	-	-	-	5.3	2.6,4.5	-
	X10	-	-	-	-	-	-	4.8	-	-
	X10	-	-	-	-	-	-	-	4.0	-
	C7a	-	-	-	-	3.9,4.6	-	-	3.3	2.7
	C7a	-	-	-	-	-	-	-	2.8,3.9	4.7,6.7
1-Basal Clays	W6	-	-	-	-	4.4	-	-	-	2.7
	W6	-	-	-	-	-	-	2.4,4.5	6.2	-
	C7b	-	-	-	-	-	-	4.1	-	-

Obviously, the quality of the measurements obtained varied considerably from one flake to the next and depended largely on the judgement and selective bias of the analyst. These purely practical problems intrude into procedures long before any question can be raised about the correct calculating formulae for the hydration rate.

In such situations, it is advisable to rank the available measurements in order of dependability. The first step in this evaluation is to count the number of thin-sections on each specimen which yielded a particular rind thickness. It is reasonable to assume that the rind thickness represented by the greater number of loci on a flake is the most reliable measurement. However, the other under-represented rind measurements should not be rejected as though they are incorrect or simply do not exist. Although fragmentary, they nevertheless provide extra clues about the life-history of the flake--both before and after it was deposited in its layer. Table 4-2 shows the frequency of thin-sections per measurement of 106 flakes arranged in the stratigraphic sequence proposed in Chapter 3.

Measurements represented by more than four of the 10 thin-sections per flake are quite uncommon (30% of all flakes), may be taken as fairly reliable. Other measurements which can be accepted with some confidence are those represented by four thin-sections and accompanied by only one "aberrant" reading or none at all (8 flakes). Also acceptable are the three flakes with only three thin-sections, all yielding the same rind thickness. Another 10 flakes, with three thin-sections of similar thickness but with one aberrant reading, have also been included. Although apparently suspect, their dominant readings fit well with the more reliable ones and are accepted on that basis.

Table 4-3 lists those specimens with relatively consistent measurements, together with those listed in Ericson (1977). The dates are calculated from Friedman's (1966) rate of $\log x = (\log y + 1.2249)^5$, for Johnson's (1969b) b-value established by fitting rind-thickness to radiocarbon dates in pit I: namely $\log x = 2(\log y + 1.2679)$. It is assumed that temperature had no significant effect on hydration rate, nor did the chemical composition of the flakes (but see Chapter 11).

Reliable OH rinds are closely associated with radiocarbon dates from most layers in pit I only, but comparisons between the various sets of C-14 and OH dates for these four layers do not yield any consistent answers about which hydration rate is to be preferred in this site. Given these uncertainties, together with the still-unresolved debates over the acceptability of universal versus local hydration rates, the wiser choice is to use the OH measurements for relative dating and to rely on the radiocarbon readings as indicators of real age.

The distribution of reasonably acceptable OH measurements (Table 4-3) is graphed in Fig. 4-2 by stratum. Purged from the diagram are several specimens which were obviously derived through the reworking of earlier deposits or, less frequently, through downthrusting of overlying deposits. These are specimens from provenience units: S4b in the 4-Mix, J9 and the oldest I9b date in the upper 5-Scaup, the older I8 date in the 6-S&B, the older I7b date in the 10-MSFL, and B3 in the 13-LAL. Fig. 4-2 makes the point that several other specimens are probably derived also, and that the dominant trend was for older specimens to be moved upwards through the deposits to become incorporated in younger overlying layers. Some of these may have been

Table 4-3

Alternative dates attributed to selected OH measurements

Stratum	Provenience	Selected OH thickness (u)	Date bp (Friedman 1966)	Date bp (Johnson 1966b)
15-Upper Arrowhead Loams	V1b	2.35	1556	1897
14-Middle Arrowhead Loams	E1-2	1.7	814	992
	E1-2	1.9	1017	1240
	C1	1.4	552	673
	C1	1.3	476	580
13-Lower Arrowhead Loams	B3	3.0	2545	3091
	C2	2.7	2054	2503
	C2	2.3	1490	1817
	I3	1.50	634	773
	I3	1.6	721	879
	I3-4	1.6	721	879
	I3-4	2.3	1490	1817
	P4-5	1.5	634	773
	V3-4	2.4	1623	1978
12-Terminal Small-flake Loams	I5	2.50	1761	2144
	I5	0.45	155	188
11-Upper Small-flake Loams	C3	2.5	1761	2144
	I6	2.69	2039	2484
	I6	2.9	2369	2928
	I6	2.69	2039	2484
	I6	2.9	2369	2928
	I6	2.70	2054	2503
	S2-3	2.3	1490	1817
	S3	2.5	1761	2144
	S3	5.5	8522	10388
	V3-4?	2.4	1623	1978
	W1-2	2.4	1623	1978
	W1-2	2.0	1127	1375
10-Middle Small-flake Loams	I7a	3.50		
	I7a	3.3	3068	3740
	I7a	3.50		
	I7b	4.3	5209	6347
	I7b	3.70	3869	4701
	I7b	3.70	3869	4701

Table 4-3 (continued)

Stratum	Provenience	Selected thickness (u)	Date bp (Friedman 1966)	Date bp (Johnson 1966b)
8-Large-flake Loams	F2b	4.0	4507	5494
	F2b	3.9	4285	5223
6-Sand and Basalt	C5b	3.8	4068	4959
	C6	3.8	4068	4959
	I8	3.64	3738	4550
	I8	4.4	5454	6647
	I8	3.64	3738	4550
	I9a	4.2	4969	6058
	I9a	4.20	4969	6058
5-Upper Scaup Muck	I9b	4.58	5910	7203
	I9b	4.2	4969	6058
	I9b	4.2	4969	6058
	J9	4.0	4507	5494
	J9	4.6	5961	7266
5-Lower Scaup Muck	I10	4.4	5454	6647
	I10	4.2	4969	6058
	I10	4.3	5209	6347
	I10	4.22	5017	6116
4-Mixed-bird Clays	L2	4.43	5530	6739
	L2	4.4	5454	6647
	L2	4.43	5530	6739
	R3b	4.6	5961	7266
	S4b	5.1	7327	8932
3-Grebe Clays	T5d	5.1	7327	8932
	T5d	4.6	5961	7266
	T6	4.4	5454	6647
	X8	4.3	5209	6347
	X8	4.8	6491	7912
2-Coot Clays	G4	4.3	5209	6347
	S5	5.0	7043	8585
	S5	4.2	4969	6058
	C7a	3.9**	4285	
	C7a	4.6**	5961	7266
	X10	4.8	6491	7912
1-Basal Clays	W6	4.4	5454	6647
	C7b	4.1	4735	5772

* Measurements to two decimal places are from Ericson (1977).

** These two rinds appear together on the same flake.

mixed during excavation, but it is also possible that obsidian was frequently scavenged from beneath the living surface of the settlement itself in order to avoid the trouble of fetching it from distant outcrops (see Chapter 11).

The measurements from the lower suite of clays (1-Basal through 4-Mix) are quite inseparable and there are indications that flakes from the 5-Scaup were also pressed down into these in the area of Pits S and C. Again, downthrusting of the 6-S&B into the 5-Scaup and/or scavenging has brought earlier specimens into the 6-S&B also. Scavenging probably brought the two 6-S&B-dated specimens into the 10-MSFL. The chronological break between the 10-MSFL and 11-USFL is supported, but the 10-MSFL readings all come from Pit I and the case for a site-wide halt in deposition is not overwhelming. If there was a gap in the site's occupation then we need to understand why the practice of scavenging was discontinued by those responsible for the 11-USFL buildup. Also, the OH rinds for the Arrowhead Loams present two distinct clusters: one group of four specimens derived from the underlying 11-USFL, and the rest. When the 11-USFL dated flakes are removed, a chronological break between the 12-TSFL and the 13-LAL becomes apparent. This provides useful support for the suspected abandonment phase at around 0 AD, but it places the 12-TSFL before 0 AD, not after it as the C-14 date suggests.

In summary, the OH dates are of limited use in terms of absolute dating, but are valuable indicators of movements of obsidian flakes between strata, and they lend support to the inference of depositional gaps in the sequence which have been hinted at by the radiocarbon record.

ENDNOTES: CHAPTER 4

1. Remaining samples are housed at the Oregon State Museum of Anthropology, University of Oregon.

2. See Chapter 3, Table 3-2 for stratum acronyms.

3. These are of course approximations, like the radiocarbon ages.

4. In the following passages the Clark (1975) date will be given in parentheses, after the (Ralph 1971) date.

5. y = OH rind thickness, x = years.

CHAPTER FIVE

DEPOSITIONAL HISTORY

The processes which caused the sequence of strata to accumulate may now be examined. Each stratum is treated in turn, with granulometric and chemical descriptions where these are available. The sequence of depositional events is then compared with the two predictive models proposed in Chapter 1 to determine which of the two best fits the data.

The Lake Bed

At the bases of most excavated pits is a light gray clay usually devoid of rocks and cultural debris. This has proved to be of lacustrine origin, accumulated in relatively deep water at a time when Lower Klamath Lake was larger and deeper than its historical configuration. The age and duration of this high lake stand is unknown as there is no systematic study of raised shorelines around the basin, nor has the gray clay itself been dated. Its depth is unknown as no pit has penetrated to the bottom of the accumulation. A 2.7m deep core was taken from the gray clay at the bottom of Pit I and another of the same depth from Pit O. Samples taken from both cores at 20cm intervals proved to be mainly silty clays (Fig. 5-1), but there is a layer of sandy loam in Pit O at about 25cm from the bed surface which dips gently northwards through Pit I. It is tentatively suggested that this thin sheet may be the outer rim of the delta fan of an ancestral Sheepy Creek, which then flowed into the lake a good way to the south of the Nightfire Island locality. The origin of the clay loam at the bottom of each core is uncertain. It is almost horizontal and may have resulted from lakebed current flow rather than offshore deposition. Apart from these two sheets, the rest of the gray clays are homogenous and thinly laminated. They are composed almost entirely of diatoms with very little sediment of terrestrial origin. It is reasonably certain, then, that this locality was permanently inundated throughout the period of gray clay accumulation.

The Drop in Lake Level

At about 6,000BC the lake level was substantially lowered so that the Nightfire Island locality was brought into a more complex deltaic/offshore setting in which the Sheepy Creek drainage now had sufficient velocity to scour the surface of the gray clays and to line the scour troughs with sediments of a partly terrestrial origin. The present surface of the gray clay can be reconstructed by interpolation between gray clay surface elevations in each pit. Some of the exposed surfaces also reveal an angle of dip which can be incorporated in the surface reconstruction. In Pits H, M, N, R, and S, the surface elevation of the gray clay had to be estimated because it was not reached in excavations. Fig. 5-2 shows that the overall slope of the gray clay surface is now eastward in the direction of Sheepy Creek, near which it steepens sharply. Furthermore, there are smaller channel-like depressions cut into the surface which may hint at former streambed alignments before the creek settled into its present channel. There is no evidence to suggest that the lake bed was

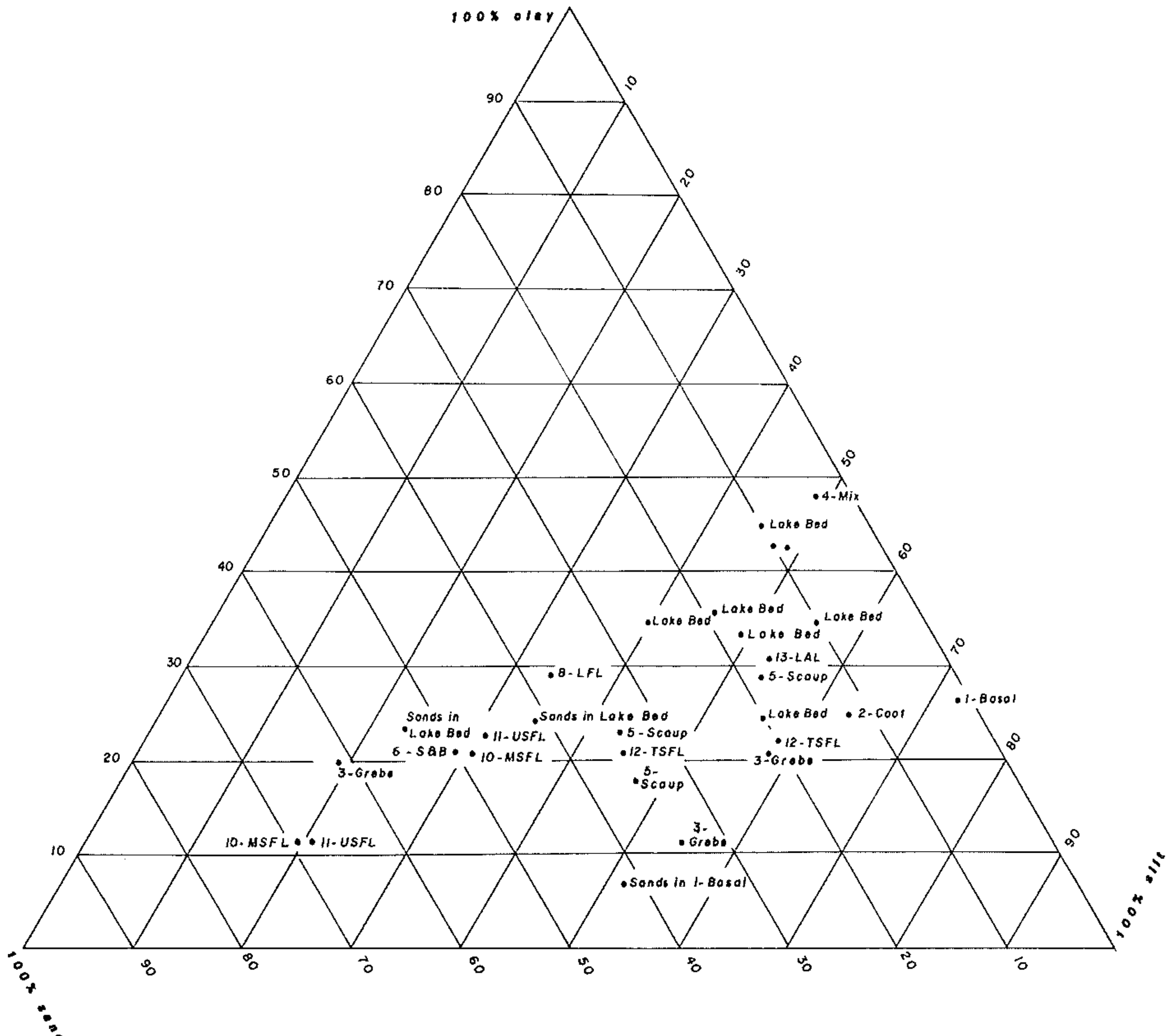


Fig. 5-1 Granulometric composition of sediments from the Lake Bed and from various strata of the Nightfire Island sequence.

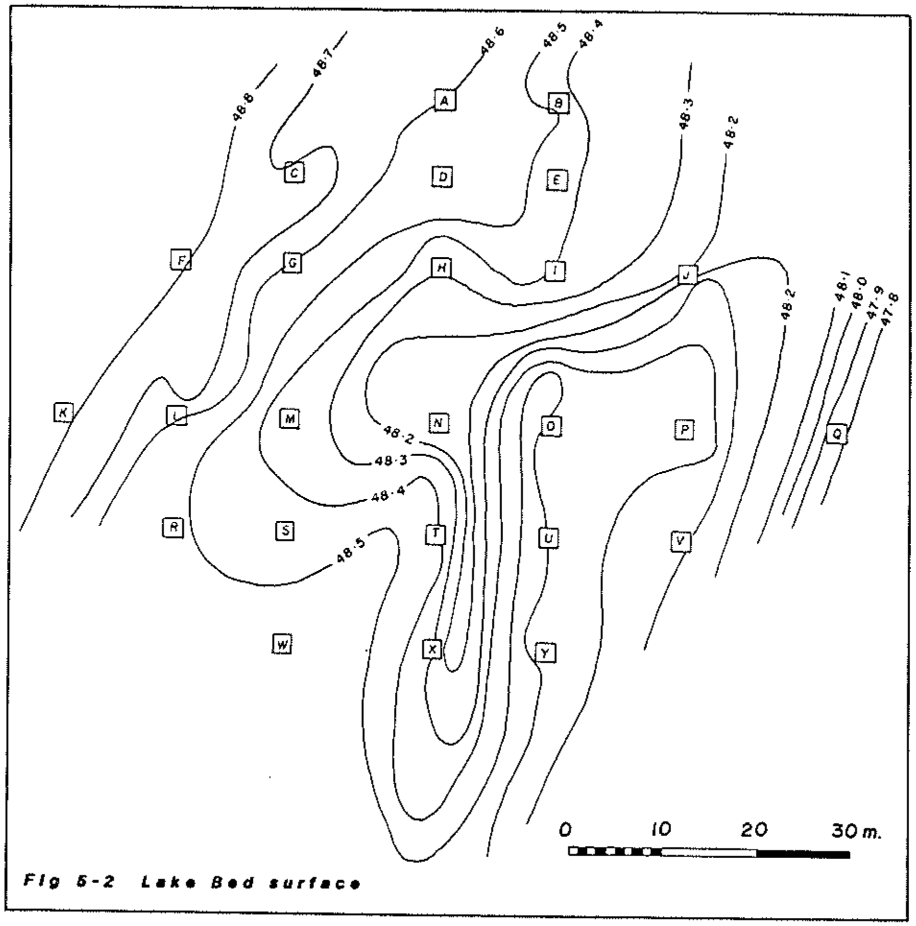


Fig 5-2 Lake Bed surface

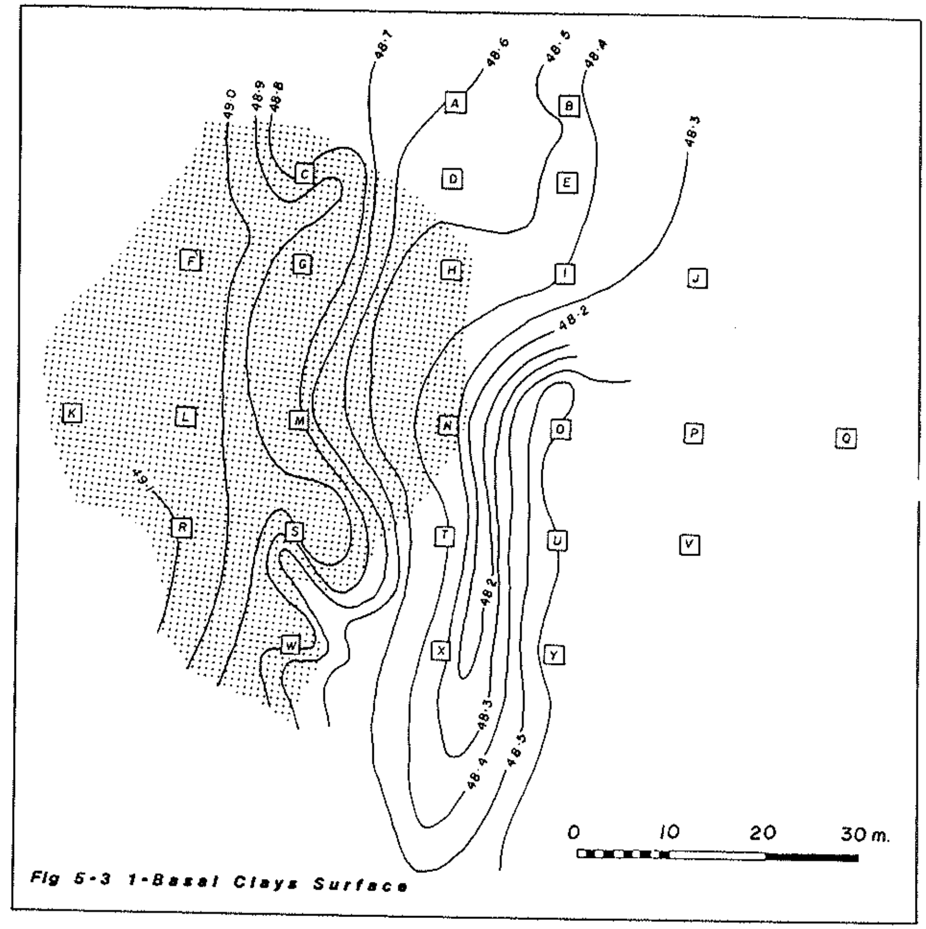


Fig 5-3 1-Basal Clays Surface

Fig. 5-2 Contours of the Lake Bed surface at 0.1m intervals interpolated between pits. Note the value of 48.0 contour line on this map represents 1248.0mT asl. This same applies to maps in Figs. 5-3 to 5-11.

actually exposed during this downcutting and reworking of its surface--all of it probably took place in shallow water. Thin layers of brown, black, tan, or organic clays line the scoured area of Pits H, M, N, R, and S. There is also a brown clay in Pit V. In Pits T, W, and X, there is a white clay with organic stains which are probably reworked diatomite mixed with traces of shoreline detritus.

The case for a 6,000BC date for the drop in lake level rests on the presence of a pumice lens in the Basal Clays which partly fill the western scour trough (see below).

The pumice was identified by Dr. L. R. Kittleman as derived from the cataclysmic explosion of Mt. Mazama (Johnson 1969a). The collapse of Mt. Mazama into the caldera which now contains Crater Lake (Fig. 1-2) took place in a series of events which started with an explosive eruption (Williams 1942). This ejected pyroclastic debris high above the volcano, which was then carried by the prevailing wind to the northeast where it was deposited over about 900,000sq km (Fryxell 1965). Traces of Mazama tephra have been claimed from sites in southern Washington (e.g., Fryxell 1962) and western Idaho (e.g., Butler 1962), but some of these are now suspected to have more localized origins (Randle et al. 1971). Following almost immediately upon this event, flowing avalanches of pumice and incandescent gas spilled over the rim of the crater and extended along the ground surface for a few kilometers around the mountain. Charcoal enclosed in these deposits has yielded radiocarbon ages of 7,010 ± 120bp (Johnson 1969b) and 6,940 ± 120bp (Valastro et al. 1968). Both dates are from the same location and replace two previously-run dates (Arnold and Libby 1951, Crane 1956). Although older than the limit of the tree-ring calibration scale, their true age must be within a few centuries of 6,000BC. It should be noted that this is a terminus post quem date for the Basal Clays at Nightfire Island, because the Mazama ash there was quite possibly derived by fluvial action and need not be a direct windborne emplacement.

While the coincidence of the Mt. Mazama explosion with the lowering of Lower Klamath Lake should not be overlooked, a cause-and-effect connection has not been demonstrated. Howe (1979:5) suggests that the lake could have been a closed drainage system before the eruption--at which time its outlet to the Klamath River may have been created by fault slippage in the vicinity of Keno (Fig. 1-3), but this has yet to be demonstrated. It is also remotely possible that tectonic tilting of the lakebed caused a local recession of the shoreline, but these large geomorphic questions require further field research. Perhaps the most compelling argument in favor of a tectonic explanation for the lake drainage is that the water level never again rose to its former elevation for periods long enough to cover Nightfire Island with diatomite. Had the cause of the lake level drop been of climatic origin, it is reasonable to suppose that the lake may have reached comparable levels in ensuing millennia. Nevertheless, there are widespread claims for an extreme arid climate with hotter and drier conditions than today in the Great Basin between 7,500bp and 6,500bp (5,400BC), so the possible effects of aridification on the lake level cannot be ruled out absolutely.

The Basal Clays

The 1-Basal[1] was laid down somewhere between 6,000 and 5,000BC (Fig. 5-3). These sediments occur in the bases of 11 pits at the west end of the site. The earliest is a thin (5cm) sheet of black laminated organic clay restricted to Pits K, L, and R at the far west end of the site. In Pit R, it is thinner (described as "muck") and it thickens in Pit L where it is banded with tan lenses. No sediment sample was taken. It is covered by a thicker deposit (av. 15cm) of brown-to-dark gray "fill" with a wider distribution. A sample from Pit L contains 1% sand, 72% silt and 27% clay and is intermediate between a silty clay loam and a silt loam. In Pits F and L it is laminated, with rare basalt chunks and pea-size stones. In Pit W7 there is the lens of volcanic pumice lapilli which is correlated with the "cream-colored sand" in Pit M10--actually a silt loam with 42% sand, 51% silt and 7% clay. Some diatoms are still present. Downslope, this thin (2-3cm) sheet has an increased clay content in Pits H and N. Upslope, it is traceable only as a sandy horizon at the top of the preceding brown-gray clays in Pits F and L.

All three substrata were deposited in the shallow waters of a swampy shoreline setting. The first two are reworked diatomites brought down by stream action from the southeast and mixed with the organic residue of rotting vegetation. At the time of deposition, they probably had a wider distribution to the east which was subsequently removed by erosion. As the white sandy layer with its derived pumice settled out in the shallow water around Pits W, M, and S, the fines were carried farther out and settled as silty clays in the deeper levels of Pits H and N (and possibly also in T and X). All three of the earliest substrata are missing from Pit G where they may have been removed by lateral cut-and-fill activity.

Following the ash layer, a tan clay was banked against this slope, and accumulated to a maximum depth of 30cm in Pit G. This very localized deposit contains sporadic basalt chunks and dispersed cultural debris which are certainly of human origin. Its stratigraphic relationship to the dark gray clay in Pits R, S, and W cannot be demonstrated clearly. A case can be made, however, for correlating the two as they appear to grade into each other in Pit L, where one sample was taken for analysis. This is a silty clay (7% sand, 52% silt, 41% clay).

By the end of the 1-Basal accumulation, the eastern part of the lakebed scour depression had been filled in. All of the cultural debris in these clays is derived from an onshore occupation by stream flow and incorporated in shallow water deposits.

The Coot Clays

These represent a development of the same processes responsible for the deposition of the 1-Basal, but after 5,000BC there was a marked increase in cultural debris, including the bones of the waterfowl after which this stratum takes its name. They are brown or dark brown clays, capped by a thin sheet of dark gray clay in Pits S and X, and by a tan clay in Pit N which is probably a deep-water facies of the yellow sand capping in Pit M and the tan clay capping in Pit R. The brown clay itself varies in texture, with sandy areas in Pits G, M, N, R, and W. One sample taken from Pit M is actually a silty clay loam (12% sand, 62% silt, 26% clay). The southwest area (Pits K, L, R) is mottled, with yellowish stains recorded in Pit K. These occur typically in marsh-derived deposits. In Pit S there are traces of laminations.

The sudden increase in cultural debris is accompanied by an increase in the quantity of basalt rubble in the clays. Although a few blocks may have been pressed into this stratum from overlying rubble layers, it is likely that most of it represents traces of the earliest attempts to stabilize the swampy shoreline with rubble fill.

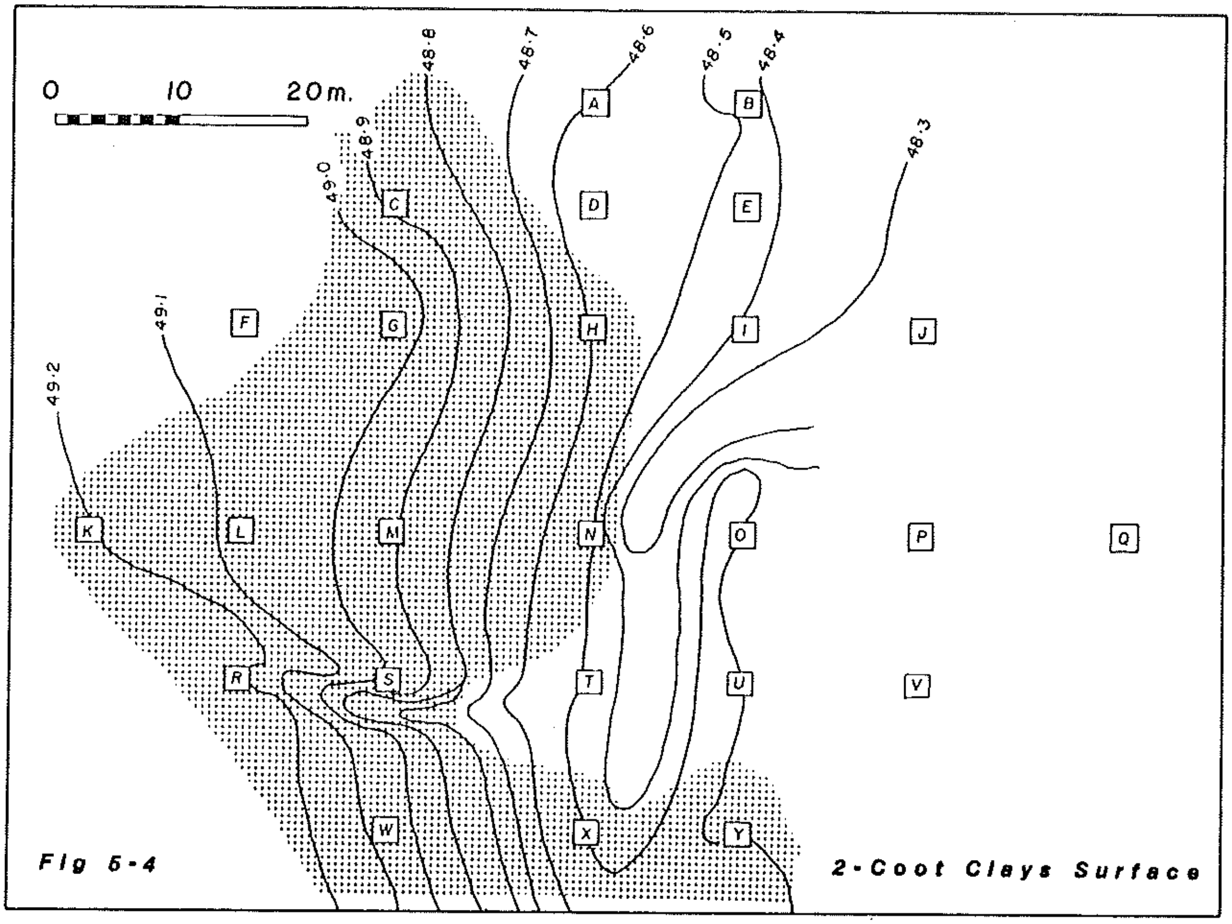


Fig 5-4 2-Coot Clays Surface

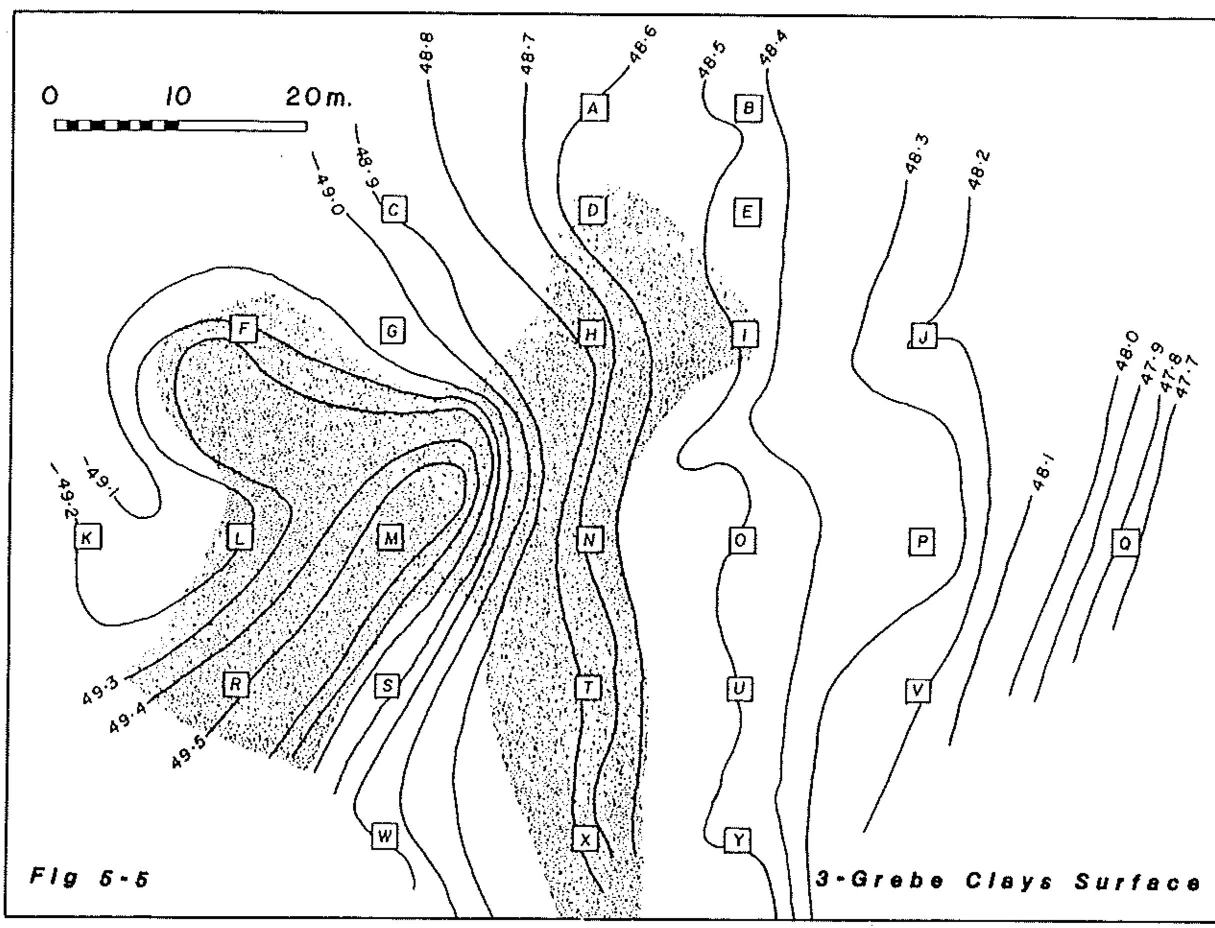


Fig 5-5 3-Grebe Clays Surface

Rubble was not deposited in the western (mottled) part of the stratum, nor does it occur in Pits M or W. The rubble therefore follows the eastern rim of the deposit where it thins out towards the lakebed surface.

Although rich in cultural debris, the stratum should not be construed as an in situ occupational horizon. There is nothing in the sediments to suggest any significant shift in depostional process between the 1-Basal and the 2-Coot, but increased human activity took place closer to the locality. Fig. 5-4 shows the interpolated surface contours of the 2-Coot stratum. It continues the eastward-trending build-up of deposits on the west flank of the original stream-cut trough in the lakebed, and it thins out as it dips eastward. There is minor channelling and surface erosion in pits S and R and possibly in pits G and H. It may be that this reflects a very brief regression of the lake level (with weathering of the clay surface in the southern pits?) but this cannot be confirmed.

A sample of this sediment from the pollen column (see Chapter 6) was subjected to routine automated chemical analysis by the soil testing service of an agricultural extension office. The Coot Clays sample could not be differentiated chemically from the overlying three samples (Fig. 6-1): all four had no alkali (pH 9.3-9.4) with very high calcium and potassium (Diatomite?), very high phosphorous (organic waste and waterfowl excreta?), and high magnesium levels, but low nitrogen. They were also rich in iron, with variable traces of zinc, copper, and manganese. None of these results conflicts with the overall interpretation of the stratum.

The 3-Grebe Clays

These deposits complete the infilling of the original stream-cut trough and they represent the first trace of in situ human activity, during the first half of the fourth millennium BC. A charcoal hearth is located in Pit M in deposits which cap a localized platform of silt loam (layers M5 and 6) which can only have been deposited by human action. This 40cm deep accumulation is brown at the bottom and tan at the top. A sample from near the top is 35% sand, 54% silt, and only 11% clay. It contains charcoal fragments and almost no other cultural debris and has become heavily calcified--the sample was 63% by weight of calcium carbonate cement before the matrix was dissolved. It may possibly equate with layer R6-7, but is absent from all other pits.

The 3-Grebe overlies this sediment and also appears in several surrounding pits. It is banked against the east slope of the 2-Coot in Pits H, N, T, and X, and is also evident to the west in Pits F, L, and R. Its textures are more varied than anything encountered in preceding strata. The occupational capping in layer M3 is actually a borderline sandy clay loam/sandy loam (61% sand, 19% silt, 20% clay) and the original sample was 31% $CaCO_3$ by weight before processing. This is most probably a continuation of the artificial land-fill operation begun in layer M6. To the east of the platform, the residual trough filled with silty and/or sandy gray clays which become darker and sandier in Pit N and thin out to the north in Pits H, D and I. A sample from layer I11 is a silty clay loam (12% sand, 54% silt, 34% clay) and the field descriptions of the other layers suggest that these are probably also silty or sandy clay loams. In Pits X and T these are covered by brown sandy clay loams.

To the west of the platform in Pit M is a series of black to brown to dark gray "clay fills" in Pits R and L. These are partly

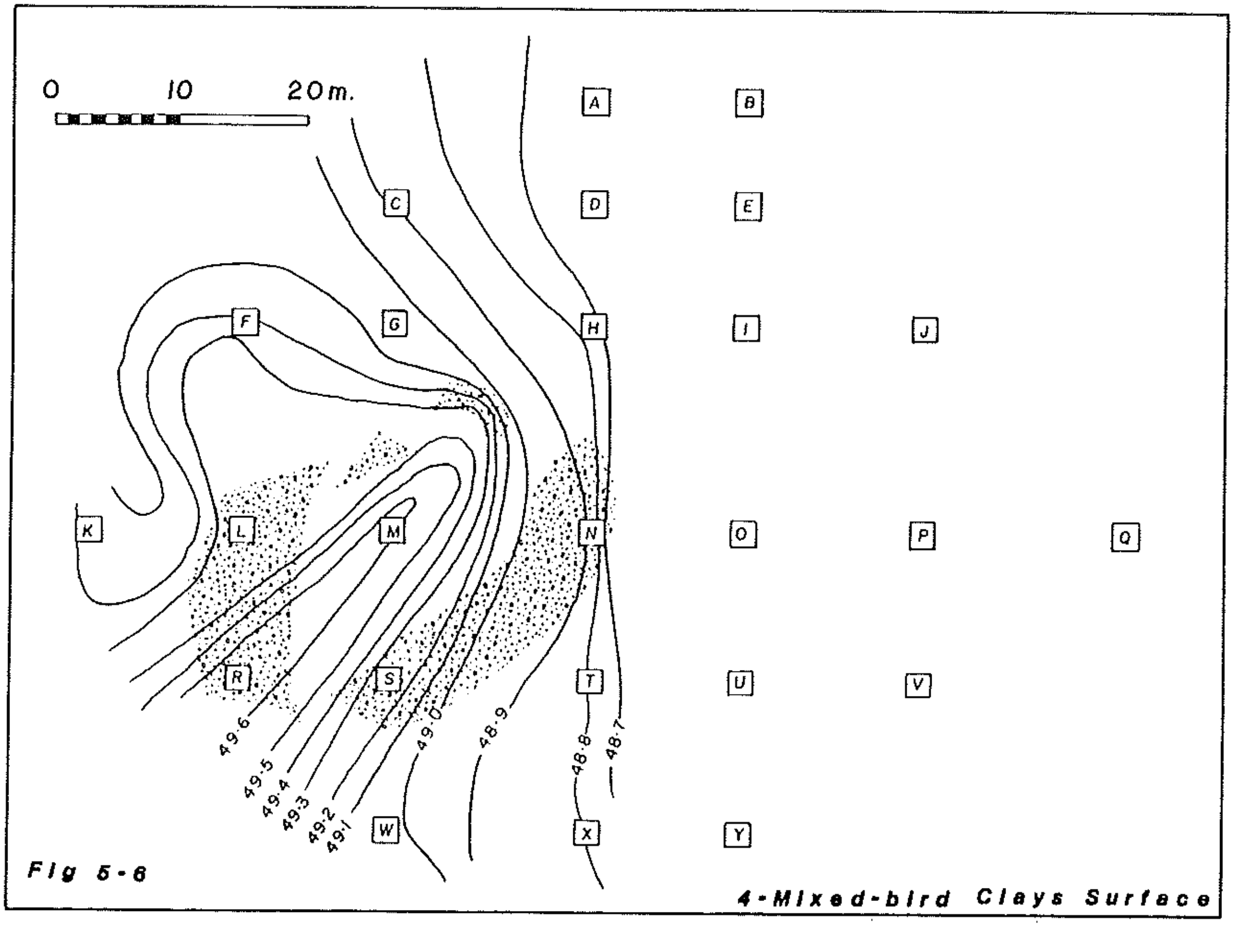


Fig 5-6 4-Mixed-bird Clays Surface

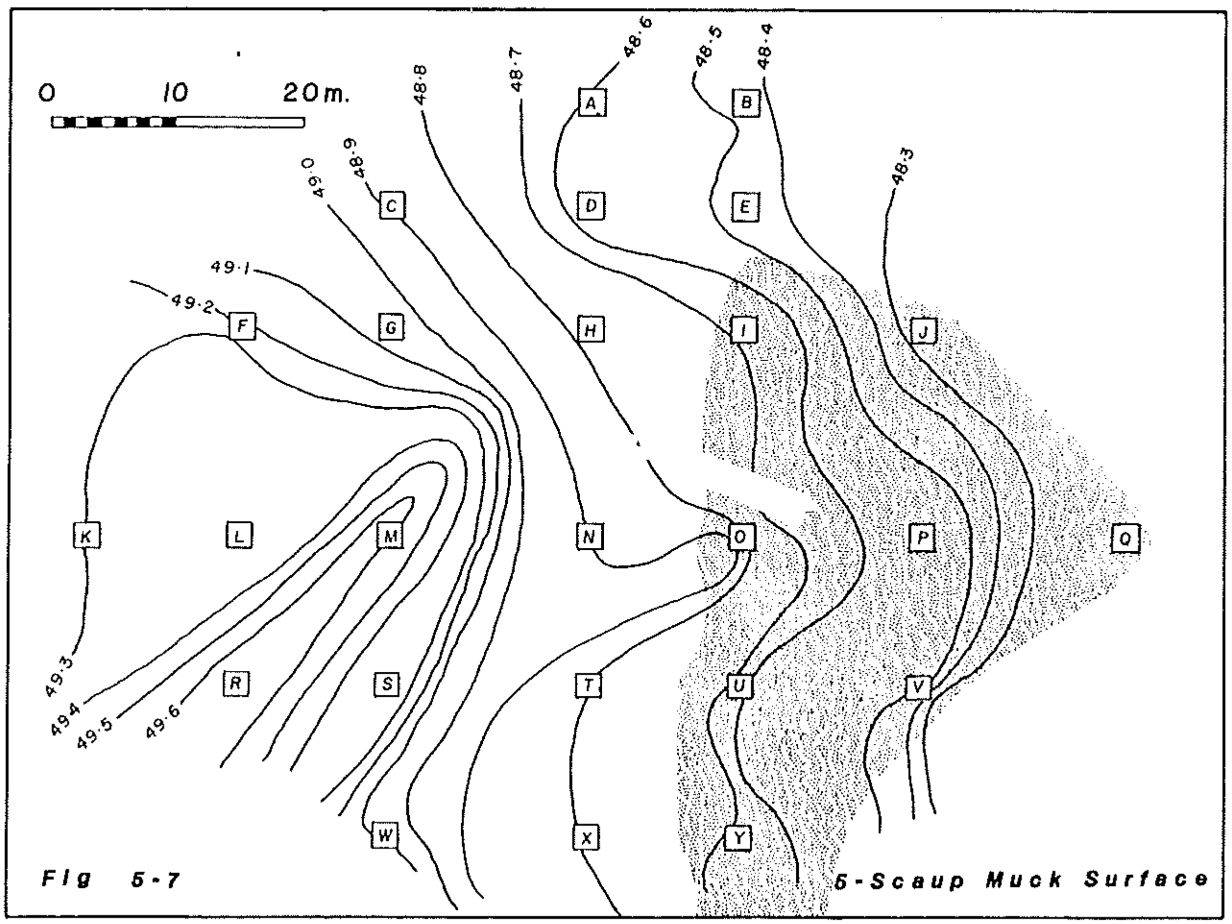


Fig 5-7 5-Scaup Muck Surface

calcified in Pit L and heavily cemented to a tan colored duripan in Pit F. A sample from Pit L4 is actually at the silty end of the clay loams (21% sand, 50% silt, 29% clay) and is only slightly sandier than Pit I11 at the north end of the trough. Diatoms are still present in Pits L and I, but are conspicuously absent in layer M3 and the underlying M6.

Although all exposures of this stratum contain basalt blocks, there are no other traces of <u>in situ</u> occupational features beyond Pit M. Presumably most of the other pits have penetrated the apron of artificial landfill and cultural debris washed down from the original platform into the surrounding marshes. The cultural remains in this apron are therefore partly derived.

The elevation of the artificially raised platform shows clearly in the surface contours of the 3-Grebe in Fig. 5-5. A spit-like promontory was built out into the marshy deposits from the southwest and this became surrounded by an apron of debris which filled in the remaining stream-bed depression of the lakebed. It is possible that the brown sandy loams in Pits T and X are also artificial fill laid down to extend the dry living surface eastward.

The 4-Mixed-bird Clays

These occur in Pits L, R, S, and N only and reflect the continued accumulation of the sediment apron around the spit-like platform in Pits R and M during the second half of the fourth millennium BC. In Pit L, they are tan silty clays (L2 contained 15% carbonate cement before processing and was composed on 3% sand, 49% silt, and 47% clay) without any rocks. In Pit R, there is only a thin covering of humic loam, but this thickens downslope to Pits S and N where an extended lobe of sandy loam and basalt rubble was laid down along the southeast flank of the original spit (Fig. 5-6). Evidently, marshy deposits continued to accumulate in shallow water to the southeast of the spit, and artificial fill was concentrated along its southeast beach only.

Obsidian hydration dates from the 4-Mix indicate that obsidian flakes were derived from the underlying 2-Coot and 3-Grebe (Table 4-3), and it has been suggested that this stratum may be reworked material from both (Chapter 3). It is quite possible that the actual camp was located to the southwest of Pit R at this time, and that the low promontory and its surrounding apron were on the edge of the site itself. In this scenario, the 4-Mix material may have come from that direction, having been shovelled from some part of the site and dumped along the marshy edge.

Stratigraphic Unconformity

The C-14 dates indicate an occupational break following the 4-Mix deposition. However, there are no convincing traces of weathering or erosion of the 4-Mix surface, but these may occur on the surfaces of the 3-Grebe (SE corner of spit X7b) and of the 2-Coot (weathering of spit C7a, and channelling of G4?) which were exposed at this time. Although the case for a lake level drop between 4,400 and 3,700BC cannot be ruled out, it is not particularly well supported by the sedimentary record either. The most compelling case in favor of this interpretation is the fact of the stratigraphic unconformity between the ensuing 5-Scaup and the underlying suite of clays. Perhaps the latter were entirely stripped away from the eastern flank of the site during downcutting of the Sheepy Creek drainage to adjust to a lower lake level at this time.

The 5-Scaup Muck

This narrow strip of deposit lies directly on the original lakebed and was banked against the preceding clays after 3,750BC. The deepest accumulation is along the north-south axis of Pits I, O, U, and Y, and it thins out to the east in Pits J, P, V, and Q where it is probably derived. It differs greatly from the earlier clays in waterfowl content and in general appearance. Consistently labelled "muck" in the field records, it is characterized by a black organic colloidal matrix derived mainly from rotting vegetation. When air-dried, this matrix yields patches of yellow sulfur which imparts a mottled appearance to the exposed sections in all pits. Basalt blocks are widespread but sporadic. Two samples were taken from spits O6a and 6b directly below it. Only the upper sample contains a trace of carbonates and some phytoliths. The sample from O6b is a borderline silty clay loam/silt loam (18% sand, 53% silt, 29% clay) and that from O6a is a loam (35% sand, 47% silt, 18% clay). The sample from Pit I differs from the other two in that it included 26% carbonate cement by weight before processing. The residue proved to be another loam (35% sand, 41% silt, 24% clay).

The surface contours of the 5-Scaup are shown in Fig. 5-7. They form an extensive apron of sediments and rubble along the marshy eastern margin of the land-fill platform already established. The western half of the site was probably raised above the marsh level and its exposed surface was already becoming permeated by calcium carbonate. There is no evidence that the western half was inhabited during the time of the 5-Scaup accumulation, and the source of the cultural debris in the 5-Scaup remains uncertain. Wherever this material came from, the Mucks themselves cannot be regarded as habitation deposits. There are no visible hearthlines, postholes, or other features which might indicate actual habitation.

The 6-Sand and Basalt

Consolidation of the marshy surface surrounding the original landfill spit in pits R and M was accomplished soon after 3,000BC by a large-scale project in which many tons of basalt rubble were carried to the site and dumped on to the muck and clay surface. This was extended over the entire north and east sides of the site in what appears to be a single operation. The deposit has an irregular depth, and was pressed deeply into the softer 5-Scaup mucks. It tends to thicken around the edges of the site, and there seems to have been a second layer covering the initial "pavement" in the area of pits C, I, and J. The "sand" from the second, yellow layer in pit I was 36% carbonate by weight before treatment and the residue was actually a borderline loam/sandy loam (50% sand, 29% silt, 21% clay), which does not differ chemically from the underlying sediments.

The surface resulting from this project (Fig. 5-8) shows two spit-like prominences extending eastward and northward towards pit B. Although there are no signs of habitation features in or on the 6-Sand and Basalt surface (except the 7-Gray Clays) the matrix is nonetheless rich in lithic debris. Bone remains are, however, extremely scarce--in sharp contrast to the preceding clays and mucks.

The 7-Gray Clays

These are at the north end of the site (Pits A, B, D, E) and reflect a localized covering of the basalt pavement. This cannot conceivably be an inundation of the pavement by diatomites. It is more likely that these four pits have penetrated the clay-plastered floors of house structures built directly on the basalt pavement in Pits B and D, while in Pits A and E the 7-Gray Clays may also reflect local and temporary interfingering with marshy deposits (Chapter 18).

This is the first stratum to be laid down since the formation of the Pit R, S spit (some 1,600 years earlier) that contains undisputable evidence of *in situ* human habitation.

The 8-Large-flake Loams

Between 2,850 and 2,450BC, the northwest area of the site accumulated a mass of loams and basalt rubble, while a number of clay-lined house floors were laid down on the basalt pavement in the northeast area. A sample from the top of this accumulation in Pit L was heavily cemented with $CaCO_3$ (59% by weight) and the processed residue is a clay loam. Calcification is heavily developed in the northwest pits (C, F, G, K, L, R) suggesting that the lake level had again receded from the edge of the site, thus permitting a carbonate buildup in drier conditions. This in turn would imply that the 8-LFL was not the result of artificial platform-raising in order to keep the habitation floor above the marsh level. Instead, the deposit is probably best described as "structural melt." The case for a lake-level recession at this stage is further strengthened by the fact that pit house floors were dug *into* these deposits (Chapter 18). This would not have been possible if the lake shore had been immediately adjacent, as the houses would have become rapidly waterlogged.

By the end of this depositional episode, the earlier surface configuration in the west had been raised but not substantially altered (Fig. 5-9).

The 9-Lower Small-flake Loams

The perimeter of the artificial platform was extended in the east (Pits J, P, V) and the south (Pits N, S, T, U, W, X) sides by tipping two kinds of deposits. The gray sands and basalt rubble reflect deliberate land-fill, while the brown humic loams are more likely to have been occupational build-up on the platform surface which was periodically scraped up and tipped over the side of the platform into the surrounding marshy deposits. This process best fits the sloping, interfingering structures of these sediments.

The main depositional question raised by the 9-LSFL is why the focus of settlement shifted form the north to the south end of the site at this time. Pit house floors were found in Pit P and possibly in Pits N and T, while deposition in the northwest part of the site halted. The most plausible explanation is that there was a slight

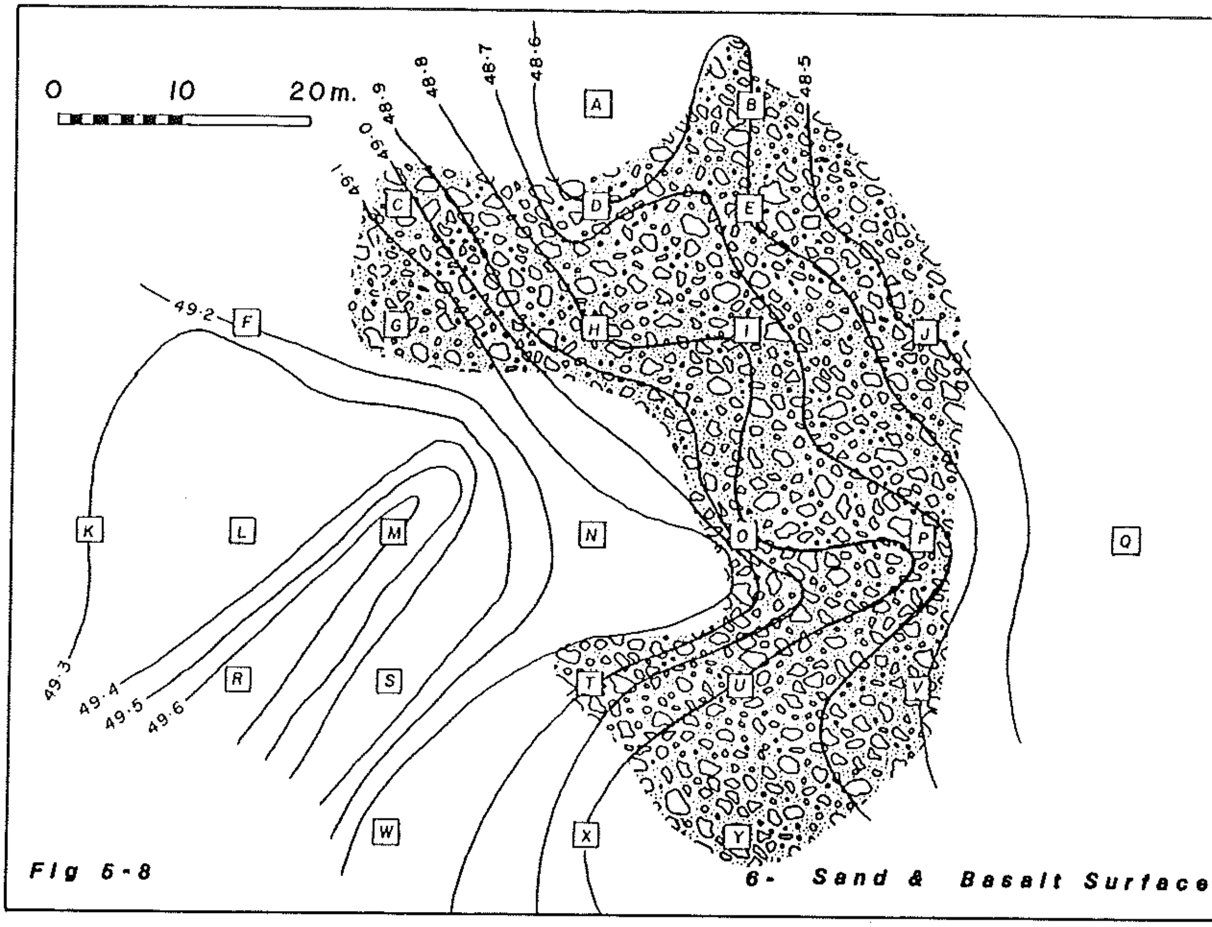


Fig 5-8 6- Sand & Basalt Surface

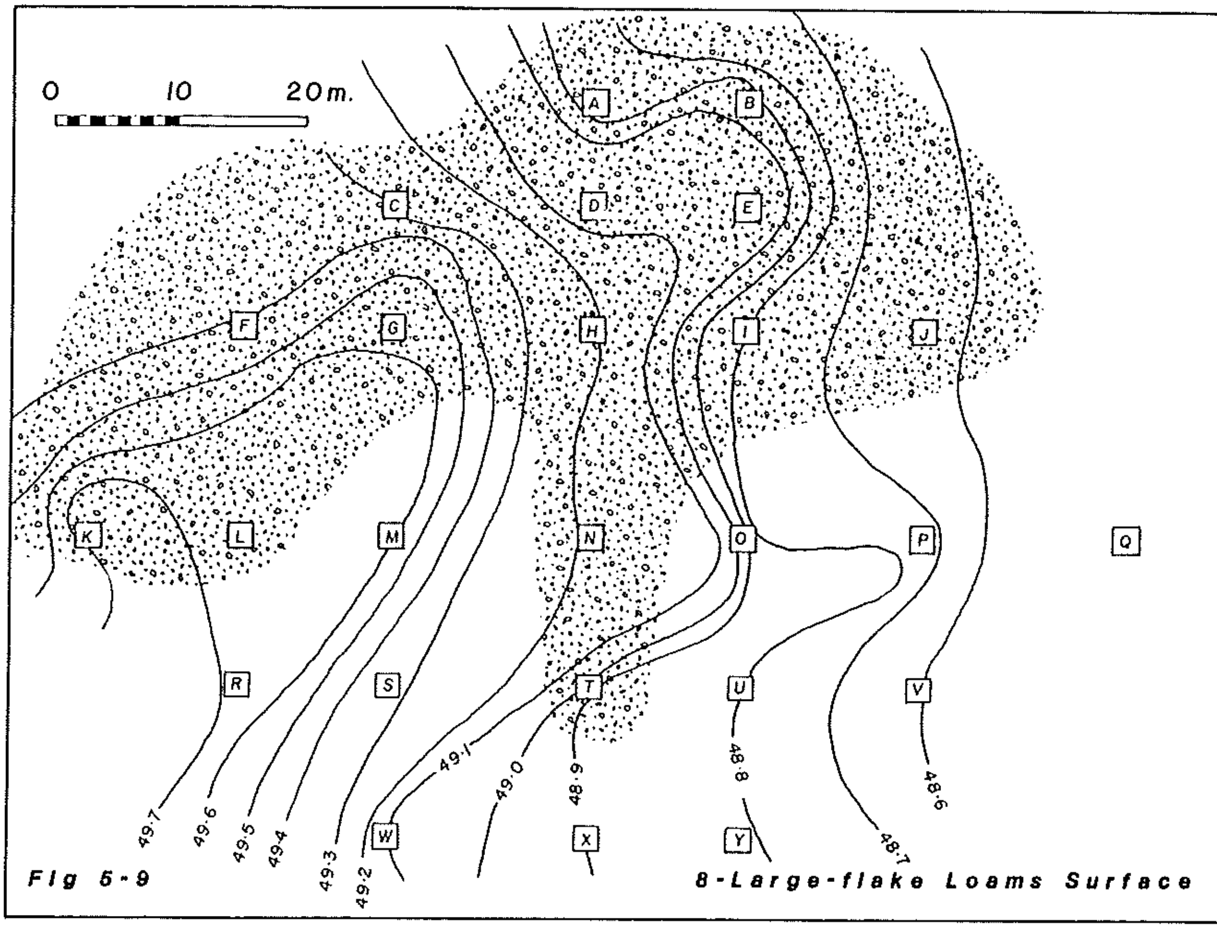


Fig 5-9 8-Large-flake Loams Surface

rise in lake level following the 8-LFL which waterlogged the dwellings at that end of the site and caused a relocation somewhat farther back from the water's edge.

The 10-Middle Small-flake Loams

A number of individual land-fill and occupational episodes is collapsed into this phase. Clay house floors appear at the base of the accumulation in Pits H and I. Together with the structure in Pit P, these may have been occupied during the build-up of the 9-LSFL and then levelled. A major levelling operation started around 1,900BC in the area of Pit I: more sand and basalt was dumped and spread out to the north and west, where it interfingered with occupational brown loams and clay loams. A sample of the gray landfill from spit I7b proved to be almost identical to the material used for the original Sand and Basalt platform base. Before processing, it contained 38% carbonate cement, and the residue proved to be a borderline loam/sandy loam (49% sand, 29% silt, 21% clay). Another sample from layer 03 was less calcified (21% $CaCO_3$) and is a typical sandy loam (69% sand, 20% silt, 11% clay). No sample of the brown humic loams was analyzed.

During this episode, houses were erected at the south end of the site on top of the 9-LSFL where house floors appear in Pits W, T, and N, together with charcoal hearths extending to Pit X. These dwellings were then abandoned and new ones erected about two centuries later in a tight cluster at the north end of the site around Pits A, C, D, E, and I. At some stage during this move, a final blanket of sand and basalt was spread over the east part of the platform in Pits J and P and tipped over the slope to extend the platform to Pits Q and V. Presumably, the first round of levelling and infilling may have been in response to a brief rise in lake level which threatened the northern end of the site. The second occupation at the north end definitely indicates that the lake level had receded some distance from the site so that pit houses could again be dug on the north edge without fear of waterlogging. Throughout this accumulation, the western end of the site remained unoccupied, and the calcification of the underlying deposits persisted throughout this time.

By the close of this platform-raising episode, the eastward slope of the whole platform had become more gradual, and a small embayment developed in the area of Pits O and U (Fig. 5-10).

Disconformity

The depositional evidence for abandonment of the site between 1,200 and 600BC is neither clear-cut nor consistent between pits, nor particularly obvious in individual sections. There are no well-developed soil horizons (these would have been destroyed by later occupation anyway), and there are no indications of long-term drowning of the site surface either (sterile clays, mucks, etc.). Changes in sediment texture and colors are apparent in most pits, however--the exceptions being those heavily calcified deposits in the west where the stratigraphy has been masked. Given that the kinds of depostional processes at work in the deposits preceding and following the purported disconformity were the same, it is hardly surprising that the event is not very clearly represented.

The 11-Upper Small-flake Loams

Platform-raising was continued after 600BC in a series of events which cannot be worked out in their correct sequence for want of continuous profile exposures. Brown humic loams with basalt rubble continued to build up in all the previously occupied areas, and spread to the western rim of the site, covering the heavily cemented surface which had long been unoccupied. Overall, this phase differs from the preceding one in that it lacks the sheets of gray sand and basalt land fill, and it is poor in clay house floors. Significantly, the floor fragments in Pits E, F, and C are all at the base of the 11-USFL, indicating that the lake level was still some distance from the site. Although some of the overlying loams must be artificial fill, their general character indicates occupational build-up with much humic staining, lenses of tan discoloration, and relatively abundant foodwaste. This suggests that the lake level rose and periodically inundated the platform so that marshy conditions invaded its surface and waterlogged the deposit.

A sample from spit I6b was more heavily calcified (58% carbonate by weight) but was otherwise identical to the material from the preceding 10-MSFL--a borderline loam/sandy loam (46% sand, 30% silt, 24% clay). In spit O1b, it is a sandy loam (68% sand, 20% silt, 11% clay).

A Second Disconformity

The next purported abandonment of the site took place about 100BC and lasted only until 50-100AD. At the northeast side of the site there is a widespread and reasonably clear change in deposition between the top of the 11-USFL and the base of the 12-TSFL in Pits A, E, I, and J. However, in the southwest Pits (F, K, R, S), the change is far less obvious.

The 12-Terminal Small-flake Loams

These two isolated patches of deposit raised above the general surface in the northeast and southwest ends of the site must reflect separate occupational events. The southwestern accumulation is a relatively homogenous stone-free loam with a single hearth in Pit R. Although this sediment was not sampled, its position and consistent field description suggests that it was probably derived from structural melt, and continued to accumulate (without a break?) on the 11-USFL surface.

The situation in the northeast was already far more complex, with various depositional events banked against one another or grading into each other between the pits. These are also rubble-filled (especially Pit E) but they vary in color and texture. Two samples from Pit I show a clear drop in sands, although they are both still loams (36% sand, 42% silt, 21% clay, and above this, 20% sand, 58% silt, and 22% clay). The most likely source for this material is a rubble and loam fill dumped into shallow marshy water along with abundant foodwaste and cultural debris. The stratigraphic implications of this are that the 12-TSFL in the northeast was laid down after the disconformity

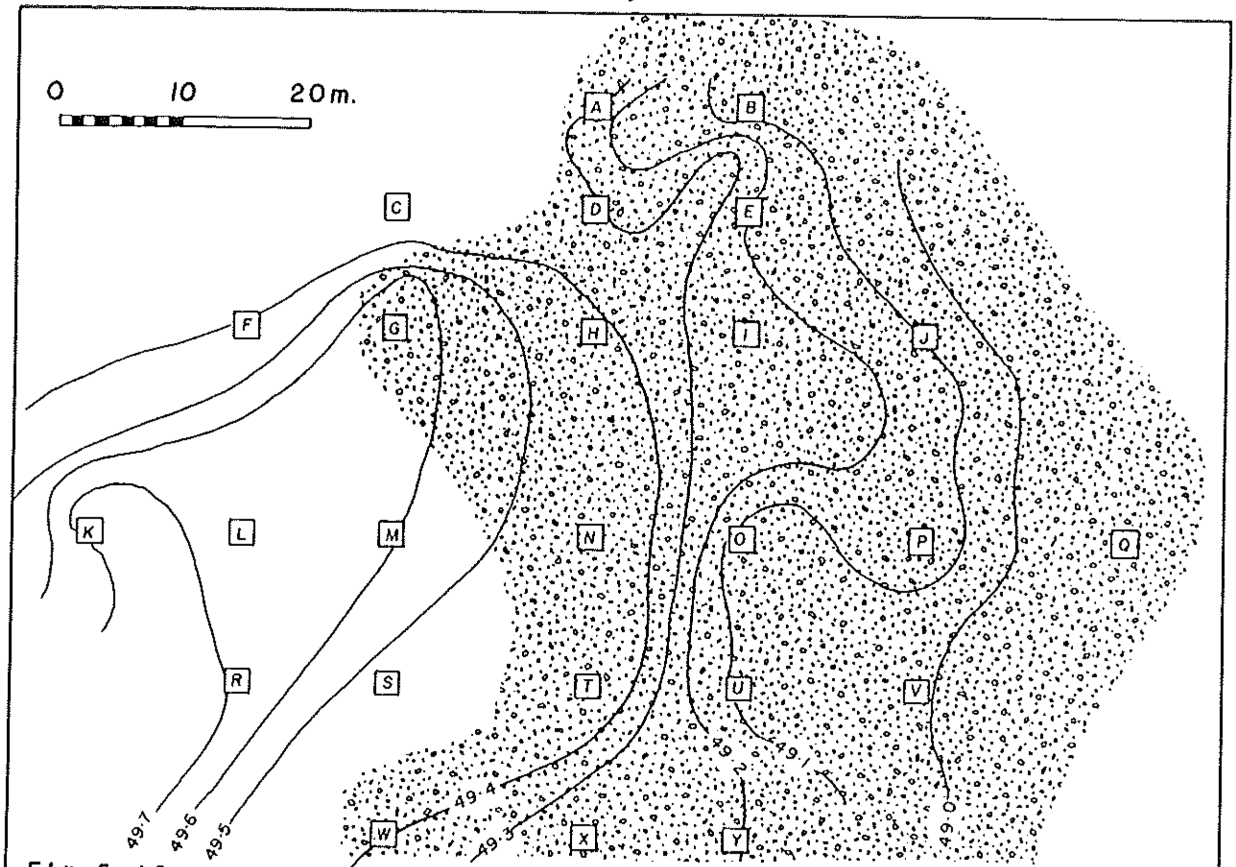


Fig 5-10 10-Middle Small-flake Loams Surface

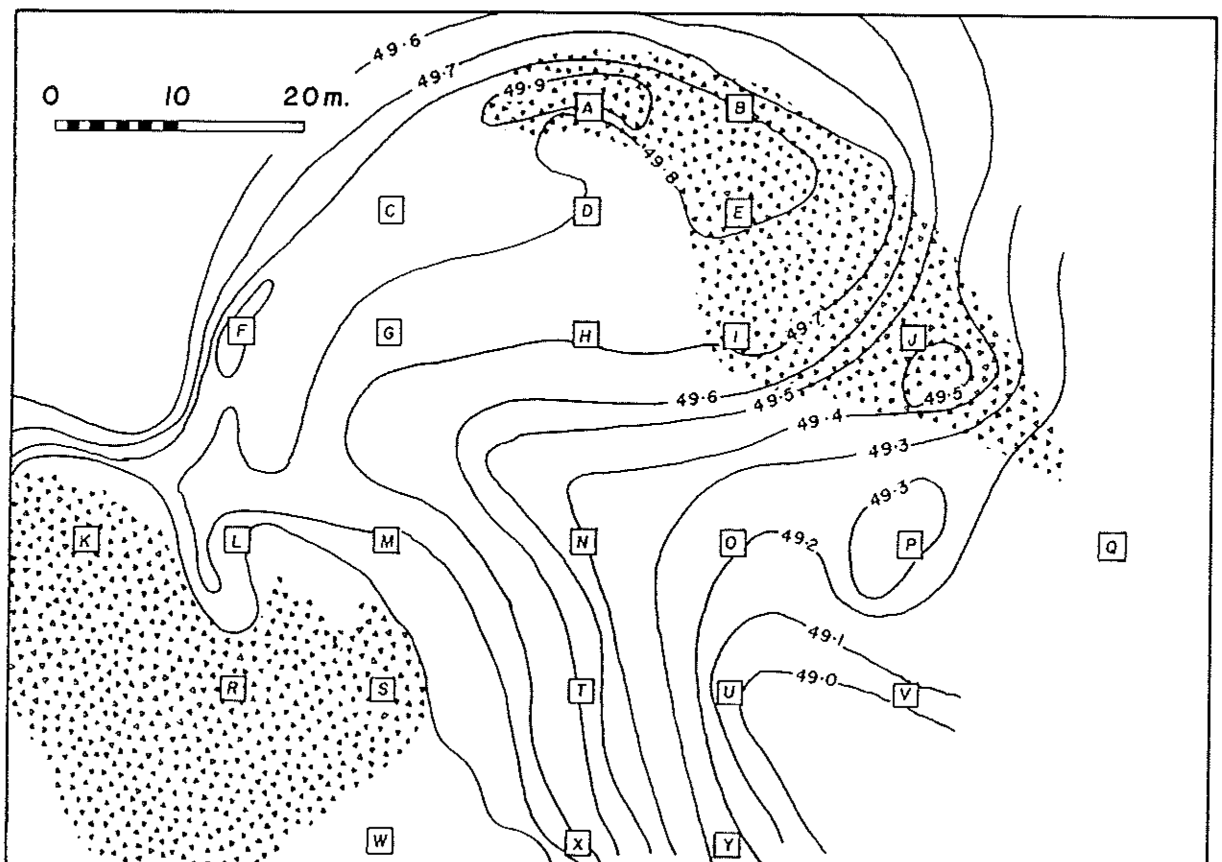


Fig 5-11 12- Terminal Small-flake Loams Surface during a time when the lake level had risen and again threatened the edge of the site. At the close of the 12-TSFL, the site surface had begun to approach its modern configuration (Fig. 5-11).

<u>The 13-Lower Arrowhead Loams</u>

These are again two disconnected suites of deposit: a sheet of relatively stone-free gray loam in the north (grading to sands in the center, and covered by brown loams in the northeast); and a more complex southeastern group with a house floor in Pit P and channel-filling in Pits V and Q. Organic staining of the deposit is evident only in the southeast group, and there are no reasons to believe that the larger north group accumulated under swampy conditions. A sample from layer I4 is a gray silty clay loam (17% sand, 52% silt, 31% clay) which was only slightly less calcified than the preceding 12-TSFL (48% carbonate by weight). Although the lake margin was obviously not too far away, the living surface must have been perched sufficiently high to avoid waterlogging. The absence of basalt rubble suggests that this gray fill may be mainly structural melt, but the absence of house floors from the northern pits raises some doubts about this interpretation. In Pits V and Q, the brown sands are streambank lag deposits composed of heavily sorted residues along the platform edge.

<u>The 14-Middle Arrowhead Loams</u>

Possibly recurrent inundations of the site surface may be responsible for the reintroduction of brown humic staining in this stratum. Along the east flank of the platform in Pits J, P, and V, there must have been some attempt at consolidation with rubble fill, but this was insufficient to inhibit the swampy encroachment culminating in peat formation in Pit Q2. There is no clear stratigraphic break between the end of the 14-MAL and the beginning of the 15-UAL, although this does not rule out the possibility of a brief abandonment, as suggested in Chapter 4.

<u>The 15-Upper Arrowhead Loams</u>

This final accumulation is almost entirely structural melt and hearth lines along a small ridge in Pits J, P, and V. Recurrent drownings may have led to small patches of sand being dumped in the uppermost levels, but swampy encroachments must have invaded repeatedly from the peaty area of Pit Q. The condition of the rest of the site surface at this time may have been marshy backwater, but surprisingly little debris was thrown back into that area (Pit X and possibly T), the inhabitants preferring to throw debris down the east slope from where it may have been carried away by stream action.

This phase closes the sedimentary history of the site which then acquired the surface configuration shown in Fig. 2-1. There are no obvious indications of subsequent erosion of the surface by runoff.

Overview

Prior to the Mt. Mazama explosion, the Nightfire Island locality stood in relatively deep water in which diatoms were deposited. The only possible trace of pre-Mazama stream activity is the northward-dipping sandy lens which could conceivably represent fluviatile detritus. At about the time of the Mazama eruption, the lake level dropped sufficiently to bring the locality within reach of the Sheepy Creek mouth. Stream action had sufficient velocity at this time to gouge a shallow trough in the lake bed, which gradually filled up first with reworked diatomites and then with brown-stained diatomite and organic residues which banked up on its left flank. At this point, human occupational debris and foodwaste began to appear in these banked sediments--apparently thrown into the marshy flank of the trough from a living surface upstream which cannot now be identified. The first trace of direct human occupation here is the man-made spit in Pits R and M which must have been raised above the marsh surface. The edge of this spit finally filled up the original trough. Sheepy Creek was deflected southeast where it cut a new trough, thus initiating its present stream channel, after the lake level had receded. After it rose again, the 5-Scaup formed a marshy apron on the left bank of this new channel and occupational waste was dropped into this from a living surface which cannot now be identified.

A decision was made to consolidate the marshy surface with a "pavement" of 6-Sand & Basalt after the initial experiment of the Pit R and M spit and its apron of loams and basalt rubbles. House structures were built on this artificial platform but were soon abandoned as it began to sink into the underlying muck. The subsequent depositional history is one of recurrent maintenance, raising, extension and consolidation of the platform. House structures were moved repeatedly, and abandoned clay floors were covered with basically two types of deposits: sandy loams with abundant rubble, and brown humic stained silty loams. The former were partially excavated from the nearby basalt scree slopes or from the peninsula jutting into the marsh, and were carried in baskets or skins by canoe to the platforms. Here they were dumped and spread as needed, becoming mingled with marshy deposits and surface dirt rich in foodwaste and broken artifacts. Although the platform remained relatively clear of the marsh surface, recurrent lake level fluctuations may have culminated at the end of the 10-MSFL in a long-term desiccation and abandonment of the site. The lake level rose to the elevation of the site once more, followed by renewed efforts to raise the platform, but this time without the characteristic clay-floored structures. Throughout these episodes the platform's southeast flank was being steadily winnowed by low-velocity stream action to form a sandy lag deposit rich in artifacts but poor in bone.

In the closing phases of its history, the platform may have been repeatedly threatened by inundation, and humic staining becomes more noticeable again towards the top of the sequence, culminating in true peat formation on its eastern and southwestern flank. The western part of the site became heavily calcified due to prolonged intervals of exposure, including two further short abandonments. The resulting calcretes are mainly in the 10-USFL and Lower Arrowhead Loams, but tend to penetrate deeper in isolated patches. Some of the calcification took place relatively recently and may still be in process today.

The Depositional Model Reconsidered

In Chapter 1, the sedimentary implications of the bristlecone pine climatic record were predicted with due consideration for the site's changing role as it grew in size. These may now be tested against reality. Fig. 1-13 predicts two alternative depositional sequences based on the decision to "build or abandon" when the lake level rises during cool-wet episodes. It is now apparent that the decision to "build" was the preferred solution, particularly after the 5-Scaup had been deposited. Prior to this, efforts to build against rising water levels were not particularly effective, and periodic drowning may have occurred during which the cultural debris of the 2-Coot through 5-Scaup were mostly shifted into derived contexts. However, evidence for site-wide drownings (sterile clays) is absent.

Predicted abandonments during extreme low lake levels (at the peak of warm-dry episodes) are well supported by the dating evidence, but they left only ephemeral traces in the sedimentary record. Calcretes did indeed form during such abandonment phases, but they fail to separate out in the stratigraphy, forming instead a single mass which must have been added to with each abandonment. Intervening high lake stands never waterlogged the site sufficiently to dissolve this mass. Also, the predicted slowing of the deposition rate during warm-dry episodes was not verified. Evidently, sediment continued to be added to the site in the form of "structural melt" during these times, so that the dates are no more mixed for these intervals than they are for deposits formed during cool-dry episodes. The model failed to take this factor into account. Also, it could not account for the final, permanent abandonment at the height of the last cool-wet phase in the bristlecone pine climatic sequence.

Next, the model of a gradually expanding platform build-up is not perfectly matched by the data. Instead, there is a sudden expansion in the 6-S&B. After this, the platform build-up shifts back and forth, with another site-wide expansion in the 11-USFL. This latter pattern fits quite well with the predicted role-shifts (permanent village during high lake stands, fishing village during lower lake levels). However, the site does not reexpand as predicted for the fourth cool-wet phase during the Arrowhead Loams sequence. Reasons for this and for other anomalies will have to be sought in new data sets.

Finally, does the dating-*cum*-sedimentary record lend more support to either the Know-it-all Model or the Learner Model? Although there is a generally better fit with the predicted sequence for the Learner Model, this is by no means a perfect match. The main problem lies with the relatively sudden expansion of the 6-S&B, which gives the impression of a well-organized project carried out by a group who already understood what was entailed and who were, by implication, fully adapted marsh-dwellers. These ambiguities can be resolved only by further testing of other aspects of the models.

ENDNOTES: CHAPTER 5

1. See Table 3-2 for acronyms of strata.

CHAPTER SIX

BOTANICAL INVESTIGATIONS

Pollen Sampling

Although pollen samples were taken from various layers in several pits during excavations, delays following recovery caused many of these to dry out (J. Gray pers. comm.). A 2x2m pit was later opened to recover a fresh column of samples from a central point in the site about midway between Pits H and N (Fig. 2-2). After completion, its north face was recorded together with the positions of the sample columns (Fig. 6-1). Two parallel columns, each composed of 17 samples, were selected and marked off. Each sample was about 10cm thick and the total column was about 1.7m deep. Care was taken to avoid mixing layers and the thickness of samples was adjusted to accommodate changes in stratigraphy. Except for sample 11, parallel samples occur in the same layer. The left (west) column was reserved for pollen analysis.

Correlation of the Samples

The stratigraphic sequence in the sampling pit is intermediate between that of Pits N and H, as befits its location, and the recognition of strata presents only minor problems. The correlation between these layers and the strata proposed in Chapter 3 is based entirely on stratigraphy and not on archaeological content. Thus, the first and second marker horizons cannot be demonstrated empirically. In fact, no arrowheads were recovered from the top of this sequence, and the second marker horizon is therefore absent.

At the base of the sequence, the gray clay represents the 2-Coot[1] (sample 17). Above this, the mottled sandy muck with waterfowl bones includes the 3-Grebe in its lower part and the 4-Mix in its upper part. These cannot be separated visually, as was the case in spits N7ab a few meters away. We may assume that sample 16 is in the 3-Grebe and that sample 14 is in the 4-Mix, with sample 15 in one or the other (or in both). Following the unconformity is a thick layer of sand and basalt rubble which correlates with the 6-S&B and the overlying 8-LFL. These two do not separate easily in this exposure, although the rocks in the lower part are somewhat larger and more closely packed than in the upper part. On this basis, sample 13 must come from the 6-S&B while samples 12, 11, and 10 probably come from the 8-LFL. The clay house floor fragment with its overlying charcoal hearth correlates with the set of house floors which cap the 8-LFL at the north end of the site.

Above this, dark brown compact loams tie into the 9-LSFL in pit N, and samples 9 and 8 must represent that interval. The calcified loams (samples 6 and 7) are in the early part of the 10-MSFL, and the calcrete (samples 4 and 5) clearly correlates with the heavily calcified 10-MSFL in this part of the site. The platy surface probably represents the abandonment episode following the 10-MSFL. The light brown calcified loam above this (samples 3 and 2) must belong to the 11-USFL and the sod (sample 1) is probably 12-TSFL. No trace of

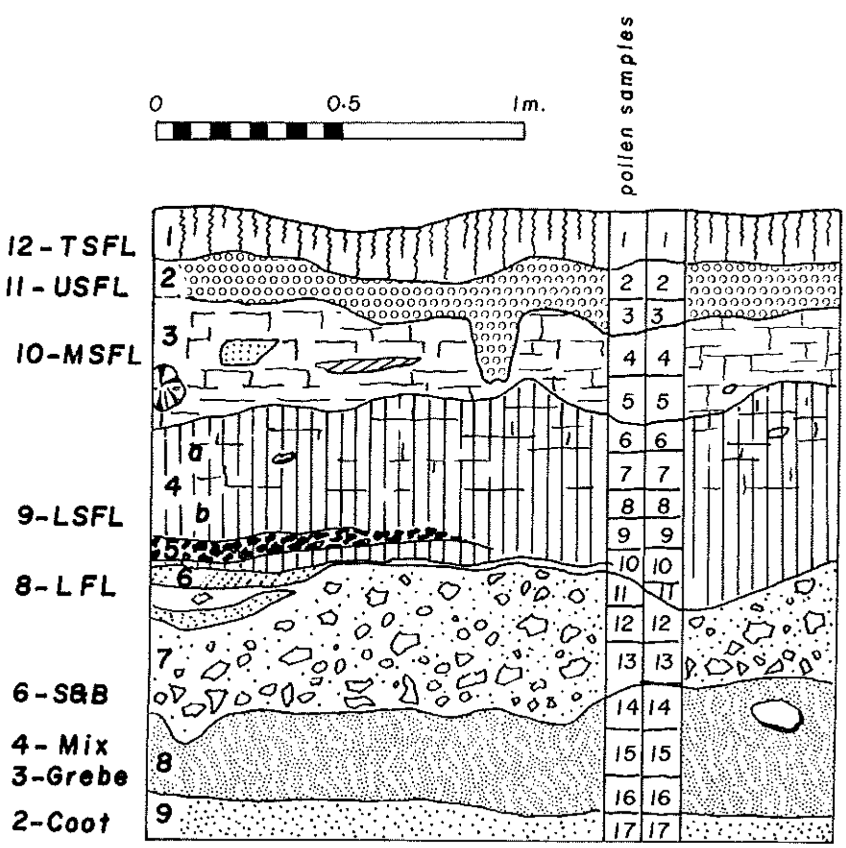


Fig. 6-1 Stratigraphic profile of the north face of the pollen sampling pit, showing position of the pollen samples in relation to layers. Equivalent strata are given on the left.

the Arrowhead Loams was seen in this sequence, and consequently we have no pollen record of that part of the site's depositional history.

Pollen Extraction Procedures

All samples were sealed immediately in plastic bags and stored under refrigeration for 2-3 months until extraction could proceed.

Ten ml of sediment was first removed from the interior of unbroken sample chunks. Each sample was boiled in 10% KOH for 30 minutes, then the residue was treated with sufficient HF (48%) to dissolve any siliceous matter. Each sample was allowed to stand overnight to assure that the reaction was completed. The residue was then floated on a saturated $ZnCl_2$ solution (specific gravity 1.97) four times with hard centrifugation between applications. This was done to separate the lighter (organic) fraction from the heavier (predominantly mineral) fraction (Gray 1965). The floated fraction was acetolysed for 20 minutes, after which the reaction was stopped with 10% KOH. The residue was then washed twice under distilled water and stored in vials to await counting.

These extraction procedures did not produce high concentrates of pollen from any of the samples. In order to acquire 100+ grains per level, three or four slides, each containing 50ml of residue suspended in 4% glycerine, were counted. Many pollen grains were partially degraded or broken into unidentifiable fragments, and these were frequently masked by abundant charcoal fragments and organic colloids which hampered the counting operation. Only whole, clear grains were included in the count, which was stopped when 100 grains of pollen *plus* spores were reached. Spores occurred in all the samples, and consequently the pollen count for each sample is less than 100.

The Pollen Diagram

Fig. 6-2 shows the percentage distribution of pollen grains per sample. Only the toughest grains have survived both the depositional processes and the extraction procedures. Three arboreal pollens dominated by *Pinus* (pine), have survived best, followed by *Gramineae* (grasses) and *Typha* (cattails). There are only traces of a few other species, and many more which might reasonably be expected in this setting have not survived.

Given these limitations, only the fluctuations in arboreal pollens and in grasses are of any interest. There are hemlock peaks in the 2-Coot, in the upper 8-LFL/9-LSFL, and a third smaller peak in the 11-USFL. Fir peaks only in the 8-LFL/9-LSFL event, while pine peaks in the 4-Mix, again in the 8-LFL, and during the long calcification episode of the 10-MSFL. There is a single grass spike during the 9-LSFL, and grasses disappear entirely thereafter. The occurrence of cattails is somewhat similar.

Because of poor preservation, these fluctuations are of only limited regional interest. Fir and hemlock are both characteristic of the higher elevations in the Cascades, their pollen being blown into the Klamath area from the west by the prevailing winds. Both trees develop best under relatively moist conditions, and they are more

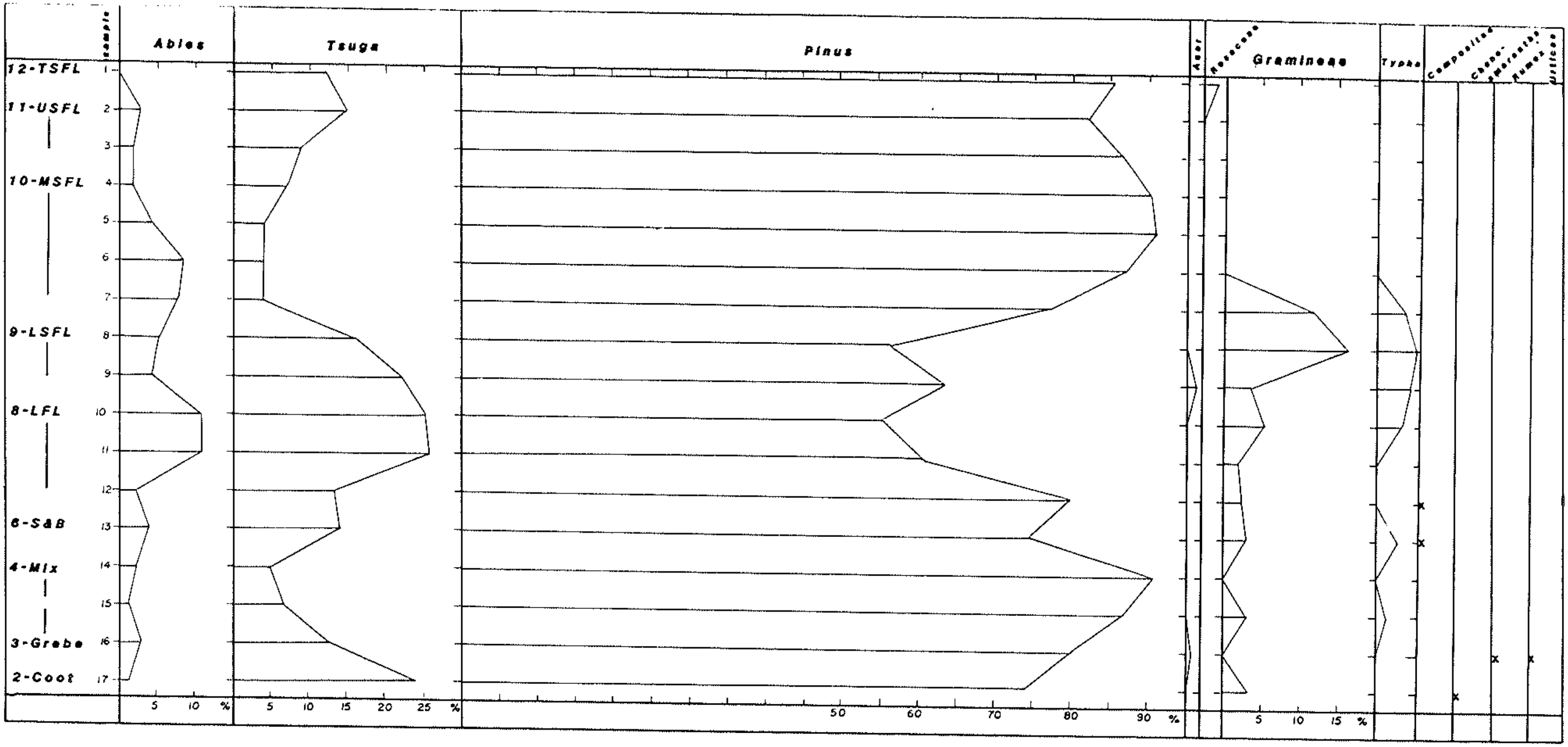


Fig. 6-2 Pollen diagram of Nightfire Island.

adaptable to extremes of temperature than of moisture. Firs, being able to withstand more cold, are generally higher up the timber line than hemlock (Fowells 1965). From these general observations we may surmise that conditions were generally warm and moist during the 2-Coot, cool and moist during the 8-LFL/9-LSFL, and moist again during the 11-USFL and 12-TSFL.

Pines develop best in relatively xeric conditions and are somewhat less tolerant of cold than the other two. Consequently, they better reflect local conditions and are a coarse indicator of warmer and drier episodes. From this we may assume that warm-dry conditions prevailed during the 4-Mix, cool-dry in the late 8-LFL (sample 12), and warm-dry throughout the 10-MSFL.

In contrast to the arboreal pollen, the grasses probably represent fluctuations in meadowland in the immediate vicinity of the site. The increase in grass pollen at the end of the 9-LSFL and in the 10-MSFL is tentatively taken to indicate an increase in surrounding meadowland as the lake level began to recede. Rises in cattail pollen could conceivably reflect increased areas of shallow water as well. The complete disappearance of both pollen types in the later part of the 10-MSFL may reflect extreme desiccation of the lake bed prior to the site's abandonment, although why these pollens do not reappear in the 11-USFL is far from clear.

Although derived from very impoverished samples, none of these fluctuations conflict with the general pattern of the bristlecone pine climatic record (Fig. 4-1) and with the generalized pattern for the Great Basin before 3,500BC. The most obvious anomalies are: the absence of any clear indication of the second cool-wet episode that should have appeared in the 6-S&B (this has proved to be elusive elsewhere in the Great Basin, also); the cool-dry spike seen in the bristlecone pine record at 2,500BC is represented in the local pollen by a cool-moist event (samples 11 and 10); and the warm-wet fluctuations in the 9-LSFL period are not reflected in the pollen record.

Spores

Two spore types were abundantly represented in all samples from the column. Both represent fungi, the large monoporate spore possibly representing a rust (Kapp 1969). The small inaperturate spore is unidentifiable, and could be from a number of different fungi. Very few fungal spores have been identified and the ecology of fungi is essentially unknown. Assuming that the large spore represents a rust, then fluctuations in its abundance could reflect fluctuations in its host species--generally herbaceous annuals and perennials.

Fluctuations in the relative abundance of pollen and spores are shown in Fig. 6-3. Pollens dominate spores in the lower part of the sequence, but this is reversed midway through the 8-LFL, and persists through the middle and upper parts of the sequence, with a spore peak in the early 10-MSFL. When the percentage frequencies of each spore type are plotted separately, it becomes apparent that it is the small spore that first proliferates in the 8-LFL, while the large (rust?) spore proliferates somewhat later at the base of the 10-MSFL (Fig. 6-4).

The significance of these frequency shifts remains unknown in the absence of any basic research on spore identification or ecology.

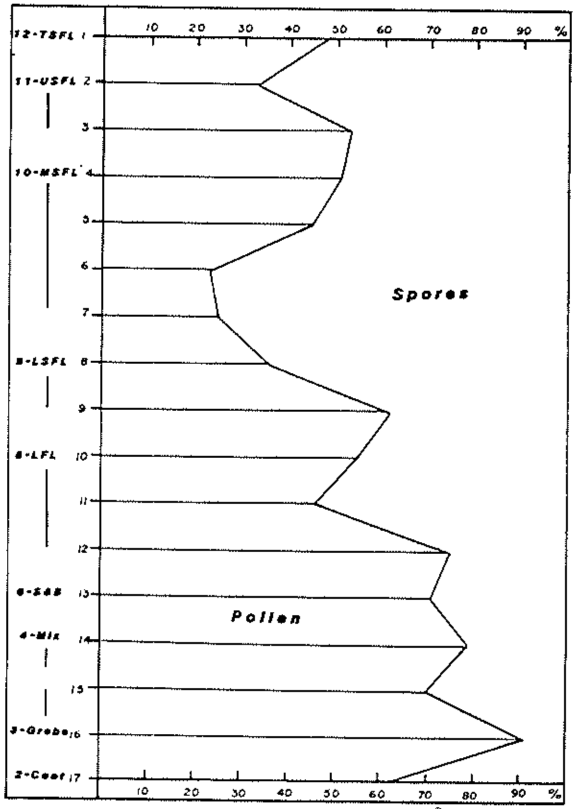


Fig. 6-3 Pollen/spore ratios from Nightfire Island.

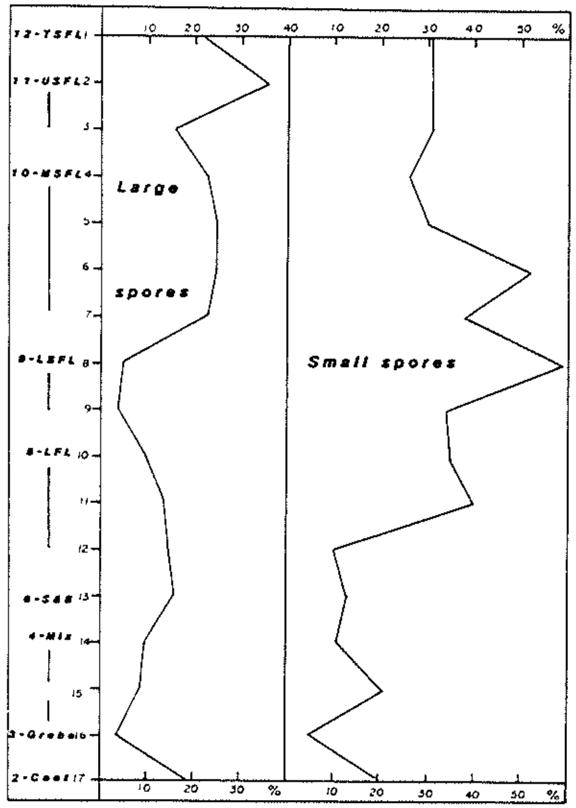


Fig. 6-4 Ratios of large/small spores from Nightfire Island.

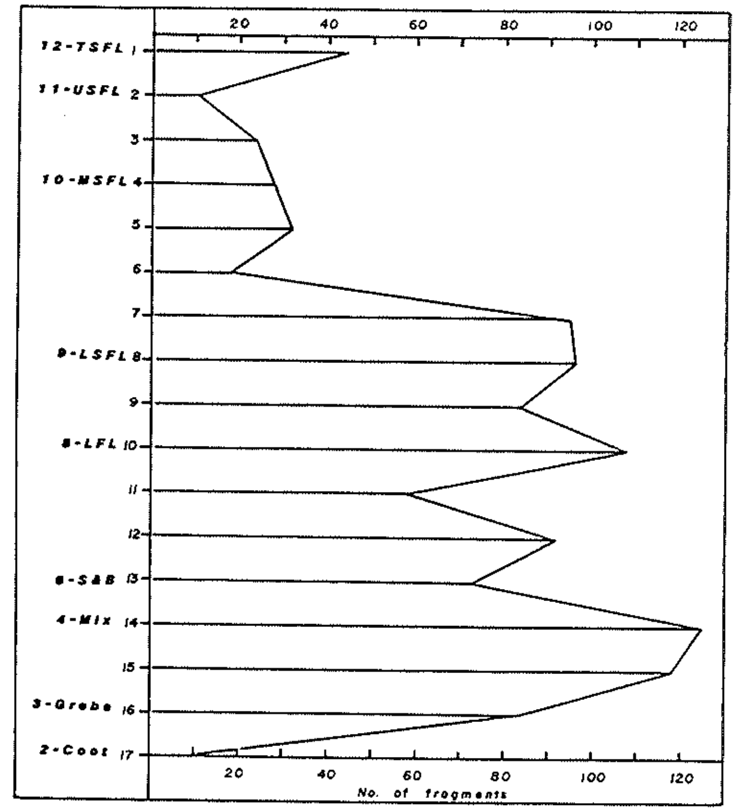


Fig. 6-5 Fluctuations in No. of charcoal fragments per unit volume of residue on pollen slides. Only fragments >80 microns included.

Nevertheless, the large (rust?) spore apparently increases in frequency during episodes of lower lake levels (8-LFL, 10-MSFL, and end-11-USFL) and it decreases during purported higher lake stands (9-LSFL and early 11-USFL). The spore could of course be associated with either a marsh-adapted plant or some land-based plant. In either case, its fluctuations add support to the general picture built up from the sedimentary and dating evidence.

Fluctuations in the smaller spore do not tie into the record of lake level changes, but correlate well with the acceleration in platform-building activities. They may come from a host species growing on the platform, or from plant material brought here for fuel or building materials or bedding so that they do not have any broader climatic or ecological significance.

Phytoliths

Phytoliths (plant opals) were observed during the granulometric analysis of the four sediment columns from Pits I, O, L, and M (see Chapter 5). Presence/absence was recorded for each sample processed, but they were neither counted nor subdivided into shape categories.

Phytoliths were absent from all the lake bed samples examined at the four localities. They were also absent from the 2-Coot in Pit M, but were observed in the sample from Pit L. Thereafter, they were present in all strata sampled, up to and including the 13-LAL in Pit I. They were, however, absent from the Lower 5-Scaup in both Pits I and O.

The origins of the phytoliths in these sediments are most probably from two sources--local water-adapted plants (mainly tule reeds) and grasses brought on to the site for bedding and other domestic uses. Because phytoliths are both heavier and more durable than pollen and spores, their wind transportation can be ruled out, although stream transportation could conceivably have contributed some plant opal to the earlier strata. The absence of phytoliths from the Lower 5-Scaup reinforces the view that this was not a true occupation horizon, but a refuse dump in nearby, shallow water.

Charcoal

The centrifuged residue containing the pollen and spores also contained abundant charcoal fragments. Their presence on the slides offered an opportunity to calculate the relative abundance of charcoal in the deposits.

Charcoal counts were expressed as concentration per unit volume of residue. Fragments larger than 80 microns in any one dimension were present in sufficient number to make reliable determinations. The figures for each level were calculated by the following formula:

$$\text{Fragments of charcoal/ml} = \frac{\text{fragments counted} \times \text{diluted vol}}{0.05 \times \text{original vol}}$$

where "fragments counted" represents the number of fragments >80 microns on the slide; "original vol" is the volume of extracted residue measured after centrifugation at a standard speed for 3 minutes; "diluted vol" is the volume after addition of an appropriate amount of 40% glycerine to this residue, and 0.05 is the volume of residue-glycerine-water suspension counted per slide. The resultant figure represents the number of charcoal fragments having a single dimension greater than 80 microns contained in one ml of extracted residue.

The frequency distribution is given in Fig. 6-5. Charcoal was almost absent from the 2-Coot, and increased through the 3-Grebe to a maximum in the 4-Mix. Although it is tempting to assume that this trend reflects a steady increase in the intensity of the use of the site during these early stages, it should be noted that the sample column is situated on the extreme edge of the 2-Coot and was more centrally placed in the overlying two strata. The decrease in charcoal in the 6-S&B should likewise not be taken as an indication of less intense occupation, but rather as an acceleration in sediment build-up during various stages of platform-raising. The increase seen in sample 10 at the top of the 8-LFL is clearly related to the clay floors and hearth line at this point, but the high values in the 9-LSFL are not easily explained in terms of some localized factor within the sample area. The rapid drop-off in the 10-MSFL is easily explained in terms of post-depositional reduction of charcoal during calcrete formation. This exercise has proved to be of only localized interest, although it does hint at increased human activity at the start of the Small-flake Loams sequence.

Identification of tree species based on charcoal structure was not attempted.

Wood Fragments

Altogether, 56 fragments of wood were recovered from the Small-flake Loams, mainly from Pits N, T, and X. All but three specimens have been preserved through partial mineralization so that the cell voids have filled with silicates and/or carbonates. They are all narrow, elongated fragments with one or both ends rounded or pointed, and all longitudinal ridges rounded. There is no convincing trace of human workmanship on any specimen. Two have transverse cut-marks which were probably caused during excavation. Ten specimens have been positively identified as *Juniperus* sp. (juniper) (R. C. Koeppen pers. comm.) and since these differ in no way from the rest of the collection, it is concluded that the entire sample is of this species, which is conspicuously absent in the pollen record. Stream action or wave action on a low energy beach must have been the shaping agent of these fragments, but the original source of the wood cannot now be determined. The greatest concentration of fragments occurs in layers N3-N5 and W4ab-W5a in the 9-LSFL. They are of quite uniform size with 35 (62.5%) falling between 30 and 50cm length, but there is no uniform shape. Single specimens of non-petrified wood occur in the 10-MSFL of layers T3, E6 and J5a.

These fragments are mainly useful as a correlating tool, but also hint strongly at periodic flooding of the 9-LSFL, as argued from the sedimentary evidence and the placement of pit house floors (Chapter 5). The three specimens from the 10-MSFL are not derived from underlying levels, but their shapes and non-petrified condition suggests that they were introduced onto the site by human portage rather than fluviatile action.

Tentative Interpretations

The lack of basic research on the morphological criteria for identifying pine pollens, fungal spores, phytoliths and charcoal structure has greatly limited the potential of these investigations for adding information on ecological changes surrounding the Nightfire Island site. However, they lend partial support to some of the interpretations put forward in the preceding chapter.

The absence of phytoliths from the lake bed supports the contention that these deposits were formed in deep, relatively open water, and that phytoliths derived from shoreline reeds were not carried out into deep water by stream action. The 2-Coot coincides with the first appearance of phytoliths, marking the advent of marshy shoreline conditions at the site. Only the northeastern edge of the stratum was sampled, so that charcoal fragments are extremely scarce, supporting the proposal that this was not an *in situ* occupation surface. It formed under relatively moist climatic conditions favoring the expansion of mountain hemlock on the Cascade ridges to the west of the site.

Local conditions must have altered somewhat during the accumulation of the 3-Grebe which contains neither grass pollens nor cattails. The pine/hemlock ratio indicates an overall drying trend which is supported by the sedimentary record (partial calcification), but the lake level has not lowered substantially (phytoliths proliferate). The appearance of traces of *Rumex*, *Urticae*, and *Rocaceae* fits well with the model of a developing *in situ* occupation, as these plants tend to colonize broken disturbed ground.

By the time of the 4-Mix accumulation, the overall drying trend has culminated in a pine-dominated spectrum. Grasses and cattails reappear in sample 15 and disappear again in sample 14, suggesting both gains and losses in marshland and meadow against open water. At this point, there is a break in the sedimentary record and the next representative sample is the 6-S&B. No vegetation record of the 5-Scaup was recovered.

At the time of the 6-S&B deposition, overall conditions may have been more moist, but there are grasses and cattails present in the spectrum, suggesting gains in marsh/meadow over open water.

Although the 8-LFL is supposed to have accumulated during an interval of somewhat lower lake levels (implied from the bristlecone pine record) the pollens show a very clear fir-hemlock spike at the end of the accumulation. This *may* correlate with the minor cool-dry spike in the bristlecone pine sequence which is also placed at the end of the 8-LFL (Fig. 4-1), but the pollen record suggests a cool-moist event instead. There is no indication, however, that this had any influence on lake level--there are no cattails in sample 11, and their recovery in sample 10 is accompanied by an increase in grasses also.

The earlier part of the 9-LSFL (sample 9) does indeed reflect the warm-moist conditions predicted for this period by the bristlecone record (Fig. 4-1). Hemlock pollen dominates the spectrum, while fir has fallen back to former levels. Also, cattails increase slightly while grasses decrease. Although these are very minor changes, they are complemented by the mass of rolled juniper twigs in the deposits which are taken to indicate periodic inundation of the site, as the latter are typical of shoreline detritus.

Again, the later half of the 9-LSFL (sample 8) is dominated by a grass spike in the pollen diagram, from which we may infer increased meadlowland. Although less pronounced, the curve in the cattail record also reaches its peak in this sample, indicating further extensions in marshland. Both of these changes imply a lowering of the lake level by the end of the 9-LSFL--an event which does not show up clearly in the sedimentary record.

At the start of the 10-MSFL, meadowland continued to encroach on marshland as the overall pine representation in the arboreal pollen began to increase. For the remainder of the 10-MSFL up to the time of the site's abandonment (above sample 4), the marsh edge must have been retreating farther away from the site as the lake continued to shrink in size. This scenario would explain the disappearance of cattails from the spectrum, but the absence of grasses is more puzzling. Possibly the site was "high and dry" during this episode, and surrounded by sparse scrub--the pollen of which has not survived the extraction process.

However, grass and cattail pollens are also missing from the 11-USFL spectra, in spite of the recovery of hemlock which must reflect the return to (predicted) moister conditions. While it has been assumed that the lake level rose again with the advent of the 11-USFL, pollen evidence for an increase in surrounding marshland is not forthcoming. Evidence from the bed of Lower Klamath Lake has proved to be more useful, however.

Some Comparisons

Four other pollen sequences from Lower Klamath Lake were analyzed by Hansen (1942). All are from deep, natural accumulations of peat which could for the most part reflect vegetation changes free of the human interference normally present on archaeological sites. Their locations are shown in Fig. 6-6. None was radiocarbon dated, and correlations were based on recurrent charcoal horizons (caused by peat fires during lowered lake levels) and on a repeated superposition of fibrous peat over sedimentary peat in each core. Although absolute dates were not then available, the surface of the fibrous peat was taken to be recent, and one column penetrated an archaeological horizon then thought to date to somewhere in the last millennium BC. Further correlations were attempted by Hansen (1942, 1947 ab) who matched frequency curves of yellow, white and lodgepole pine pollen from Laird's Bay with the Narrows profiles. However, this approach has been challenged on the grounds of doubtful identification (Flint and Deevey 1951, Martin and Gray 1962) and ambiguous climatic interpretations (Martin and Mehringer 1965, Grayson 1973a). If the various pine pollens are lumped into a single category (Pinus), then the diagrams (Figs. 6-7 and 6-8) become directly comparable with the Nightfire Island record (Fig. 6-2).

It is immediately apparent that the survival rate and representation of pollens in the relatively undisturbed lakebed settings are quite similar to those from the archaeological sediments of Nightfire Island: pine, hemlock and fir dominate the arboreal pollens, thus lending support to the assumption that the fluctuations seen in the archaeological sequence have some overall climatic validity and are not just reflections of the relative survival rates of different pollen grains. The non-arboreal pollens, on the other

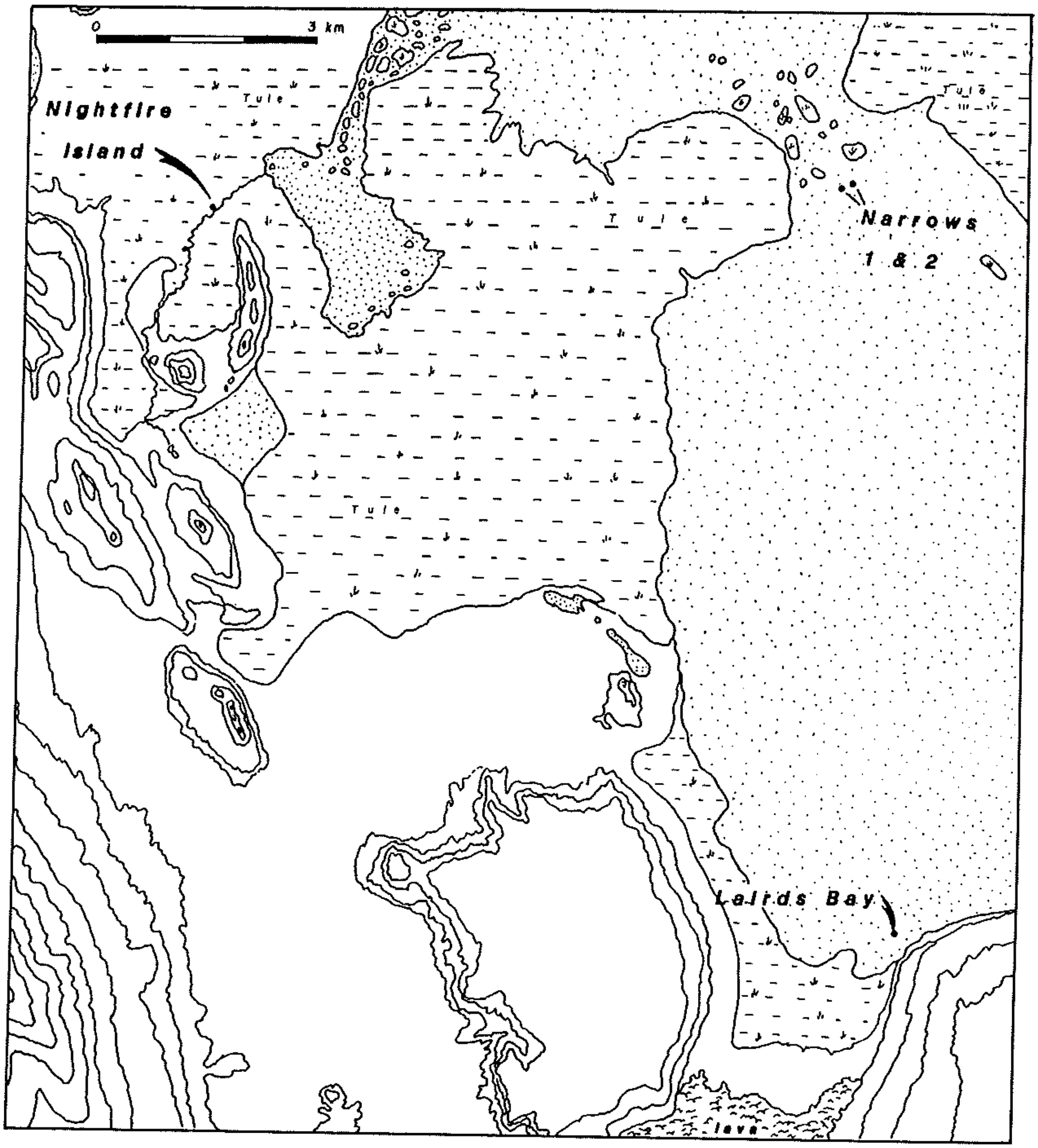


Fig. 6-6 Locations of Lairds Bay and Narrows 1 & 2 pollen columns.

hand, vary widely from site to site. Most of these are derived from more localized species around each site, but there has probably been more destruction of grains (e.g., Chenopods) in the archaeological sequence, due to human interference on and around the site.

Another important contribution of the lake bed diagrams is the set of burned horizons and the archaeological level, all of which demonstrate that the lake did indeed shrink in size repeatedly during the time of the Nightfire Island occupation.

Only three of the four lake bed sequences lend themselves to correlation. The fourth profile came from near Klamath Falls, 16km southwest of the town. Neither the locality nor the elevation was reported. This 2.5m deep profile lacked the fibrous peat at the top of the sequence, and its setting was so different from the others that correlations are impossible without C-14 dates.

Of the remaining three profiles, the most important is that from Laird's Bay on the southern shore, only 14km southeast of Nightfire Island. Silt and sands were observed at the base of the core, and these were followed by 2m of fine sedimentary peat with two thin layers of charred organics. At 1m depth, there is a third episode of burning and the artifact-bearing zone occurs above this. Over this is a 1m accumulation of fibrous peat composed mainly of cattail-bulrush remains. The artifact horizon is seen as a temporary exposure (and burning) of the peat surface followed by reflooding and regrowth of younger peats (Fig. 6-7).

The thin artifact-bearing horizon was reported at an elevation of 1242.5m--some 5-6m lower than the lake bed surface under Nightfire Island. The artifacts (Cressman 1940, 1942) contain very few finished pieces, but these include no arrowheads. The few whole flakes fall within the size range of the Small-flake Loams at Nightfire Island, but no closer typological correlation can be achieved. At this time, the lake level must have been several meters lower than the Nightfire Island living surface, and the Nightfire catchment must have displayed the sort of configuration shown in Fig. 1-11d--virtual disappearance of open water in the basin. Thus, the most likely correlation with the Nightfire Island sequence would be one of the warm-dry episodes--probably the 10-MSFL which was the most extreme of all. If this link is accepted, then the Laird's Bay assemblage must date to within a few centuries of 1,000BC--inside the age limits estimated by Bennyhof (1958) and Meighan (1959) for this horizon. Passing on down the Laird's Bay sequence, the best fit for the fir spike is with the cool-dry event at the end of the 8-LFL. The next charred horizon would fit with the lowered lake level predicted for the 8-LFL, and the lowermost charred horizon would match with the predicted low lake stand which caused the unconformity between the 4-Mix and the 5-Scaup.

Why hemlock is poorly represented through the Laird's Bay profile is difficult to understand. Instead, grasses tend to peak during almost all lower lake stands except the extreme case of the archaeological horizon. In this lakeshore setting, meadowland presumably encroached each time the lake level (and surrounding marshland) shrank in area. During the actual occupation of the lakebed, meadowland was entirely absent, as was the case at Nightfire Island during the 10-MSFL when, it was suggested, the lake bed may have desiccated to the point where only a thin scrub covered its surface.

The fibrous peat formation which followed the archaeological horizon at Laird's Bay is composed mainly of cattail and bulrush (the latter conspicuously absent from the pollen profile). This presumably

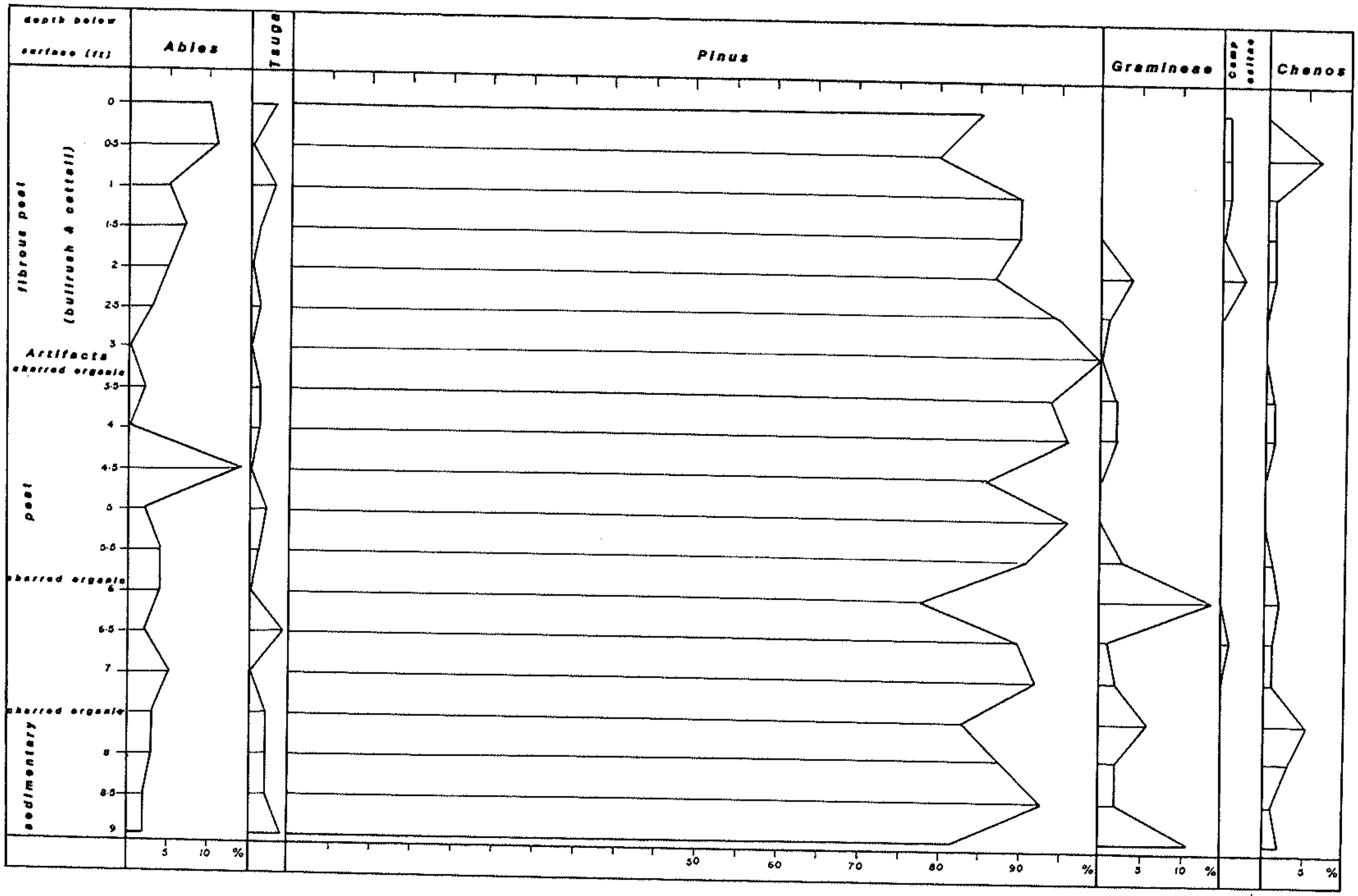


Fig. 6-7 Pollen diagram from Lairds Bay. All species of pine pollens combined.

formed during the 11-USFL and the ensuing cool-wet episodes of the bristlecone pine record.

Two additional profiles were exposed at the Narrows only 9km east-northeast of Nightfire Island and 10km north of Laird's Bay, near the center of the lake. The exact distance between the two profiles is not recorded, but they are crudely mapped at about 100m apart (Cressman 1942:fig. 55). The first was 3m deep and the second 3.3m, but the bottom of the peat could not be reached. There is an abrupt change from sedimentary peat to fibrous peat at 1m depth--confidently correlated with the same feature at Laird's Bay (Hansen 1942:104). But charred organics occur at 1.4m in one profile only, hinting that they may not be identical. It remains uncertain which of the two charred horizons at Laird's Bay is represented here.

The adjusted pollen diagrams for the two profiles (Figs. 6-8 and 6-9) also indicate that they do not represent identical sequences. Narrows 1 has a Chenopod peak between its charred horizon and the top of the sedimentary peat, but this is entirely missing from Narrows 2, which has Chenopod maxima near the bottom of the profile. As these occur below an ostracod zone which appears at the base of Narrows 1, the latter profile may not have reached these Chenopod-rich levels. Otherwise, the two Narrows profiles correlate without much difficulty: fir spikes occur just below the top of the sedimentary peat in both; pine spikes also occur just above the sedimentary/fibrous peat interface. These also occur in the Laird's Bay sequence in the selfsame positions.

Given that the Narrows was located in a deeper part of the basin than the more marginal Laird's Bay setting, it may not be too far-fetched to correlate the two Chenopod spikes in the lower part of Narrows 2 with the two grass spikes in the lower part of the Laird's Bay sequence. This assumes that the Chenopods were associated with the shoreline of the residual lake while Laird's Bay stood in or near surrounding meadowland. A tentative correlation of the four pollen sequences is offered in Fig. 6-10.

In summary, the pollen evidence from the Lower Klamath Lake bed in no way contradicts the predicted sequence of lake level fluctuations based on the combined dating, sedimentary, and botanical evidence. Furthermore, the lake bed profiles have provided an independent view of fluctuations in pollen rain away from the site itself.

ENDNOTES: CHAPTER SIX

1. See Table 3-2 for acronyms of strata.

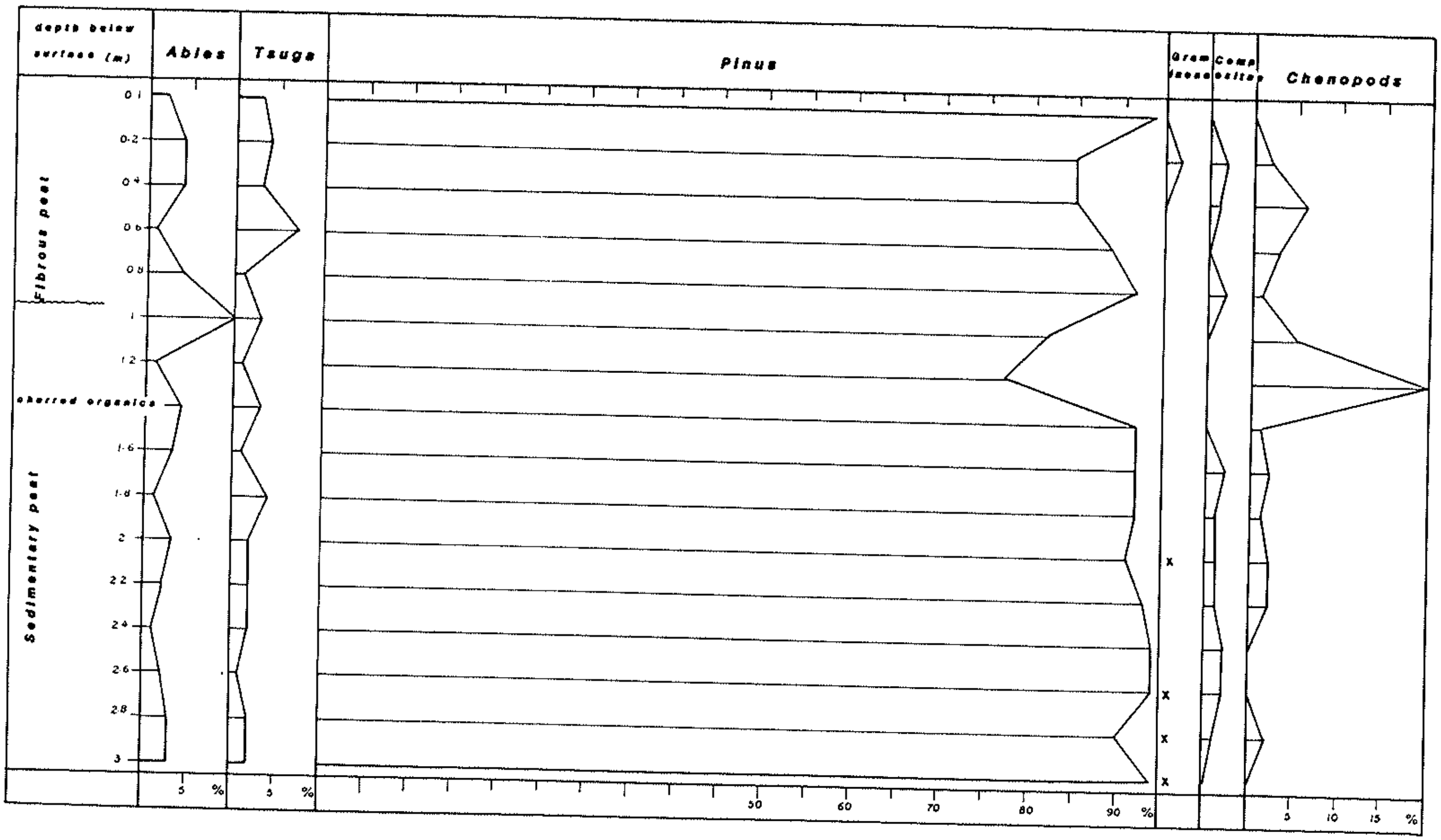


Fig. 6-8 Pollen diagram from Narrows 1. All species of pine pollens combined.

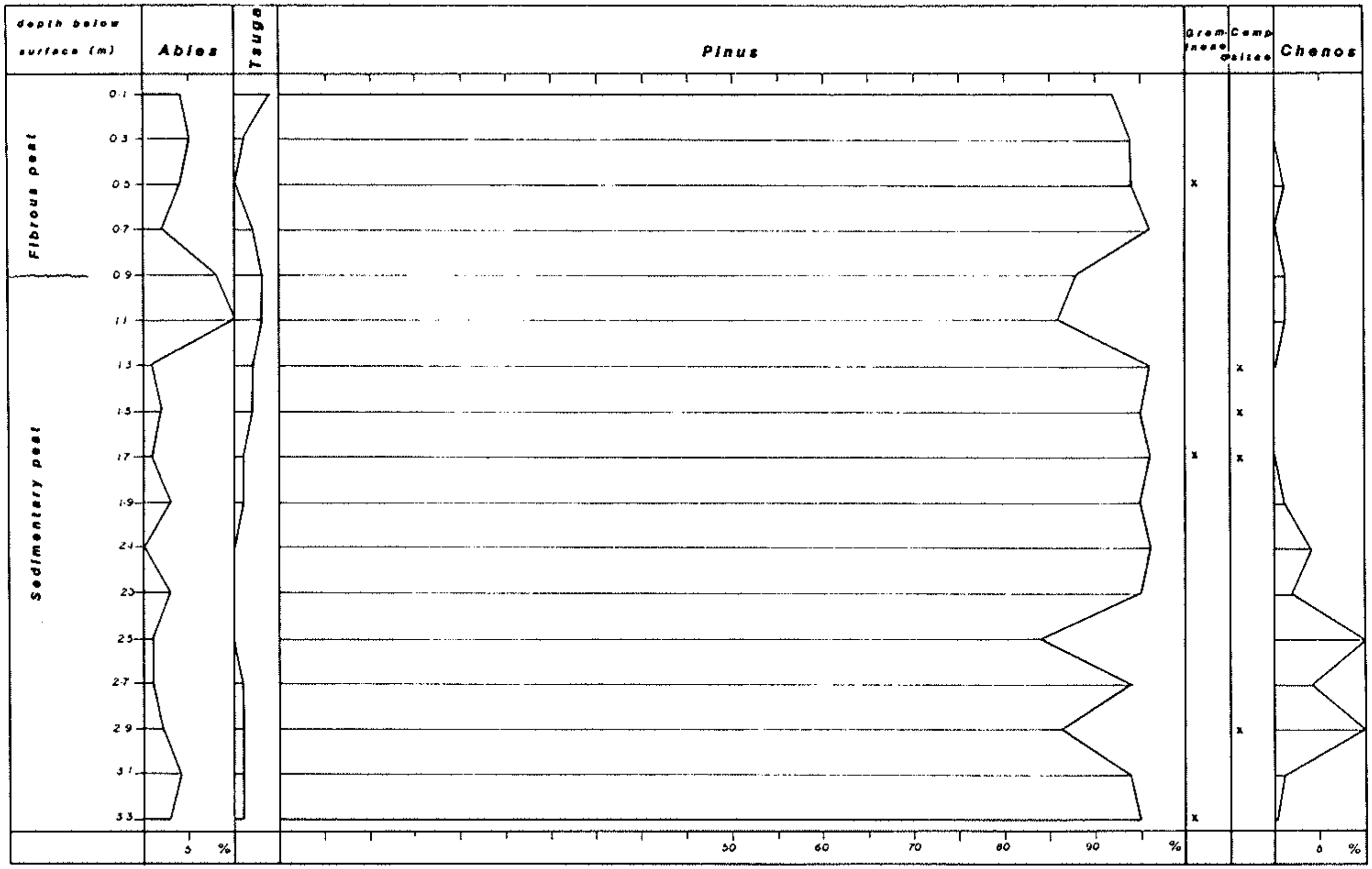


Fig. 6-9   Pollen diagram from Narrows 2.   All species of pine pollens combined.

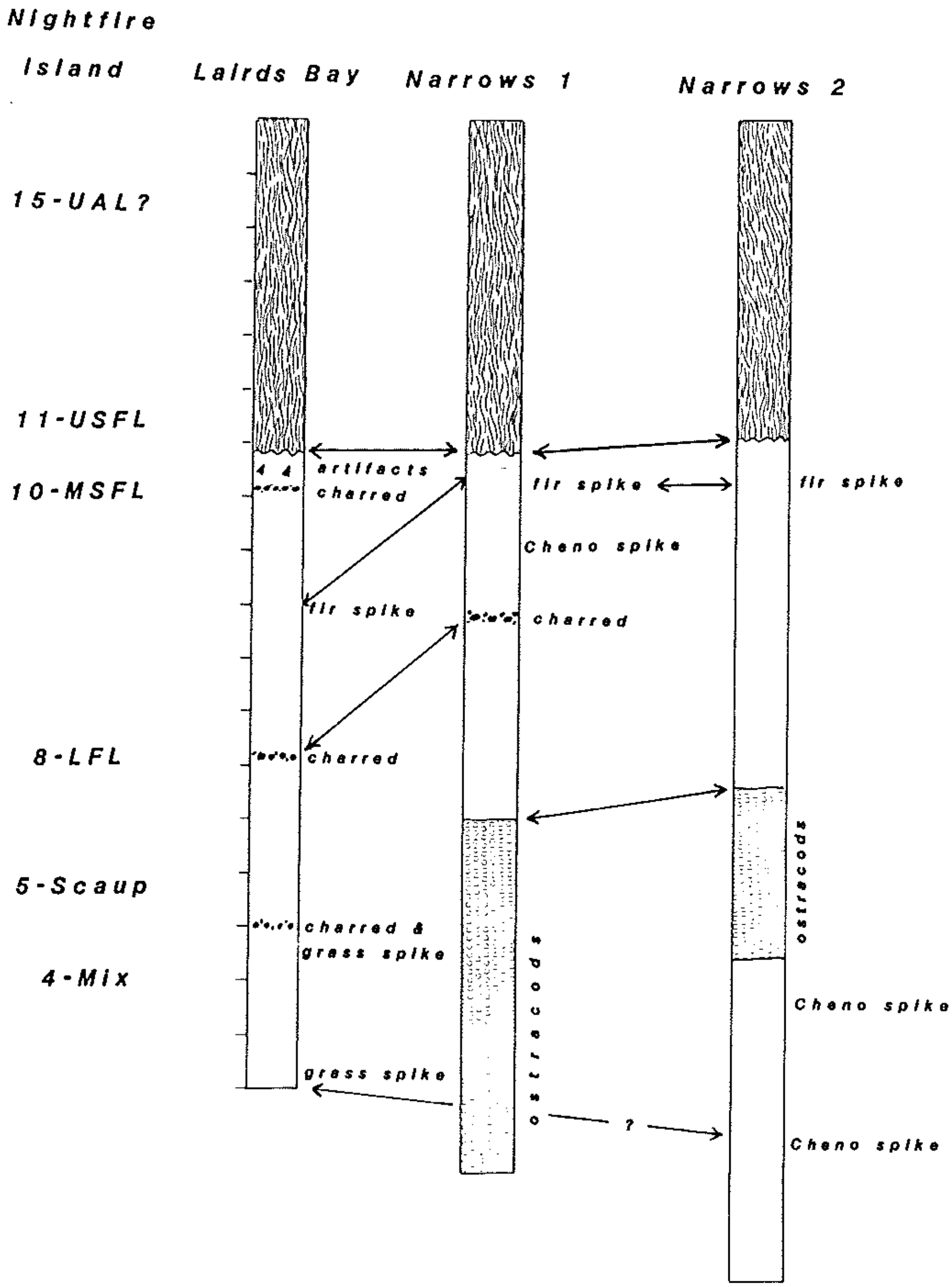


Fig. 6-10 Tentative correlation of Lairds Bay and Narrows 1 & 2 with the Nightfire Island sequence.

CHAPTER SEVEN

MAMMALIAN FAUNA

Mammal bone was recovered from all strata in Nightfire Island (Grayson 1973a, 1976). Altogether, 22 taxa could be recognized at the species level plus one taxon (Canis spp.) at the generic level only. Of these, 11 taxa are carnivores, and seven are rodents. The larger mammals include four artiodactyls and a bovid. The complete list is given in Table 7-1 and Fig. 7-1.

The following sections contain brief notes on the ecology and population dynamics of each species in the area surrounding Nightfire Island. These data are then used to model predicted changes in the relative amounts of mammal bone in different strata of the site, in the light of changes in catchment configuration proposed in the preceding chapters.

Wolf (Canis lupus)

As Bailey (1936) suggested for eastern Oregon, the number of wolves in this area may have been greatly reduced after the bison disappeared from the Klamath area (see below), and the specimen(s) from the 11-USFL must reflect opportunistic killing rather than systematic hunting. Grayson (1973a) has reviewed the historical sightings of wolves in the surrounding area and has argued that the sagebrush hills surrounding the lake would have served as a suitable habitat.

Coyote (Canis latrans)

Coyote mandibles and teeth were separated from those of dog following the guidelines of Allen (1920), Gidley (1913), and Lawrence and Bossert (1967). A few relatively complete postcranial bones were ascribed to coyote because they display smaller muscle attachments and less limb bone curvature than the more rugged Nightfire dogs. More fragmentary postcranial material was relegated to "Canis spp." and could be coyote or dog.

Coyote are still commonly sighted along the shores and adjacent uplands of Lower Klamath Lake and Tule Lake where they have also been observed on small islands (USDI 1942). They are year-round residents having population peaks in the August birth season and late-Fall/winter influx following migratory deer (Forsell 1961).

Dog (Canis familiaris)

Criteria for separation from coyote remains are cited above. Most of the fragmentary postcranial material with sufficient surfaces was thought to be dog. For the most part, dog bones were broken and scattered about in each stratum like the rest of the fauna, and there is no reason to doubt that dogs were eaten throughout the site's history. However, this may not have been the invariable rule because a very young pup was buried in the fill of a pithouse in the 10-MSFL at Pit E. The scattered remains of an immature large dog were also recovered from the 3-Grebe at Pit T. Complete skulls were also recovered from the 8-LFL in Pit G and from the 15-UAL in Pit A. Historically, the Modoc did not eat dog, even during famine (Ray 1963). The historical Klamath to the north and the Achomawi to the south of the Modoc both ate dogs, but their eastern and western

Table 7-1. Mammal Elements

	Wolf *Canis lupus*		Coyote *Canis latrans*		Dog *Canis familiaris*		Canids *Canis spp*		Otter *Lutra canadensis*		Mink *Mustela vison*		Racoon *Procyon lotor*		Marmot *Marmota flaviensis*	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
15-UAL	–		7	3.4	12	5.8	14	6.8	31	15.0	13	6.3	1	0.5	–	
14-MAL	–		4	3.0	16	11.9	21	15.7	13	9.7	7	5.2	–		–	
13-LAL	–		1	1.0	16	15.2	9	8.6	18	17.1	3	2.9	–		1	1.0
12-TSFL	–		–		8	18.2	4	9.1	2	4.5	4	9.1	2	4.5	–	
11-USFL	4	1.1	8	2.2	61	16.9	36	10.0	15	4.2	7	1.9	4	1.1	2	0.6
10-MSFL	–		1	0.4	38	16.7	36	15.8	9	3.9	14	6.1	1	0.4	2	0.9
9-LSFL	–		4	4.0	4	4.0	22	22.0	3	3.0	7	7.0	1	1.0	1	1.0
8-LFL	–		1	1.1	16	18.0	16	18.0	1	1.1	14	15.7	–		–	
7-GraCl.	–		–		–		5		–		–		–		–	
6-S & B	–		2	3.8	14	26.9	14	26.9	4	7.7	2	3.8	–		–	
5-Scaup	1	4.8	1	4.8	4	18.0	3	14.3	1	4.8	3	14.3	1	4.8	–	
4-Mix	–		–		1	4.2	2	8.3	–		1	4.2	–		–	
3-Grebe	3	5.3	5	8.8	18	31.6	6	10.5	2	3.5	3	5.3	–		–	
2-Coot	4	10.5	–		2	5.3	4	10.5	3	7.9	2	5.3	1	2.6	1	2.6
1-Basal	–		1		1		1		1		1		1		–	
Lake Bed	–		–		–		–		–		–		–		–	

Table 7-1 (Continued)

	Badger *Taxidea taxus*		Bobcat *Lynx rufus*		Grizzly *Ursus horribilis*		Mule Deer *Odocoileus hemionus*		Elk *Cervus canadensis*		Pronghorn *Antilocapra americana*		Mountain Sheep *Ovis canadensis*		Jack rabbit *Lepus californicus*		Cottontail *Sylvilagus nutalli*	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
15-UAL	-		1	0.5	-		6	2.9	2	1.0	50	24.3	27	13.1	13	6.3	11	5.3
14-MAL	11	8.2	-		1	0.7	6	4.5	1	0.7	21	15.7	10	7.5	4	3.0	9	6.7
13-LAL	-		1	1.0	-		5	4.8	2	1.9	11	10.5	12	11.4	9	8.6	7	6.7
12-TSFL	-		-		-		3	6.8	-		4	9.1	7	15.9	3	6.8	6	13.6
11-USFL	1	0.3	-		-		35	9.7	12	3.3	53	14.7	86	23.8	11	3.0	17	4.7
10-MSFL	1	0.4	2	0.9	-		14	6.1	5	2.2	16	7.0	45	19.7	28	12.3	15	6.6
9-LSFL	-		-		-		3	3.0	7	7.0	11	11.0	16	16.0	4	4.4	2	2.0
8-LFL	-		4	4.5	3	3.4	4	4.5	7	7.9	5	5.6	10	11.2	3	3.4	-	
7-GrCl	-		-		-		-		-		-		-		-		-	
6-S & B	-		1	1.9	2	3.8	1	1.9	-		-		2	3.8	-		-	
5-Scaup	-		-		-		-		2	9.5	2	9.5	-		1	4.8	-	
4-Mix	-		-		2	8.3	2	8.3	2	8.3	3	12.5	-		2	8.3	2	8.3
3-Grebe	-		-		-		5	8.8	3	5.3	4	7.0	2	3.5	1	1.7	1	1.7
2-Coot	-		-		-		3	7.9	1	2.6	8	21.0	7	18.4	-		-	
1-Basal	-		-		-		-		-		4		1		-		-	
Lake Bed	1		-		-		-		1		-		-		-		-	

Table 7-1 (Continued)

	Porcupine *Erethizon dorsatum*		Beaver *Castor canadensis*		Striped Skunk *Mephitis mephitis*		Meadow Vole *Microtus* sp.		Montane Vole *Microtus montanus*		Bison *Bison bison*		Total Element Counts	% of Total
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
15-UAL	1	0.5	1	0.5	-		6	2.9	10	4.8	-		206	99.9
14-MAL	-		1	0.7	-		6	4.5	3	2.2	-		134	99.9
13-LAL	-		-		-		4	3.8	6	5.7	-		105	100.2
12-TSFL	-		-		-		1	2.3	-		-		44	99.9
11-USFL	7	1.9	-		1	0.3	-		1	0.3	-		361	99.9
10-MSFL	-		-		-		-		1	0.4	-		228	99.8
9-LSFL	-		-		-		2	2.0	1	1.0	12	12.0	100	100.0
8-LFL	-		-		-		-		-		5	5.6	89	100.0
7-GrCl	-		-		-		-		-		-		5	-
6-S & B	1	1.9	-		-		-		-		9	17.3	52	99.7
5-Scaup	-		-		-		-		-		2	9.5	21	100.1
4-Mix	5	20.8	-		-		-		-		2	8.3	24	99.8
3-Grebe	1	1.7	1	1.7	-		2	3.5	-		-		57	99.9
2-Coot	2	5.3	-		-		-		-		-		38	99.9
1-Basal	-		1		-		-		-		-		12	-
Lake Bed	-		-		-		-		-		-		2	-

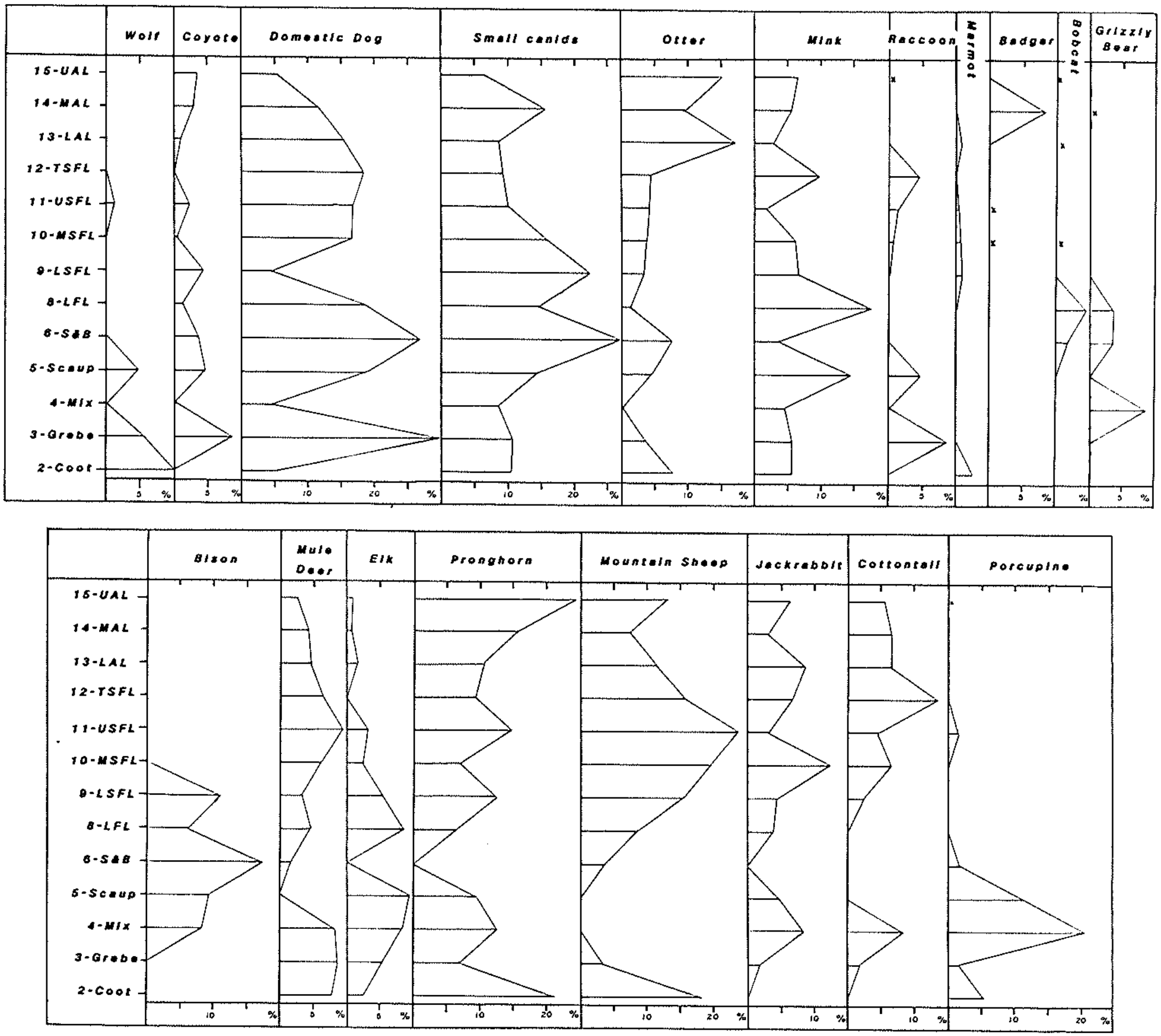


Fig. 7-1 Fluctuations in the percentages of mammal elements by stratum.

neighbors, the Paiute and Shasta, did not (Driver and Massey 1957). Assuming some time depth to the dog-eating practice of the Klamath and Achomawi, Grayson (1973a) has pointed out that this habit may have been spatially continuous through all three groups and that the Modoc had politically split with the other two in relatively recent times, as Gatschet (1890) first suggested.

"Canis spp."

This comprises the unassignable postcranial fragments of coyote and dog, but excludes wolf. The observed fluctuations have no significance other than the degree of fragmentation of coyote and dog bones. Because numbers are small in the lower strata of the site, this category may contribute more distortion to the early frequency curves of other species.

Grizzly Bear (Ursus arctos)

Grayson (1973a) has sifted through the rare documented sightings of grizzly in the territory surrounding the lake and concludes that the Nightfire inhabitants would have had access to them in the more forested region to the northeast, north and west, with a possible secondary source to the south and southeast.

Bobcat (Lynx rufus)

Bobcat are still common year-round residents, seen both in the sagebrush, grasslands and marshy areas surrounding Lower Klamath Lake (USDI 1970).

Badger (Taxidea taxus)

Badgers prefer dry open country and have not been seen in recent times in the vicinity of the lake. They occur today in the uplands surrounding Clear Lake (USDI 1970) and in Lava Beds National Monument. They first appear in April and become inaccessible in mid-October (Forsell 1961). It is reasonable to assume that the Nightfire specimens were caught between spring and early fall.

Raccoon (Procyon lotor)

Raccoons are commonly found in the cattail-bulrush marshes of the lake and must have been locally available near the site. When nearby Tule Lake was drained, their numbers decreased (Brainerd 1941), suggesting that this species may be taken as a crude indicator of local marshy conditions.

Striped Skunk (Mephitis mephitis)

Although very common along Lower Klamath Lake shoreline in both the marshes and sagebrush and grasslands (USDI 1970), they were no doubt avoided by the Nightfire inhabitants.

Mink (Mustela vison)

Mink were formerly common along the Lower Klamath marshes (Grinnell et al. 1937), and many were killed during the Lower Klamath peat fires of the early 1900's (Henshaw 1917). Population numbers are clearly sensitive to long-term changes in the marshy habitat.

River Otter (Lutra canadensis)

Like mink, otters must have been common in Lower Klamath Lake, but are restricted to the cattail-bulrush marshes to the north of the lake and to adjacent Upper Klamath Lake and Hawk's Marsh.

Bison (Bison bison)

Although bison has not been recorded in either the historical or archaeological record for the area, there are scattered reports of sightings to the east of the Klamath basin (Bailey 1923, 1936; Merriam 1926; Riddell 1952) which are mapped in Fig. 7-2.

Elk (Cervus canadensis)

Given the extreme scarcity of elk in the historical record of the area--a lone bull sighted just north of the lake (USDI 1944)--the trend observed in Fig. 7-1 is significant. Bailey (1936) notes that elk were relatively common on the western slopes of the Cascades, but virtually absent from the eastern slopes. Grayson (1973a) suggests that severe winters might have brought groups or scattered individuals down into the basin, but that increasing human occupation made it less and less attractive to elk as a refuge habitat.

Mule Deer (Odocoileus cf. hemionus)

Mule deer (O. hemionus) and white-tailed deer (O. virginianus) cannot be distinguished on the basis of fragmentary skeletal material; the assignment to O. cf. hemionus is made on distributional grounds. Moffit (1934) pointed out that mule deer were much scarcer in the Modoc region at the time of European contact than in recent times. The proliferation of mule deer followed extermination of the mountain sheep, logging activities and extermination of natural predators, especially coyote and bobcat (Grayson 1973a). Although recently enlarged through human interference with the habitat, the whereabouts and seasonal movements of modern herds are nonetheless of some interest. Most relevant is the Mt. Dome herd which summers in the highlands 15-20 miles south, then moves down to Lower Klamath Lake in winter to augment the small resident population.

Pronghorn Antelope (Antilocapra americana)

Although now greatly reduced in numbers, there are still two local herds whose movements are related to this study (Fig. 7-3). The Mt. Dome herd has been frequently sighted along the south slope of Lower Klamath Lake (USDI 1944-1970) in both winter and summer.

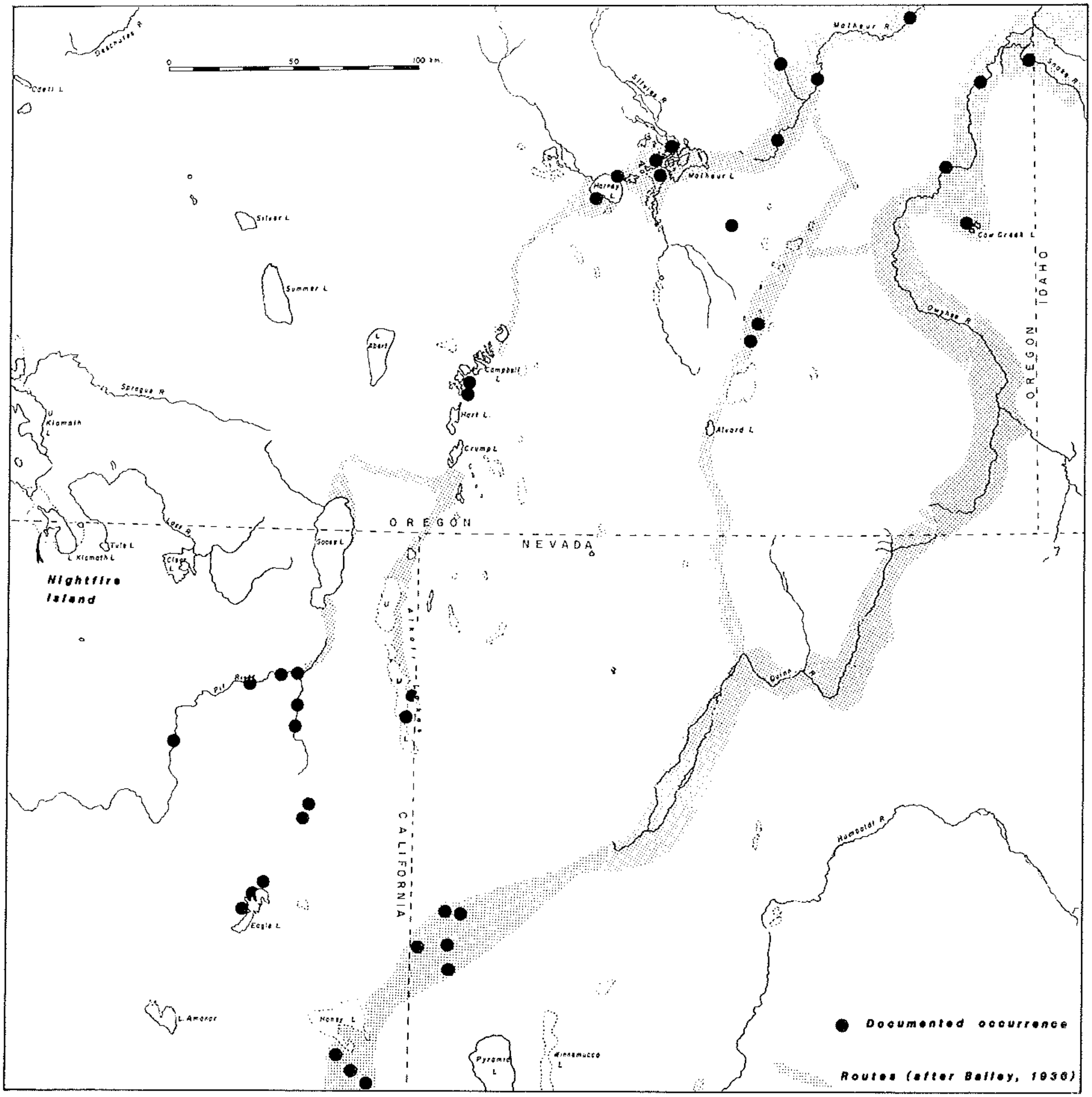


Fig. 7-2 Map of documented occurrences and hypothetical routes of <u>Bison bison</u>.

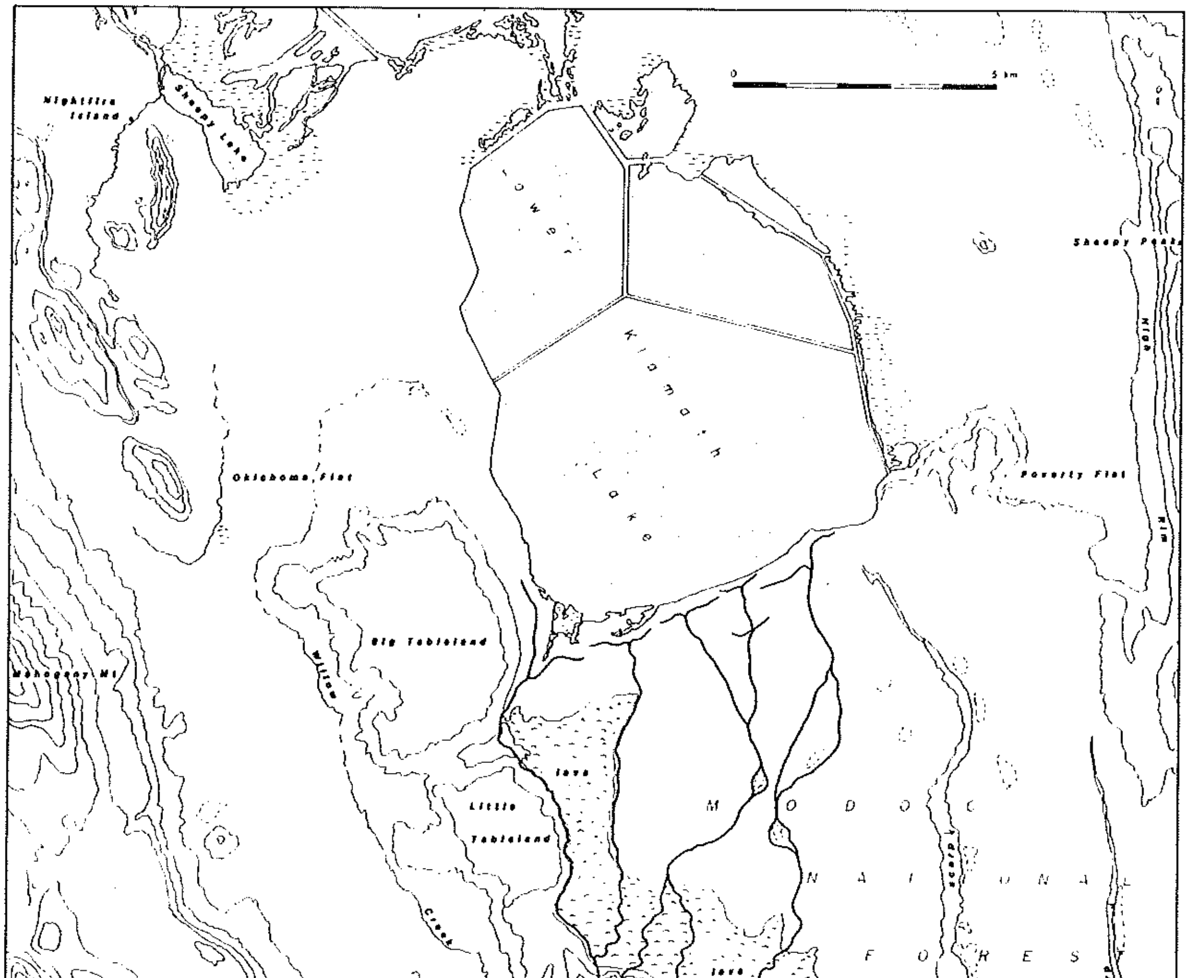


Fig. 7-3 Routes of two local herds of Pronghorn antelope between the slopes of Mt. Dome and Lower Klamath Lake.

Mountain Sheep (*Ovis canadensis*)

Mountain sheep were evidently waning in numbers in the late 19th century and are now locally extinct.[1] However, something is known of their location and movements (Starr 1934; Fisher n.d.; and Jones 1950). Opportunities for taking these animals nearby the site must have been frequent.

Black-tailed Jackrabbit (*Lepus* cf. *californicus*)

One recent estimate of the black-tail population around Lower Klamath Lake was given as 300 individuals (USDI 1965).

Nuttall's Cottontail (*Sylvilagus nuttali*)

Modern surveys show cottontail numbers around Lower Klamath Lake close to or just exceeding those of jackrabbit--a pattern which is represented throughout the frequency curves (Fig. 7-1).

Yellow-bellied Marmot (*Marmota flaviensis*)

They inhabit the rocky grassland of the Lower Klamath area and are dormant (and inaccessible) between mid-July-August and February-March (Forsell 1961). The individuals represented by this sample were almost certainly caught in spring or summer.

Beaver (*Castor canadensis*)

Although absent from the lake in recent times, Bailey (1936) has documented an observation of 1860 that the lake supported large numbers of beaver. Since beavers prefer water bodies with tree stands nearby, this may have been a shortlived colony rather than a steady population reaching back into prehistoric times.

Belding's Groundsquirrel (*Spermophilus beldingi*)

The mode of occurrence of this rodent in the site is typical of natural deaths among burrowers in the deposits. Fresh and unstained skulls occur in S2-3, E-3 and 4a--the latter two with mandibles. In E3, there are numerous other parts of a single animal. They have been omitted from the list in Fig. 7-1 and were not included in the percentage frequencies on the grounds that they are recent intrusions.

Porcupine (*Erethizon dorsatum*)

A recurrent trace throughout the site's depositional history, porcupine elements cannot be interpreted as intrusive burrow deaths. Teeth and mouth parts occur in six pits, and limb bones were found in F and T. This distribution duplicates that of other food bones. They are relatively common in the sagebrush-juniper area around the lake today.

Montane Vole (*Microtus* cf. *montanus*)

Elements of this small rodent are restricted to the Loams sequence of strata and increase in relative frequency towards the top. Mandibles and maxillae were used in the identification. Grayson (1973a) suggests that this material derives mainly from burrow deaths in the site and the species need not be involved in the inhabitants' diet. However, the physical appearance of the bone resembles that of the other fauna, but the elements are restricted to the loose sediments in the north (Pits A-E and I) and east (Pits P, V) with one in X3b. This vole is found in sagebrush and sagebrush→juniper associations and is most abundant near streams and marshes all year round (Maser and Storm 1970). It has been included with the percentage frequencies because voles are of broad ecological significance.

Meadow Vole (*Microtus* sp.)

This rodent has an overlapping distribution with the Montane vole elements in the site, except for a small scatter in Pits S and T in the 3-Grebe. The same caveat applies to both species.

A Note on Methodology

Minimal Individual (MIND) calculations have been deliberately omitted from the analysis. Given the sampling strategy used to recover the fauna, any such calculation would be no more than an artful manipulation of the numbers, as pointed out by Grayson (1973a, 1974) and several others. Grayson (1973b) has worked out the MIND counts for individual layers in each pit and interested readers are referred to this source.

Detailed enumeration of body parts has also been ignored in this chapter. A full listing is available in Grayson (1973a). Given the present state of knowledge of the taphonomy of the species involved, the significance of body part frequencies in each stratum defies interpretation.

Catchment Changes Reflected in the Fauna

The preceding notes show that mammals were taken from six niches within the 10km catchment of Nightfire Island (Fig. 1-8a) and that each niche yielded its own specific group of animals. The niches (and their associations) are: the site itself (dogs, most of "*Canis* spp.," groundsquirrel, Meadow vole); the cattail/bulrush marsh (mink, otter, raccoon); the shoreline of the marsh (coyote, bobcat, skunk, beaver); the sagebrush and grassland flats (bison, wolf, bobcat, jackrabbit, cottontail skunk, Meadow vole, marmot); the sagebrush hills (wolf, coyote, bobcat, badger, skunk, porcupine, jackrabbit, cottontail, Montane vole); the mountainous uplands (Grizzly, elk, mule deer, pronghorn, Mountain sheep). As the last four species are seasonal migrants, they are likely to winter in the hills, flats, and shoreline as well. Some of the smaller carnivores are not restricted to one niche either (coyote, bobcat, skunk).

The model of catchment changes (Chapter 1, Fig. 1-12c) predicted increases in grassland and sagebrush flats over marshland during warm-dry episodes when the lake level dropped. Losses in marshland should be reflected, therefore, as coterminous decreases in the relative numbers of marsh-adapted species among the non-domestic mammals. Specifically, declines in marshland taxa should occur in the

4-Mix, 8-LFL, upper 9-LSFL and 10-MSFL. The species most affected should be beaver, otter, mink, and raccoon. Others frequenting the shoreline are of more catholic habit, which enables them to seek refuge in other niches nearby the site. This prediction is underpinned by one important (untested) assumption; that trapping of fur-bearing animals did not increase in response to demands for pelts as part of an inter-village exchange network. Fig. 7-4 gives the percentage fluctuations of these marshland taxa against flats- and hills-adapted species. Declines in marshland taxa do in fact occur in the 4-Mix, 9-LSFL and 10-MSFL as predicted, but the 8-LFL contradicts the model by showing a peak instead. The 8-LFL anomaly fits well with the anomalous fir-hemlock (implied cool-moist) spike in the pollen diagram for this stratum. Both bits of evidence suggest that the climatic record of the Klamath Basin over this period is at variance with the bristlecone record. Marshland species also drop slightly in the 14-MAL, perhaps anticipating the onset of the cold-dry spike during which, it is suspected, the site was abandoned (see Fig. 4-1). Such a scenario conflicts, however, with the sedimentary evidence (humic staining, peat formation, rubble fills) which bespeak lakeshore encroachment during the 14-MAL. A case for marshland drowning (see below) is presented to resolve the anomaly. Another anomaly is the marked decline in marshland species in the 6-S&B, where none is expected. Although this may be noise caused by inadequate sample sizes, it could also suggest marshland losses as the lake level began to decline. This too will require support from other lines of investigation.

Gains in sage- and grass-flats during the same warm-dry episodes should be reflected also in gains among flats-adapted taxa. Of those listed for this niche, the least catholic (and therefore the most representative) species are bison, jackrabbit, cottontail, meadow vole, and marmot. These should increase in relation to marsh- and hills-adapted species in the same four strata already reviewed. Fig. 7-5 shows that gains do in fact occur in the 4-Mix, 9-LSFL and 10-MSFL, but not in the 8-LFL. The 8-LFL anomaly again contradicts the bristlecone record. The 12-TSFL peak supports the contention that the lake could have been lowered during the warm-dry spike in the bristlecone record at the start of this period. The 14-MAL decline hints at marsh shrinkage without accompanying gains in flats. This could occur during a lake level rise in which marshes were drowned--another conflict with the bristlecone record. Again, the 6-S&B anomaly recurs, suggesting that lake shrinkage could indeed explain the marshland losses over this period.

Another important aspect of the flats-adapted fuana not anticipated by the model is that bison appear during the 4-Mix accumulation at a time of lowering lake levels. If this warm-dry episode was indeed widespread in the Great Basin, then these specimens could conceivably be part of a refugee population from farther east. Although they persisted locally during the warm-dry event proposed for the period of the 4-Mix/5-Scaup unconformity, they failed to survive the apparently more severe episode following the 10-MSFL after which they disappear from the record.

Temperature Changes Reflected in the Fauna

The fluctuating catchment model was derived from the model of lake level fluctuations which was itself derived from the bristlecone climatic record and the pre-3,500BC record for the Great Basin. If the temperature fluctuations in that record were regional, then they should have occurred in the Klamath Basin also. Therefore, during colder episodes in the record the model calls for longer more severe winters with snow covering the highland grazing for more months of each year. Under these conditions, migratory herds would be forced to winter for longer periods near the lakeshore and within the site's catchment. Consequently, the chances of encountering these animals in the catchment would increase during such episodes. Specifically,

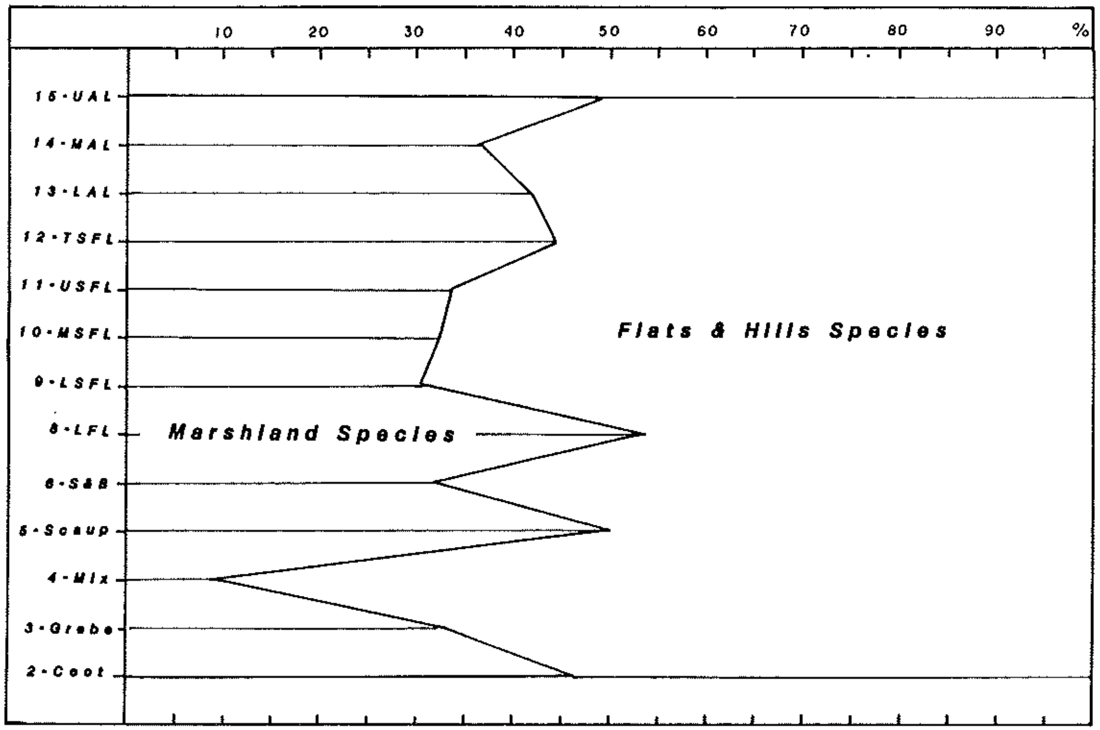


Fig. 7-4 Fluctuations in the ratios of marshland species (beaver, otter, mink and raccoon) against flats- and hills-adapted species. Percentages are derived from element count.

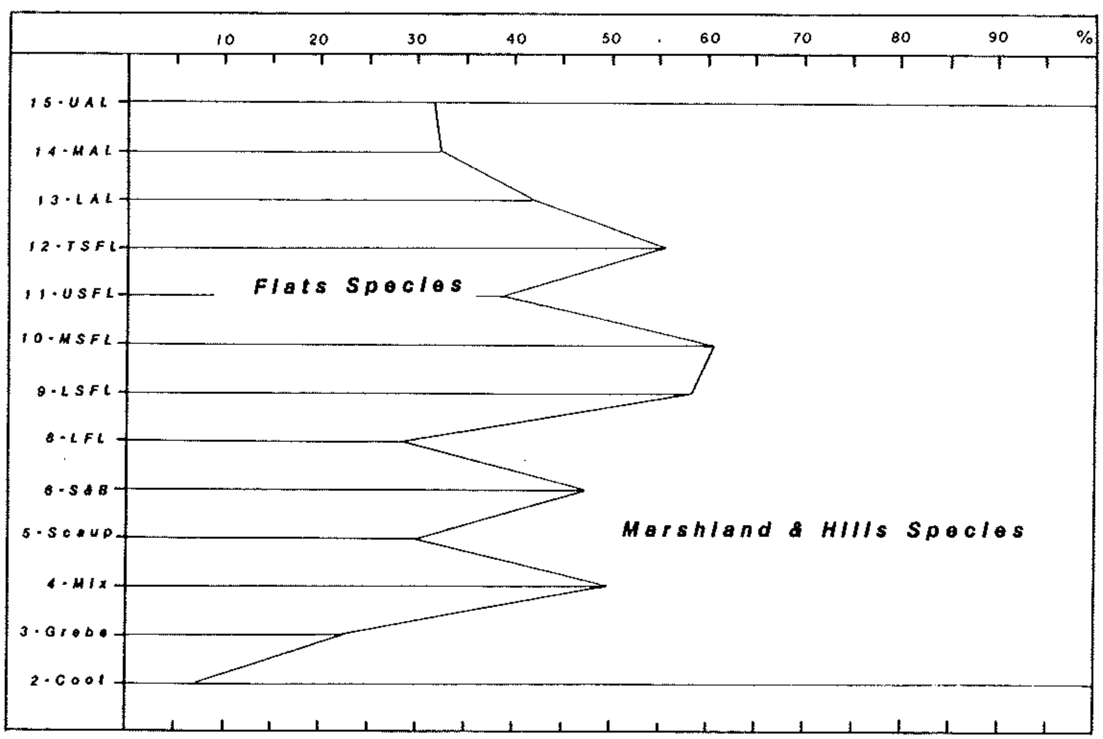


Fig. 7-5 Fluctuations in the ratios of Flats species (bison, jackrabbit, cottontail, Meadow vole, marmot) against marsh- and hills-adapted species. Percentages are derived from element counts.

montane taxa should increase during the 2-Coot/3-Grebe, the 5-Scaup/6-S&B, the 10-MSFL/11-USFL, and during the 14-MAL/15-UAL.

Fig. 7-6 gives the actual fluctuations of montane taxa, with mountain sheep figured separately as the species most likely to be affected by changes in upland grazing. This time there is a reasonably good fit between model and reality, with peaks in the 2-Coot, 11-USFL and the 15-UAL all correlated with cooler episodes. The conspicuous anomaly is the 5-Scaup/6-S&B which shows the exact opposite of the predicted trend. This fits well with an identical anomaly in the pollen record (Fig. 6-2). As this particular cool-wet event has not been identified elsewhere in the Great Basin, it is reasonable to assume that the Klamath Basin record also differed from the bristlecone sequence during this period. Conditions may be best defined as warm-wet in the 5-Scaup tending to warm-drier in the 6-S&B. Another point of interest is that there is a sharp increase in montane species in the 8-LFL. This confirms the pollen records' indication that this episode was indeed <u>cool</u> and not warm-dry, as indicated in the bristlecone sequence.

Faunal Implications of the Rival Models

In the Know-it-all Model of Chapter 1, the pre-adapted marsh-dwellers from the Pluvial Lakes of the Great Basin disperse westwards as their parent niches disappear. They seek out the Klamath Basin and settle it swiftly and efficiently as they are familiar with all its potential resources. Its rival, the Learner Model, has the local land-based hunter-forager population gradually exploring the extent of marshland resources, then colonizing the marsh itself by stages.

Neither model is easily tested by means of mammalian fauna because the populations in both models are assumed to be accomplished and well-adapted hunters. The only useful implications can be drawn from the marsh-adapted taxa. In the Know-it-all Model, the incoming colonists will at once set about laying the appropriate trap lines, with the consequence that beaver, otter, and mink will be well represented in the fauna from the start of the site's occupation. In the Learner Model, terrestrial trapping techniques will have to be adapted to the marshland and these taxa will be poorly represented at the start of the site's depositional history. However, if the learning process <u>began</u> with the extension of terrestrial trapping systems out into the marshes, then marsh-adapted species might dominate the fauna of the earliest levels.

The test is spoiled by the paucity of material in the 1-Basal which, nonetheless, has a strong showing of marshland taxa. In the 2-Coot and 3-Grebe they make up almost 20% of the elements in each stratum. Later fluctuations (Fig. 7-7) are due to noise from the catchment and temperature fluctuations already reviewed, and there is no clear evidence of a long-term increase in marshland taxa with time. In the balance, this slightly favors the Know-it-all Model, with the caveat that fur-trapping may have been the initial motive for penetrating the marsh in the Learner Model.

The next comparison attempts to fit the domestic dog data to the two rival models of lakemarsh adaptation. Throughout this exercise, it is assumed that dogs were eaten as a normal part of the diet from the earliest occupation onwards, and it is also assumed that the bulk of the remains labelled "<u>Canis</u> spp." is from domestic dog and not from coyote. The Know-it-all Model predicts that the amount of dog eaten will gradually decline in proportion to wild mammals as the newcomers from the Great Basin learn more about the behavior of the fauna in this unfamiliar terrestrial catchment. The Learner Model predicts that the amount of dog eaten will remain steady through time because the resident hunters already know the terrestrial part of the catchment at the time that they first move into the marshes. Either

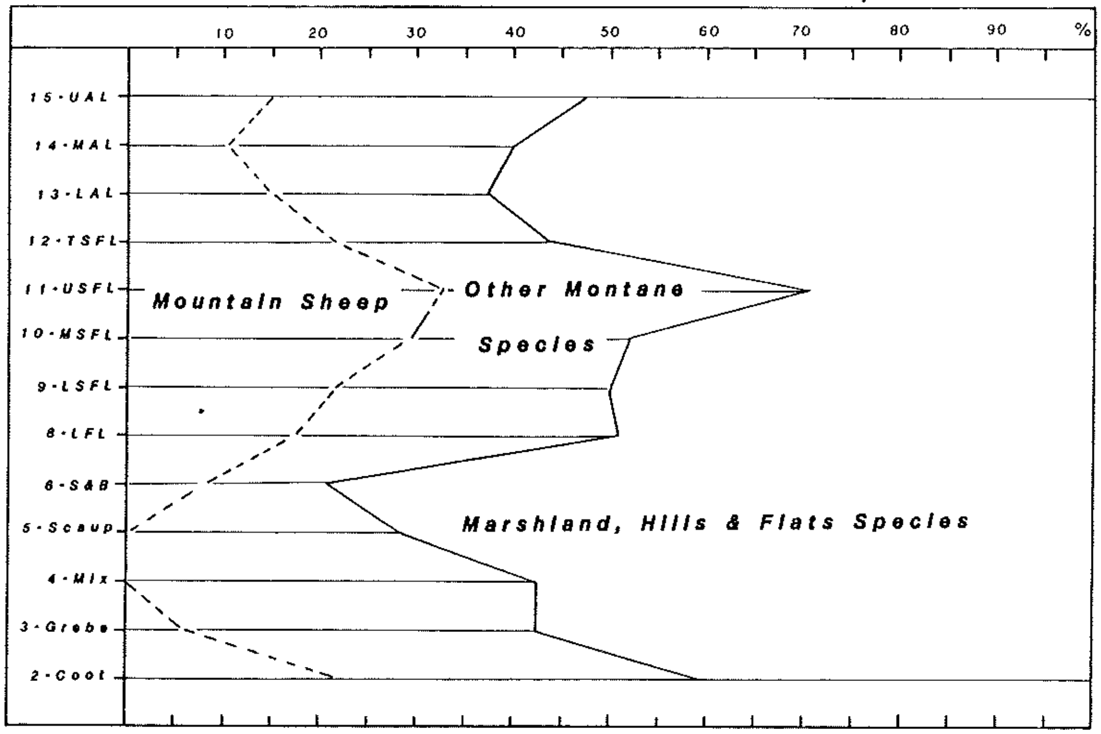


Fig. 7-6 Fluctuations in the ratios of Mountain Sheep plus other montane species (grizzly, elk, mule deer, pronghorn). Percentages are derived from element counts.

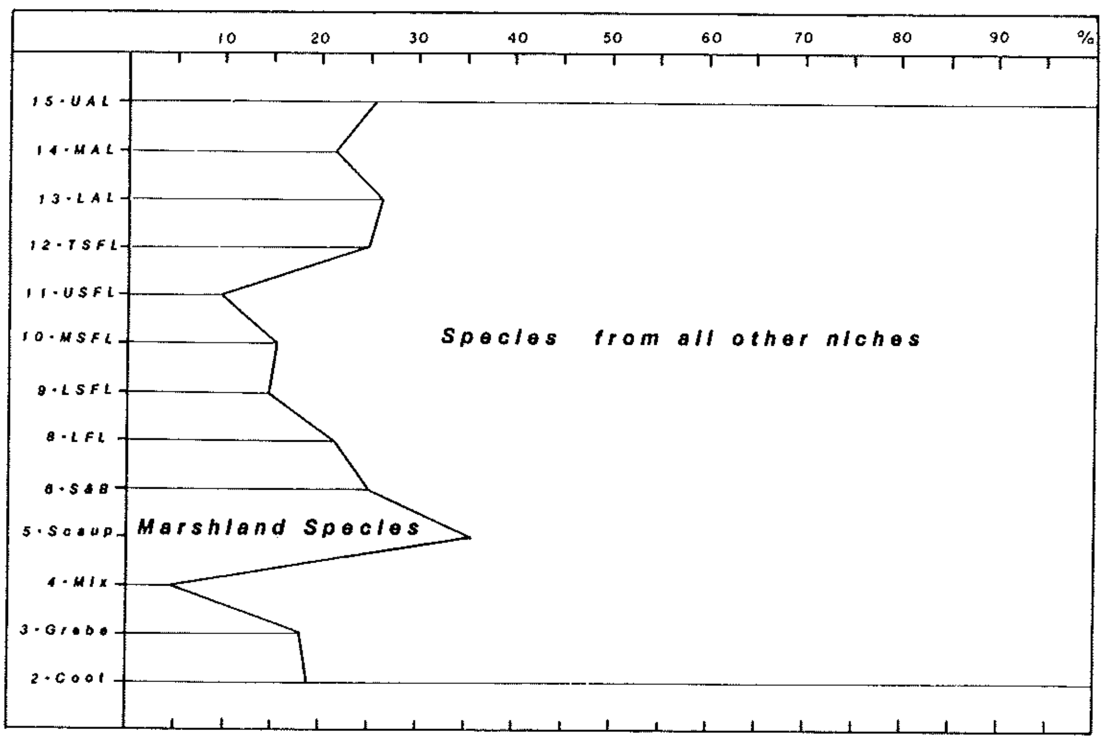


Fig. 7-7 Fluctuations in the ratios of marsh-adapted species (beaver, otter, mink, and raccoon) against all other non-domestic species. Percentages are derived from element counts.

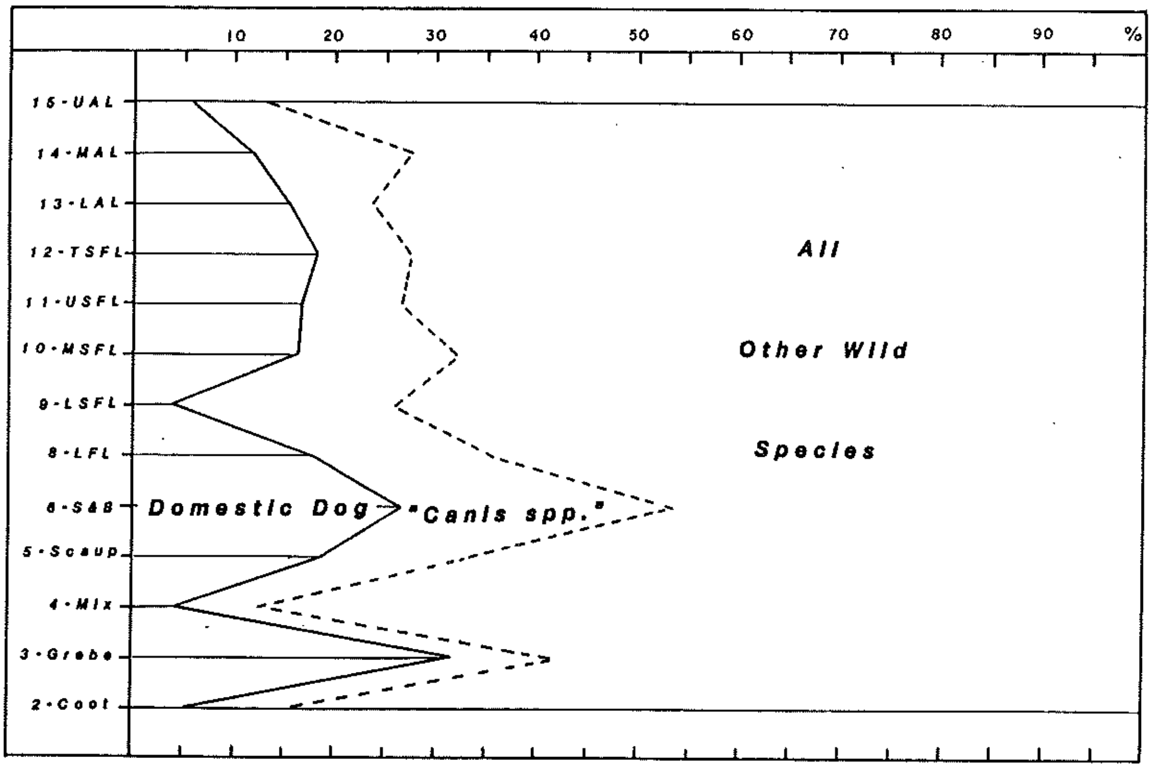


Fig. 7-8 Fluctuations in the ratios of domestic dog plus "Canis spp." against all wild species. Percentages are derived from element counts.

trend could be disrupted by two kinds of short-term fluctuation: (a) dog remains will increase in strata associated with extreme dry episodes when the carrying capacity of the catchment has been depleted; (b) the amount of domestic dog will decline rapidly at the end of the sequence as a prelude to complete abandonment of the dog-eating custom in recent times (see above).

Fig. 7-8 shows the fluctuations in domestic dog elements together with the very similar changes in "Canis spp." suspected to be mainly dog. Increases during dry episodes are not very consistent noise--why there should be more dog in the 6-S&B than in the far more severe dry episode of the 10-MSFL is not clear. Also, dog bones decline in the 4-Mix instead of increasing--an anomaly for which there is no explanation (other than sampling noise). The reasons for the decline in dog in the 9-LSFL are unknown, but the decline in the 15-UAL is best explained in terms of the shifts in ethnic alignments which eventually brought about the Modocs' abandonment of the dog-eating custom altogether.

Again, the test is spoiled by small sample sizes in the lowest strata, but there is an impressive increase in dog during the 3-Grebe which up to now has not been regarded as a particularly dry episode. Also, this marks the first in situ encampment on the site, so that the figures tend to favor the Know-it-All Model once again.

Dietary Implications

Of the 65 species currently found in the Klamath Basin today (Grayson 1973a: Table 6), inhabitants apparently made use of all the Artiodactyls (plus bison--now locally extinct), 10 of the 16 Carnivores (plus domestic dog), two of the four Lagomorphs, the one Castorid (beaver), but none of the abundant microfauna, except the marmot. The Nightfire Island list includes all the species eaten by the historic Modoc (Ray 1963) except black bear, cougar, gray and silver fox, snowshoe rabbit, flying squirrel, and pine squirrel. It is unlikely that any of these was common around Lower Klamath Lake.

It may be concluded that the range of game procured by the Modoc in historical times was essentially similar for the preceding six millenia, with two significant exceptions: the appearance of bison between about 4,450 and 1,300BC in the Nightfire Island diet; and the abandonment of dog as part of the Modoc diet by the time of contact.

The frequency with which each animal was taken by the Modoc over prolonged periods is unfortunately unknown, and we cannot tell, therefore, what taphonomic factors may have distorted the frequencies seen in the fauna samples from the final strata at Nightfire Island. However, if we assume that these factors were more or less constant throughout the site's depostional history, then some comparisons between strata--at least in the Loams series--are of interest. The first broad trend worth noting is the steady decline in the frequency of elk from the bottom to the top of the Loams. This bolsters Grayson's (1973a) suggestion that these animals may have become less inclined to enter the Klamath Basin in winter, as the human inhabitants proliferated. The second notable trend is the decline in dog bones during the Arrowhead Loams. This may reflect the increased fragmentation of dog bone (thus increasing the postcranial category of "Canis spp.") but there are no obvious signs of this in the bone sample. Given that dog-eating had ceased in historical times, this trend is taken to have real dietary significance and suggests that the prohibition was not necessarily introduced abruptly.

Procurement Implications

The mammalian fauna is too diverse in species and too poor in number to allow inferences to be drawn about procurement techniques, butchery practices, age or sex preferences, or seasonality of procurement. Neither the badger nor the marmot could have been taken in winter, but all other animals--including the migratory species--would have been available locally all year around. Even in summer when the large artiodactyls were in the uplands, there were still residual resident groups near the lake. Alternatively, the minor herds would have been within reach while pasturing on Mt. Dome.

Only one departure from the normal pattern of opportunistic procurement may be suggested by the data in Fig. 7-1, namely the concentration on fur-bearing animals in the Arrowhead Loams. An increased need for pelts as part of a wider exchange system may be partly responsible for the rise in other elements: the peak in badger, and the reappearance of bobcat and grizzly.

ENDNOTES: CHAPTER SEVEN

1. Lava Beds National Monument was successfully restocked in 1971 (Grayson 1973a).

CHAPTER EIGHT

AVIFAUNA

Bird bones were recovered from most strata in Nightfire Island and were so abundant in some of the lower layers of individual pits that they formed the main constituent of the deposit. Consequently, certain strata have been named for the dominant waterfowl species found in them. The avifauna has been analyzed in detail and extensively described by Grayson (1973a, 1976, 1977).

Altogether, the excavations have yielded 5,817 diagnostic fragments of bird bone of which 97% are of water birds while the remaining 3% comprise all others. A total of 42 different taxa could be recognized. They include six non-diving waterfowl which do not habitually dive for food or to escape (trumpeter swan, whistling swan, geese spp., Canada goose, mallard, teals spp.); also included are two other non-diving water- or shore-birds (white pelican and herring gull). There are 10 diving waterfowl (canvasback, ringneck, greater and lesser scaup, bufflehead, goldeneye, hooded merganser, red-breasted merganser, American merganser and ruddy duck); also seven other diving water birds (common loon, horned grebe, eared grebe, western grebe, pied-billed grebe, double crested cormorant and American coot). Other shore-birds are the American bittern, black-crowned night heron and great blue heron. Birds of prey include the marsh hawk, golden eagle, bald eagle, great horned owl, snowy owl and short-eared owl. Other miscellaneous birds include sage grouse, plover and raven.

Most of these species are relatively scarce occurrences (Tables 8-1 & 8-2) being swamped out by only five taxa. As shown in Chapter 2, American coot is the first species to gain numerical dominance in the site's depostional history. These are replaced by the grebes, then the scaups, and are later matched by the geese and teal. Other birds which are well represented but which never gain a majority in any stratum are the bufflehead, mergansers and ruddy duck. Brief commentaries on each of these birds follow, in the order of their maximum occurrence within the site.

American Coot (Fulica americana)

Coot bones were recovered from every stratum except the 7-GraCl and they are numerically dominant in the 2-Coot, 4-Mix, and in all of the Loams sequence (Fig. 8-1). The frequency of coot bones declines throughout the Arrowhead Loams, but they continue to dominate those of other species throughout.

These smallish, ducklike, dark gray water birds with their bright white beaks can be recognized on Lower Klamath Lake at any time of year. They tend to flock in very large concentrations and are relatively unwary compared to other waterfowl (Bent 1926). They resort to open water if disturbed and tend to dive rather than fly if harassed, being able to swim fast and far underwater. They surface quickly but rise from the water with difficulty. Coots are frequent bottom feeders, being competent divers, even though their feet lack webs. These are in fact adapted to mud flat grazing and also serve well for seed-eating on dry land (Jones 1940). Coot numbers fluctuate during the annual cycle (Fig. 8-2) with a minor peak in Spring when the northward flights pass through (see Chapter 1) and a major peak in Fall when the flights--now enlarged with young--pass to their winter ranges in California. In October, about a third of a million coots are present on the lake, but to the observer they are more apparent in June when they are relatively more numerous than any other species.

Table 8-1. Waterfowl Elements

	Coot *Fulica americana* #	%	Western Grebe *Aecmorphis occidentalis* #	%	Greater & Lesser Scaup *Aythya marila/affinis* #	%	Canada Goose *Branta canadensis* #	%	Geese *Anser* spp. #	%	Geese Geese spp. #	%	Mallard *Anas platyryn-chos* #	%
15-UAL	34	23.6	3	2.1	23	16.0	2	1.4	1	0.7	11	7.6	8	5.6
14-MAL	25	33.3	-		5	6.7	2	2.7	2	2.7	5	6.7	9	12.0
13-LAL	58	41.1	3	2.1	12	8.5	1	0.7	5	3.5	9	6.4	7	5.0
12-TSFL	26	49.0	-		2	3.8	2	3.8	1	1.9	4	7.5	3	5.7
11-USFL	194	40.2	10	2.1	43	8.9	11	2.3	21	4.3	77	16.0	17	3.5
10-MSFL	166	39.7	8	1.9	33	7.8	3	0.7	15	3.6	63	15.1	22	5.3
9-LSFL	103	41.2	26	10.4	33	13.2	1	0.4	4	1.6	15	6.0	14	5.6
8-LFL	4	16.0	3	12.0	9	36.0	-		-		2	8.0	1	4.0
7-GraCl	-		-		-		-		-		-		-	
6-S & B	28	13.8	13	6.4	147	72.4	-		-		1	0.5	3	1.5
5-Scaup	684	24.0	86	3.0	1841	64.7	3	0.1	-		4	0.1	7	0.2
4-Mix	103	52.8	23	11.8	16	8.2	-		-		4	2.0	17	8.7
3-Grebe Cl	116	36.4	148	46.4	14	4.4	-		1	0.3	8	2.5	10	3.1
2-Coot	209	73.3	21	7.4	4	1.4	2	0.7	-		4	1.4	5	1.7
1-Basal Cl	10	47.6	3	14.3	-		-		-		-		1	4.8
Lake Bed	-		-		-		-		-		-		-	

Table 8-1 (Continued)

	Teal *Anas* sp. #	Teal *Anas* sp. %	4 Species Teal *Anas* med. size #	4 Species Teal *Anas* med. size %	Bufflehead *Bucephala albeola* #	Bufflehead *Bucephala albeola* %	Hooded Merganser *Mergus cucullatus* #	Hooded Merganser *Mergus cucullatus* %	Red-breasted American Merganser *Mergus serrator*/merganser #	Red-breasted American Merganser *Mergus serrator*/merganser %	Ruddy Duck *Oxyura jamaicensis* #	Ruddy Duck *Oxyura jamaicensis* %	Total Elements	Total %	Diver Elements	% of Total
15-UAL	1	0.7	17	11.8	4	2.8	-		16	11.1	24	16.7	144	100.1	104	72.2
14-MAL	2	2.7	16	21.3	2	2.7	-		5	6.7	2	2.7	75	100.2	39	52.0
13-LAL	1	0.7	23	16.3	3	2.1	-		12	8.5	7	5.0	141	99.9	95	67.4
12-TSFL	3	5.7	11	20.7	-		-		-		1	1.9	53	100.0	29	54.7
11-USFL	7	1.4	46	9.5	7	1.4	1	0.2	13	2.7	35	7.3	482	99.8	303	62.9
10-MSFL	24	5.7	35	8.4	10	2.4	2	0.5	11	2.6	26	6.2	418	99.9	256	61.2
9-LSFL	1	0.4	15	6.0	1	0.4	7	2.8	11	4.4	19	7.6	250	100.0	200	80.0
8-LFL	1	4.0	3	12.0	-		-		2	8.0	-		25	100.0	18	72.0
7-GrCl	-		-		-		-		-		-		-	-	-	-
6-S & B	-		2	1.0	-		-		-		9	4.4	203	100.0	197	97.0
5-Scaup	5	0.2	12	0.4	14	0.5	75	2.6	75	2.6	40	1.4	2846	99.8	2815	98.9
4-Mix	2	1.0	6	3.1	2	1.0	1	0.5	15	7.7	6	3.1	195	100.1	166	85.0
3-Grebe	-		12	3.8	3	0.9	-		6	1.9	1	0.3	319	100.0	288	90.3
2-Coot	3	1.1	6	2.1	3	1.1	10	3.5	4	1.4	14	4.9	285	100.0	265	93.0
1-Basal	3	14.3	3	14.3	-		-		-		1	4.8	21	100.0	14	66.7
Lake Bed	-		-		-		-		-		-		-	-	-	-

Table 8-2. Other avifaunal elements

Stratum	Terrestrial Birds									Shore Birds				
	Marsh Hawk	Golden Eagle	Bald Eagle	Sage Grouse	Grant's Plover	Great horned Owl	Snowy Owl	Short-eared Owl	Raven	Herring Gull	American Bittern	Black crowned night Heron	Great Blue Heron	White Pelican
15-UAL	-	1	5	1	-	-	-	-	-	-	1	1	1	-
14-MAL	-	-	-	-	1	-	-	-	-	-	-	-	-	1
13-LAL	-	-	-	-	-	-	-	-	-	-	1	-	1	-
12-TSFL	-	-	-	1	-	-	1	-	-	-	-	-	1	-
11-USFL	1	5	2	3	-	-	-	-	-	-	1	2	-	2
10-MSFL	-	-	-	-	-	-	-	-	-	-	-	-	-	1
9-LSFL	-	-	-	-	-	1	-	1	-	1	-	-	-	1
8-LFL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6-S&B	1	-	-	-	-	-	-	-	-	-	-	-	-	-
5-Scaup	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4-Mix	-	-	-	-	-	-	-	-	-	-	-	1	-	-
3-Grebe	-	-	1	-	-	-	-	-	1	-	1	-	-	-
2-Coot	-	-	-	-	-	-	-	-	-	-	-	-	1	-
1-Basal	-	-	-	-	-	-	-	-	-	-	-	1	-	-

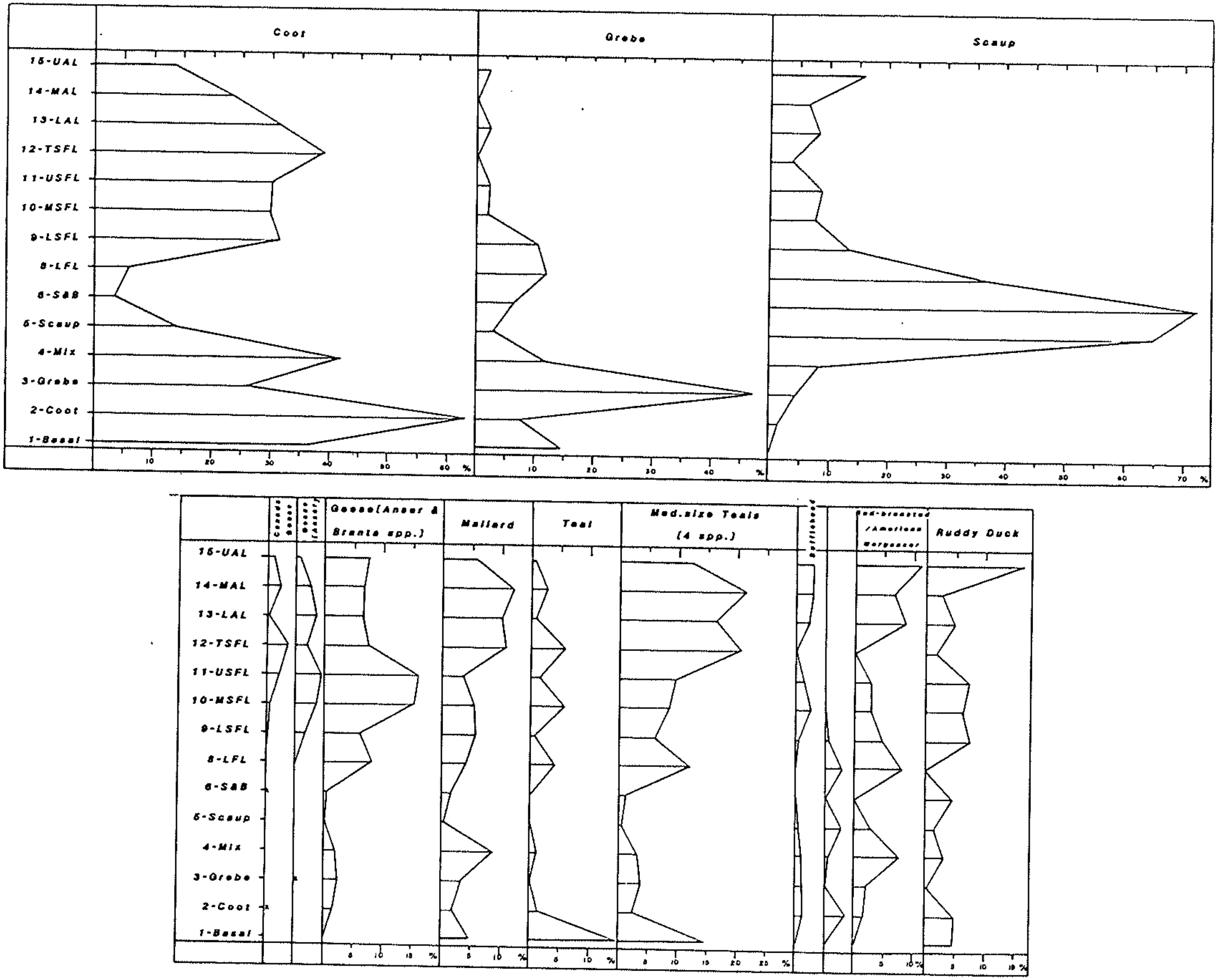


Fig. 8-1 Percentage frequencies of waterfowl elements for each stratum.

Western Grebe (Aecmorphis occidentalis)

Grebe bones attain numerical dominance in the 3-Grebe, then become a minor constituent in the avifuana during the remainder of the site's history. Although quite well represented in the 8-LFL and 9-LSFL, they are little more than a trace in other strata.

This small diving bird has a relatively long, swan-like neck and a light yellow bill. Its black back and white frontal plumage makes it easy to recognize while afloat or in flight. Mainly a fish-eater, it prefers to dive in deep water for its food and tends to keep away from the shore, even in winter (Jewett et al. 1953:60). If pursued it prefers to swim, then dive, and will fly as a last resort.

Western Grebes are year-round residents, although the lake is not within their main breeding range. Today they occur in quite insignificant numbers. Grayson (1973a) has compiled monthly counts for three parts of the annual cycle based on recorded counts from USDI 1960, 1965, and 1970. These suggest a relatively stable population with a minor exodus in the winter: January-April=415; May-August=1165; September-December=1265. These counts indicate that they are relatively scarce in the Klamath Basin, and the preponderance of this species in the 3-Grebe obviously conflicts with its modern presence.

Greater and Lesser Scaup (Aythya affinis & marilis)

Separation of the bones of the two species was not possible on morphological grounds. The dimensions of individual elements in the sample tended to form a unimodal distribution with the mode at the lengths where the two species overlapped. Size was therefore rejected as a valid criterion for separation, and the two species have been combined. Their bones dominate those of all other birds in the 5-Scaup Muck and in the 6-S&B (part of which is thrust into the 5-Scaup Muck). In other strata, they form a minor constituent, but show a small peak at the end of the sequence.

The two species look very much alike, except that the male's head is higher crowned and glossed with purple in the Lesser, while it is rounder and green in the Greater. At a distance, the back of both species appears whitish with head and tail black and a blue bill.

The Lesser Scaup today has small breeding populations in NE California, but its principle range extends across the north continent to Minnesota. The Klamath Basin is also on the NE-oriented axis of a minor migration between California and Alberta. Fall migration southward is relatively swift, but the Spring migration northward for breeding is staggered over 3-4 months, with the peak in April. During July, flightless males are most common when they are moulting and this may continue into August. They are bottom feeders, concentrating on clams (Yocum and Keller 1961) in 3-6m of water, with a preference for night feeding (Forbush and May 1939; Jewett et al. 1953). They dive when pursued and are reported to stay under if hurt, eventually drowning (Studder 1903:96). Like coots, they flock in vast dense clusters on open waters, but are more wary and rise more readily. They are more prone than other divers to nest on uplands away from the marsh, usually within 50m of the water's edge. Hens may desert the nest before the young are able to fly and abandoned broods tend to join to produce large concentrations of chicks under the escort of single hens during the summer (Bellrose 1976). Procurement of chicks is relatively easy for human predators during these months.

The Greater Scaup breeds mainly in Alaska. They begin the southward flight along the Pacific coast in mid-September through early October and reach the NW coast in mid-late November, when the males moult and some become briefly flightless. Females moult in late winter, and the males go through a second moult in March (Billard and Humphrey 1972). The Klamath Basin is on a minor interior flyway, relatively poor in their preferred food--mollusks (Cottam 1939). They are easy prey to hunters familiar with their behavior. Some hunters consider the flesh unpalatable (Studder 1903), resembling spoiled fish, although the young are considered preferable because they are more tender.

The modern abundance of Greater and Lesser scaup on Lower Klamath Lake never reaches the proportions of coots (Fig. 8-3), and the small scaup peak in Fig. 8-1 is obviously no reflection of the modern population balance at the Lake in any month of the year.

Geese (Anser spp.)

The modern population includes white-fronted goose (*A. albifrons frontalis*), Lesser snow goose (*A. caerulescens*) and Ross's goose (*A. rossi*). It has not been possible to separate the bones of these individual species on morphology or size and they have been grouped together so that identification is not in doubt. Some elements cannot be distinguished from *Branta*, and Fig. 8-1 shows the frequency of this residual sample as "Geese spp." which is a mixture of two genera. Although *Anser* appears as a trace in the 3-Grebe, they first appear as a consistent presence in the 9-LSFL and persist throughout the sequence. "Geese spp." attain a maximum in the 10-MSFL and 11-USFL.

All these species winter in California and breed in the Arctic circle. Availability on Lower Klamath Lake is shown in Fig. 8-4. In June through August and again in December and January, geese are virtually absent from the lake, although rare specimens are seen during these "away" months. All three feed in shallow water by dipping the neck and they also eat abundant surface vegetation.

The Canada goose (*Branta canadensis*) has discontinuous breeding ranges which include the Klamath Basin (Miller and Collins 1953), but this area is also within a migratory funnel for Cackling goose (*B.c. minima*) connecting the Columbia Basin with the Central valley of California. In both feeding and escape behavior, they are similar to other geese, but they are more eclectic in choice of nesting places. Flight feathers are lost from adults when the nestlings are about a month old and cannot themselves fly, so they are briefly more vulnerable to capture. Their current availability on Lower Klamath Lake is year round, but their numbers are greatly swollen in Fall and Spring by migratory Lesser Canada goose and Cackling goose which are absent from the lake in winter and summer (Fig. 8-4). Unfortunately, the bones of the smaller and the common Canada goose cannot be distinguished and this sample may be a mix of both species.

Mallard (Anas platyrynchos)

Mallard bones increase in frequency in the 12-TSFL and remain at the same frequency through the next two strata. There is also a minor peak in the 4-Mix. In other strata, they represent little more than a trace.

This very abundant and widespread species both breeds and winters in the Klamath Basin; consequently, it is seen year-round on the lake (Fig. 8-5). In feeding and escape behavior, it is akin to the geese. Mallard flocks, however, can occur in thousands (Jewett *et al.* 1953).

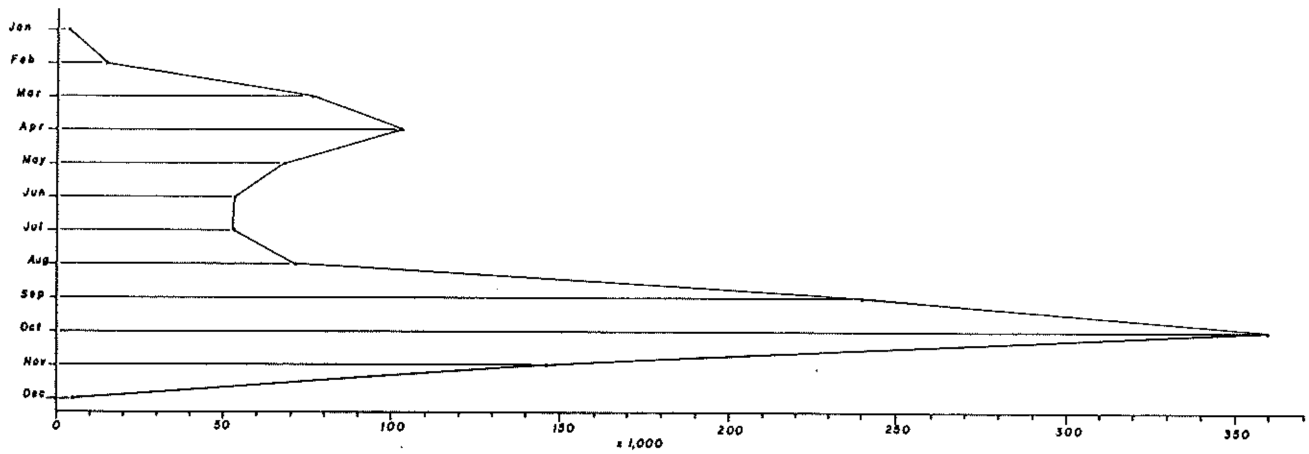


Fig. 8-2 Average monthly counts of American Coot in the Lower Klamath Wildlife Refuge.

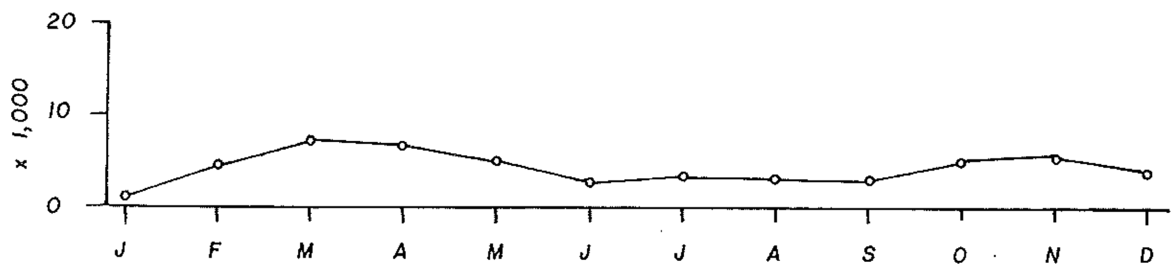


Fig. 8-3 Average monthly counts of all species of Scaup in the Lower Klamath Wildlife Refuge.

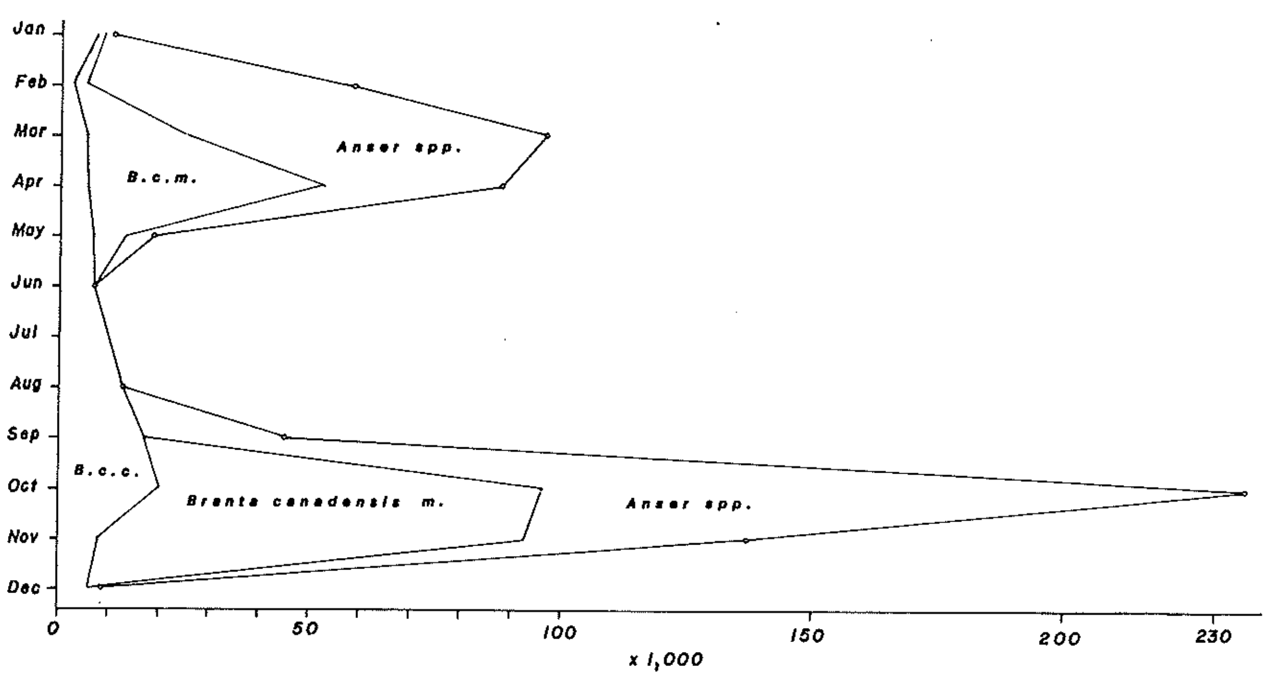


Fig. 8-4 Average monthly counts of all species of Geese in the Lower Klamath Wildlife Refuge.

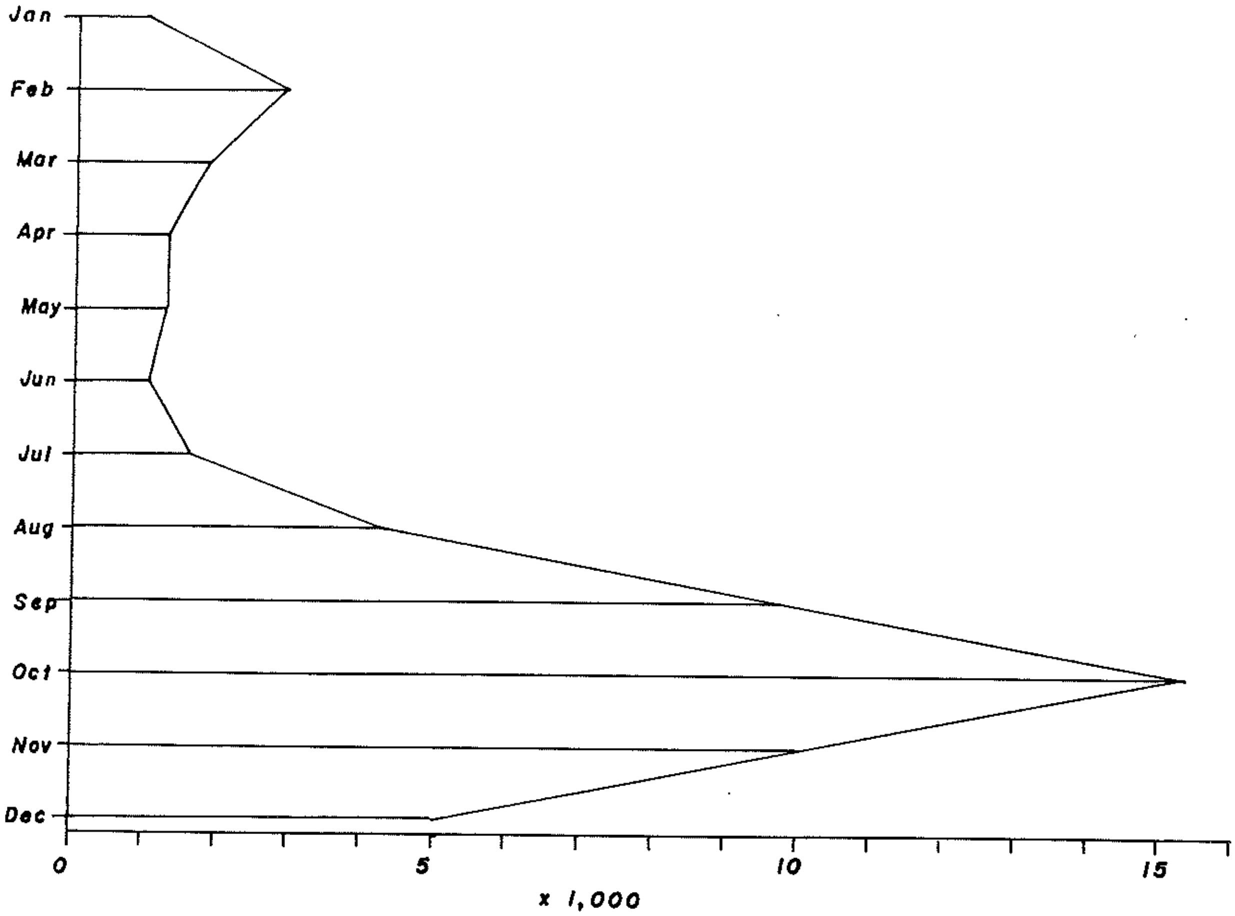


Fig. 8-5 Average monthly counts of Mallard in the Lower Klamath Wildlife Refuge.

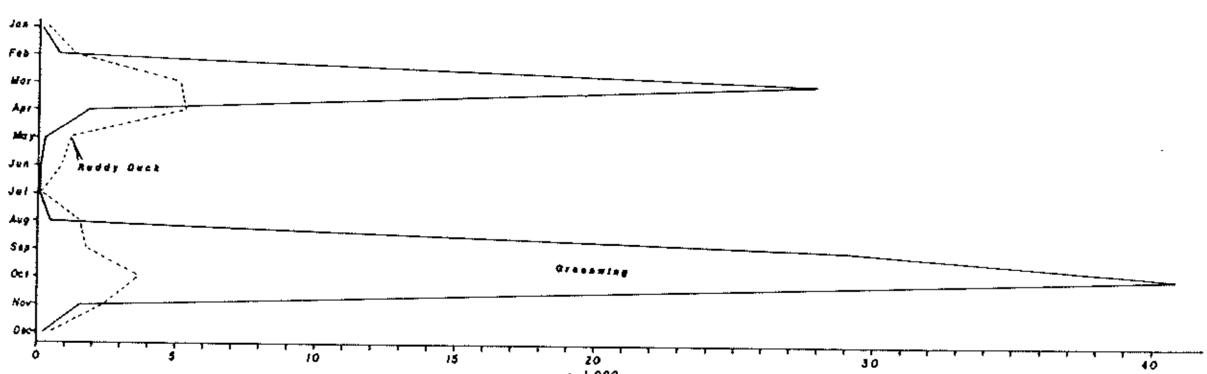


Fig. 8-6 Average monthly counts of Greenwing teal and Ruddy Duck in the Lower Klamath Wildlife Refuge.

Anas "medium size"

This sample includes the bones of gadwall (A. strepera), pintail (A. acuta), baldpate (A. americana), and shoveller (A. clypeata) which cannot be separated with any confidence (Grayson 1973a pace Woolfenden 1961). The bone frequency curve covaries with that for mallard, with a spurious peak in the 8-LFL. All four use parts of NE California as both a breeding and a wintering ground. Gadwalls breed here and become quite scarce in winter, but baldpates are rare in summer. It follows that birds of each species may be seen on Lower Klamath Lake at any time of year, but dominate the bird life in Spring and Fall when they use the lake as a waystation on their northward migration.

The very abundant pintail dominates other species during three months: there are over a million in September, two and a quarter million in October and nearly three quarters of a million in November. Given the numerical dominance in the modern figures, it is likely that this species made up the bulk of the mixed archaeological sample. Like mallards, they rise almost vertically from the water, but they tend to clump upon rising (Kortright 1967). All four are dabbling feeders, with some limited diving ability. Only baldpates associate with divers, from whom they steal bottom food.

Teals (Anas spp.)

The modern avifauna of the lake includes the greenwing (A. crecca), the cinnamon (A. cyanoptera) and the bluewing (A. discors). Although teal bones could be readily separated from those of the larger mallard and the medium-sized ducks, they could not be identified to species with any confidence. These three very small birds are all dabblers feeding on mudflats and/or shallow marsh. They can flock in great numbers and rise quickly if harassed. Lower Klamath Lake is an important waystation on the migration route of the greenwing teal, but it neither breeds nor winters here. Consequently, its numbers fluctuate dramatically in Spring and Fall when they are second only to the abundant pintails (Fig. 8-6). The cinnamon teal is a summer resident as the lake falls within one of its main breeding ranges. Lower Klamath Lake falls outside the main breeding range of the bluewing, only a few hundred of which are present in summer.

The flesh of all three is considered excellent eating today, although their small size--about that of a pigeon--does not produce much meat from single birds. They would therefore give a poor return for effort if hunted with bows and arrows and would require a smaller mesh for netting above the water surface.

Ruddy Duck (Oxyura jamaicensis)

Bones of the ruddy duck form an erratic trace in the avifaunal record of the site and only become a significant proportion of the bird bone in the Upper Arrowhead Loams.

Ruddy ducks are known to breed and to winter in NE California and the Klamath Basin is an important Californian breeding ground today. They are nevertheless present all year round, with an influx of migratory flocks in Spring and Fall (Fig. 8-6).

In its feeding and escape habits, the ruddy duck closely resembles the grebe, and is equally helpless on land, being a very poor walker (Kortright 1967; Forbush and May 1939; Studder 1903).

Mergansers (*Mergus merganser/serrator*)

The bones of the hooded and red-breasted merganser in the Nightfire Island sample could not be separated with any confidence. When combined, they form a significant proportion of the bird bone from the Arrowhead Loams, and they covary with the frequency of ruddy duck in this level. The minor peaks in the 4-Mix and 8-LFL may be spurious because the sample is too small.

Both species use the Klamath Basin as a wintering ground, but are rarely seen except during Spring migrations. However, a few are present in every month of the year. These fish-eating divers are not valued for eating, especially the larger red-breasted merganser which is considered to have a rank taste on account of its fish-dominant diet.

Catchment Changes Reflected in the Avifauna

Fluctuations in lake level were the prime cause of changes in catchment configuration (Fig. 1-12). The avifauna are arguably the most sensitive of all available indicators of lake level changes through time because water depth determines the relative numbers of different species able to feed around the lake margins. Thus, gains in open water over marshland during periods of raised lake level will increase the area of lake bed suitable for bottom-feeding waterfowl. This will lead to a relative increase in the number of diving species using the lake, and this in turn should register as an increase in the relative number of diver elements in any stratum believed to equate with a cool-wet episode in the bristlecone record. According to the original model (Chapter 1), this should occur in the 2-Coot/3-Grebe, the 5-Scaup/6-S&B, 11-USFL, 13-LAL, and 15-UAL.

Gains in marshland over open water should lead to a marked increase in dabbling waterfowl with consequent rises in the numbers of dabbler elements in strata assigned, on the same grounds, to warm-dry episodes. Again, the original model calls for such dabbler peaks in the 4-Mix, 8-LFL, 10-MSFL, and possibly the 12-TSFL and 14-MAL. Fig. 8-7 gives the ratio of combined diver elements against all dabbler elements in the site, and it reveals a remarkably close fit with the model's expectations. Of particular interest is the pronounced drop-off in divers following the 6-S&B, which Grayson (1973a, 1976) first pointed out as compelling evidence for a major drop in lake level. Following a brief recovery in the 9-LSFL, there is another emphatic drop in divers at the 10-MSFL after which they never again recover their former dominance.

Ornithological Implications

Some of the temporal changes in element-frequencies shown in Fig. 8-1 might have been caused by changes in the migration corridors of certain species (Grayson 1977). Although there is no way to test this assumption, it should be realized that some species which abound in Lower Klamath Lake today are comparatively scarce at Nightfire Island.

A notable rarity in the site, the redhead (*Aythya americana*) is more abundant on the lake than the scaups (Fig. 8-3), particularly in the early Fall. It is unreasonable to assume that this bird has always been available on the lake but was avoided by the Nightfire Island hunters. Today, the Klamath Basin is on the edge of one of its main breeding ranges, but it winters farther south. Being a poor diver, it feeds and rises in densely packed groups, making it relatively easy to catch. It is a relatively trusting, unwary waterfowl. Although

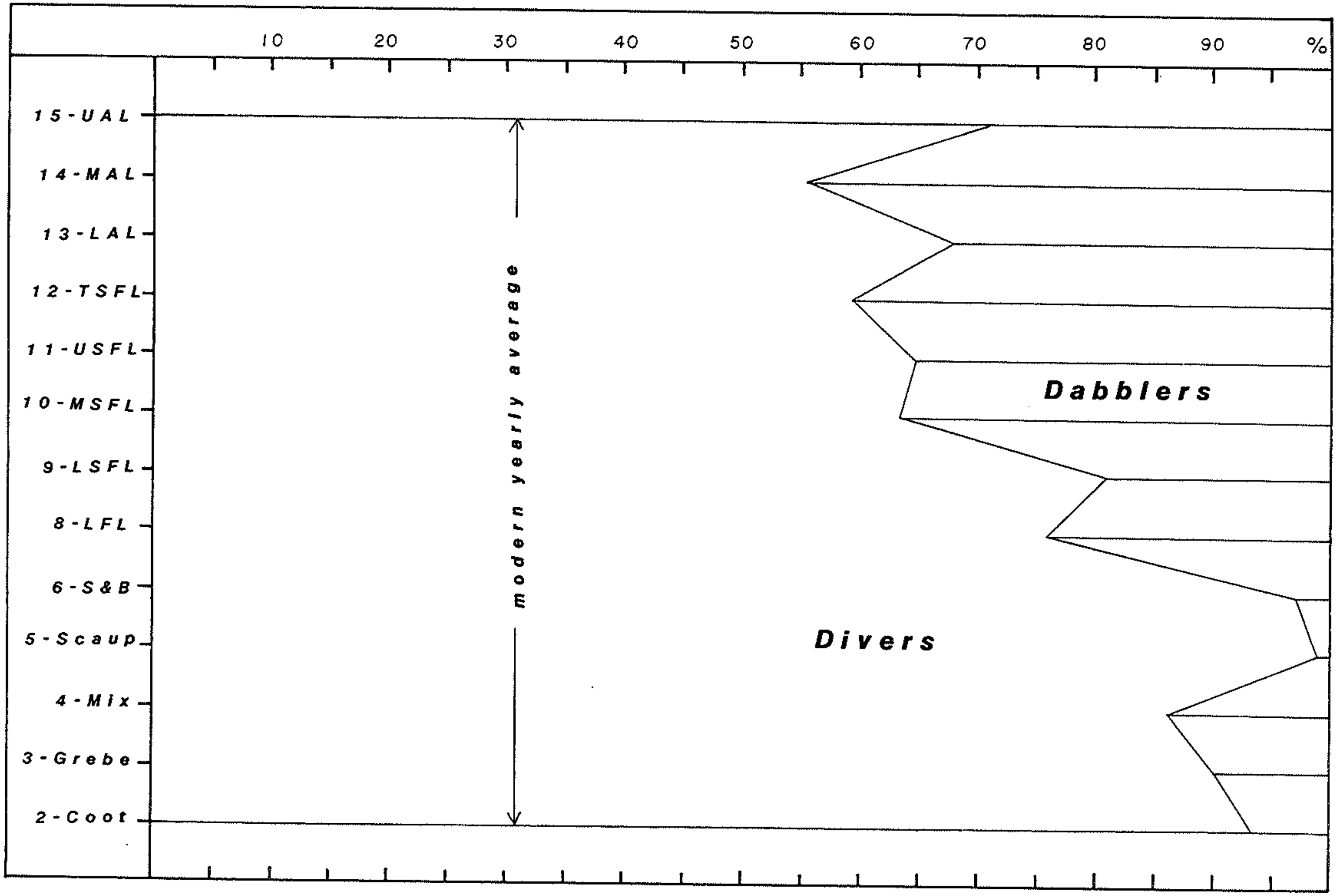


Fig. 8-7 Fluctuations in the ratios of divers and dabblers in the Nightfire Island sequence. Percentages derived from element counts.

small, its flesh is regarded as highly as that of the canvasback (Kortright 1967). A few of the bones ascribed to Aythya spp. are probably redheads (Grayson 1973a), but they form only a trace in the Loams sequence.

The greenwing teal (Anas crecca) is also made conspicuous by its rarity. Although it cannot be separated from the cinnamon teal, nonetheless it is no more than a trace occurrence in the site. This conflicts markedly with its present abundance in Spring and Fall (Fig. 8-6). Although it might be argued that it was so small as to fly through the mesh of a set net, or that it was ignored by hunters because of its low meat yield[1], there remains the possibility that its flight path differed in prehistoric times. However, this can only be tested through wider field research.

Trumpeter swan (Cygnus cygnus/buccinator) is another bird no longer seen on the lake--a casualty of overkill after European contact. It recurs in the site however.

Seasonal Implications

In Chapter 1, the two rival models call for changes in the role of the site through time and, therefore, changes in the season of the site's occupation. As a permanent village, it would be occupied mainly in winter; as a fishing village, mainly in Spring and Fall; as a wocus camp, in late-summer/early-Fall; but as a waterfowling station it might be used at any time of year that suited the subsistence round in use at the time.

The avifauna offer the only chance available to establish the season(s) of occupation for different strata in the site, but the procedure for doing so is fraught with difficulty. The time-honored method is to isolate the best seasonal markers in the modern avifuana, then using their current migratory behavior as an analog, to claim their presence in the site as evidence for a season of occupation. The weakest point in this line of reasoning at Nightfire Island is that it depends wholly on the assumption that (a) the migration of marker species remained unchanged during most of the later Holocene and (b) that their modern frequencies on a much-altered Lower Klamath Lake Wildlife Refuge are a true reflection of their past frequencies. While the preceding section leads to doubts about the validity of the assumption (a), the modern diver/dabbler ratio for the shrunken, shallow and diked Lower Klamath Lake Wildlife Reserve shows that assumption (b) is also suspect (Fig. 8-7). In our present state of ignorance, neither assumption can be tested, and whatever conclusion is reached, there will always be doubt due to this weak underpinning.

Yet the effort must be made because it is our only chance to gain access to seasonality. If enough circumstantial evidence can be brought to bear on a case for seasonality in a single stratum, the inference will be strengthened and doubts about the assumptions will lose some of their force.

There are seven species in the modern avifauna of the Lower Klamath Lake Wildlife Reserve which appear in relatively small numbers for a few months and are totally absent for the rest of the year (Fig. 8-8). All but two of these are winter visitors, and it follows that these can be caught only in winter. The ethnohistoric record shows that this was certainly so for herring gulls (Ray 1963), but also applied to pelicans (Ray 1963; Vogelin 1942) which are year-round residents. The presence of any of these in a stratum may be used to infer a winter occupation, as long as there is no contradictory association. The presence of conflicting seasonal markers in the same stratum may indicate multi-season or year-round occupation, or it may mean that the season of site use was not always the same during the accumulation of the stratum. Fig. 8-9 shows the distribution of these potential seasonal markers within the site, less cinnamon teal which could not be separated from the other teals. Spring/summer occupation can be inferred for the 2-Coot, Spring (or almost year-round) for the 3-Grebe and 4-Mix, and Spring/summer for the 5-Scaup. There is no evidence for the 6-S&B or 8-LFL. winter/Spring (or almost year-round) occupation is documented for the 9-LSFL through 12-TSFL, and Spring (or almost year-round) is suggested for the 13-LAL through 15-UAL.

In an effort to eliminate the ambiguities (i.e. the alternative cases for year-round occupation), we are forced to turn to another seasonal data set which may be of more marginal value on its own, but which has some use when compared with the previous set of markers. There are eight migratory waterfowl in the modern avifauna which use the lake as a waystation to and from their wintering and breeding range (Fig. 8-10). Although a <u>few</u> birds of each of these species remain behind in winter or summer, their numbers are so small that it is unlikely that they would be captured in sufficient numbers to survive in the archaeological record.

Of the eight species, only the canvasback, the bufflehead, and the snow- and white-fronted goose (lumped under <u>Anser</u> spp.) are discernible in the site. When these are combined with the marker-species (Fig. 8-9), it becomes apparent that year-round occupation for any of the ambiguous strata is not supported. Spring (March-April) occupation in the 3-Grebe and 4-Mix gives additional support, however, because it is during these months that all the species involved are most likely to co-occur on the lake. This also applies to 9-LSFL through 12-TSFL sequence where a late Fall/Winter/early Spring occupation is more strongly supported than a year-round one. Also, for the 13-LAL through 15-UAL sequence, a Fall (October-November) and a Spring (March-April) occupation has far stronger support than the year-round option.

A third data set which is certainly too weak to stand alone (Grayson 1973b) is the <u>relative</u> availability of waterfowl on the modern lake for each month. Seen in the light of these percentage curves, a Spring/summer occupation for the 2-Coot makes good sense because it is during these seasons that coot are most abundant--particularly in the summer months. This also applies to the 3-Grebe. However, the western grebe makes up so small a percentage of the modern summer population that it remains far from clear why the occupants began to take these in preference to coots. This is especially puzzling as coots once again dominate the waterfowling bag in the ensuing 4-Mix--again suggesting a Spring/summer occupation. Then, in the 5-Scaup and 6-S&B, scaup were taken in preference to coots. Although they make up only a tiny proportion of the modern summer population, it is nonetheless during these months that they are most prevalent, and the modern curve in no way contradicts the inference already drawn for a Spring/summer occupation in the 5-Scaup. However, reasons for preferring these to the more abundant coots remain elusive. It is frustrating to have no adequate seasonal markers for the 6-S&B and 8-LFL as these are thought to mark the switch to a Fall/winter/Spring (semi-permanent village) occupation. Although the modern scaup curve includes a minor winter peak, this does not constitute evidence in support of the predicted switch--but it does fail to contradict the prediction. The increases in geese, mallard, and teal in the 8-LFL are best seen as symptoms of a much-reduced lake level (see above) but it is worth noting also that these increases in no way conflict with the purported switch to a Fall/winter/Spring occupation. For it is during these seasons that the dabbling ducks numerically overwhelm all other species on the modern lake. The same argument applies to the 9-LSFL through 12-TSFL sequence. Also, the case for a Spring and/or Fall occupation in the 13-LAL through 15-UAL meets no serious opposition from the modern frequency curves. Indeed, the increase of Ruddy Duck in the 15- AL waterfowl bag may have been caused by a preferred Spring occupation, but this cannot be confirmed from other sources.

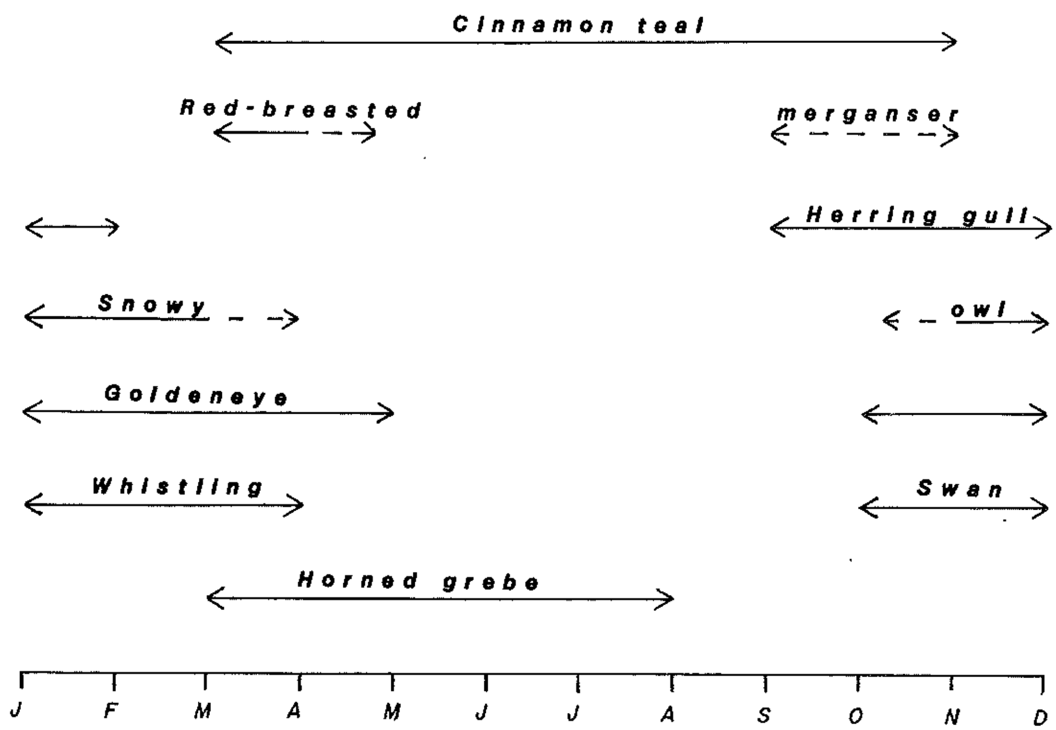


Fig. 8-8 Modern seasonal occurence of seven avian species found at Nightfire Island. After Grayson (1973a).

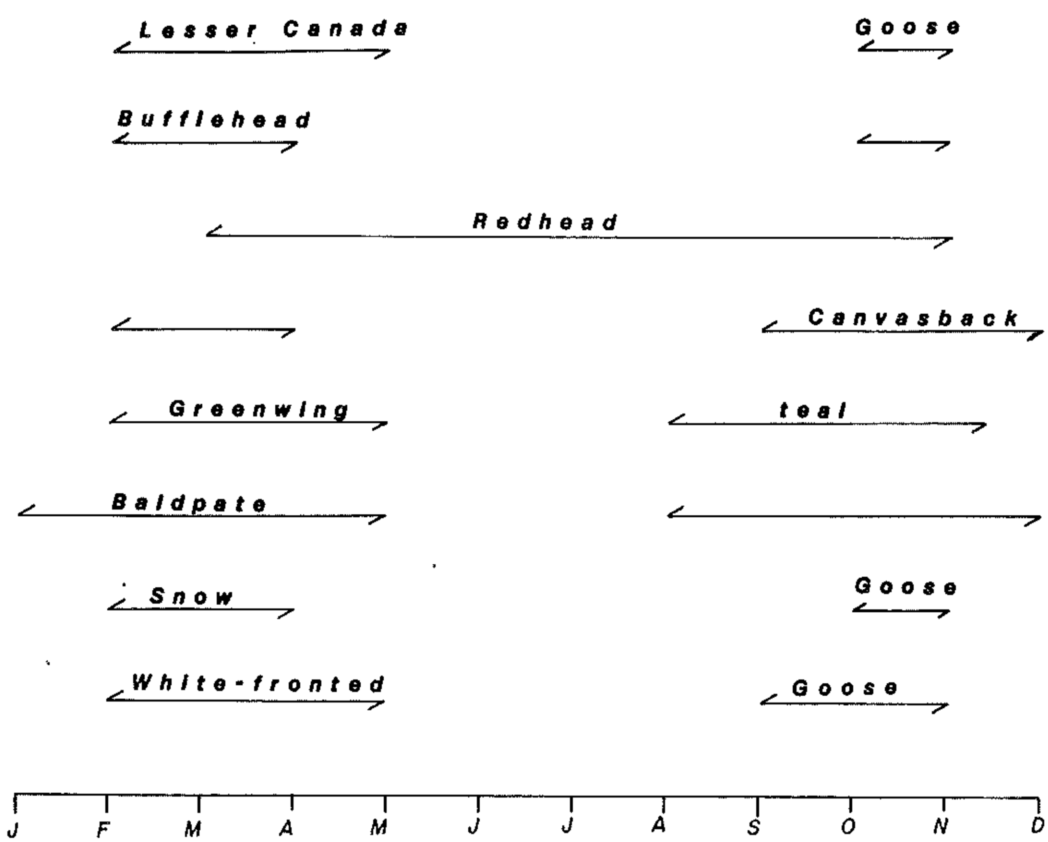


Fig. 8-9 Modern seasonal distribution of migratory species found at Nightfire Island. In winter and summer these species are present, but rare.

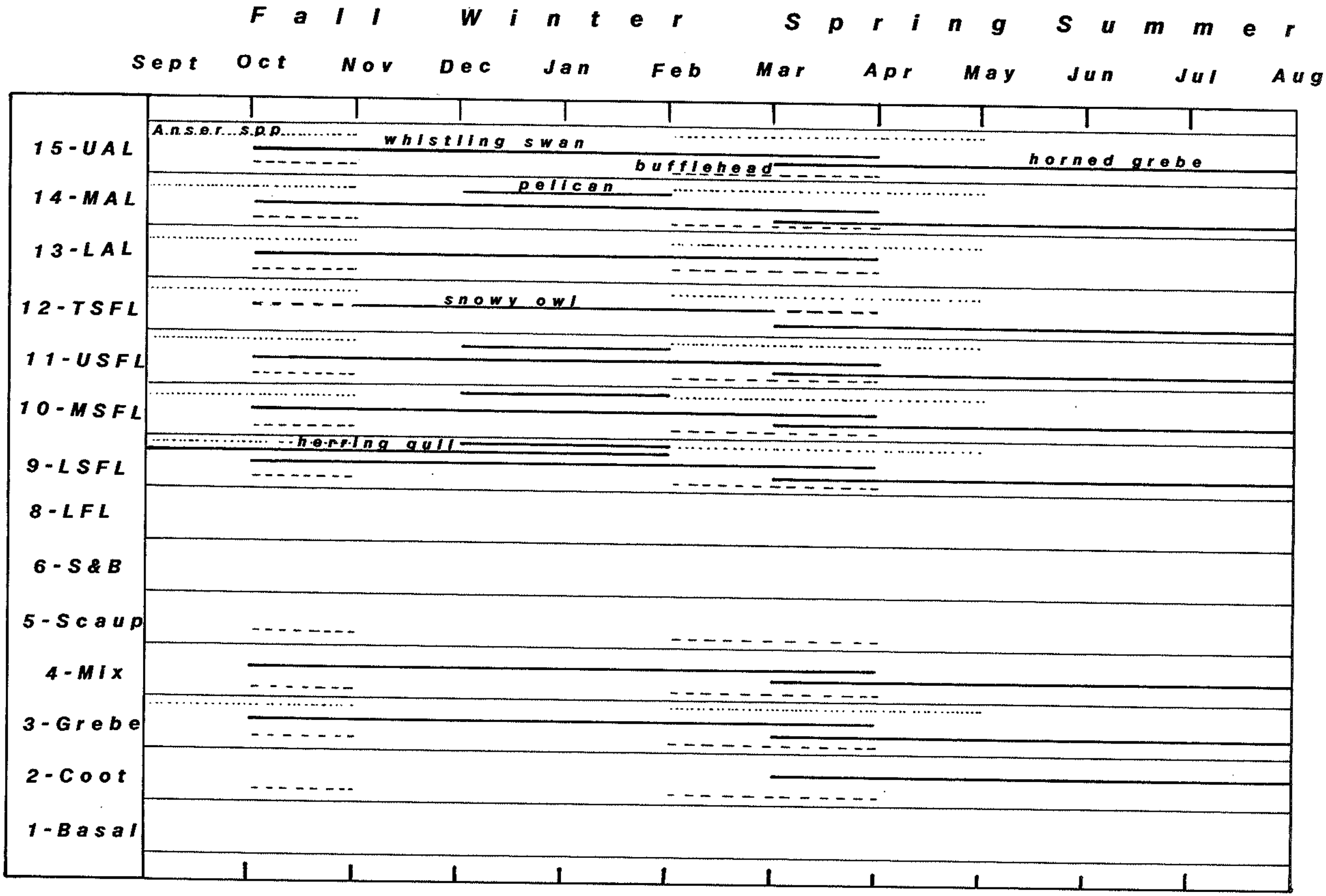


Fig. 8-10 Distribution of seasonal markers in each stratum of Nightfire Island.

Procurement Techniques: the Ethnohistorical Record

Another possible contributing factor to species fluctuations (Fig. 8-1) could be the introduction of new technology for bird procurement during the site's occupational history. Although direct evidence for such innovations must be sought among the artifacts (see Chapter 10) rather than the avifauna, this is nonetheless an appropriate place in the narrative to introduce the topic. The ethnohistorical record makes it clear that divers were caught with far less equipment but with a good deal more effort than was normally expended for ducks and geese. Ray (1963) records that the Modoc clubbed or simply grabbed coots on the ice in winter, and Bent (1923) also describes native employees in Manitoba driving young Lesser Scaup towards the shore by simply wading towards them. The birds preferred to dive back between their legs, rather than creep into the grass on the shore. Many were caught by hand while the water remained clear, and the rest were caught when they eventually tired and attempted to hide in the grass. The anecdote is an important key to the escape behavior of diving birds. By exploiting their unwillingness to be driven ashore or to rise from the water, they can be taken by hand or with hand-nets in large numbers during organized drives.

A far wider variety of equipment was used for the taking of ducks and geese. Vogelin (1942) records accounts given of various Modoc techniques in use in the second half of the last century. They used hand-held nooses on sticks, traplines with suspended nooses, nooses hung from poles on riverbanks at night, long vertical nets set in straight lines, and bag-shaped nets set as traps in the water. Ambush tactics were also used; dugouts were run into the tules with the hunter inside a tule blind covering the prow and sides. Blinds were also constructed of various plant materials.

To attract waterfowl, stuffed birdskin decoys were floated on the water and honking noises were made in imitation of the appropriate birds. At night, in freezing weather, jacklights were used to attract waterfowl. The neighboring Klamath put fires in the prow of the dugout, surrounded by tule matting and floated downriver--attracted duck were shot with bow and arrow.

Bird arrows were variable. Cane shafts were used for ducks but the Modoc also used serviceberry (Amelanchier spp.) stems for solid shafts. The fletch was three-veined and straight and the tip was either headless or the stone point was wrapped.

The most detailed account of a Modoc set-net is given by Ray (1963). The mesh was of plant cordage and varied in size according to the waterfowl sought. The net was rectangular--one meter wide by nine meters or longer--and attached so as to hang loosely between poles. These were driven vertically into the marshy bottom, some 2m from the shore. They were set at night, and visited the next morning, freed of the birds entangled in them and then set the next night somewhere else. Decoys of stuffed bird skins or sewn buckskin were sometimes fastened to the base of the net.

Equipment was not always so elaborate. When there were many flightless birds and/or fledglings available, drives through the tules were conducted by the men who flushed the birds out to be clubbed by the waiting women with nothing more than long poles.

If this pattern (more equipment for ducks and geese, less for divers) is a valid analog of past patterns, then the archaeological remains of such gear should fluctuate accordingly. The implications of this model will be explored in Chapter 10.

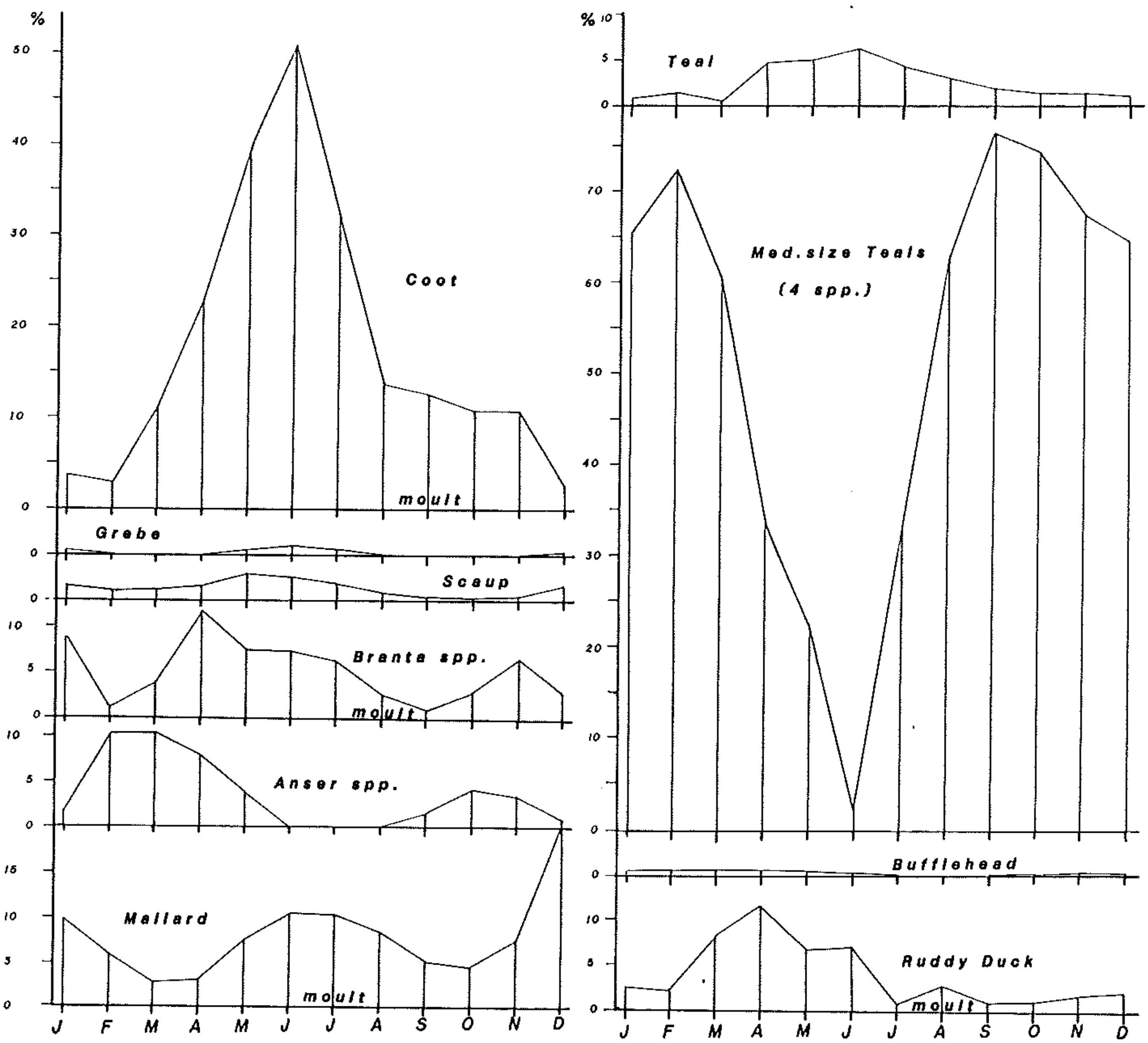


Fig. 8-11 Relative seasonal availability of 10 species. Percentages are of combined monthly birdcounts.

A Question of Taste

The prevalent waterfowl eaten at Nightfire Island do not all taste similar. The diagram in Fig. 8-12 is a subjective attempt to rank the taste of the relevant birds on a scale of 1 (outstanding) to 6 (vile, barely edible). The diets of those low on the scale include fish, clams, and insects. The ranking is a rather free interpretation of the judgements of such authorities as Kortright (1967), Bent (1923, 1926) and Martin et al. (1951). It need have no bearing on the Nightfire Island inhabitants who may have cared less about the tastes of different birds, but there are a few hints from the ethnohistorical record that this was not definitely so. Ray (1963) states that the Modoc would only eat loons, gulls, and pelicans (all fisheaters) in lean months, and Vogelin's (1942) informants reported that pelican was only eaten in winter. They also claimed, however, that the flesh was much liked, so that we cannot assumed that their palates invariably matched our own.

Fig. 8-12 also gives the average weight of males and females for the relevant species. On neither scale (taste or weight) do the coots, grebe or scaup exhibit any qualities to suggest that they would be preferred or desireable prey. The excessive amounts of these birds in the lower strata are unlikely, therefore, to reflect hunting preferences based on weight returns or taste.

About Botulism

So densely packed are the bird bones in the strata below the 6-S&B that we may reasonably question whether they were all introduced into these clays by humans. Mass waterfowl deaths are known to occur through epidemics of botulism[2], but Bellrose (1976) points out that the toxin kills quickly so that the bird does not deteriorate before death. The taphonomic history of waterfowl carcasses following such epidemics has yet to be studied, but it is reasonable to assume that many would float and break up, with partly articulated limbs, finally settling into the lakeshore mud. So infrequent is the occurrence of articulated bird parts in the lower strata of the site, and so rare are bird heads, that it seems unlikely that these bird remains are the byproduct of anything else but human activity. However, wildfowl epidemics must have been a periodic threat to the Nightfire Island inhabitants during times of extreme lake level drops or rapid rises.

Taphonomic Considerations

Yet another factor which might have partly influenced the species fluctuations seen in Fig. 8-1 is the post-depositional history of the bird bones themselves. At a settlement in which dogs were present throughout its history and which must have been permanently surrounded by small wild scavengers, the rate of loss and damage to all bone material must have been relatively high (e.g., Brain 1967). Under such conditions, it is likely that numerical distortions will occur in any recovered sample because the more durable bones of certain species have a far better chance of survival. Although controlled experiments involving waterfowl carcasses are yet to be conducted, the Nightfire Island collection does allow a few preliminary but useful observations.

Fig. 8-13 shows the relative proportions of elements surviving for selected species, taken from all strata and combined. There is a clear distinction to be made between the divers and the dabblers in that the coracoid of diving birds survives in the greatest numbers by far. Among the larger dabblers (mallards and geese), the coracoid is

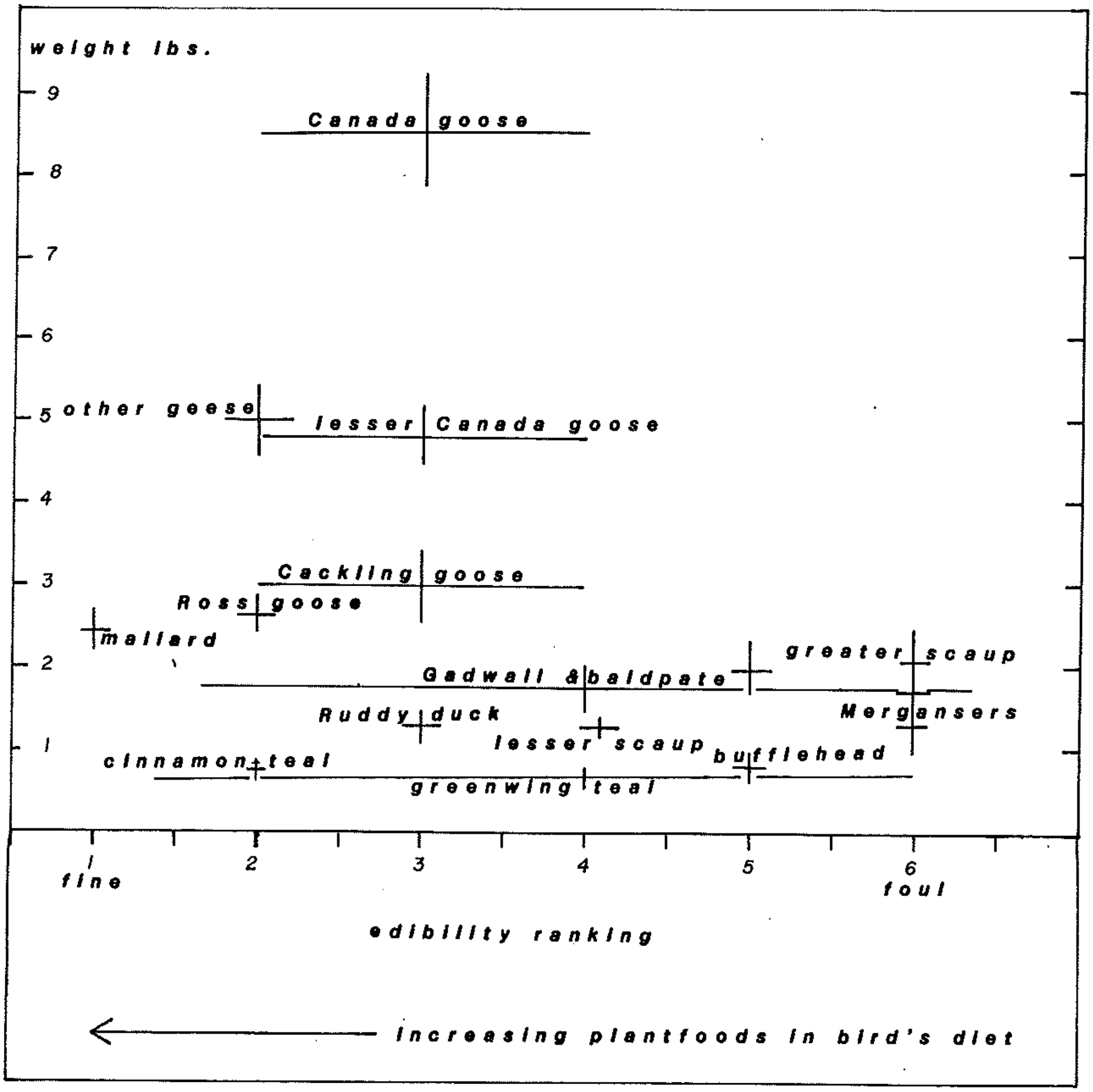


Fig. 8-12 Weight ranges and qualitative edibility ranking of waterfowl found at Nightfire Island.

matched in numbers by scapulae and humeri. The medium-size ducks differ slightly in that the sternum is the dominant surviving bone. There is no reason to doubt that these general proportions reflect the relative durability of different parts of the skeleton and have nothing to do with the manner of dressing or preparing the dead bird by the Nightfire Island inhabitants. Nor are there any clues in this diagram to suggest that one species may be more durable than another or that one may become overrepresented through differential survival of body parts[3]. The teal sample is unfortunately too small to yield reliable percentage calculations. It is dominated by humerus (28.3%), sternum (26.4%), and an anomalous 17% of carpometacarpus which may be a hint that the bones of the small waterfowl may be subject to different rates of loss.

One further taphonomic consideration is the survival of birdbone in different depostional contexts. It seems reasonable to predict that bones washed into a marshy tip area such as that suggested for the lower strata could be subjected to forces different from those at work on the bones strewn on the surface of a habitation platform, such as that proposed for the Loams sequence. The prediction can be tested only on the coot bones because there are large enough samples from this species in several strata. Fig. 8-14 gives the relative proportions of coot elements from these strata.

The first and most significant shift occurs, as predicted, between the 5-Scaup and the 9-LSFL. The frequency of coracoids drops and there is a general increase in the proportions of limb-bones of all kinds. As the coracoid is the most durable bone by far in the skeleton, this may be taken to indicate that the degree of attrition in the lower strata was <u>more</u> intense than in the Loams. The reasons for this remain unclear, but it is intriguing to note that the closely matching coracoid/scapula curves also covary with the frequency curves from domestic dog (Fig. 7-1). There is an even closer resemblance to the curve for dog and coyote elements combined, but it should be remembered that the mammalian samples from the lower strata are sadly inadequate and that there is an element of doubt about the validity of the earlier parts of the two canid curves. Nevertheless, it is possible that a decrease in the amount of dog scavenging in the Loams sequence was partly responsible for the shifts in coot element frequencies.

ENDNOTES: CHAPTER EIGHT

1. The bones of these smaller birds may also not have survived the scavenging activity of dogs, but the surviving elements of teal in the sample show no extra signs of damage or fragmentation.

2. Hunter <u>et al.</u> (1970) monitored one such outbreak in California in the late 1960's and found that several terrestrial invertebrates provided the nutrient medium for the spread of the bacterium. Significantly, this took place when they were drowned by rising lake levels in warm weather <u>and</u> when aquatic invertebrates were exposed on the mudflats left by receding waters. The decay of these animals changed the quality of the lake water which in turn killed more invertebrates still covered by the lake. Fish then began to die and the carcasses produced maggots which were eaten by the waterfowl which also died. Maggots from dead waterfowl were then devoured by living birds and deaths rapidly reached epidemic proportions.

3. Overrepresentation of <u>Anas</u> spp. may occur in a MIND count because each sternum represents one bird whereas two of most other elements represent a single bird. MIND counts have been deliberately omitted, therefore (see also Grayson 1977).

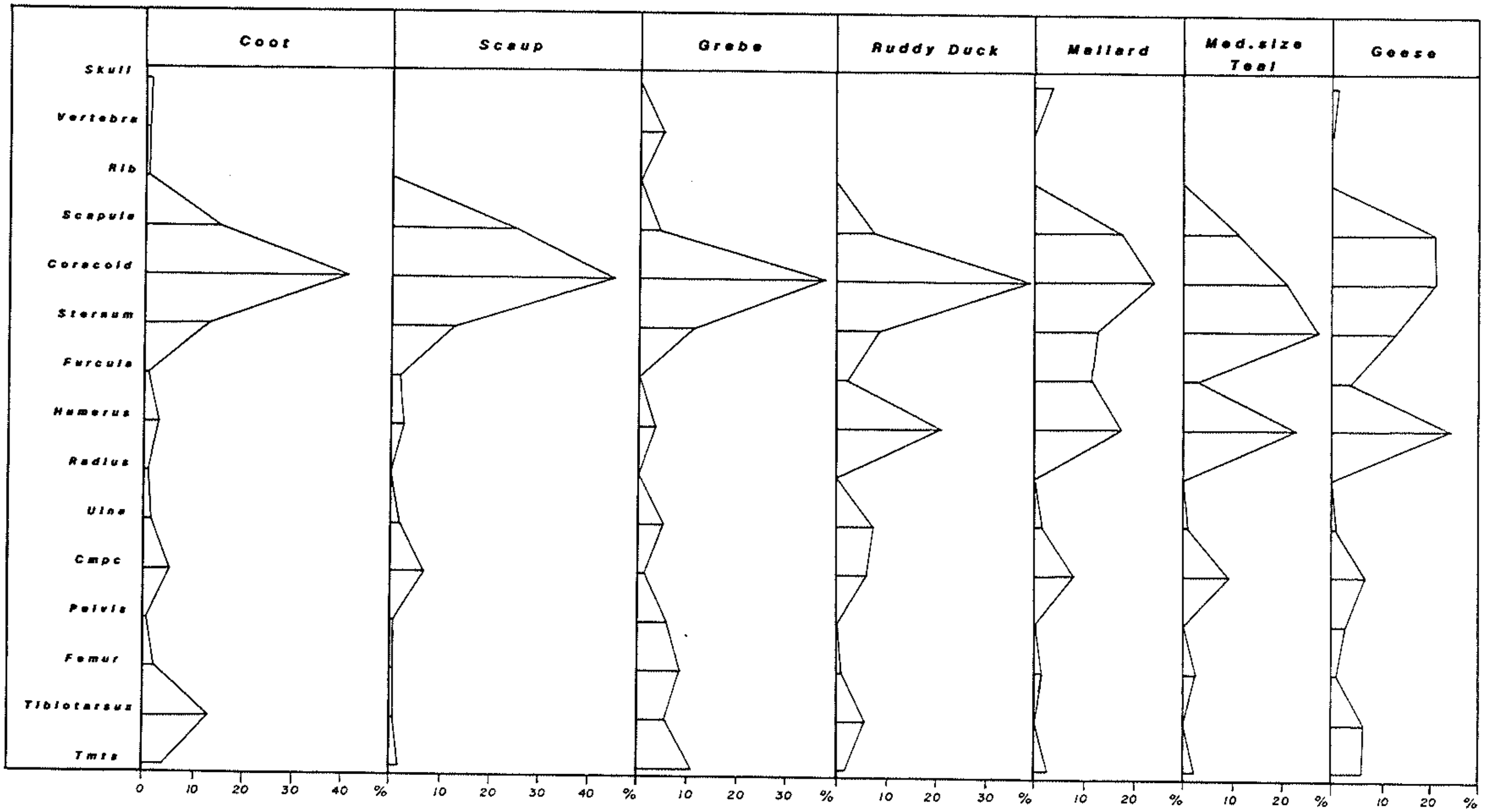


Fig. 8-13 Percentage distribution of elements for seven taxa of waterfowl found at Nightfire Island. Elements from all strata are combined for each taxon.

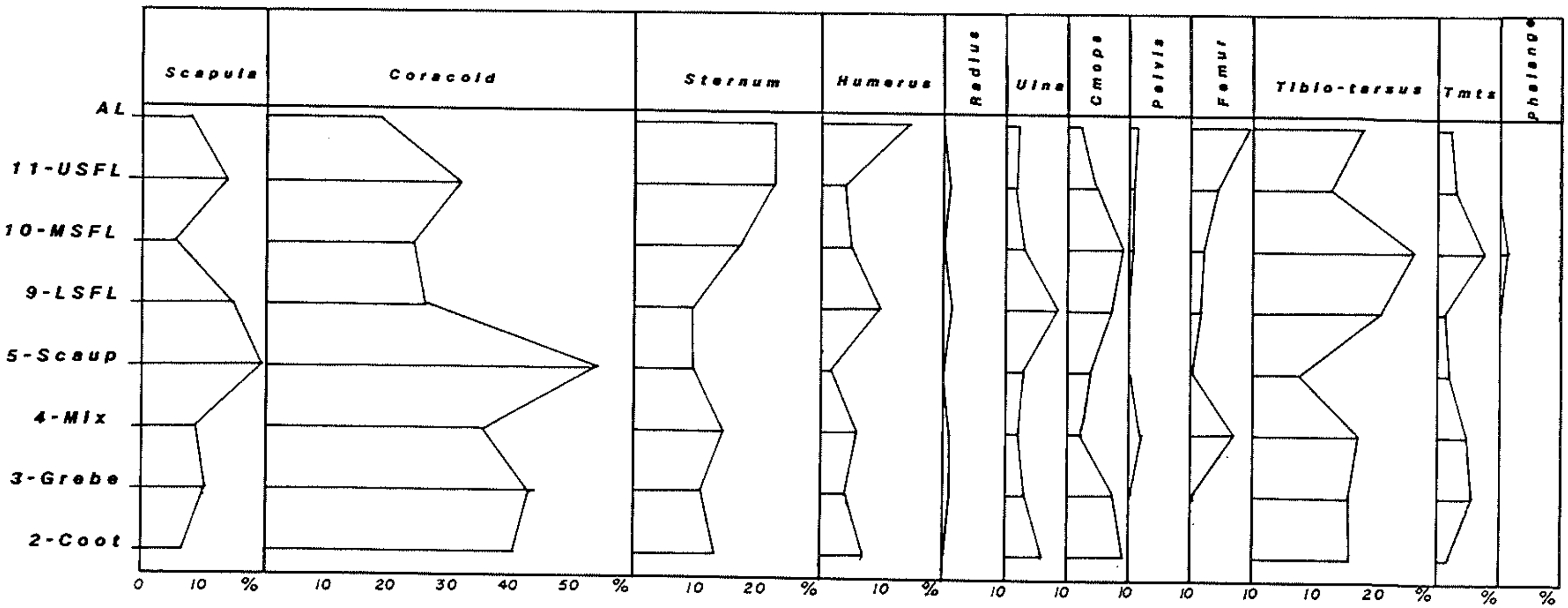


Fig. 8-14 Percentage fluctuations of Coot elements per stratum. All Arrowhead Loams are combined.

CHAPTER NINE

ENVIRONMENT AND DIET*

In this chapter, the separate interpretations of the dating, sedimentary, floral, and faunal records are synthesized, reconciled, and combined with data on miscellaneous faunal items not already treated. It also serves as a bridge between the ecological/dietary aspects of the site and the artifacts to be described in the following chapters. The extent to which changes in the environment may have influenced the inhabitants' diet are assessed as a prelude to exploring the interplay of dietary and artifactual changes through time (Chapter 21).

Miscellaneous faunal items are reviewed first.

Fish Remains

Fish bones were recovered from 13 pits and were relatively abundant in the later part of the Loams sequence. Due to unforeseen circumstances, neither the identifications nor the quantitative data on fish remains can be presented here (K. Dunn, pers. comm.). However, fish bones were present in a microcolumn taken from the west face of Pit I (see Fig. 2-14).

The microcolumn samples do not in all cases coincide with the recorded layers of Pit I. The following layers are represented by single, combined samples only: layer 2ab, layer 3ab, layer 6ab, and layer 7abc. Also, the sample from layer 8 was apparently combined with layer 9a below it. Layers 9b, 10, and 11 were all combined in a single sample. None of this constitutes serious mixing except possibly in the lowermost example, but here the sample is so small that this leads to no very grave consequences.

Preliminary screening of the microcolumn material through 1/4 in., 1/8 in., and windowscreen meshes produced separate bags of flora, fauna, obsidian, basalt, charcoal, etc. for each sample. Only the faunal samples--some of which were further subdivided into coarse and fine fractions--are considered here.

The identifiable fish bones were separated from the coarse fraction of each faunal sample. Taxa and elements were identified where possible, and each extracted unit was weighed and counted. Table 9-1 gives fish bone as a percentage by weight of total faunal fragments in each of the coarse fractions.

The fine fractions were treated as follows: a five dram vial was drawn from each of the stratified fine fractions and the content of each vial was processed in exactly the same way used for the coarse fractions. The results are given in Table 9-2. Predictably, the fines contain much higher percentages of unidentifiable fragments with consequently lower proportions of detectable fish bone. The two sets of data from the coarse and fine fractions are presented separately, therefore.

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Table 9-1

Frequency of Fish bones by weight in the microcolumn of Pit I: Coarse fraction only.

Stratum	Layer	Fish	Non-Fish
14-MAL?	1	20.9%	79.1%
14-MAL	2 ab	3.3	96.7
13-LAL	3 b	NO SAMPLE	
13-LAL	4	0.5	99.5
12-TSFL	5	3.8	96.2
11-USFL	6 ab	7.0	93.0
10-MSFL/ 8-LFL	7 abc	6.0	94.0
6-S&B	8 & 9 a	NO SAMPLE	
5-Scaup/ 3-Grebe	9b-11	5.8	94.2

Table 9-2

Frequency of Fish bones by weight in the microcolumn of Pit I: Fine fraction only.

Stratum	Layer in Pit I	Fish	Non-Fish
14-MAL?	1	8.1%	91.9%
14-MAL	2	NO	SAMPLE
13-LAL	3	NO	SAMPLE
13-LAL	4	NO	SAMPLE
12-TSFL	5	NO	SAMPLE
11-USFL	6	4.5	95.5
10-MSFL/ 8-LFL	7	2.4	97.6
6-S&B	8	2.8	97.2
5-Scaup/ 3-Grebe	9	1.1	98.9

The fines data-set indicates a limited use of fish in the deepest strata (3-Grebe and 5-Scaup) and suggests slight increases in the 6-S&B and again in the 11-USFL. It is impossible to determine, however, whether miniscule changes such as these had site-wide significance or not. Furthermore, the absence of a fine fraction from above the 11-USFL remains enigmatic as there is no record of whether or not fines were extracted from these upper layers. If they were not extracted (and subsequently lost from the collections) then this must surely be of considerable taphonomic significance. However, a fine fraction has survived from the disturbed brown sands of layer 1 at the top of the column, suggesting that the others may indeed be lost.

The coarse fraction data also indicate a minor use of fish in the 3-Grebe and 5-Scaup without any really significant changes through the 11-USFL. However, in the 12-TSFL and the 13-LAL there is a marked drop in the relative amount of fish bone and an insignificant amount in the 14-MAL also.

It is unfortunately only in the disturbed brown sands of layer 1 that fish bone first becomes a significant proportion of the coarse fraction (20%), indicating a marked shift in the economy towards fishing. As this layer was massively disrupted by a bulldozer cut, it was excluded from the original correlation. As the microcolumn passed through an apparently undisturbed patch of this layer, it is reasonably safe to assume that it belongs to the later part of the 14-MAL.

Taken together, the microcolumn data indicate that fish were present, but of relatively minor importance until the later part of the 14-MAL. It remains to be seen however, whether this view has site-wide significance. This was checked by thorough combing of all available field records for any mention of fish bones observed during excavations. Isolated large vertebrae were seen in the Lake Bed in Pits R and L. These do not appear again in the sequence until the 3-Grebe in Pits R, L, and M where they are rare items. There are also a few bones in the 4-Mix, a vertebra in the 5-Scaup, and a few bones from the 8-LFL in Pits D, N, and L. None of these items can be taken as evidence of systematic exploitation of fish. Systematic fishing began in a small way in the 11-USFL where vertebrae, cranial parts and facial bones appear in large numbers for the first time in Pits L and R, and in an arc-shaped scatter through Pits D, I, O, and T. They increase in density in the 12-TSFL and Pits I and J only, and throughout the Arowhead Loams: in the 13-LAL of Pit I, the 14-MAL of B and I, and in the 15-UAL of J, P, and V where they were recovered in dense patches of fish bone-rich yellow-stained sediment.

Clearly, the patchy occurrence of fish bones in the 12-TSFL and upwards means that any microcolumn is unlikely to capture a truly representative picture of site-wide changes in fishing intensity. Evidently, the column from Pit I failed to intersect with patches mentioned in the field notes from the 12-TSFL and 14-MAL.

Of the 4142 identifiable fish bones recovered from the column, 96% belong to the cyprinid family (minnows), while only 4% are catostomids (suckers). One salmonid vertebra, probably trout, was recovered from the 11-USFL. The taxonomic identifications are shown in Tables 9-3 and 9-4.

All of the 480 cyprinid bones which were identified to the generic level are chub belonging to the genus Gila. Of those identifiable to the specific level, 53 are tui chub (Gila bicolor) and 25 are blue chub (G. coerulea).

Both blue chub and tui chub are very common in the Klamath drainage, although they have somewhat different habitat preferences. The tui chub are most commonly found in quiet waters and the weedy shallows of lakes, while the blue chub are more common in open water or along rocky shores (Moyle 1976: 166-169). However, the young of the

Table 9-3

Taxonomic Identifications of Fish bones from the microcolumn: Coarse Fraction

Stratum	Layer	*G. Bicolor*	*G. coerulea*	G. sp.	Cyprinid	*Gila**	Cato-stomid	Cato-stomid**	Salmonid	Unident-ifiable	Total
14-MAL?	1	38	9	132	1050[a]	997	43[b]	31		763[c]	3063
14-MAL	2ab	1		9	8	34				7	59
13-LAL	3b	NO SAMPLE									
13-LAL	4									2	2
12-TSFL	5			9	4	11	1	3		11	39
11-USFL	6ab	12	14	45	4	231	4	45	1	85	479
10-MSFL/ 8-LFL	7abc	1	1	24	9	41		12		18	106
6-S&B	8d9a	NO SAMPLE									
5-Scaup/ 3-Grebe	9b-11		2	40	12	87	4	1		43	189
Total		52	25	259	1087	1401	52	92	1	929	3898

* vertebrae of size to suggest *Gila*

** vertebrae of size to suggest catostomid

[a] Layer 1 contained more than 1500 fish scales. Only 10% of these were randomly selected for taxonomic identification. The counts obtained were multiplied by 10, and the figure 1050 is extrapolated from the actual identification of 105 cyprinid scales.

[b] This number represents 3 catostomid bones. The remaining count of 40 represents scales, of which 10%, or 4, were actually identified as catostomid.

[c] This figure includes 323 unidentificable fish bones and 450 scales, 45 (10%) of which were actually examined for taxonomic identification.

Table 9-4

Taxonomic Identifications of Fish bones from the microcolumn: Fine Fraction

Stratum	Layer	*G. bicolor*	*G. coerulea*	*G.* sp.	Cyprinid	Gila*	Catostomid	Catostomid**	Salmonid	Unidentifiable	Total
14-MAL?	1			5	222	193	1			86	507
14-MAL	2ab	NO SAMPLE									
13-LAL	3b	NO SAMPLE									
13-LAL	4	NO SAMPLE									
12-TSFL	5	NO SAMPLE									
11-USFL	6ab	1		17		205		8		16	247
10-MSFL/ 8-LFL	7abc			62	3	246				13	324
6-S&B	8&9a				16	141				23	180
5-Scaup/ 3-Grebe	9b-11			10	4	39				10	63
Total		1	0	94	245	824	1	8	0	148	1321

* vertebrae of size to suggest *Gila*
** vertebrae of size to suggest catostomid

two species are known to school together (C. E. Bond, pers. comm.). Many of the Gila remains identified from the column represent immature individuals, and the presence of both species may not be indicative of any particular choice on the part of the Nightfire Island fishermen.

Suckers, known to have been an important item in the diet of the ethnographic Modoc and Klamath Indians, are very meagerly represented in the column sample. This probably represents a difference in procurement and processing of suckers and minnows, rather than a strong preference for minnows. Spier reports that the Klamath removed the head and the backone when splitting fish to be dried in the sun (Spier 1930:155). It is likely that larger fish, such as trout and suckers, which appear under-represented in the midden, were processed in this fashion and their bones were disposed of where they were processed or tossed back into the water. Smaller fish, such as minnows, may well have been processed whole, rather than filleted, thus resulting in their bones being more common at the site.

Turtle

Apart from the sparse scatter of turtle bones and carapace in the Lake Bed clays of Pits L, M, and N, there is a small amount of carapace in the 14-MAL in Pit J. This must reflect a chance catch or find and suggests that turtle was a negligible part of the diet.

Snail

Snail shell fragments occurred throughout the calcified layers of Pits K, L, and R with a thinner distribution in surrounding pits. They are not necessarily intrusive, but reflect local sedimentary conditions and are not connected in any way with the occupants' diet.

Miscellaneous Fauna

Very rare elements of snake, lizard and other vertebrates were recovered, but have not been studied. They reflect chance captures or discoveries and play no significant part in the Nightfire Island subsistence round.

Environment

There are no conflicts among the various kinds of paleoecological data from the 2-Coot which formed in a marshy shoreline setting during a relatively high lake stand in a cool-moist climatic regime that fits well with the start of Mehringer's (1977) episode of increased effective moisture at about 5,400 BC.

The peaks in the frequencies of montane mammals, hemlock pollen and marsh-adapted mammals all suggest cool-moist conditions. A relatively high lake stand is suggested by the predominance of diving waterfowl and the scarcity of grass/sage-flats adapted animals. Although marshlands were clearly present, they had not yet matured and there was far more open water than in the 1905 configuration, e.g. Fig. 1-11a.

The 3-Grebe accumulated under only slightly altered (or altering) conditions with the lake level still very high (90% diving birds), but with possible losses in marshland (marsh mammals decline) due either to drowning (grebe can operate in deeper water than coots), or to a slight drop in water level (grass/sage flats animals increase) in a gradually warming and drying trend (pine pollen gains at the expense of hemlock, montane mammals decrease). This stratum fits neatly into the later half of Mehringer's episode of increased effective moisture.

The 4-Mix build-up took place while the lake was still open (85% diving waterfowl) but evidently beginning to drop so that marshland animals decreased to a record minimum with complementary gains in grass/sage-flats adapted species. The lake level drop coincides with an apparent drying trend (peak in pine pollen with a hemlock minimum) possibly accompanied by a warming trend also (Mountain sheep disappear), but there are no shifts in the ratio of combined montane mammals. The trend evidently continued to the point when the lake edge retreated a modest distance from the site and it was not in use for the following few centuries. There being no deposition during this interval, paleoecological data ceased to accumulate. The entire episode falls into the warm-dry interval between Mehringer's 5,400-4,400BC moist episode and the first of the cool-wet events in the bristlecone record.

Clearly, the lake level rose again at the beginning of the 5-Scaup and dense marshland formed once more on the very edges of the site (mucks, marshland animals greatly increase over flats animals). However, the lake itself remained a relatively deep and open body of water (99% diving birds). Although this lake rise was no doubt accompanied by an increase in effective moisture, this has not been demonstrated (no pollen records). The amount of runoff must have been substantial as it occurred during a relatively warm interval (Mountain sheep have not reappeared, and montane mammals are fewer than ever before). Most of the 5-Scaup must belong in the earliest segment of the bristlecone record (3,500-3,100BC) which plots out unambiguously as a warm spike, although the relative amount of moisture has not been recorded. The first cool-moist episode in the bristlecone sequence (3,100-2,850BC) is certainly not registered as such in the 5-Scaup data which converge to suggest a warm-moist episode instead.

Precise dating for the 6-S&B is also difficult because of mixing with underlying 5-Scaup material, but the platform was laid down at some time between 3,000-2,850BC, with the later end of this range preferred because it fits better with the bristlecone record. Marshland species decline to the advantage of flats animals, but it is difficult to tell whether this signifies a lake level rise with marshland drowning, or a lake level drop with marsh shrinkage and gains in flats. The latter may be preferable since the montane mammals continue to decline indicating the continuation of the warming trend. However, there are ambiguities: Mountain sheep reappear, and the pollen shows a slight increase in hemlock (moist conditions?) over the 4-Mix. In the balance, lake shrinkage seems the better interpretation, otherwise the building of the 6-S&B platform would make no sense. If shrinkage was the cause of marshland losses near the site, this must have been a very minor change since the lake itself remained deep and open (97% diving birds).

Temperature conditons during the centuries of the 8-LFL (2,850-2,450BC) are at greater variance with the bristlecone record than at any other time. Marshland animals are again at proportions similar to the 5-Scaup and this time there is a very pronounced drop in the quantity of diving birds, with complementary gains in dabblers. Both lines of evidence point to a significant increase in marshland within the site catchment, but there are no gains in flats adapted species at all. Actually, birds almost disappear from the site at this period (see Chapter 8), implying that the lake level dropped so much that the site almost ceased to function as a waterfowling station since the distance from site to marsh was too far. This evidently took place during a cool episode (fir-hemlock peak, emphatic rise in montane mammals). The reconstruction conflicts with the bristlecone record's warm-dry spike (peak at 2,700BC) which ends abruptly around 2,500BC in a brief minor cool-dry spike. The four centuries between 2,900-2,500BC were not uniformly warm-dry, therefore. The only evidence for within-stratum change in paleoecology during the 8-LFL comes from the pollen diagram, and this suggests that the cooling event (fir increase) did indeed take place during the later half of its accumulation. Although temperature fluctuations may have been somewhat different in the White Mountains and in the Klamath Basin, changes in effective moisture were certainly similar.

The chronic shortage of dates from the 9-LSFL prevents us from pinpointing its depostion within the 500-year span of 2,450-1,950BC. Marsh animals decrease again to proportions similar to the 6-S&B, this time to the advantage of the flats-adapted species. As this dovetails neatly with a small decrease in dabbling waterfowl, there are grounds for reconstructing a slight change in lake level which either drowned or desiccated marshland within the catchment. Given the abundance of rolled juniper twigs in the 9-LSFL, a slight rise in water level is probably to be preferred, at least in the earlier part of the deposit. In the upper levels, however, there are signs of a decrease in effective moisture (hemlock declines) with a marked rise in grass pollen that nicely fits the increase in flats-adapted mammals. The implication is quite clear that the meadowland was gaining over marshes in the later centuries of the 9-LSFL build-up due to a lowering of lake level responding in turn to a decrease in effective moisture. This reconstruction is in reasonable harmony with the bristlecone record of mildly fluctuating warm-wet conditions leading to a warm-dry spike between 2,100-1,900BC.

With the advent of the 10-MSFL, this drying trend continued unabated (emphatic gains in pine pollen over hemlock) and culminated at about 1,300BC in a hot-dry event (pine peak). Midway through the sequence there was a cool-dry spike in which firs made some slight gains. This reconstruction dovetails neatly with the bristlecone record for 1,900-1,300BC, including the cool-dry spike (1,700-1,600BC) which has been coupled also with a treeline drop in the White Mountains. Although a decline in effective moisture should have lowered the lake level substantially, there are only slight gains in flats-adapted animals over marshland species, but grass pollen remains high. However, a massive decline in diving waterfowl suggests that the lake had indeed become shallower, with marshes encroaching on open water. There are only slight losses in montane fauna, in spite of the pronounced warming trend, but this could have been caused by mixing of mammal samples from both the warm-dry and cool-dry parts of the episode. Evidently, the lake and its surrounding marshes continued to shrink after 1,300BC at such a rate that the entire resource-base of the site retreated too far and the site itself was abandoned. For the next 600 years, its surface experienced weak soil development with accelerated calcification of the B-horizon so that massive calcretes came to mask much of the microstratigraphy of the 10-MSFL and several parts of the underlying strata also. This abandonment phase dovetails with the cool-dry episode of the bristlecone record between 1,200-700BC.

The site was reoccupied at about 600BC and paleoecological data began to accumulate once more in the 11-USFL. At that date, the mean temperature seems to have been cooler than before (large spike in montane mammal frequencies, with coterminous peak in Mountain sheep) and effective moisture was also relatively high (hemlock increase). Under these cool-wet conditions, the runoff clearly re-established the lake to about its former depth (no change in diver/dabbler ratio) with about the same amount of marshland (mammal ratios unchanged). Grasses never recolonized the surrounding flats however, and these were presumably replaced by the thin sage brush cover of today. There is a good match between the 11-USFL data and the peak of the second cool-wet episode in the bristlecone record. Mixing of samples from this stratum may have obscured any indications of a fit with the ensuing warm-wet interval of 300-100BC.

The 12-TSFL indicates a new warming trend (marked drop in montane species) with slightly drier conditions (pine recovers at the cost of hemlock). An expanding marshland is suggested, at the expense of open water (dabblers increase). The lake may have shrunk somewhat at this interval, as there are overall gains in flats species as well. Considerable difficulty surrounds the exact placement of the 12-TSFL within the bristlecone record because there are not enough reliable dates and because there are two separated depositional units which cannot be correlated.

Climatic conditions in the ensuing 13-LAL are intractible for want of a pollen record. The lake may have risen slightly (slight losses in marshland and flats species). Increased effective moisture is implied by this event, but there is a further decrease in the ratio of montane species so that a minor warm-wet peak is implied. If most of the 13-LAL dates to around 300-400AD, this interpretation fits the bristlecone sequence well enough, but the crucial C-14 date is inverted, thus marring the case for this fit.

In the 14-MAL, thought to date to 500-700AD, there are further losses in marshland and flats species, but with a record maximum in dabblers. A further rise in lake level leading to drowned marsh- and meadowland seems the most likely explanation for these changes. Slightly cooler conditions are suggested by the increase in montane mammals. This fits reasonably well with the third cool-wet episode in the bristlecone record.

The date of the 15-UAL has not been established, and will have to be inferred by fitting it to the bristlecone record. The montane mammals indicate a cooler mean temperature, and there is also a marked recovery in diving birds, suggesting a deeper lake, with increased marshland (recovery of marsh-adapted species, peat growth on the site). As the paleoecological data converge to suggest a cool-wet episode, it would fit more readily into the final cool-wet episode of the bristlecone sequence than with the preceding warm-dry or cold-dry spikes. This would place it at 1300AD and later, which agrees with the youngest OH dates, but is some two centuries more recent than the youngest C-14 date (which comes from the 14-MAL anyway)[1]. The implications of this is that there may have been an abandonment of the site between the 14-MAL and the 15-UAL during the extremely dry centuries of 900AD and 1200AD.

This concludes the review of short-term fluctuations inferred from the paleoecological data. One additional trend that cuts through these oscillations is the long-term gains in dabbler over diving waterfowl after the 6-S&B (*ca.* 2,900BC). Although the diver/dabbler ratio continues to fluctuate back and forth in response to changes in lake level, marshland extent and (by implication) runoff and effective moisture, the dabblers continue to gain steadily through time. The model which best fits this larger trend is a gradually maturing lake in which bottom sediment and plant remains are slowly filling in the basin. This process advances independently of runoff oscillations and, therefore, of climate (Fig. 9-1).

In summary, then, the site's catchment was subject to short-term climatic fluctuations very similar to those in the bristlecone record some 500km to the south, with one exception in the early part of the 8-LFL. These in turn caused fluctuations in lake level, marshland expanse, and the duration of summer grazing in the adjacent mountains. An explanatory model of the interplay of these three factors fits reasonably well with the dating and paleoecological data presented.

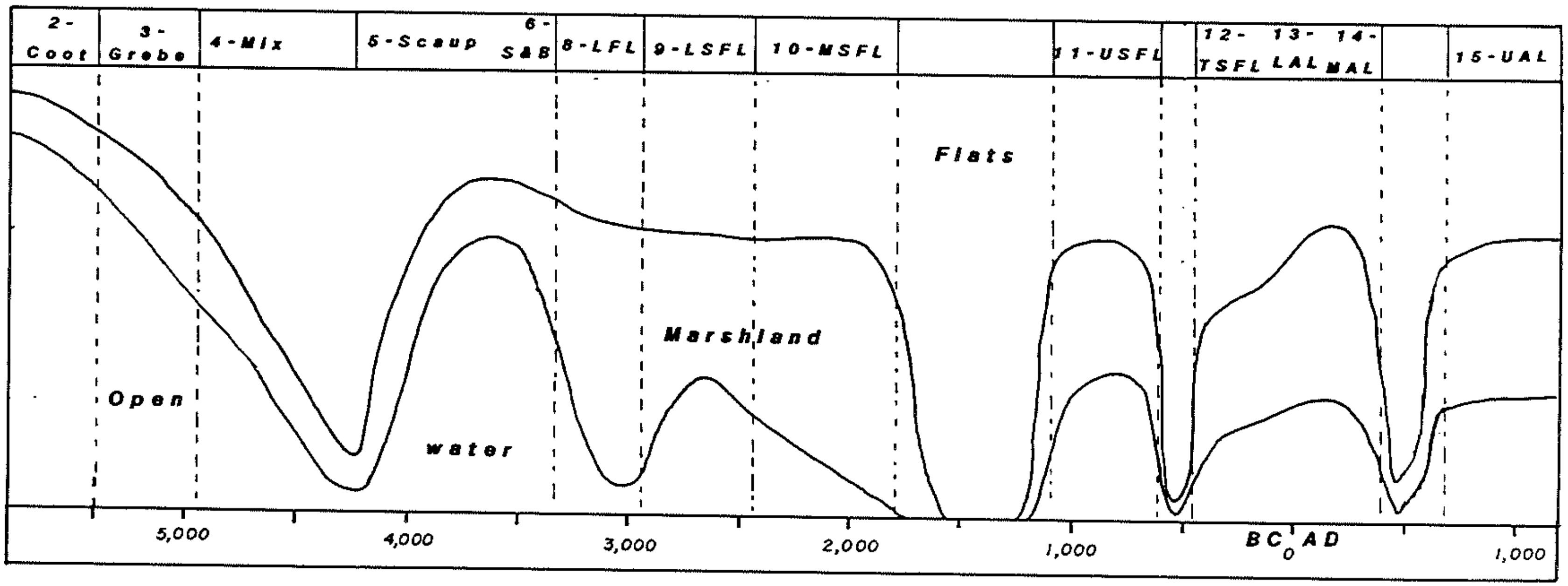

Fig. 9-1 Approximations of the catchment configuration for each stratum, based on combined evidence from sediments, pollen, mammals, and avifauna examined within the framework of the bristlecone climatic sequence and ancillary paleoecological data from the western Great Basin.

Diet

The model as outlined so far is extremely deterministic. It implies that all changes in human diet were controlled exclusively by oscillations in the catchment and that the inhabitants simply took whatever they could get in proportions roughly reflecting their natural availability. The question may now be raised whether human choice played any part in forming the observed frequencies. Fig. 9-2 shows the percentage fluctuations of total mammal elements against total bird elements. Birds overwhelm the mammals in all the lower strata up to the 5-Scaup, after which a trend develops towards increased mammals with time, significantly interrupted only in the 8-LFL when birds dwindle to a mere 20%. Also, there are minor reversals in the 13-LAL and 15-UAL, both cool-wet episodes in which divers increase against dabblers. Overall, this curve is not too different (8-LFL excepted) from the diver/dabbler curve (Fig. 8-7) which is thought to reflect a steadily maturing, infilling Lower Klamath Lake. If the model of opportunistic procurement is maintained, then we are obliged to accept that the marshed-over lake was steadily reducing its bird population as time passed, with only periodic minor recoveries which were never enough to reverse the inevitable trend. Thus mammals came to play an increasingly important part in the inhabitants' diet through time.

The trouble with this view is that it fails to account for the 8-LFL anomaly in Fig. 9-2 and it also fails to deal with the rapid (but unquantified) rise in fishbones from the 11-USFL onwards, culminating in dense patches of fish remains in the 15-UAL. Were numerical data on fishbones available, these would have the effect of displacing the graph line in Fig. 9-2 substantially to the left (e.g. Fig. 9-3) after the 11-USFL, thus converting it to a three-step trend, plus the 8-LFL anomaly as an additoinal step.

Figure 9-3 provides a slightly idealized model of four dietary episodes: Step I (2-Coot to 6-S&B) in which the inhabitants were eating abundant (diving) waterfowl supplemented by dogs, the occasional migratory artiodactyl, and bison when they became available; Step II (8-LFL) in which they ate dogs, artiodactyls, bison and only the occasional waterfowl over a few centuries; Step III (9-LSFL to 11-USFL) in which waterfowl are once more a significant part of the diet, but less so than before and with increasing numbers of ducks and geese; and Step IV (12-TSFL to 15-UAL) in which the diet contains increasing amounts of fish, decreasing amounts of dog, and increasing numbers of fur-bearing animals--the last two trends connected to socioeconomic forces rather than to ecological changes.

Each of the four steps, of course, contain the short-term oscillations already' fitted to the deterministic/climatic model. However, changes from one step to the next are of larger moment than these, and the mechanical model fails to explain the larger changes. It is suggested that human decisions in the face of specific catchment changes have contributed to the larger shifts in diet, and each decision concerned the role of the site within the larger subsistence round.

Site Roles

For the first 2.8 millennia of its existence (ca. 5,300-3,000BC), Nightfire Island was used as a seasonal waterfowling station by household groups requiring little living space. Hunting and foraging trips were periodically launched from the small artificially maintained platform so that mammal bone occasionally reached the site from the surrounding catchment. Changes in ratios reflect short-term oscillations in climate and catchment configuration. Whenever the

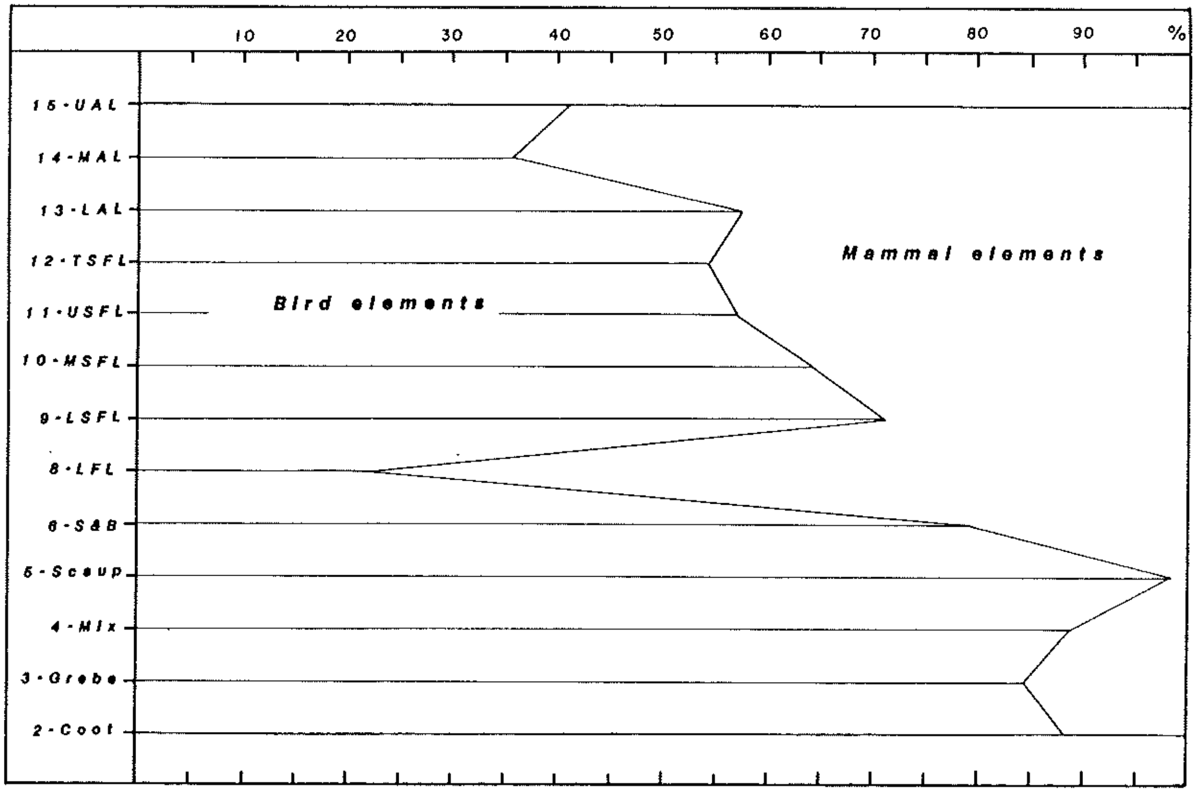

Fig. 9-2 Fluctuations in the ratios of bird/mammal elements by stratum.

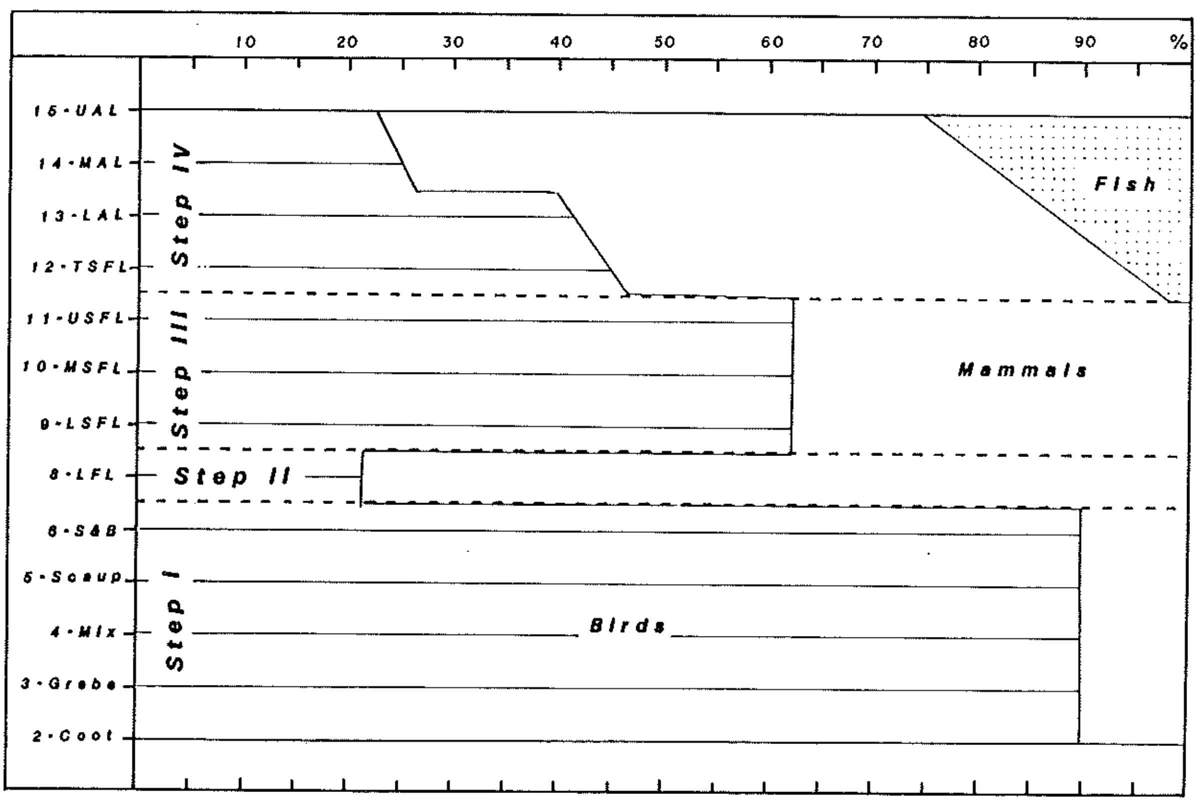

Fig. 9-3 Summary diagram of dietary episodes in the development of the Nightfire Island sequence, in four steps. The amount of fish in Step IV is a qualitative estimate.

lake level dropped and the shoreline retreated from the site, Nightfire Island was simply dropped from the group's list of options in its annual subsistence round. Whenever the shoreline advanced around the site again, it was refurbished and put back on the list. As time passed, the predominant diving birds taken here changed from coots, to grebe, to coots again, then to scaup. Reasons for these changes are unfathomable: They may reflect changes in water depth, in the marsh/open water ratio near the site, in the months of occupation of the site, or in the flyways of the three birds involved. A cogent argument can be made for each of these but neither is to be preferred over the others.

Soon after 3,000BC a decision was taken to convert Nightfire Island into a winter (?) village. At enormous costs in effort, the marshy platform was stabilized with rubble and sand, then expanded into a reclamation project (the 6-S&B) no doubt encouraged by signs that the lake level was dropping. The underlying reasons for this decision remain obscure, but catchment changes certainly encouraged it. In its pioneering days, the community continued to rely heavily on scaup as the staple meat supply, and half of the animals they ate were dogs. This, of course, has no bearing on the relative meat-weights consumed, as the occasional bison represents thousands of birds in nutritional terms. A more realistic view of the meat diet is that the people ate mainly bison and dogs when they could, supplemented by a steady supply of scaup, with only sporadic contributions by other animals to the meat diet. This switch in site role at the end of dietary Step I thus had little impact on the overall pattern other than to increase the amount of dog eaten at the site.

The decision to invest heavily in the site was rather ill-timed as the lake edge continued to retreat from the site during the 8-LFL to the point where the waterfowl staple was no longer accessible. Although the villagers were now able to dig more pit house floors into the now drying (and calcifying) deposits, the retreat of the marshland forced them to rely more heavily on mammals (Step II) so that the site was converted eventually to a seasonally occupied gathering camp with supplementary hunting. This lasted for a few centuries until a point was reached when it was probably abandoned for a brief period. If so, this event would be represented in the site by the First Marker Horizon of Chapter 3.

Throughout dietary Step III, the site reverted to a permanent village whenever its location was tenable. It was possibly abandoned after the 9-LSFL for a century or two, then again after the 10-MSFL for about six centuries, and briefly again at the end of the 11-USFL at around 0 AD. With each return, the village platform grew in size, and the diet altered in sub-steps coterminous with the fluctuating catchment and the steady marsh-over of the lake.

The 12-TSFL marks another shift in the site role that correlates with the advent of dietary Step IV. On the return to the site after a short abandonment around 0 AD, it was converted to a seasonal fishing village occupied by smaller groups. Hunting and waterfowling continued to contribute bone to the site. There are no realistic grounds for believing that fish became available near the site for the first time in the 12-TSFL, unless we assume that the Sheepy Creek drainage became the focus for sucker runs only after 100AD. As this cannot be demonstrated by other means, it seems more likely that the pattern of the larger subsistence round was altered at this date so that the site no longer played a central role, but reverted to a Spring and/or Fall peripheral camp.

The Rival Models

Arguments for and against each model may now be summarized. In support of the Know-it-all Model, there is the strategic wisdom in choosing to place the site in this location in order to maximize the amount of accessible marsh edge within the catchment (Chapter 1).

Although the 6-S&B stabilizing event suggests a highly organized marsh-adapted society, this occurred too long after the people's initial arrival to provide convincing support for the case. Instead, we have the immediate exploitation of marshland animals requiring specialized traplines, and the apparently minor reliance on dogs in the first occupations (Chapter 7). Other than these points, the Know-it-all Model has little to recommend it, because the site was not used as a basecamp in the annual round of its first inhabitants.

The case for the Learner Model has somewhat more support thus far: The site's early role as a waterfowling station may reflect an experimental, probing stage of the marshland adaptation, followed by increased investment in the site, with more time each year spent in the marsh itself. The trend towards more ducks and geese in the diet may reflect not only the marsh-over of the lake, but also increased technical skills and equipment needed to acquire the larger and (at least to our judgement) better tasting waterfowl. Finally, the rise in fish remains could be seen as stemming from an increased refinement in waterfowling equipment (nets and skeins) that gave them access to the lake's least visible asset. Fishing would then be taken as the culminating refinement of the lakemarsh adaptation. Each of these possibilities will have to be tested against the artifactual data.

ENDNOTES: CHAPTER NINE

1. Typological arguments in support of the post-1300AD date for the 15-UAL are advanced in Chapter 13.

CHAPTER TEN

NON-FLAKED STONE ARTIFACTS

Before analyzing the more abundant and complex obsidian tools, this chapter will cover those larger, heavier artifacts shaped and finished by grinding, pecking, hammering and grooving. Although some flaking may have resulted from use damage, or from rough conversion after breakage, it was not used in manufacture. Basalt and scoriacious lavas were used almost exclusively to make these tools.

There are three groups of material: those associated with the processing, storage and serving of dried meat and plantfoods (mortars, bowls, platters, pestles, mauls, grinding slabs, manos); those associated with equipment for procuring game, fish, and waterfowl (atlatl weights, bolas stones, net sinkers); and finally those various roughly shaped and battered rocks used as hammerstones either for making the above objects or for flaking obsidian. Descriptions and discussions follow in this same order.

Pounding and Grinding Equipment

Mortars and pestles were still in use among the Modoc and Klamath at the time of contact when they were used for pulverizing dried camas roots, wocus seeds, dried meat, and sometimes whole fledglings or fish. Although they were used extensively outside the marshes, their use for processing marsh-related foods is also well attested. Grinding slabs and manos excited less comment from early ethnographers so that there are no good analogs for their use. It is assumed that they were used mainly for grinding wocus seed in the Nightfire Island catchment. Because plant remains were not recovered during excavations (flotation methods were still in the experimental stage at the time) these artifacts provide the only general reflection of plantfood exploitation by the site's inhabitants.

Under the conditions of the Know-it-all Model, both items should occur in their finished forms in the lowermost strata, having been brought in by fully marsh-adapted peoples. Designs should remain stable through time, but the relative abundance of grinding/pounding equipment can be expected to change in accordance with the vagaries of the marshland's extent and with switches in the site's role. Also, more traces of on-site manufacture are to be expected at times when the site was a permanent village.

A lifeway that fits the Learner Model could produce two quite different data-sets for these items, depending on whether the equipment had been developed already in a hunter-forager system outside the marsh (in which case the data would resemble those for the Know-it-all Model) or had been developed during the marshland adaptation. In the latter case, the earliest strata should yield a few roughly-formed pieces, followed by strata with more diverse and refined equipment. Thus a distinction between the rival models will be possible only if the last pattern emerges in the data. All these models are based on the assumption that the earliest occupants were not using wooden pestles and mortars, replaced later by stone ones.

Mortars and Vessels

Altogether 66 specimens were recovered from 13 pits on the southern and eastern sides of the site. Figure 10-1 gives the fragment count per stratum with a breakdown of the types of rock out of which mortars were shaped. Because heavy fragments tend to settle

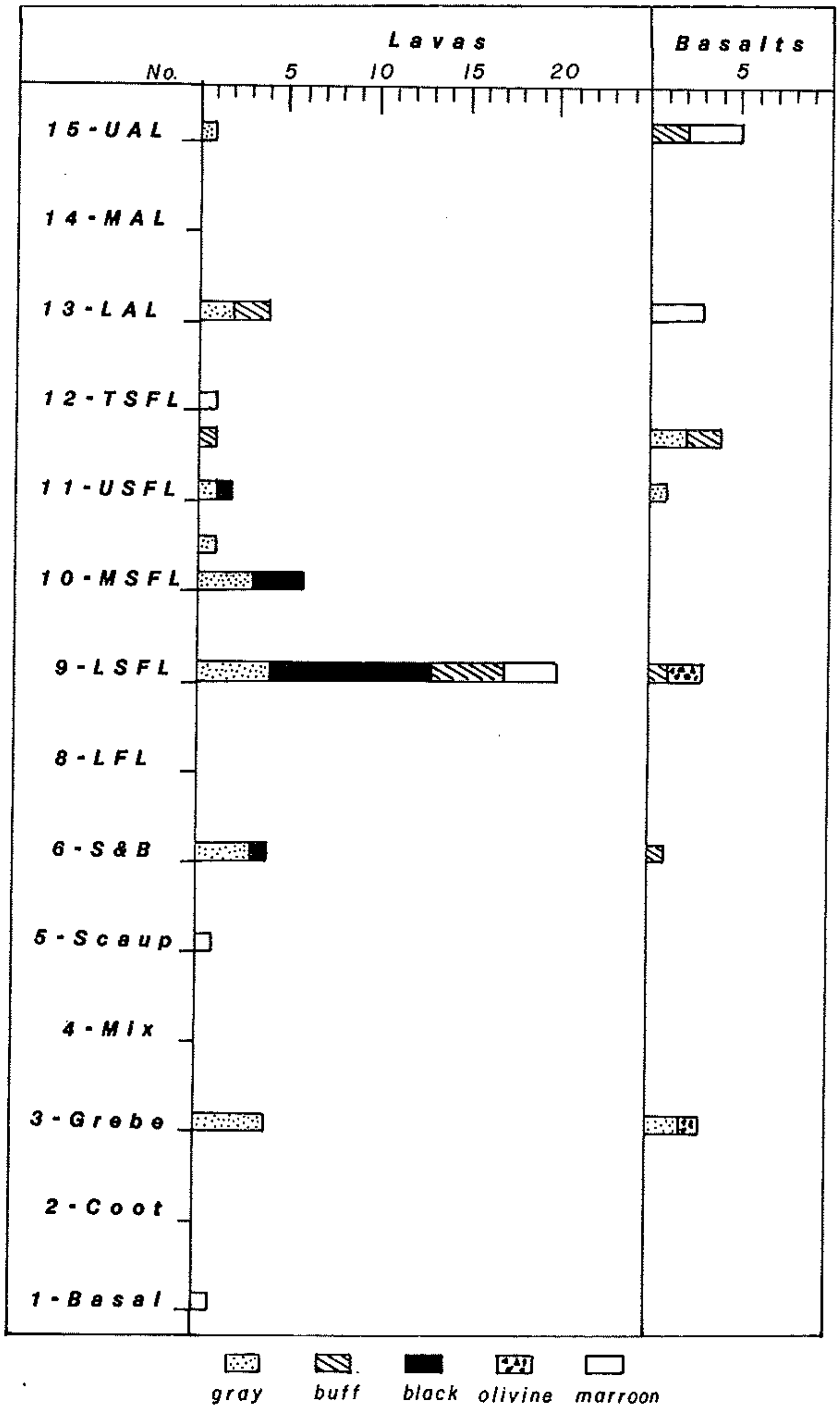

Fig. 10-1 Numbers of mortars and mortar fragments per stratum.

in mud, the context of the specimens in the 1-Basal and 3-Grebe may be in doubt. The single specimen in the 1-Basal (Fig. 10-4g) is from a thin gray clay lens in H7 and the 3-Grebe specimens (Figs. 10-5bc, 10-6c, 10-8a) all come from Pits N, T and X which contain numerous fragments in overlying layers. Not until the 6-S&B can we be reasonably certain that the context of the fragments is sound. There is a significant increase in the density of specimens in the 9-LSFL and a marked shift towards harder basalts for mortar manufacture in the Arrowhead Loams.

A typical mortar fragment is shown in Fig. 10-2. All but 26 specimens are, like this example, too fragmentary to allow a reconstruction of the original mortar shape. Specimens which are diagnostic range from complete to very small rim fragments. Reconstructions followed the routine procedures used for reconstructing ceramic rimsherds.

Five types can be recognized (Fig. 10-3): Type 1 has an external depth greater than its diameter, and a converging base (Fig. 10-4). The only complete specimen (Fig. 10-4b) has a greasy fill in the lava vesicles exposed in the interior surface. Although Howe (1979) indicates that this design was used by the historic Modoc, and that its distribution coincides more or less with the Modoc tribal territory, this is not yet documented.

Type 2 is a very large mortar of indeterminate shape, but with a mouth wider than its depth. No complete specimens were recovered, and the shape of the bottom exterior could be flat or round (Fig. 10-5). In all fragments, the curvature of the side wall is too exaggerated for them to belong to the elongated Type 1 form. Two specimens also have rims which are thicker than the side walls. The reconstructions suggest bowls or storage vessels rather than mortars, but without the base portions this cannot be verified.

Type 3 is an unequivocal bowl (Fig. 10-6). There is one complete specimen and sufficient fragments for another two to permit an adequate reconstruction. The earliest of these (Fig. 10-6c) may be unfinished or intended as a platter or grindstone.

Type 4 is referred by Howe (1968, 1979)--on the basis of an informant's interpretation--to "old peoples mortars". These were private mortars employed by the elderly who had lost their teeth (Figs. 10-7 and 10-8).

Type 5 is a catch-all category for miscellaneous, poorly-finished specimens.

Although the sample of restorable specimens is very small, their distribution within the site does suggest an increase in the number of smaller over heavier types in the later levels of the Loams sequence. The more delicate bowls in basalt appear first in the later part of the same sequence. Among the heavier pieces, those from the 6-S&B and 9-LSFL appear to be larger and thicker-walled than mortars of the same type form higher up the sequence. Although these trends hint at increasing refinement and skill in mortar manufacture, such inferences cannot be placed on a sound quantitative footing.

Howe (1979) has discovered isolated specimens abandoned after breakage during manufacture. The hollow was formed by pecking out a ring at the mouth. This was deepened and the central column, thus isolated, was broken off at the required depth of the interior hollow.

Pestles and Mauls

The stone pestles are predominantly of one form, best described as cigar-shaped. A total of 10 whole examples was recovered, plus 132

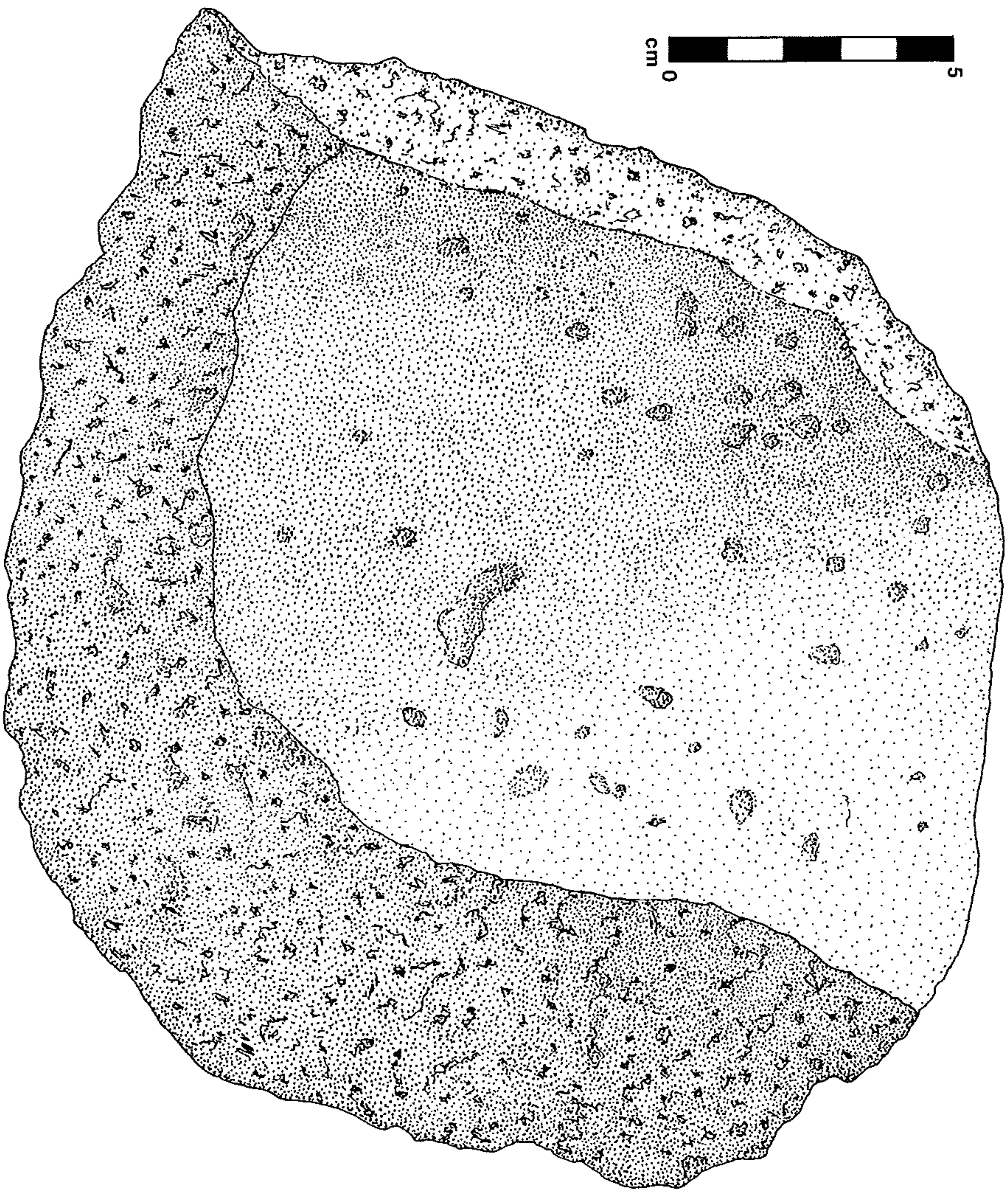

Fig. 10-2 Typical undiagnostic mortar fragment from which the original outline cannot be reconstructed. Black lava. From the 6-S&B in B9-10.

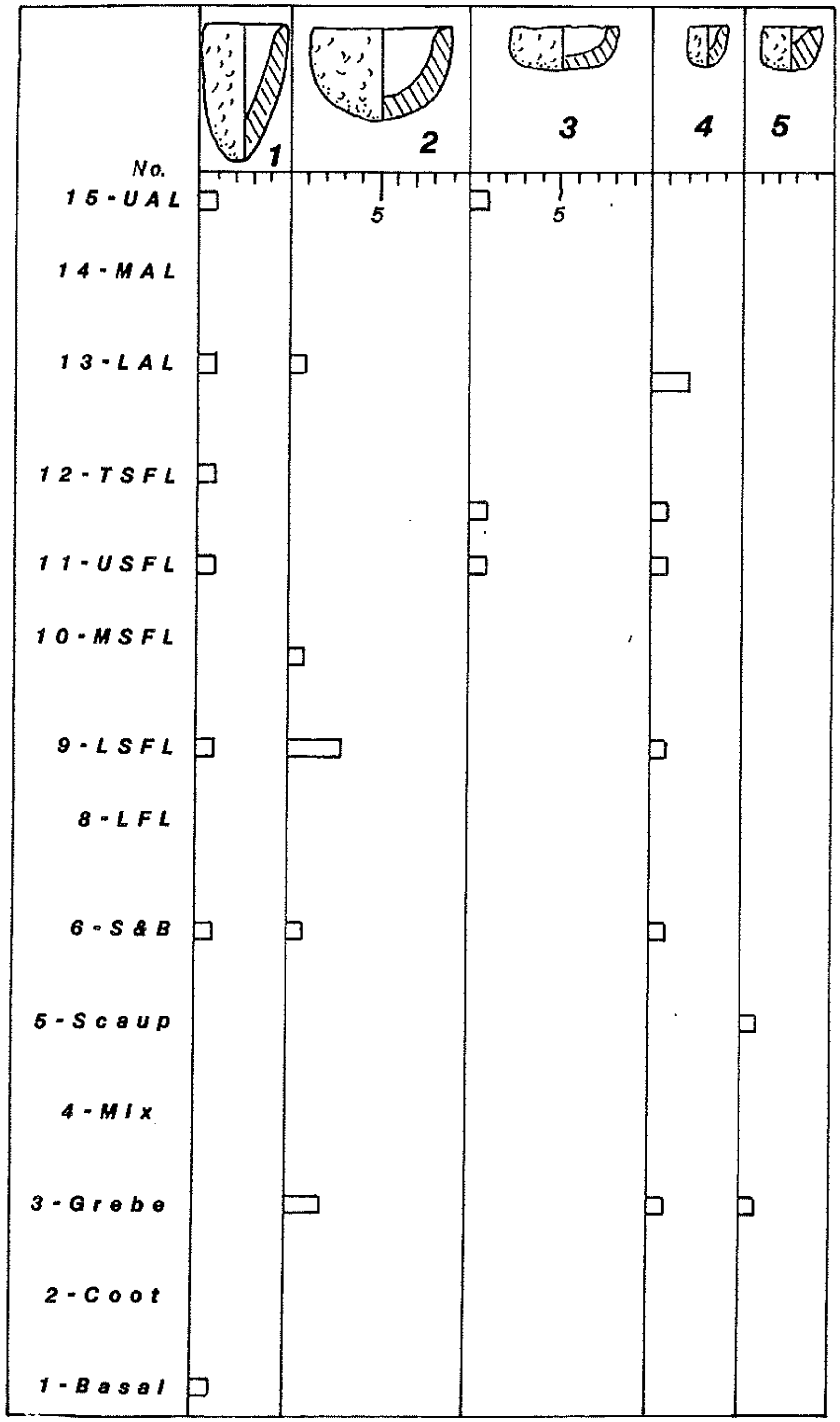

Fig. 10-3 Distribution of mortar shapes by stratum. Type descriptions are given in the text.

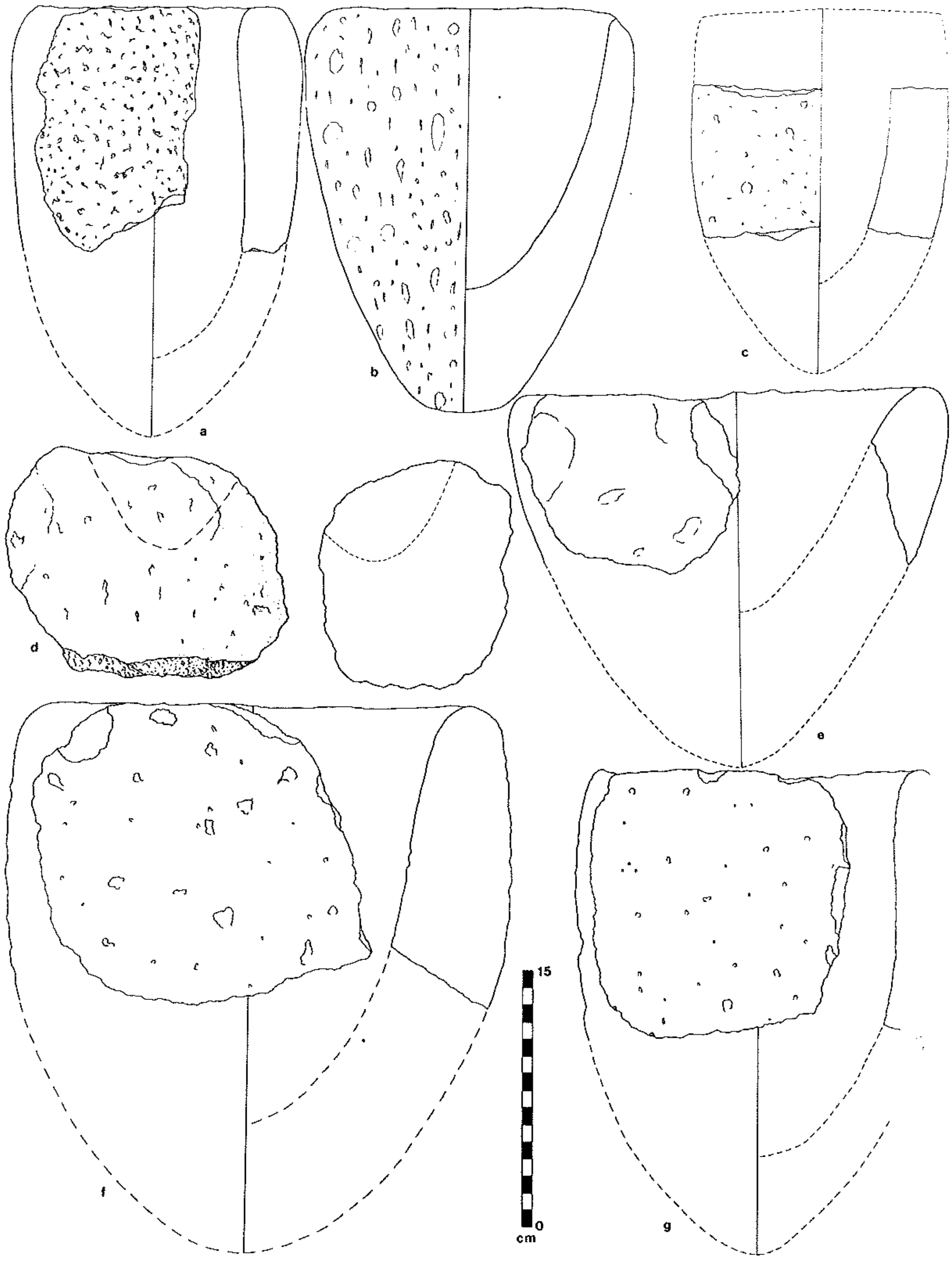

Fig. 10-4 Type 1 mortars: (a) 12-TSFL in J3; (b) 11-USFL in X3a; (c) 9-LSFL in X6; (d) fragment, 13-LAL in Q3a; (e) 15-UAL in P2a; (f) 9-LFL on floor B6/7; (g) 1-Basal in H7.

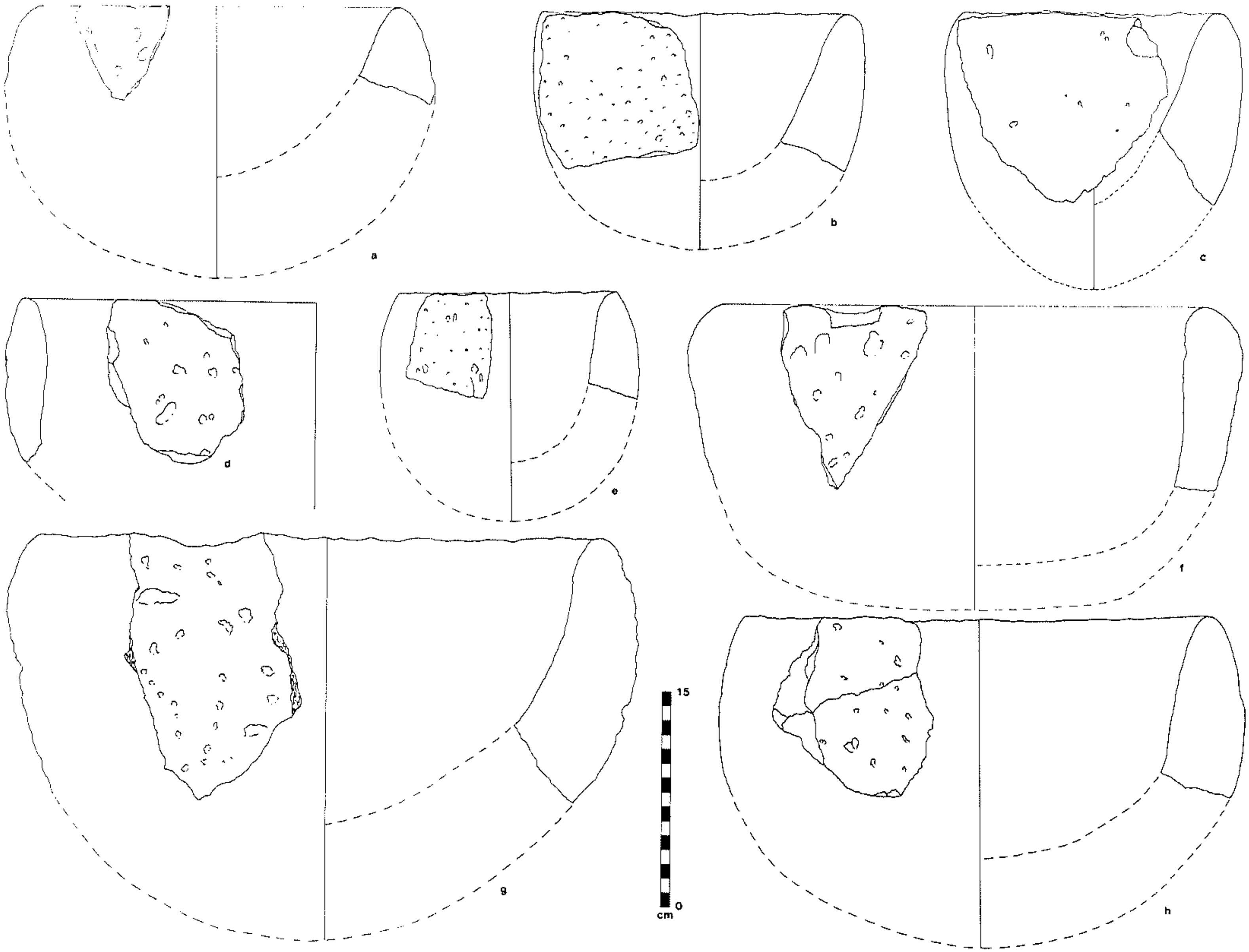

Fig. 10-5 Type 2 mortars: (a) 13-LAL in U1a; (b) 3-Grebe in T6; (c) 3-Grebe in X7b; (d) 9-LSFL in P9; (e) 9-LSFL in N4; (f) 10-MSFL in X5a; (g) 6-S&B in E11; (h) 9-LSFL in T5a.

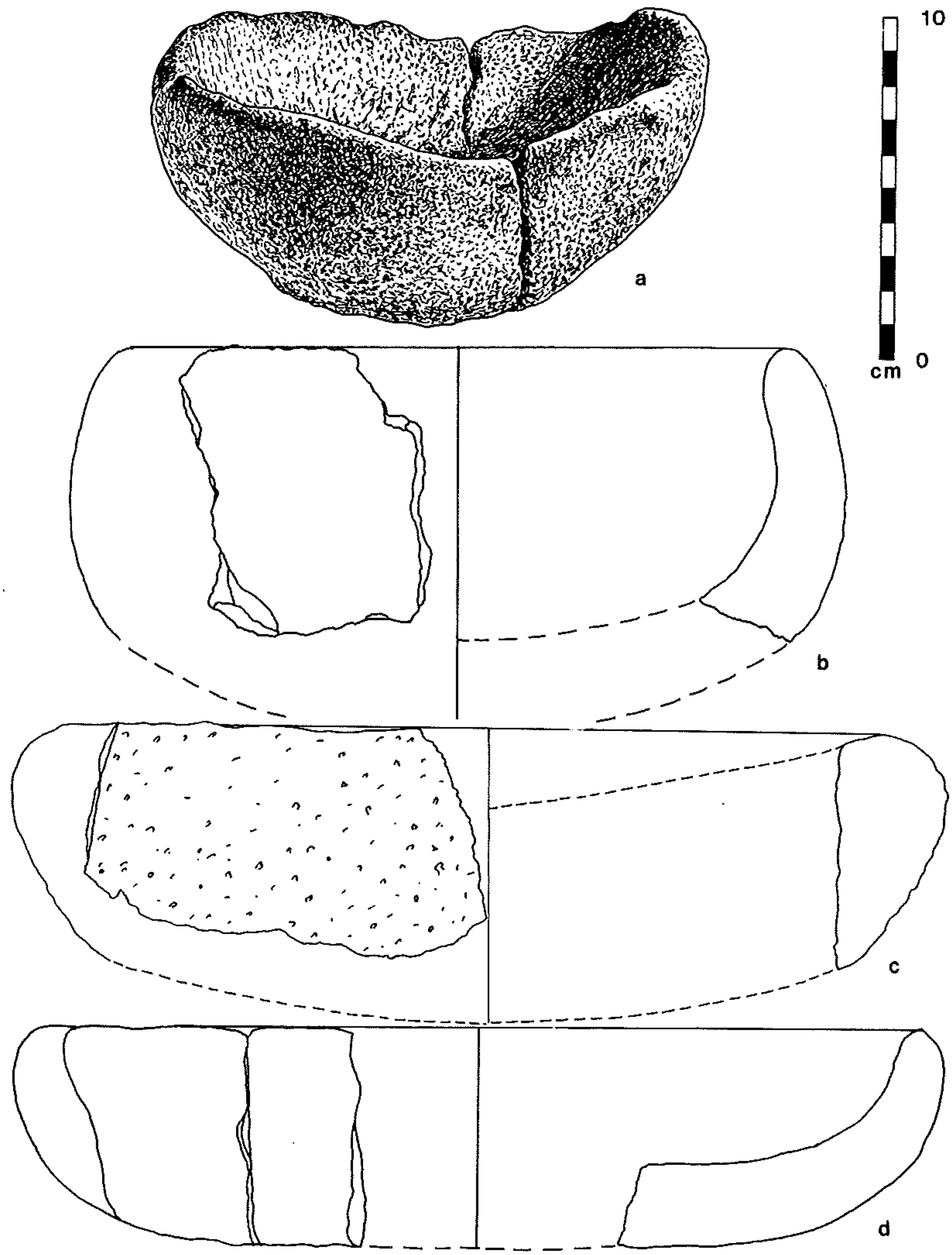

Fig. 10-6 Type 3 bowls: (a) 11-USFL from floor of the burned structure in E4b; (b) 15-UAL in P2a; (c) 3-Grebe in N7b; (d) 11-USFL or 12-TSFL in Q3c.

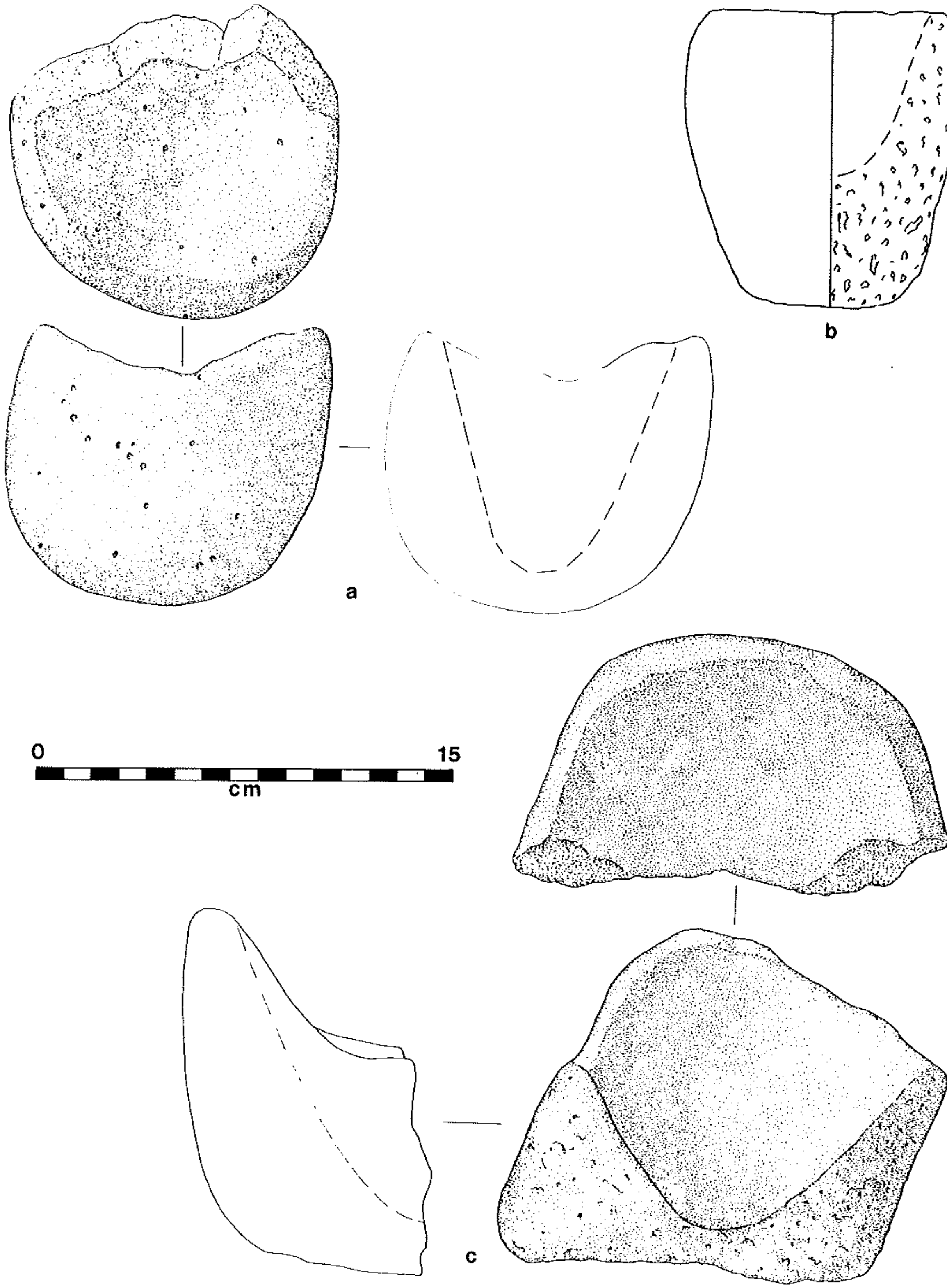

Fig. 10-7 Type 4 small mortars: (a) 11-USFL in X3b; (b) 6-S&B in J7; (c) 9-LSFL in T5a.

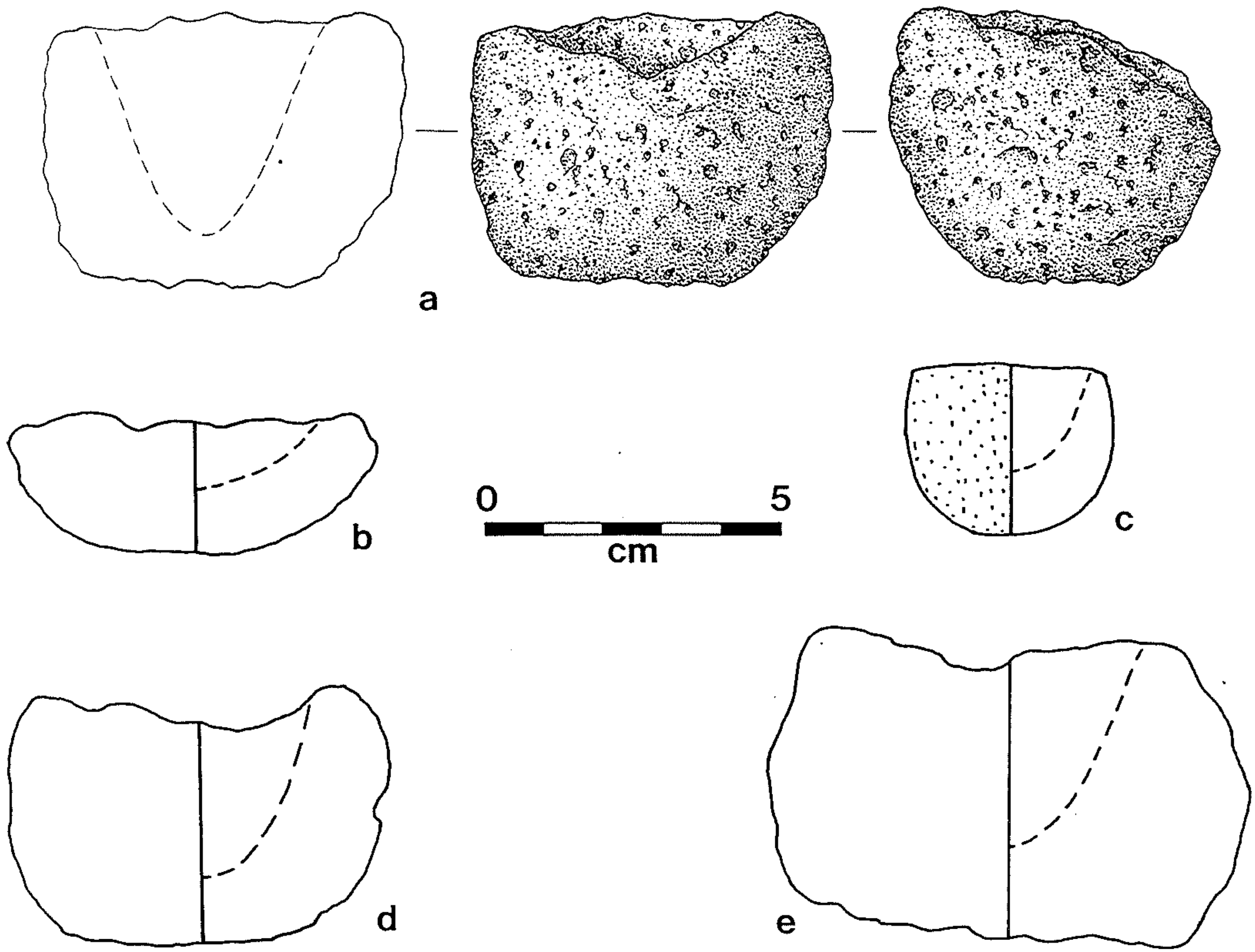

Fig. 10-8 Type 4 small mortars: (a) 3-Grebe in T6; (b) 12-TSFL or 11-USFL in Q3c; (c) 10-MSFL in Q4; (d) 13-LAL in Q3a; (e) 5-Scaup in 19b.

fragments. Their distribution by stratum is shown in Fig. 10-9. Like the mortars, these items are heavy and sink in mud, but the circumstances surrounding some of the deeper finds suggest little cause for doubt: the complete pestle in the 2-Coot comes from N8 (Fig. 10-10) with only two fragments several layers above it. Similarly, one almost whole specimen (Fig. 10-11a) in the 5-Scaup is from Y8b, above which there are no fragments at all. If these had been overlain by numerous other specimens, there would be more reason to doubt their contexts. The other two specimens are from X8 and V6 which both have overlying specimens so they are consequently suspect.

Pestles were made mostly of basalts, available near the site. Only 8 (5.6%) were made of scoriaceous lava--one of these from the 5-Scaup in V6 has a heavily weathered surface. Obviously, the additional weight and hardness of basalt made this a preferred rock type. There can be little doubt that they were used in combination with the mortars: their distribution overlaps with that of mortar fragments and their shape invites comparison with the interior hollow of the Type 1 mortars. Both ends could be used. Although six specimens form the earlier strata (Figs. 10-11 through 14) have curved, elliptical-sectioned tips to facilitate the grip, most others have symmetrical, circular-sectioned tips, of which four (7%) show clear signs of battering, and six others (10.5%) are spalled, suggesting that the more pointed end was occasionally used for pounding. Any low ridges or prominences along the body tend to show high polish (e.g. Fig. 10-16h). Fifteen (36.6%) of the butts are scaled or flaked around the sides from use.

When broken, conveniently shaped pestle fragments were reused as hand-held grindstones, thus providing a flat-ground face on the previously curved surface (e.g. Fig. 10-13d). Some longer tip fragments were merely reground across the fractured end to form a shorter pestle (e.g. Fig. 10-16a). A few smaller tip fragments were reused as pounders (e.g. Fig. 10-13b) as were conveniently shaped butt fragments (e.g. Fig. 10-15f).

Because of the extensive reuse of pestle fragments, there are too few specimens on which to base any judgements on design changes through time. Although the larger, curved-grip specimens are more numerous in the earlier strata, they occur together with conical-tipped specimens. A larger sample is needed to track the development of pestle design at the site.

Far less numerous are the flanged mauls. Two fragmentary specimens were found in the 9-LSFL, both heavily flaked in order to remove the flange itself, but leaving a slight constriction or neck above the flaked zone (Fig. 10-18ab). The restricted timespan of this type, and the deliberate removal of the flange may suggest that these were stray finds brought back to the site and converted to local needs. Although attributed locally to the Shasta to the south of the Modoc, their geographical distribution has yet to be documented. This same stricture applies to the complete specimen (of uncertain stratigraphic provenience) found by R. C. Howe (Fig. 10-18c).

A third group of pestles is the diminutive specimen, presumably used with the small Type 4 mortars. The most complete specimen is shown in Fig. 10-19. A second specimen from the edge of the 5-Scaup (P11a) has a similar shape, but no obvious ground surface. A third group from either the 12-TSFL or 11-USFL in Pit P is battered on one end and has a rounded grinding surface at the opposite end. The only other specimen in this category is nothing more than an elongated basalt pebble with a battered end from the 6-S&B in J8. The 5-Scaup specimen in 12cm long, and all the others were around 5-6cm long.

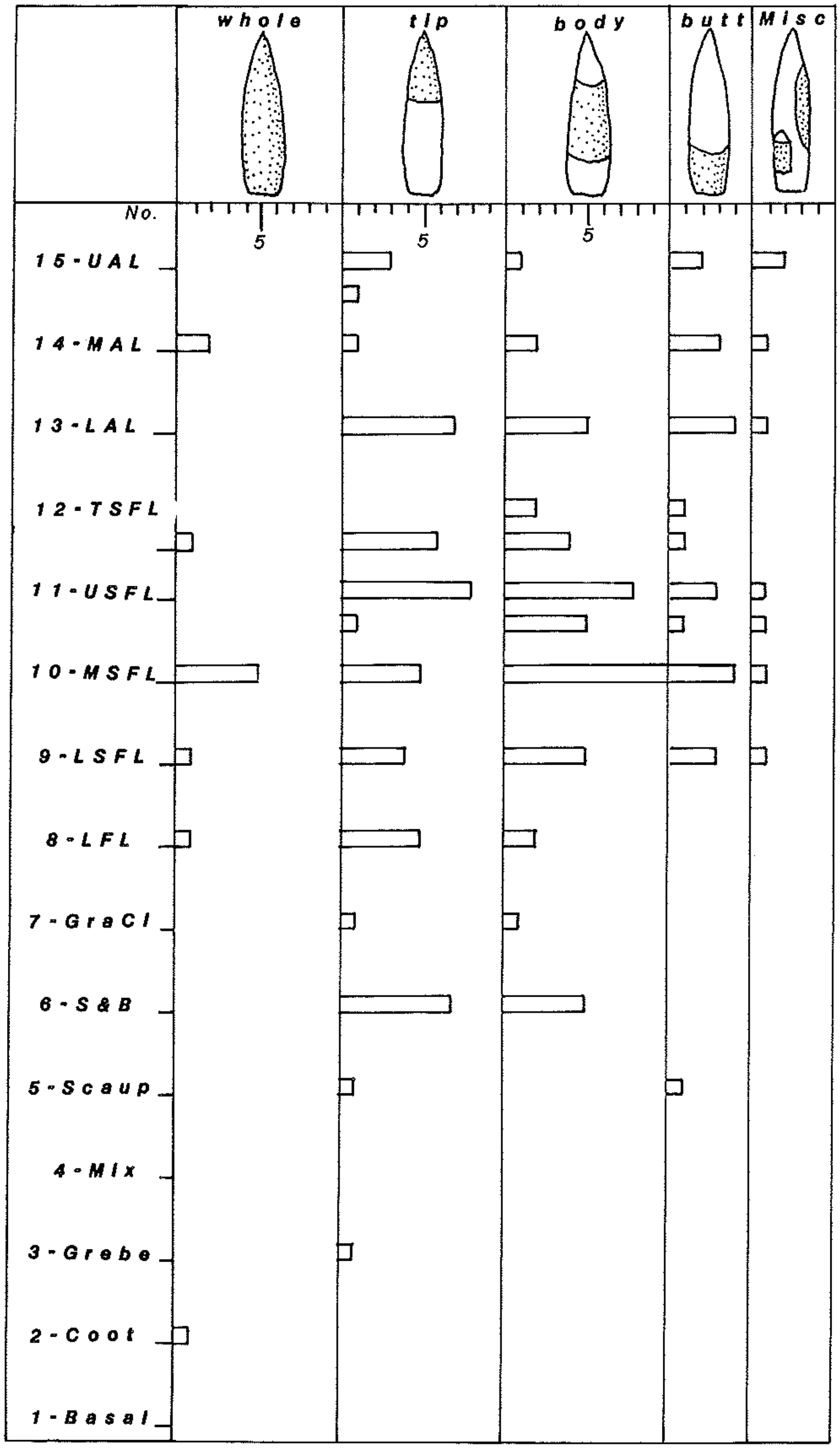

Fig. 10-9 Distribution of whole pestles and pestle fragments by stratum.

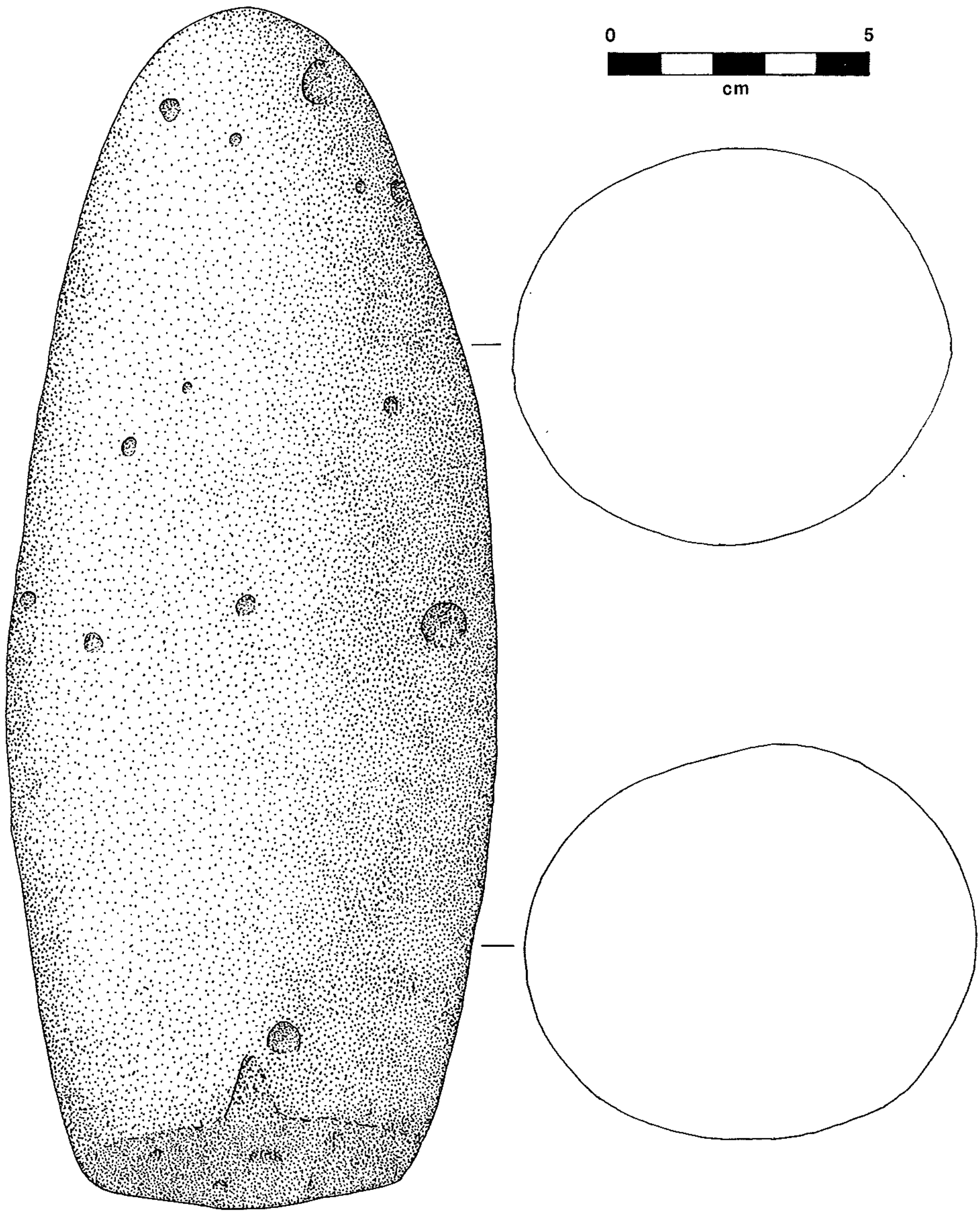

Fig. 10-10 Pestle from the 2-Coot in N8. Fine-grained basalt.

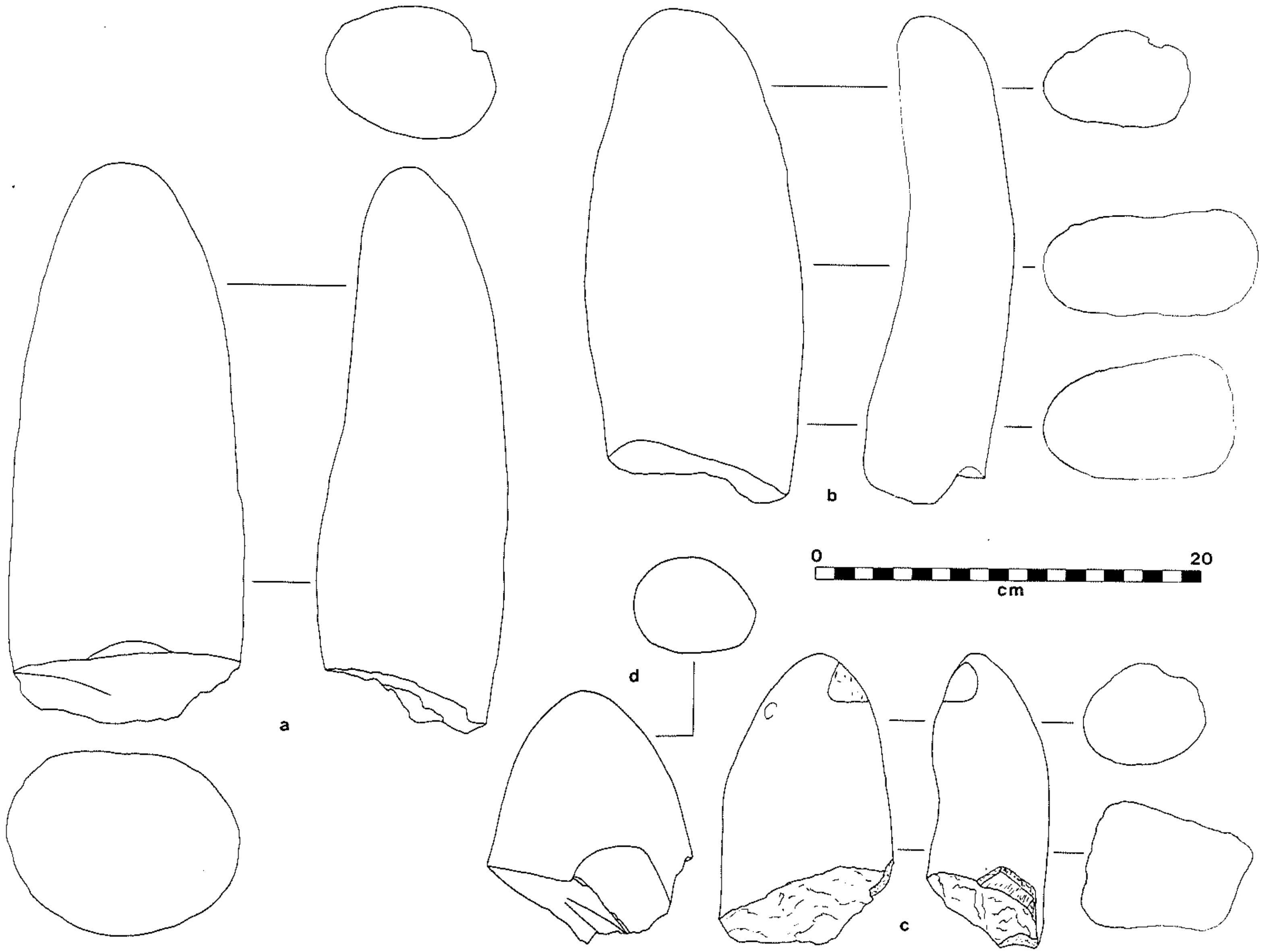

Fig. 10-11 Pestle fragments: (a) 5-Scaup in Y-8b, butt missing, localised polish on tip; (b) 6-S&B in J7, butt missing; (c) 7-GraCl in B8, tip fragment; (d) 6-S&B in H4, tip fragment with concave facet on one side.

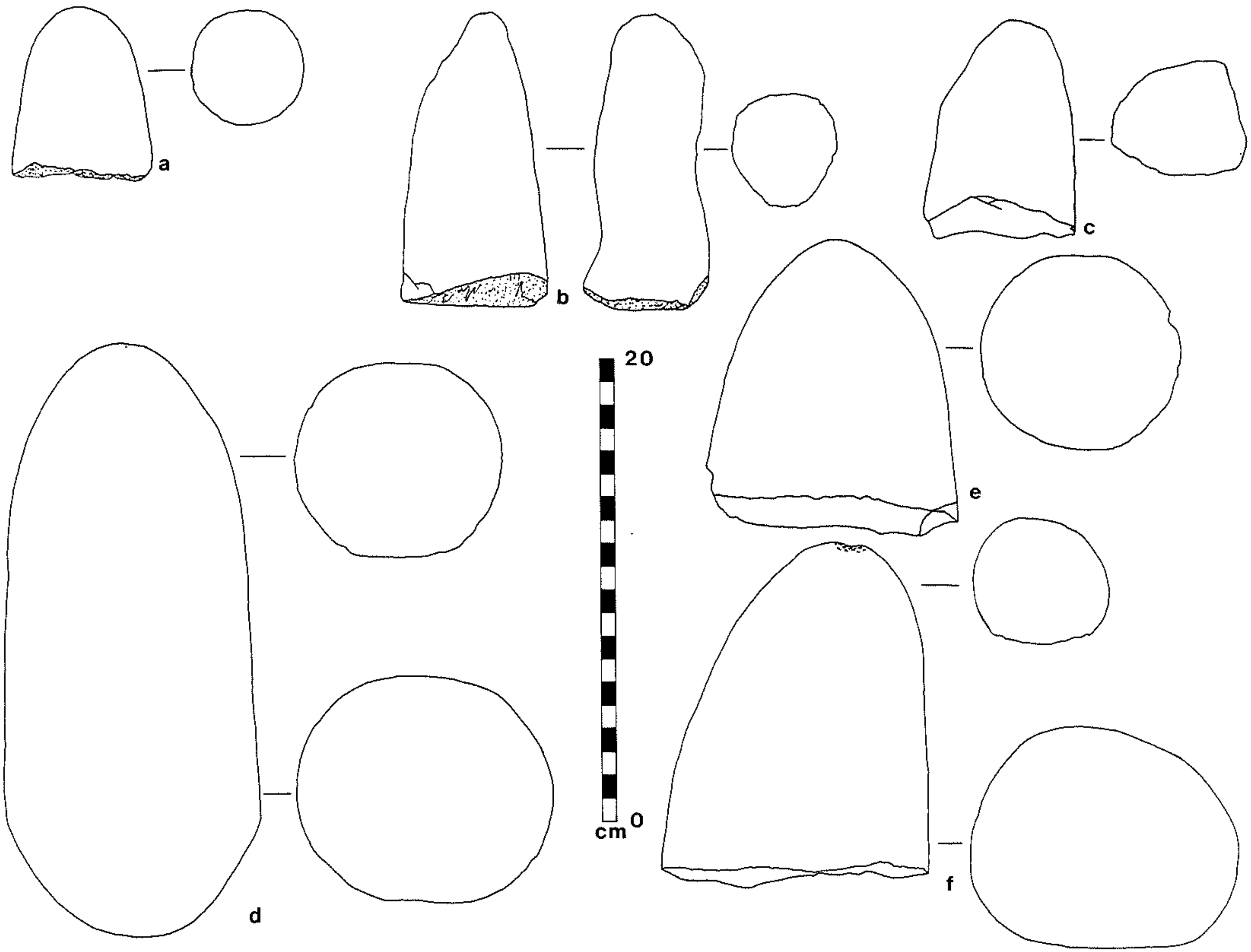

Fig. 10-12 Pestle fragments: (a) 7-GraCl in E10, tip fragment; (b-f) 8-LFL: (b) in E9, tip fragment (c) in H3e, tip (d) in H3e, whole pestle with rounded butt (e) in H3d, tip (f) in T5b, tip with battered end.

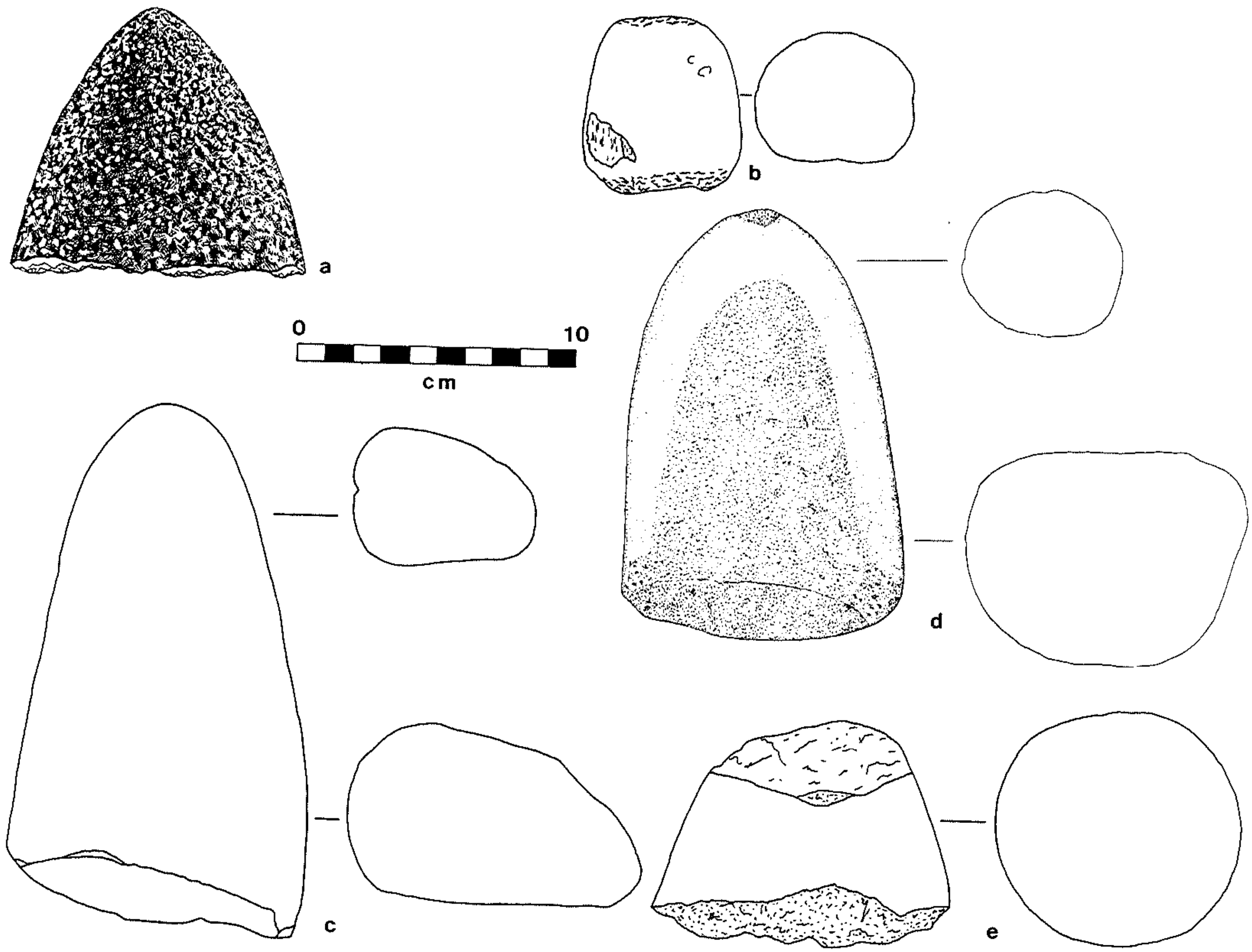

Fig. 10-13 Pestles and fragments from the 9-LSFL: (a) in U2b, tip (b) in T4, tip converted to double-ended pounder (c) in X7, tip with polished longitudinal ridges (d) in O2, tip with reground butt and battered tip (e) in N3, body fragment near tip, highly polished.

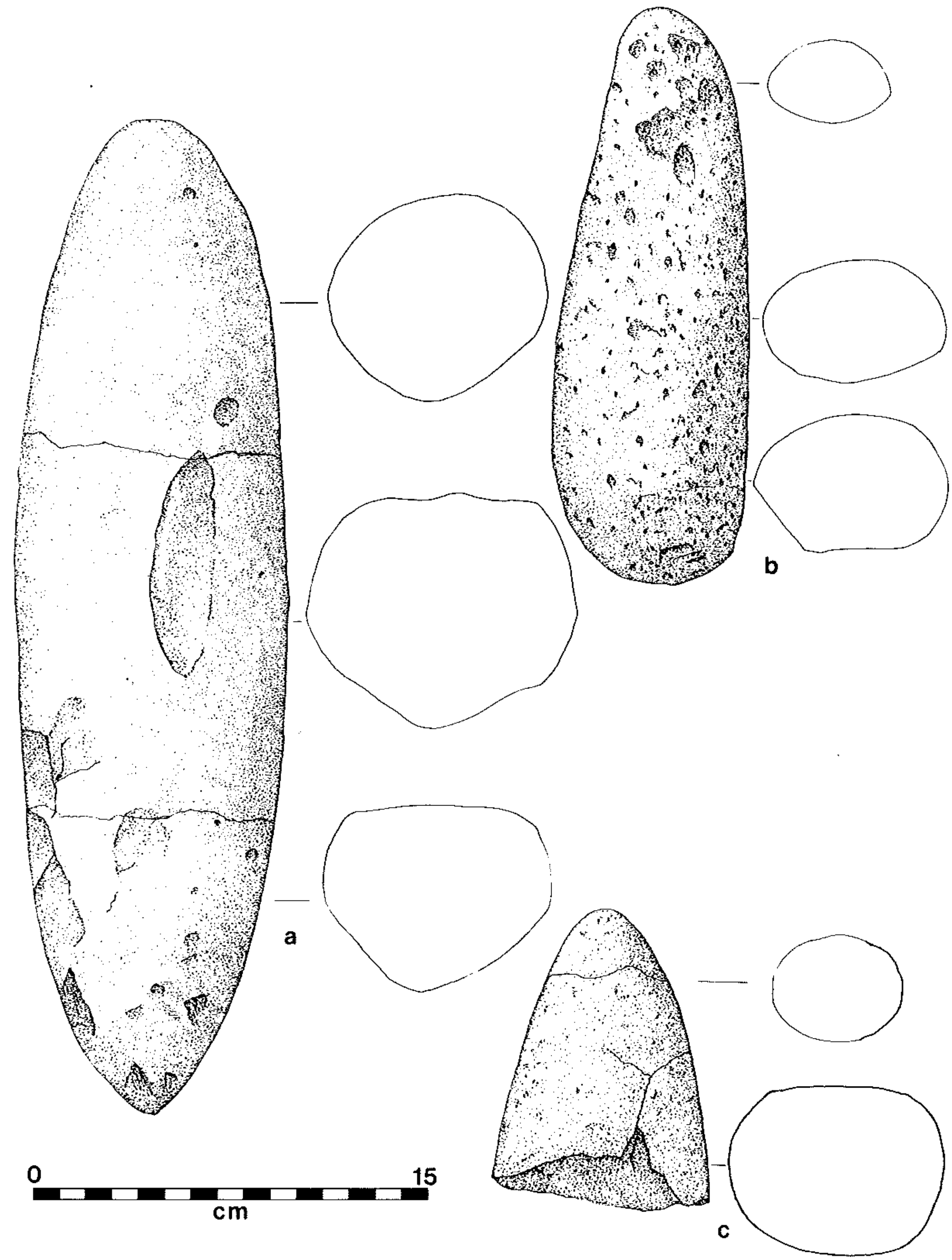

Fig. 10-14 Pestles and pestle fragments from the floor of the burned structure in E4b - see Fig. 18-9: (a) whole pestle, broken in two places, with firecracked surface (b) whole pestle, scoriaceous lava (c) tip fragment, firecracked.

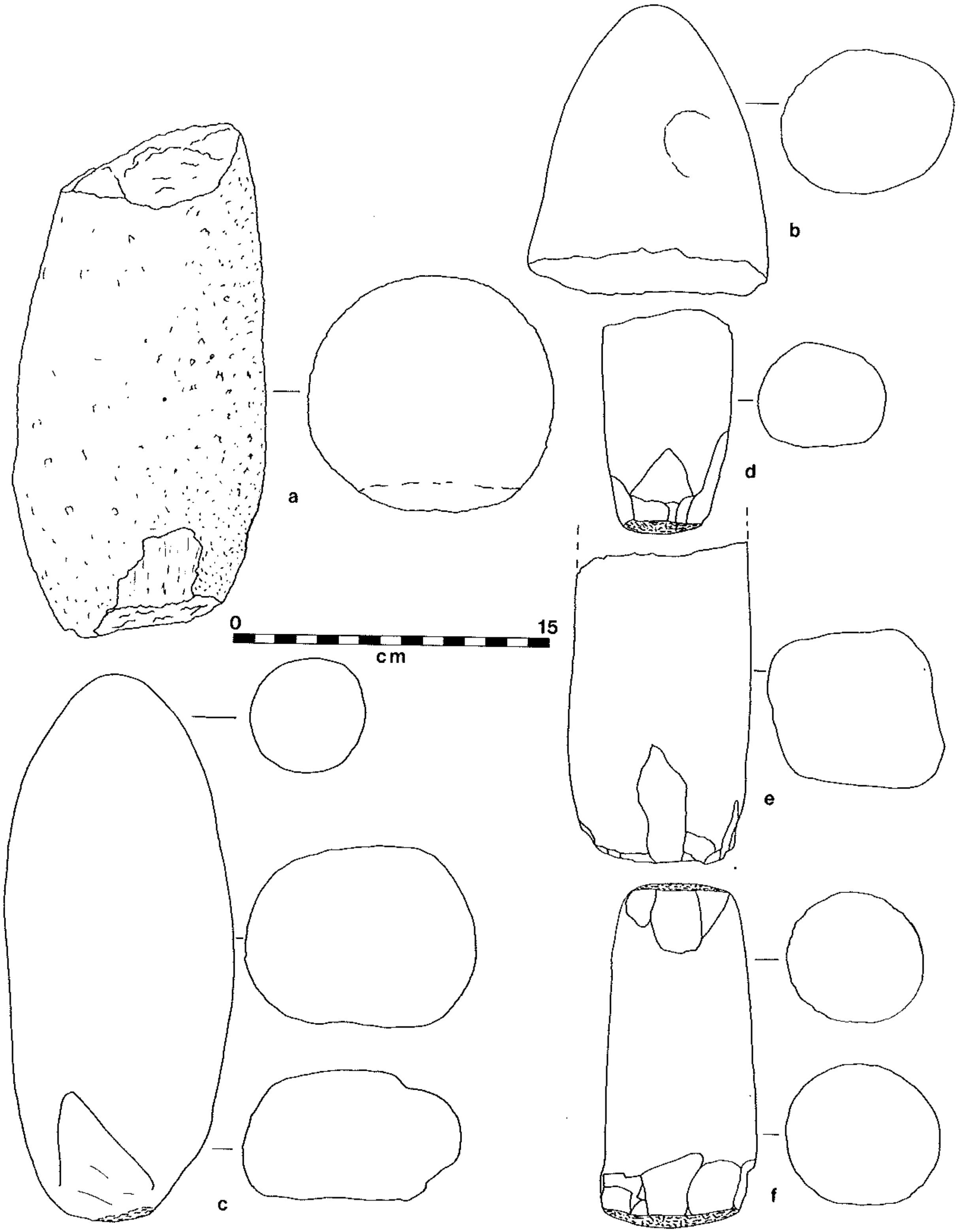

Fig. 10-15 Pestles from the 10-MSFL: (a) in pit house fill of E6, body fragment of scoriaceous lava (b) in Olc, tip (c) in pit house fill of E6, whole pestle with highly polished facets on opposing sides (d) in I7a, butt fragment with flaked end (f) in I7a, body fragment converted to double-ended pounder.

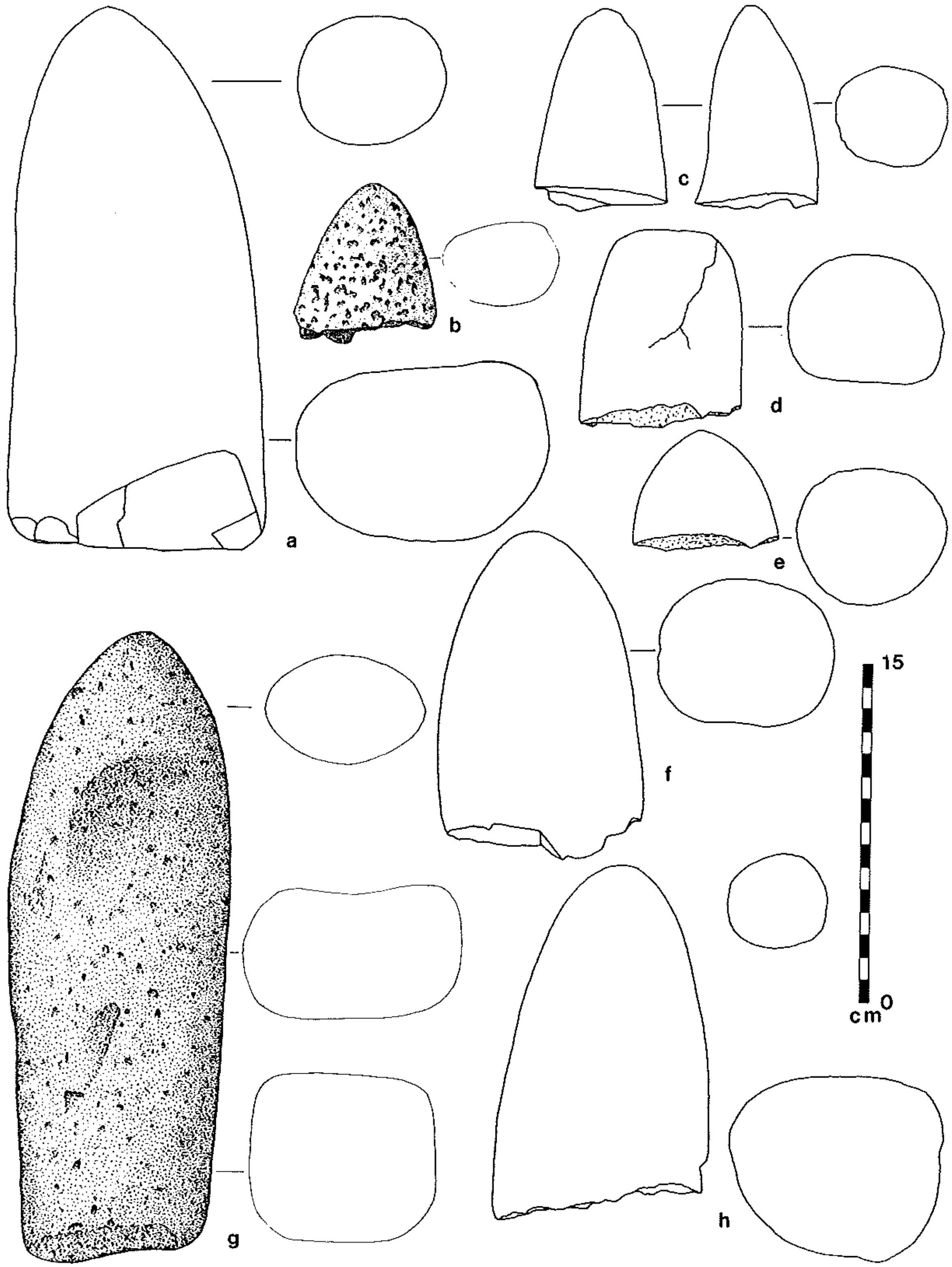

Fig. 10-16 Pestles and pestle fragments: (a) 11-USFL or 12-TSFL in S2-3; (b) as in (a) in B4ab, tip fragment; (c) as in (a) in Q3c, tip fragment; (d) 11-USFL in B4c, tip fragment; (e) 11-USFL in B4c, tip fragment; (f) 11-USFL in H3a, tip fragment; (g) as in (a) in E3-4, complete; (h) as in (g), tip fragment with polished longitudinal ridges.

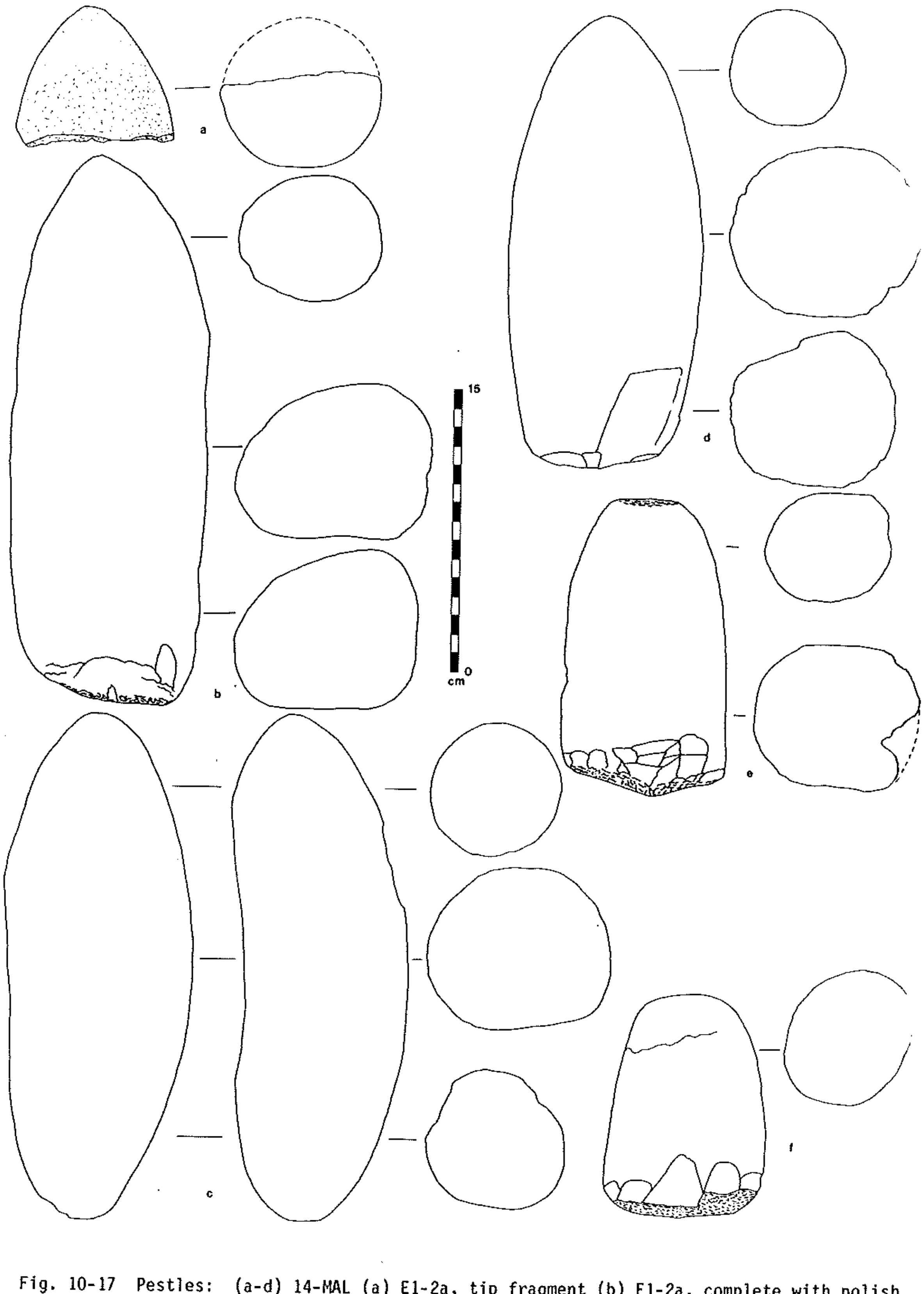

Fig. 10-17 Pestles: (a-d) 14-MAL (a) E1-2a, tip fragment (b) E1-2a, complete with polish on longitudinal ridges (c) V2, whole (d) V2, complete, with flaked butt; (e) 13-LAL in U1a, tip fragment converted to double-ended pounder; (f) 13-LAL in P3-4, tip fragment with broken end, converted to pounder.

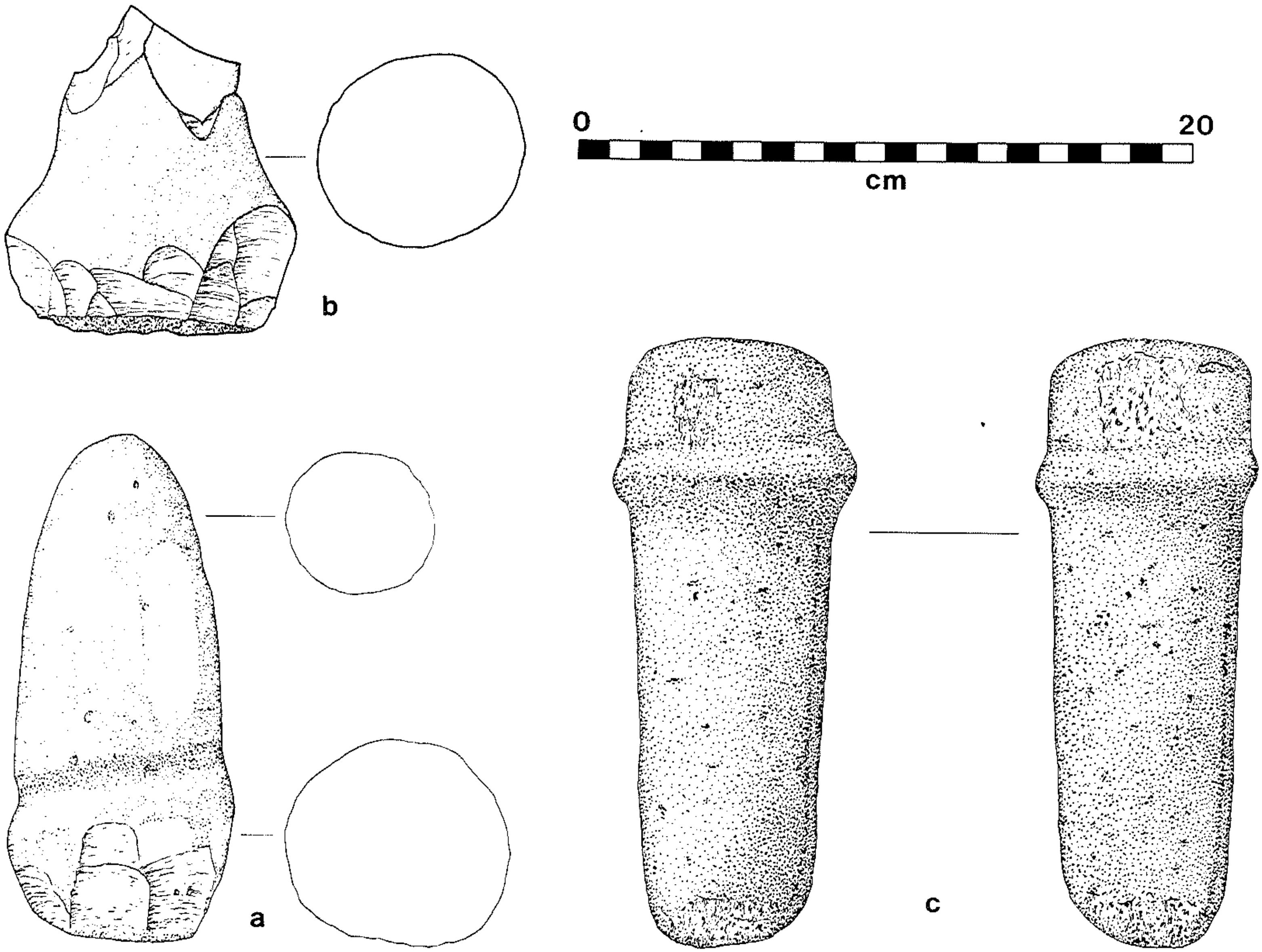

Fig. 10-18 Flanged pestles: (a) 9-LSFL in W3, neck intact, with flange deliberately flaked away (b) 9-LSFL in P9, butt fragment with flange flaked away; (c) probably from Arrowhead Loams between D and E, recovered by C.B. Howe.

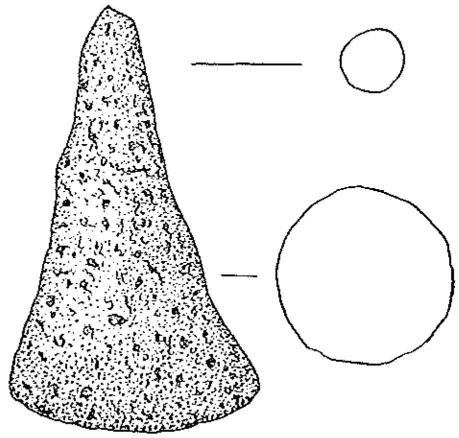

Fig. 10-19 Small pestle, 10-MSFL in 17a, scoriaceous lava. Full size.

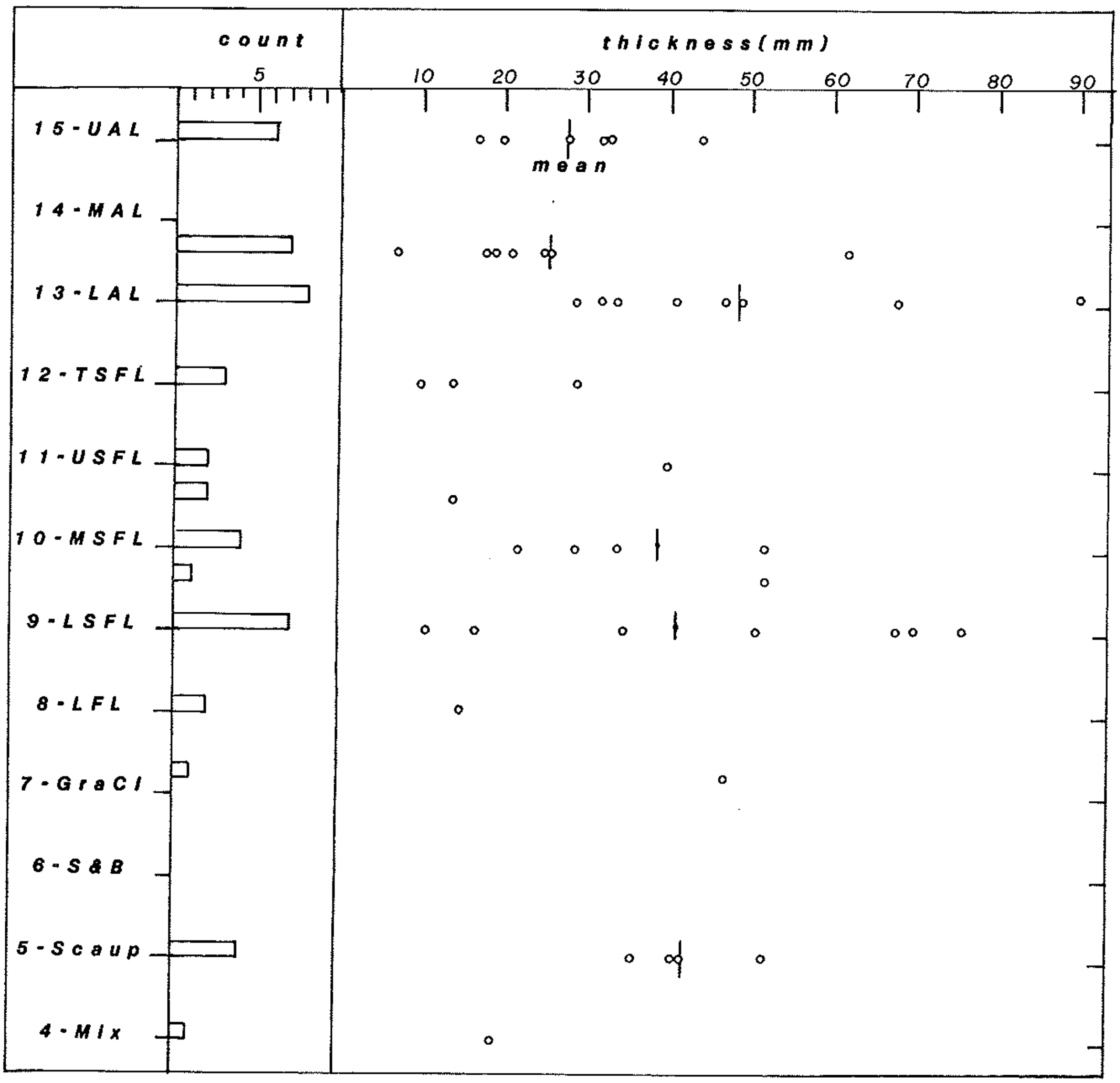

Fig. 10-20 Distribuion of Lower Grindstone fragments by stratum, also showing slab thickness.

Grinding Slabs

No complete lower grinding slabs were recovered, but 47 fragments were found, mainly in the easternmost Pits J, P, V, and Q with relatively few from surrounding pits. Their distribution by stratum is shown in Fig. 10-20. Three of the 5-Scaup specimens come from pit P and are almost certainly derived, but this need not be the case for the specimen from Y8b or the 4-Mix item in N7a. There is a higher density of fragments in the upper part of the Loams sequence. Because all the material is fragmentary, the only measurement possible is slab thickness. The means and ranges shown in Fig. 10-20 suggest a trend towards thin slabs during the Arrowhead Loams accumulation. Six specimens show burn marks, but these are scattered through the whole sequence and do not cluster spatially. All but four specimens are of basalt, with three of the exceptions in gray-black lava and one in tuffaceous silt. Altogether, 23 fragments had grinding faces on both sides of the slab--either flat or concave. Only 15 pieces had part of the original rim of the slab preserved--all others had four or more break facets around the edge. Rims are irregular and show no signs of deliberate shaping. Considering the preponderance of fragments with multiple broken edges, the original slabs must have been quite large to have broken up into so many pieces. However, smaller specimens were produced: C. B. Howe's excavations yielded a single complete specimen from between Pits N, O, U and T, probably from the Small-flake Loams (Fig. 10-21).

Hand-held Grindstones

Manos were created by systematic use of any conveniently shaped stone which came to hand: pebbles, split cobbles, slab fragments, mortars or pestle fragments and miscellaneous chunks. Very little effort was invested in creating formal shapes; consequently the collection of 54 manos defies typological subdivision. Instead, their stratigraphic distribution is given in Fig. 10-22 together with selected attributes. The specimen in Fig. 10-23a is virtually unique in that it has been extensively shaped, unlike the other two more typical specimens (Fig. 10-23bc) on basalt pebbles. Although typological changes are not apparent through the sequence, there is one reasonably clear change: specimens larger than 10cm in length proliferate for the first time in the 9-LSFL. No other changes are visible in this modest sample.

Flat Circular Grindstones

This type has a uniform shape, but it occurs widely scattered through the site. There is one in the 5-Scaup in U4b, another in the 6-S&B in J7, two in the 9-LSFL at P9 and X6, and four others from the TSFL/USFL--one in V3-4 and the rest from Q3c. These are of basalt and the rest are of scoriaceous lava, like the fragment shown in Fig. 10-24b. Also like this specimen, four others have grinding facets on opposite faces. Six of the nine specimens have a maximum thickness between 24-27mm. The others are 18, 20, and 36mm thick. Their function(s) remains enigmatic, but could include upper or lower grinder and/or platter.

Commentary on the Pounding and Grinding Equipment

The processing of plant foods did not become a significant activity on the site until the 6-S&B. Prior to this, while it still functioned mainly as a waterfowling station, items of such equipment

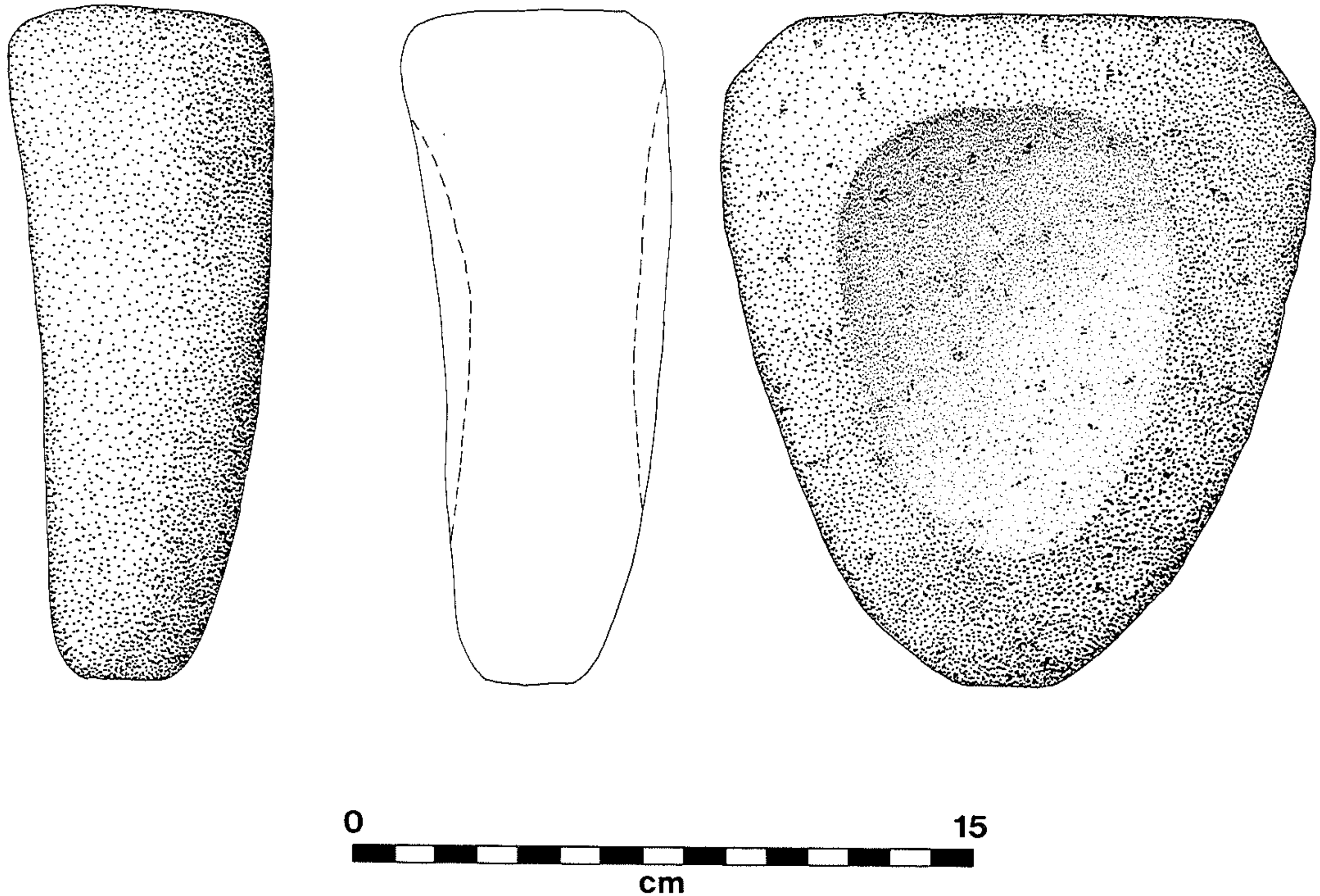

Fig. 10-21 Complete grinding slab recovered by C.B. Howe from the NOUT area, stratigraphic context uncertain.

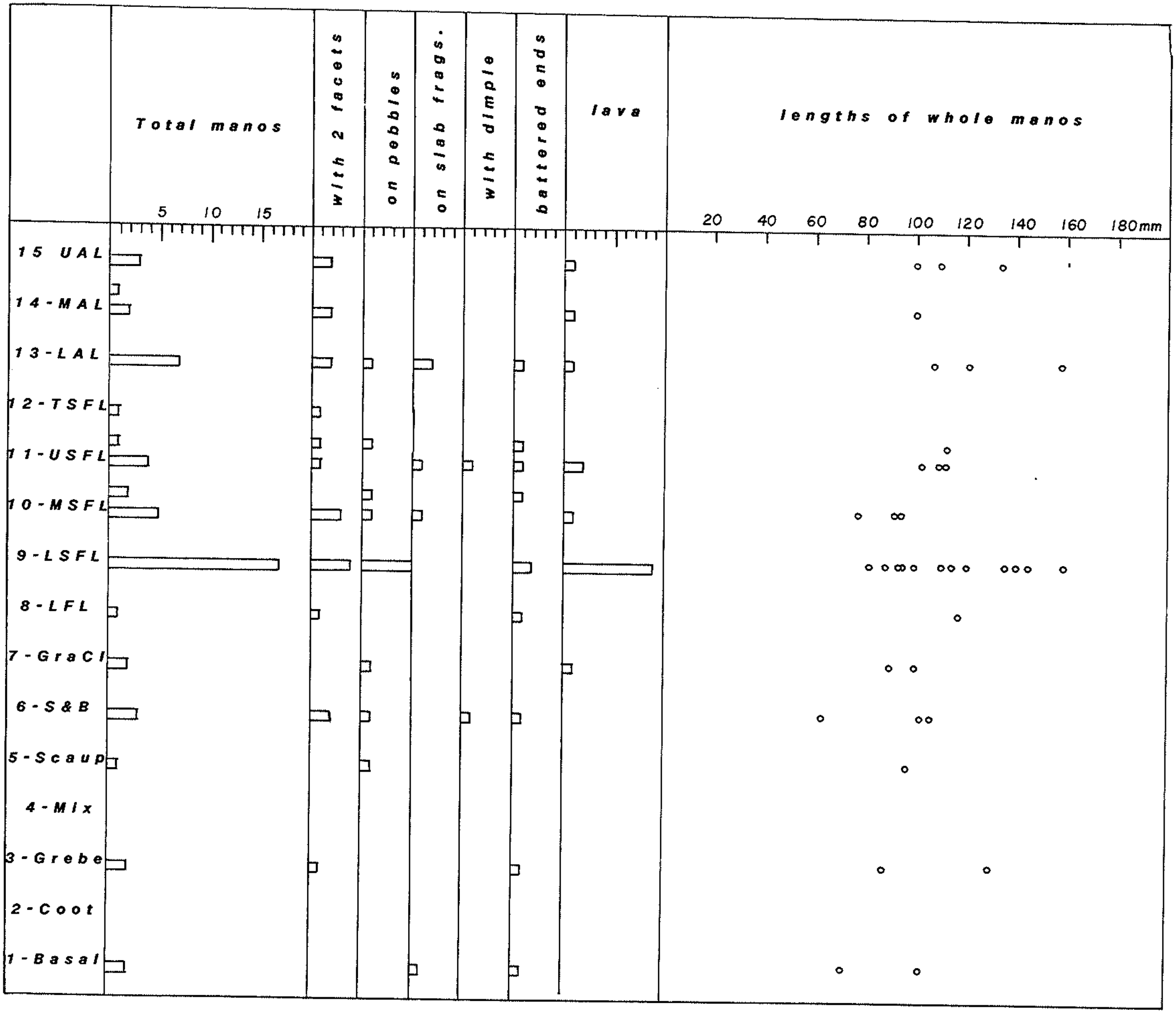

Fig. 10-22 Distribution of Manos by stratum, with distributions of selected attributes.

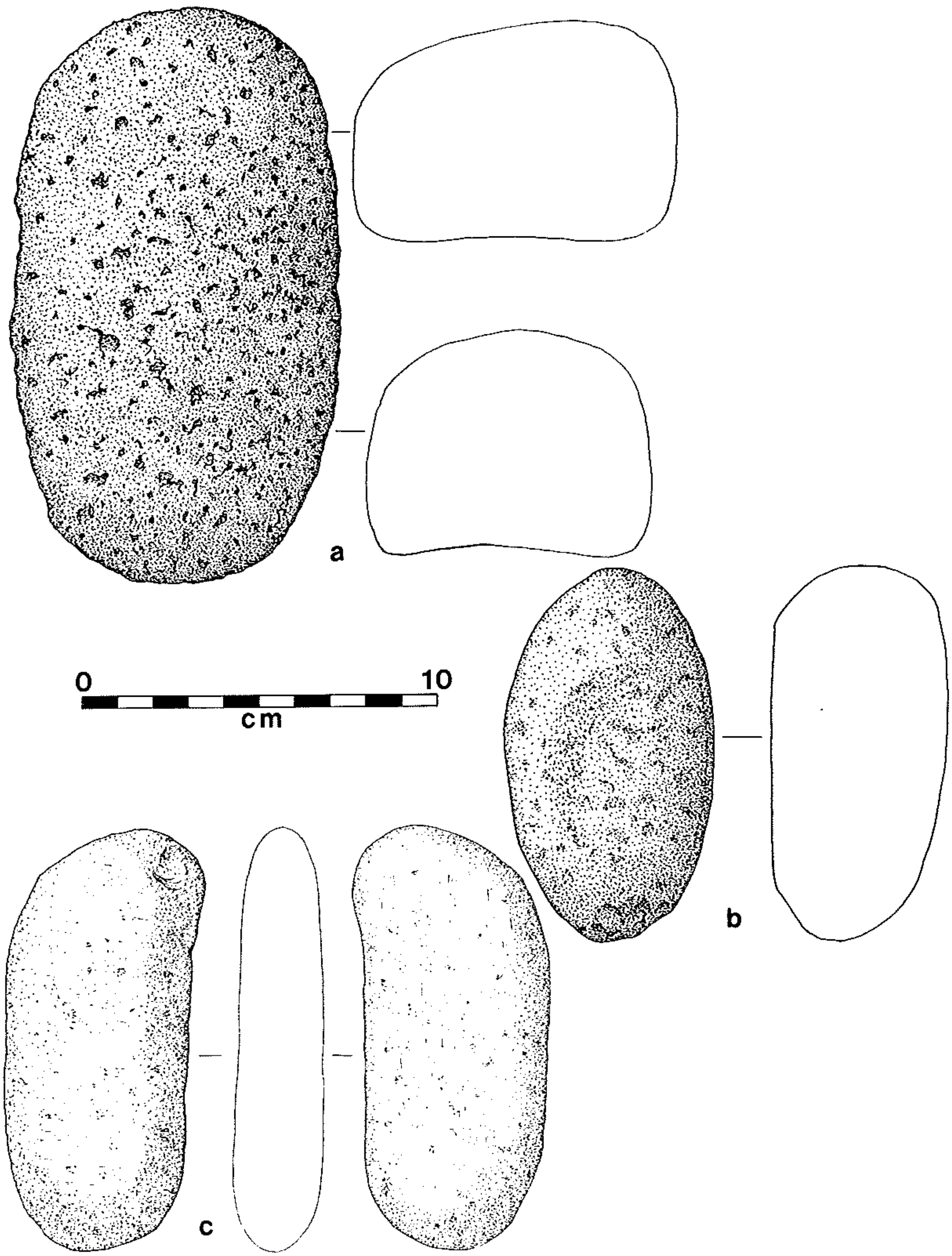

Fig. 10-23 Hand-held grindstones: (a) 9-LSFL in N3, lava; (b) Lake Bed, derived from 1-Basal in G6, grinding facet on basalt pebble, with battered end; (c) 13-LAL in V2-3, opposed grinding facets on flat basalt pebble.

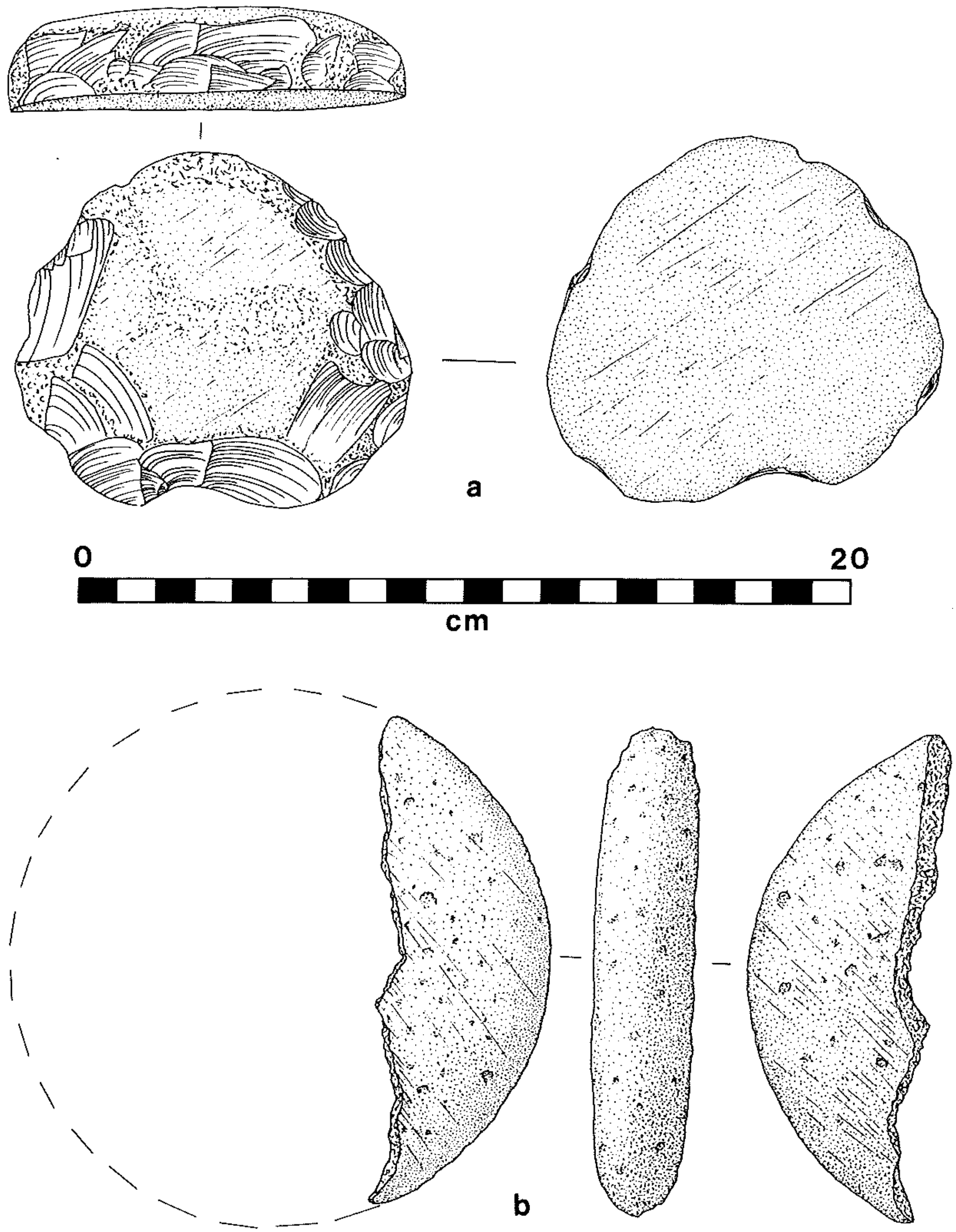

Fig. 10-24 (a) Mano from 15-UAL in P1, converted from thin body fragment of pestle; (b) flat circular grindstone fragment, 11-USFL or 12-TSFL in V3-4.

were only rarely abandoned at the site. Nevertheless, there were enough pieces recovered to demonstrate that mortar and pestle technology had been fully developed elsewhere before the site came into use. The proliferation of items in the 6-S&B no doubt reflects the switch in site roles at this time, with the consequent increase in group size associated with a village.

From the 6-S&B onwards, there are no stylistic refinements that could be taken to represent an important advance in lakemarsh adaptation. The only notable trends are the abandonment of the elliptical-sectioned grip for pestles, and the general thinning of mortar and bowl walls, as well as the thinning of grinding slabs. Given the amount of time involved, these are relatively minor changes which serve to lighten the weight of the equipment but need not necessarily make it any more efficient, other than to make it more easily portable.

When fitted to the fluctuating-catchment model summarized in Chapter 9, the relative numbers of items in each stratum are of some interest. If we assume that plantfood yields were linked to marshland area, then fluctuations in marshland might have some impact on the amount of grinding equipment present. First, the overall increase in equipment in the 6-S&B, and thereafter, does indeed coincide with the marsh-over trend inferred from the diver-dabbler ratios. There are also hints that shorter-term fluctuations had some effect on this equipment: earlier in the site's history there are decreases in the number of items in the 4-Mix and 8-LFL relative to other strata. These both formed in relatively dry intervals when it is thought that the lake level dropped. Later in the site's history, only slight decreases are evident for the next two dry intervals (10-MSFL, 12-TSFL). Perhaps as the lake became shallower, these drier intervals increased the marshland rather than shrinking it as may have happened earlier on when the lake was deeper.

Finally, the exceptionally abundant items in the 9-LSFL must reflect a relatively intense focus on plantfood gathering, but the diet was still sufficiently mixed that this need not reflect another switch in site roles. In conclusion, neither of the rival models is to be preferred in the light of the pounding and grinding equipment.

Pestle fragments tend to outnumber those of mortars, although the latter should break up into more pieces. Howe (1979) suggests that wooden mortars may have been in use at the same time. Other possibilities are: mortars were for communal use whereas pestles were personal equipment, one to each woman in the community; bedrock mortars were used elsewhere in the territory, so that relatively few were needed in camp; mortar fragments were often converted into manos or weight/missle stones. It is impossible to tell which of these explanations is to be preferred.

Procurement Equipment

A variety of functions can be inferred for each type in this category since the ethnographic record provided no clues to their uses. Of most interest are those specimens that could have served as netweights for either fowling or fishing because these permit further tests of the rival models: the Know-it-all Model predicts abundant, diverse, and well-finished sinkers from the earliest strata onwards, whereas the Learner Model predicts a gradual increase in numbers and refinement in manufacture of sinkers with time. The test is spoiled, however, by the fact that potential sinkers may have had other uses as well.

Bipointed Stones (Fig. 10-25ab)

These small, uniformly shaped specimens appeared first in the 5-Scaup: One came from L9b, and a cluster of 54 specimens was retrieved from these same mucks near Pits O and U by uncontrolled digging (Howe 1979:45). There can be little doubt that their shape and size (length ranges between 61-53mm) had been standardized elsewhere before their first appearance on the site, and they did not undergo any further changes during their relatively brief use here: They persisted through the 6-S&B (P10) and into the 8-LFL (A14, Y5). Although a single specimen comes from the 10-MSFL (Y4), this may be derived from the underlying layer, so their continuity after the First Marker Horizon (2,400BC) remains in some doubt. Although the cluster may represent the weighted end of a bundled net, this interpretation is not helped by the fact that at least half the objects are made of lava--hardly an ideal choice for weight-stones, although easier than basalt to peck into the desired shape. This cluster detracts from the notion that they were atlatl weights or bolas stones or line sinkers, unless of course this was a cache of unattached stones. Howe's suggestion that they were gaming stones has merit, but cannot be verified.

Grooved Stones

Nine small pebbles with a light groove pecked into the circumference were recovered. Six are of lava, the rest basalt. Maximum diameters range from 89mm to 49mm. One is from the 6-S&B (C5b), one from the 8-LFL (J6), two from 9-LSFL (T4, N4), three from 10-MSFL (I7a, E5, X5), one from 11-USFL (O1b) and one from the LAL/MAL (D1). They are thus widely scattered within the site. Although their morphology suggests line sinkers or light throw-net sinkers, some could have served as atlatl weights.

Cross-Grooved Rocks

These rocks and fragments of broken utensils are incised such that each specimen has two complete grooves at approximate right angles, intersecting on opposite faces. There are two in the 9-LSFL at V5, each with diameters just over 200mm: one is of lava, the other of basalt--with a concave surface, suggesting that it may have also served as a temporary grinding surface. Another basalt specimen from the TSFL/USFL in Q3c has one pecked and battered end, and the grooves are lightly pecked rather than incised. It should also be noted that one of the lower grinding slab fragments from the MSFL/LSFL at X5 has a slight groove pecked across its second (convex) grinding face.

Obviously no great care was exerted in the making of these objects which must have served temporary needs of the moment. They are certainly heavy enough to have held down an underwater net, anchored a dugout canoe, served as weights for a hide-stretching rack or to have anchored the reed matting over the frame of a temporary shelter (Howe 1979:106).

Pecked Spheroids

These sub-spherical basalt stones have been shaped with some care and vary in size from 90mm to 48mm diameter, with most specimens in the 55-75mm range. The largest specimen is shown in Fig. 10-26a. Spheroids appear first in the 8-LFL of Y5. There is one spheroid from the 9-LSFL (X6), and one from the 10-MSFL (D4a), five from the 11-USFL

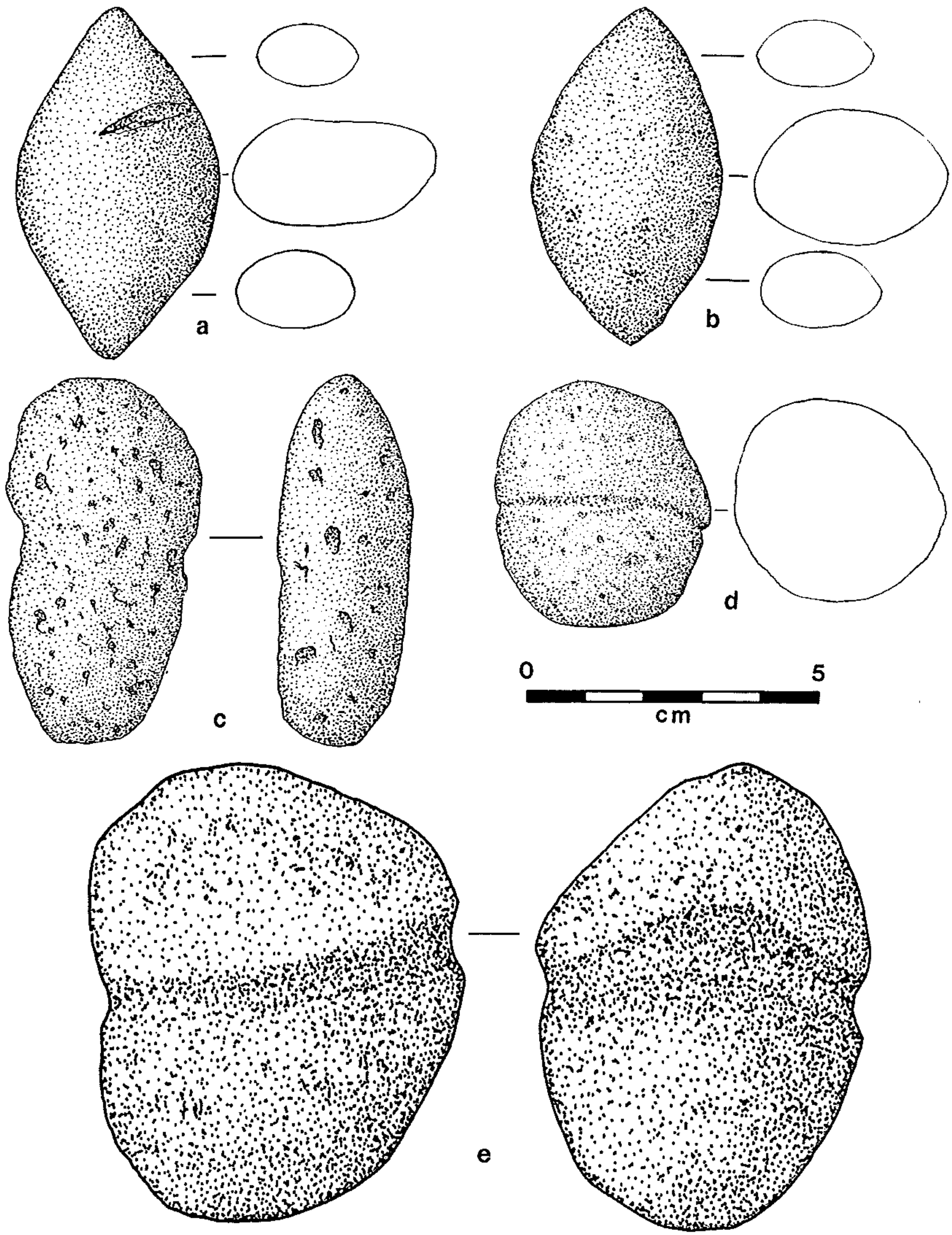

Fig. 10-25 (ab) Bipointed stones, 10-MSFL in Y4, basalt; (c-e) grooved stones (c) 10-MSFL in X5, purple lava (d) 8-LFL in J6, purple lave (e) 10-MSFL in E5, gray lava.

(A7, D3a, H3ab and V3-4) and one from the MAL in E1-2. Like several other types, these were probably multi-purpose objects, serving as weights, possibly as bolas stones and as temporary grinders--there are four small grinding facets on the specimen from A7, one on the H3b spheroid and there is a dimple pecked into the surface of the D3a specimen.

Miscellaneous Shaped Pieces

Two shaped fragments do not readily fit any of the categories already described. The first (Fig. 10-26d) is a gray lava fragment shaped into a triangular cross-section, but lacking any grinding facets. All three sides are shaped, but the ends are broken. It is from the 6-S&B in U2c. The second specimen (Fig. 10-26e) is of basalt, possibly a worked-out grinding slab, later converted to a perforated weight-stone, and subsequently broken. The fracture surfaces are weathered. It comes from the 3-Grebe in T6.

Commentary on the Procurement Equipment

Except for the perforated weight stone in the 3-Grebe and the cluster of bipointed stones in the 5-Scaup, most of these items were abandoned during the period when the site served as a permanent village. The most economical explanation for this would be that more of this equipment was being made on the spot between the 6-S&B and the 11-USFL when objects were more likely to be abandoned. During the site's earlier and later roles as a temporary procurement platform, ready-made items were brought to the site for brief spells and were less likely to be abandoned here. There are no grounds for testing the rival models with these data, however.

The disappearance of the bipointed stone after 2,400BC (First Marker Horizon) is enigmatic. There are no significant losses in the paleoecological data to which this disappearance might be linked, so a functional or environmental/deterministic explanation is not possible. Perhaps the coincidence of its demise with the shift in mean flake size is a spurious one. The overall decline in missile-and/or weight-stones at the end of the Small-flake Loams however, could be linked to a shift away from net and bolas technology after the advent of the bow-and-arrow.

Manufacturing Equipment

The changes in site role through time (waterfowling platform; permanent village; Spring/Fall fishing village) inferred from the paleoecological data can be used as the basis for predicting changes in the relative amounts of manufacturing equipment in different strata. Stones used for hammering and shaping mortars, pestles, etc. should be relatively scarce in the 2-Coot to 5-Scaup sequence when the site was briefly visited in the seasonal round. They should increase in the 6-S&B when the site became a permanent village, and decrease in the 12-TSFL when it reverted to a temporary procurement platform. The contexts of various types are reviewed in the following sections.

Incised Pebbles

All recovered specimens are illustrated in Fig. 10-27. The 3-Grebe specimen (Fig. 10-27b) is a small elongated hammerstone lightly ring-incised at one end--possibly an atlatl weight. The 6-S&B specimen (Fig. 10-27e) is also a small hammerstone, lightly cross-hatched and nicked, possibly with a conscious design, although

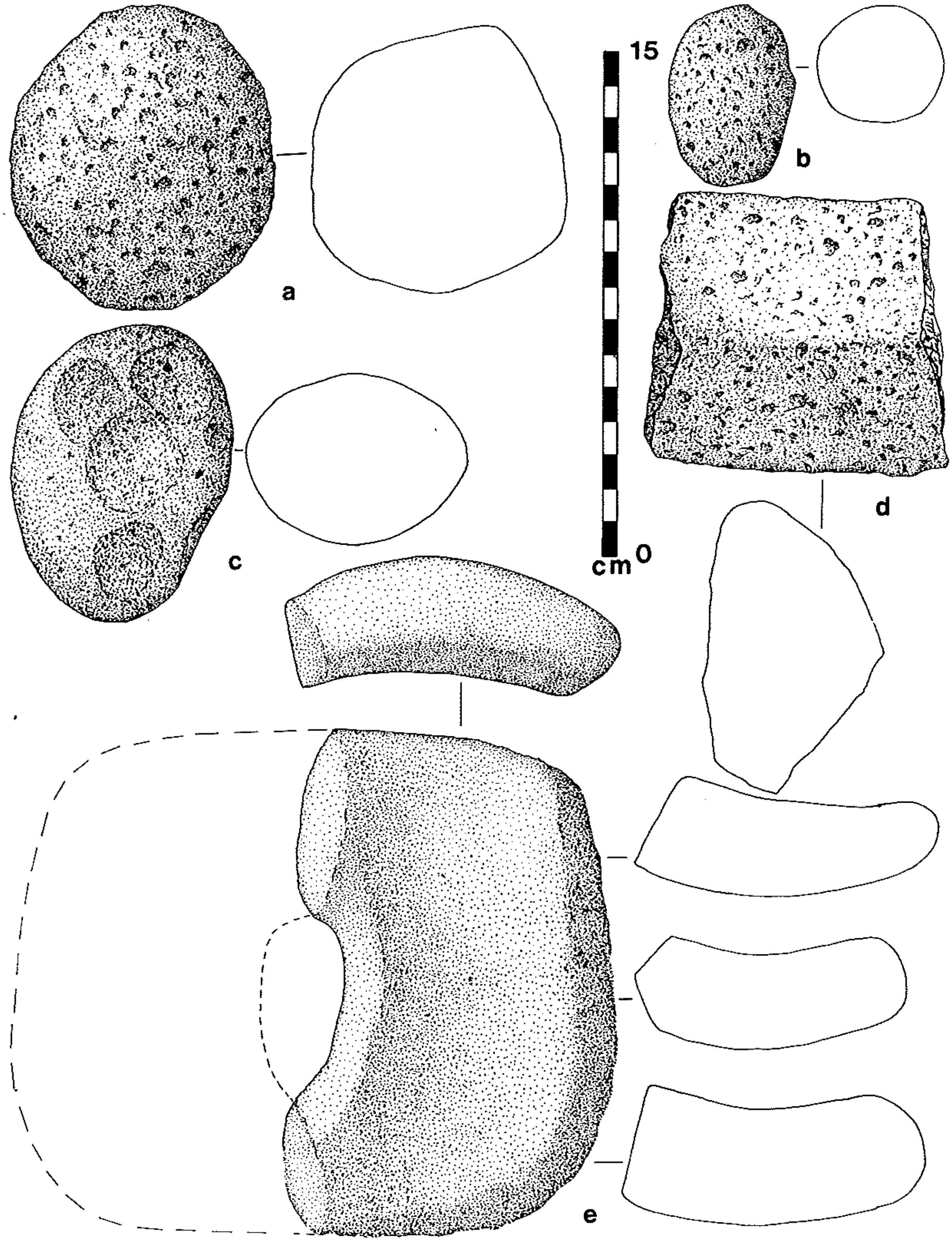

Fig. 10-26 (a) Pecked spheroid, 14-MAL in E1-2a; (b) maroon basalt pebble, 10-MSFL in E6 pit house fill; (c) pebble hammerstone, 6-S&B in E11, buff basalt, heat spalled; (d) lava chunk, 6-S&B in U2c; (e) possible shaped weight? 6-S&B in T6, basalt.

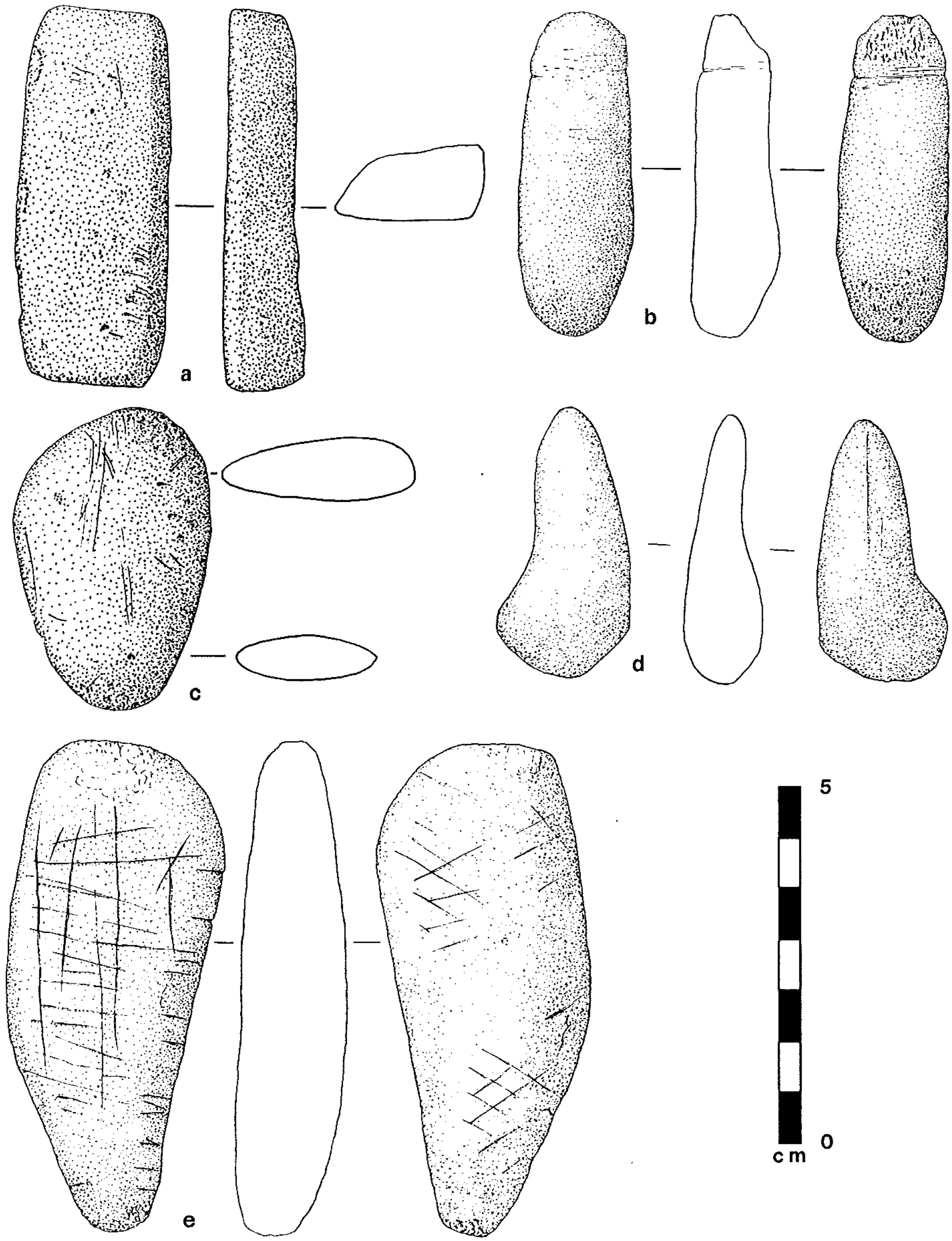

Fig. 10-27 Incised pebbles: (a) Lake Bed, presumed derived from 5-Scaup in U4b; (b) 3-Grebe in T6; (c) 10-MSFL in B4e; (d) 9-LSFL in U2a; (e) 6-S&B in J8.

markings of this kind can be induced if the stone was used as a base on which some soft substance was placed for cutting. The other three specimens appear to have been accidentally incised, probably through the same method.

Pebble Hammerstones

Of the 12 specimens recovered, three are of quartz and the rest of basalt. They vary in size between 104-36mm maximum diameter. Half of them have heavy battering at opposed ends, and three are split, probably during use. Three have minor grinding facets, suggesting use as temporary manos. One specimen (Fig. 10-26c) is heat spalled. The size and weight of all these specimens would make them suitable for light obsidian flaking. They are distributed widely through the site, in nine different pits and in most strata between the 5-Scaup and the 14-MAL.

Pebble Manuports

Apparently unmarked pebbles were recovered from nine different pits widely distributed across the eastern half of the site. There is also a cluster of seven pebbles in the 8-LFL at A14-15, and single specimens come from the same strata in Pits H, I and Y. They are also scattered through the 10-MSFL in Pits E, I, N, Q, W, and Y, but none was recovered above this stratum. Of the 25 pebbles found, one is of quartz, one of lava (Fig. 10-26b) and the rest of basalt. They are of very uniform size; 19 fall between 55-45mm max. diameter, the largest being 85mm, and the smallest 35mm. They could have functioned as hammers, small weight-stones or as bolas stones.

Battered Chunks

Miscellaneous chunks with bruised ridges, corners and promontories occur sporadically throughout the site from the 1-Basal to the top of the 12-TSFL, but not in the Arrowhead Loams. In the 6-S&B of E, G, and O, there are three elongated basalt splinters heavily battered at opposite ends, suggesting use as chisels. All the other specimens are of basalt, except one quartz chunk in the 4-Mix of R3b. Most of these 19 specimens were probably used in the shaping of mortars and other classes of basalt and lava implements formed though pecking and hammering.

Commentary on the Manufacturing Equipment

The data on battered chunks fit the model of changing site-roles fairly well, but some on-site manufacture of mortars and pestles must have taken place during the site's earlier phase as a waterfowling station. As predicted, on-site manufacture stopped after it became a Spring/Fall fishing village. After the 12-TSFL, older pieces were being scavanged and reworked, or ready-made items were brought in from elsewhere (Fig. 10-28).

The pebble items are of less interest as these were no doubt used mainly for flaking obsidian--an activity which will be examined in the following chapters.

ENDNOTES: CHAPTER 10

1. Three complete specimens were recovered by Mr. C. B. Howe between Pits N, O, T, and U, but their stratigraphic provenience is uncertain (Howe 1968:191; 1979:53).

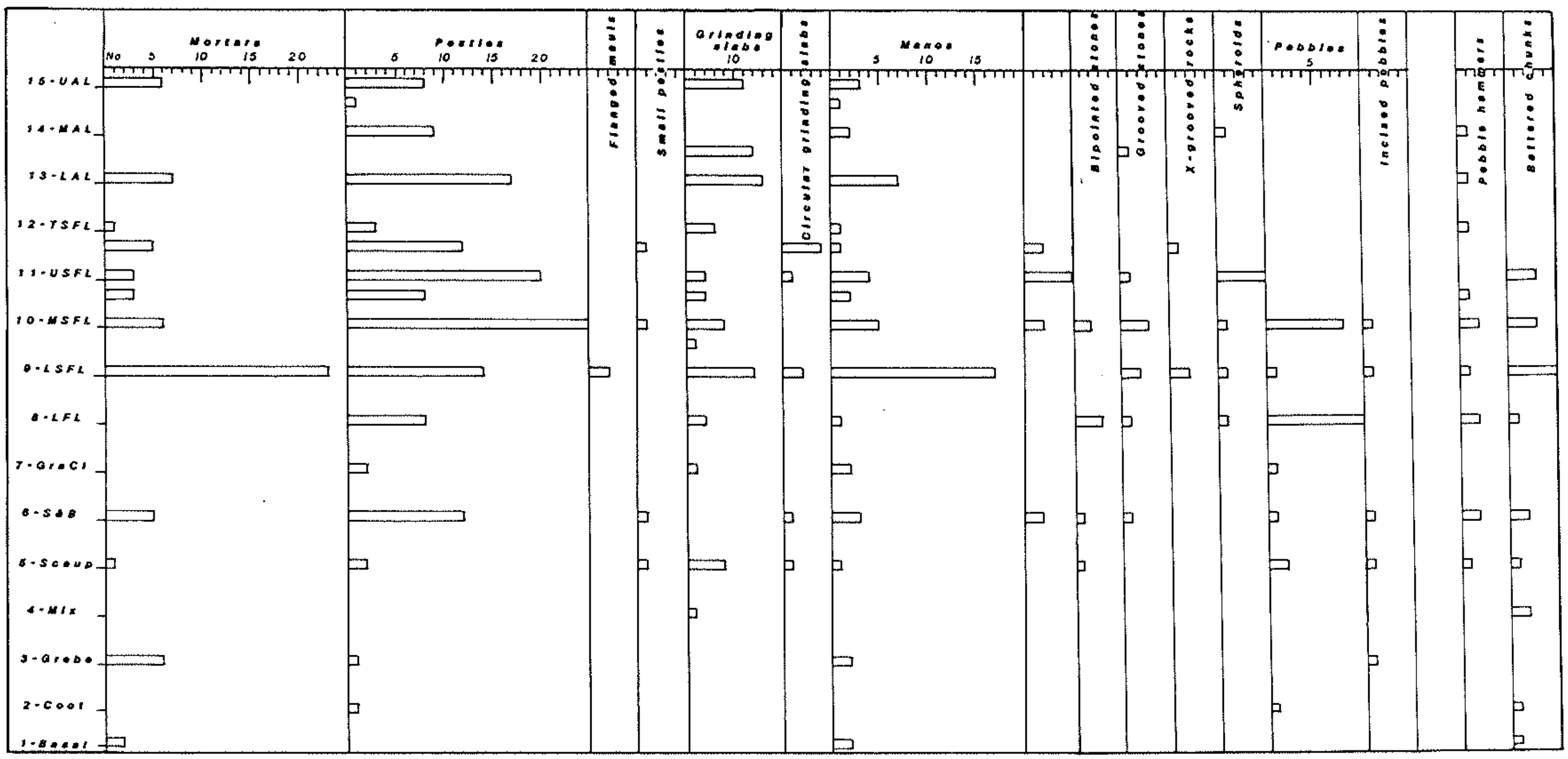

Fig. 10-28 Distribution of all non-flaked stone categories by stratum. Counts include whole and fragmentary specimens.

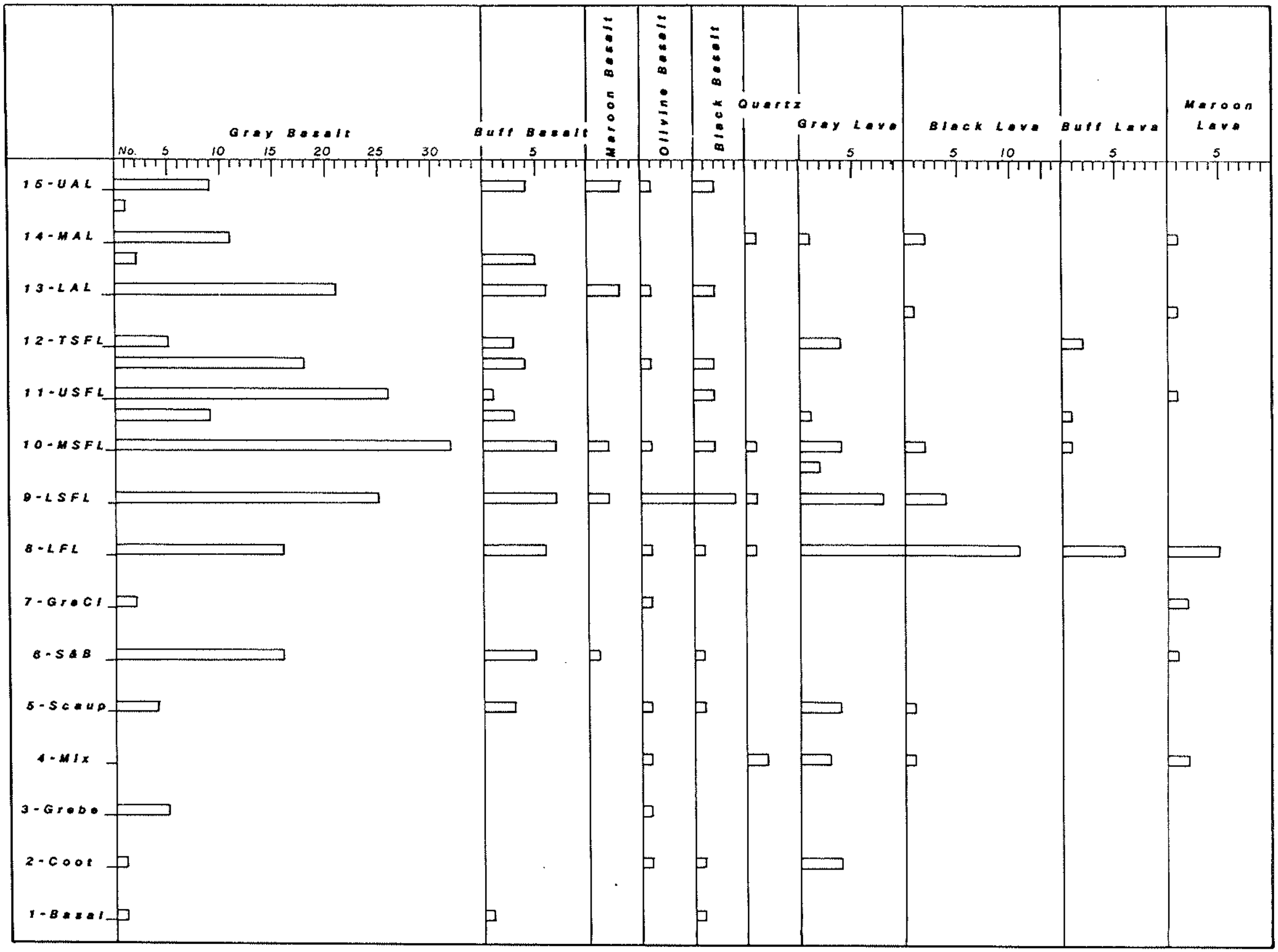

Fig. 10-29 Distribution of raw materials by stratum, used to make non-flaked stone artifacts.

CHAPTER ELEVEN

OBSIDIAN SOURCES*

Introduction

Few areas of western North America contain evidence of Pleistocene and Holocene silicic volcanism to rival northeast California and southern Oregon. The extremely complex mosaic of volcanic events in these two areas produced numerous and abundant deposits of rhyolitic obsidian that were apparently exploited for millennia by local human groups. The physical properties of volcanic glass make it ideally suited to serve as a raw material in the manufacture of chipped stone tools, and the particular geophysical makeup of obsidian renders it susceptible to rapid and non-destructive characterization on the basis of distinctive combinations of trace elements. Because obsidian is a supercooled liquid silica melt it is extremely homogenous and this usually allows analyses of relatively few source samples to adequately represent the range of variability in trace element concentrations for the source (cf. Jack and Carmichael 1969; Jack 1971, 1976; Carmichael 1979). This trace element uniformity is so striking in some sources that there exists no more variability in trace element composition between flakes detached from the same core and the same number of flakes detached from different cores collected at intervals across the surface of the flow (Hughes 1983). However, this is not invariably the case and misclassifications can and do occur. Most of these can be identified and corrected using the procedures outlined below.

X-ray Fluorescence Analysis

Numerous techniques have been employed to characterize obsidian, but the most widely applied are x-ray fluorescence and neutron activation. X-ray fluorescence was used in the Nightfire Island analysis because: (1) it requires no special sample preparation, (2) it is completely non-destructive, (3) analysis of certain trace element concentrations can be completed in only a few minutes, and (4) data generated for significant trace elements are sufficiently precise to use in quantitative comparisons between laboratories (cf. Bertin 1978:104-110).

An extensive discussion of x-ray fluorescence spectroscopy is unnecessary here, as presentations appear in Woldseth (1973), Jenkins (1974), Jenkins and DeVries (1975), and Bertin (1978), among others.

Equipment employed in this analysis is housed in the Department of Geology and Geophysics, University of California, Berkeley. It consists of a Spectrace 440 (United Scientific Corporation) energy dispersive machine equipped with a 572 power supply (50 kV, 1 mA), 534-1 pulsed tube control, 588 bias/protection module, 514 pulse processor (amplifier), Tracor Northern 1221 100 mHz analog-to-digital converter (ADC), and a Tracor Northern 2000 computer based analyzer

* by Richard E. Hughes

with a LSI-11 microcomputer with 24k word capacity. The Tracor Northern 2000 is linked to a Data Systems DSD 210 Diskette Memory System with dual floppy disk drive where stored references are accessed. Hard copy is output from a Teletype ARS-43 printing terminal. Primary x-ray excitation is provided by an Ag transmission target tube for analysis in the low and mid-Z regions of the energy spectrum (ca. 0-10 and 5-25 keV, respectively). The x-ray tube was operated at 30.0 kV, .20 mA pulsed with a .05mm Ag primary beam filter in an air path at 200 seconds livetime, and all x-rays were detected by a Si(Li) solid state detector with 142 eV resolution (FWHM) at 5.9 keV in a 30mm^2 area. Analytical lines used were: Pb (Lβ), Th (Lα), Rb (Kα), Sr (Kα), Y (Kα), Zr (Kα) and Nb (Kα).

Prior to and during analysis of Nightfire Island artifacts, the U. S. Geological Survey G-2 rock standard was analyzed and parts per million concentrations generated were compared with those values recommended in Flanagan (1976). Present results compare favorably with published values.

The data reduction procedures used in this analysis require some additional comment and explanation. A static recalibration option available with the present x-ray fluorescence system automatically corrects for any possible peak shifts due to temperature fluctuations or long-term machine drift. This feature assures that no differences in energy calibration between the unknown and known reference spectra will introduce errors in the subsequent least squares polynomial fit routine (McCarthy and Schamber 1981:291-294).

Following static recalibration, net peak intensities are converted to parts per million. This is accomplished by using a set of pure reference standards (U. S. Geological Survey and other international standard rocks) whose peak-to-intensity concentration values are stored on reference disks. These pure element standards ("knowns") are compared to the "unknown" spectra for peak identification and measurement. This comparison appears as a "K-ratio" which is the ratio of the background corrected intensity of the unknown to the background corrected intensity of the known reference standard. Once K-ratios for analytical lines have been determined, matrix effect corrections are applied and overlapping peak contribution is suppressed. Finally, the resultant K-ratios are converted into parts per million by dividing each elemental peak intensity by the intensity of the incoherently scattered radiation (Compton scatter) from the x-ray tube. This conversion can be made because "the relationship between the Ag Kα Compton intensity and the mass absorption is a logarithmic function" (Franzini, Leoni and Saitta 1976:84). Furthermore, matrix effects can be determined using this same Ag Kα Compton scatter (Leoni and Saitta 1977; Giauque, Garrett and Goda 1977). The linear relationship between K-ratio intensity vs. concentration, once calibrated using stored reference standards, allows peak/continuum ratios to be converted automatically to parts per million using a least squares polynomial fit routine (cf. Bice 1980:421-422).

Obsidian Sources and Obsidian Source Groups

Obsidian came to Nightfire Island from three directions: the south, the northeast and the east (Figs. 1-17 and 1-18). The large number of obsidian sources so far identified in northeast California, southern Oregon and northwestern Nevada (see Hughes 1983) made it necessary to group the sources (Table 11-1)[1]. Obsidian occurrences were combined with one another only when their trace element compositions overlapped and they were located within the same physiographic context (mountain range, volcanic field). For example, the Buck Mountain geochemical type presently consists of nine occurrences located within a 2.4km (ca. 1.5 miles) radius of one

Table 11-1

Concordance of Geographic Groups, Trace Element Group Acronyms and Obsidian Sources Identified in the Nightfire Island Artifact Assemblage

GEOGRAPHIC GROUP	TRACE ELEMENT GROUP ACRONYM	OBSIDIAN SOURCES INCLUDED
Medicine Lake Highland	GRLIWRS	Grasshopper Flat, Lost Iron Well, 142M*, Red Switchback
	EMEDLK	Yellowjacket, Stoney Rhyolite Core
	EGLASMT	East Glass Mountain
	CUGRBT	Cougar Butte
	CALOBSFL	Callahan Obsidian Flow
	RRGR	Railroad Grade
Warner Mountains	BUCKMT	Nelson Quarry, North Fork, Pink Lady, Lassen Creek, Middle Fork, Needle Grass Spring Junction, Tick Rise, Buck Mountain, Lodgepole
	SUGRHL	North Cottonwood Flat, Upper Ross, Junction, Sugar Hill
	SWARNER	Dodge Reservoir, Alaska Canyon, Sworinger Basin
Spodue/Sycan	SPDUMT	Spodue Mountain, Sprague River, West Horton Reservoir
	SLKSYM	Silver Lake, Sycan Marsh
Drews Creek/McComb	DWSCKBF	Drews Creek/Butcher Flat
	MCMBT	McComb Butte
Blue Mountain	BLUEMT	Blue Mountain
Massacre Lake/Guano Valley	MASGUNO	Sand Spring, Grassy Ranch, Stevens Camp, South Hanging Rock, Windmill Quarry, IXL, Guano Valley, Horse Canyon Spring

another. Since these sources could not be distinguished on the basis of trace element concentraitons, they were combined into a larger grouping (denoted as BUCKMT in the Trace Element Group Acronym column in Table 11-1).

Furthermore, despite the fact that the Buck Mountain Trace Element Group is geochemically distinct from both the Sugar Hill and South Warner Groups, all three chemical types were subsumed into the Warner Mountains Geographic Group to facilitate ready comparisons and contrasts in geographic directions from which obsidian came to Nightfire Island.

Although use of these Trace Element and Geographic Groups helped order discussion of variability in direction and distance over which raw material and social contact may have taken place, these groupings should not be taken to indictate that the sources subsumed necessarily possess sufficient geochemical similarities to use in obsidian hydration dating. It is possible to treat some sources as a unit for hydration dating purposes, but this can be done only after the proper geochemical determinations of major and minor element composition have been made (Friedman and Long 1976; Hughes 1982).

Despite the fact that concentrations for seven trace elements were determined for all sources and projectile points, only four of these (Rb, Sr, Y and Zr) were used for comparison with obsidian sources. Quantitative analyses of pressed pellets of obsidian from several areas of the western United States documented a lack of variability in Pb, Th, and Nb values (Jack and Carmichael 1969; Jack 1971, 1976) suggesting in advance that these elements probably would not be of much use in distinguishing between obsidian sources represented in the present study. As expected, Pb, Th, and Nb concentrations generated from the present analysis (see Hughes 1983; Tables 2-6 through 2-8) conformed to the pattern of low variability found in earlier research, and these values were not used in assigning artifacts to source.

Misclassifications

Thirty-one Nightfire Island specimens were incorrectly correlated to obsidian sources by the Statistical Package for the Social Sciences (SPSS) discriminant analysis program employed in this analysis. These assignment errors were identified by comparison of trace element concentrations and source specific Mahalanobis D^2 distances (see Hughes 1984, 1986). Correct assignments were made by subjecting specimens to additional elemental analyses.

Nine specimens were misassigned to the Cowhead Lake chemical group. Because Cowhead Lake and Drews Creek/Butcher Flat are quite similar in terms of the trace element concentrations used in this discriminant analysis, it was expected that misassignments would occur between these two groups. Then subjected to further analysis, this ambiguity was resolved (see Hughes 1983, Fig. 5-3).

On the basis of the present evidence, it apepars that Hager Mountain obsidian was used quite infrequently during prehistoric times. Therefore, the assignment of two specimens to this source was suspect. When analyzed for Fe/Mn, one correlated closely with Spodue Mountain while the Fe/Mn ratio determined for the other (40.9) indicated that this specimen was not from Hager Mountain.

Five specimens were assigned to Kelly Mountain, but when subjected to further analysis it was clear that all five were manufactured from Medicine Lake Highland obsidians (ibid, Fig. 5-4).

Two specimens were misassigned to the Sugar Hill chemical group. Trace element concentrations for Rb, Sr, and Zr generated for one do not match well with the Sugar Hill chemical group. Furthermore, it yielded a Fe/Mn ratio of 42.1--well outside the range for Sugar Hill (27.1-30.4). This specimen is therefore considered to be from a source outside the sampling universe. The other had a slightly inflated D^2 value (11.5); examination of trace element concentrations and a Fe/Mn ratio of 50.2 (op. cit., Figs. 5-5 and 5-6 for comparison) suggests that this specimen may have been manufactured from an obsidian occurrence in the Medicine Lake Highland.

Two specimens were assigned to the Harris Flat chemical group. An unusually high D^2 value (45.2) for one of these documents that it lies far from the Harris Flat source centroid, and a Fe/Mn ratio of 28.6 also eliminates it from Harris Flat group membership. This specimen, therefore, is considered to be from a source not included in the sampling universe. Similarly, the other specimen has a high D^2 value (25.2) and a Fe/Mn ratio (48.0) well outside the range of the Harris Flat chemical group. This Fe/Mn ratio also eliminates it from attribution to the Badger Creek chemical group, so it is considered to have been made from an obsidian source not included in the present study.

Three specimens were misassigned to the Rainbow Mine source in the Warner Mountains. Two of the three have moderately high D^2 values (10.0 and 12.4 respectively) and show a poor fit with the Rainbow Mine source profile. When analyzed for Fe/Mn ratios (op. cit. Fig. 5-6), these specimens were re-assigned to the Grasshopper Flat/Lost Iron Well chemical group.

Another three specimens were assigned to the East Glass Mountain chemical group. However, all three yielded moderately high D^2 values (11.5, 15.7, and 11.5, respectively) and inspection of trace element concentrations further indicated a poor fit with the East Glass Mountain chemical group profile. When analyzed for Ba, La and Ce, it is clear that all three were manufactured from Cougar Butte obsidian.

Five additional specimens were misassigned. One was assigned to the Tucker Hill chemical group, but its Zr concentration value does not match the assigned source profile. When analyzed for Ba, La and Ce, it is clear that this point was manufactured form obsidian of the Spodue Mountain chemical type. The second, assigned to the Del Prat Spring chemical group, similarly registers too low in Zr concentration and exhibits a poor overall fit with the source profile (D^2 = 21.6). Comparison of Ba, La and Ce concentration values suggests a correlation with obsidian of the Railroad Grade chemical type. A third was assigned to the Sugar Hill chemical group with a very poor fit (D^2 = 23.3). Although Ba, La and Ce concentrations do not provide a convincing basis for attribution, this specimen yielded a Fe/Mn ratio of 40.4, which clearly eliminates it from inclusion as a member of the Sugar Hill chemical group. On the basis of available evidence, it would appear that this point was manufactured from Grasshopper Flat/Lost Iron Well obsidian. The fourth was assigned to the Coglan Buttes chemical group. As documented previously, Coglan Buttes and Buck Mountain are quite similar along the dimensions used in this discriminant analysis so it seemed appropriate to investigate the possibility that this point might, in fact, have been manufactured from Buck Mountain obsidian. Ba, La and Ce concentrations suggest, however, that the attribution to Coglan Buttes is correct. The fifth specimen was assigned to the McComb Butte chemical group, but this is not an especially good fit (D^2 = 14.2); Ba, La and Ce concentrations clearly indicate that this specimen should instead be assigned to the Buck Mountain chemical group.

Finally, specimens manufactured from red-and-black obsidian in upper strata (two from the 15-UAL and one from the 14-MAL) require special comment. Earlier I had suggested that red obsidian could not be obtained in the Medicine Lake Highland (Hughes 1978:60) because, at the time of that writing, extensive surveys had failed to produce any evidence of it. Recently, however, two small sources of red-and-black obsidian have been discovered. One of these localities (Red Switchback) overlaps, on the basis of all trace elements measured in this study, with nearby major occurrences at Grasshopper Flat and Lost Iron Well. Since these latter sources do not contain red varieties, red or red-and-black obsidian projectile points with trace element concentrations identical to the Grasshopper Flat/Lost Iron Well localities are assumed to have been derived from the Red Switchback locality.

Nightfire Island Specimens used in the Analysis

Three hundred forty-seven obsidian projectile points were selected for x-ray fluorescence analysis. This total includes 318 points randomly selected within depositional strata (Table 11-2) and all 29 specimens recovered from burial contexts (see below). Obsidian source attribution for each artifact--by type and stratum--appears in Hughes (1983: Appendix 3, 3a-3f).

The only restriction imposed on the selection of projectile points was that each specimen be sufficiently complete and morphologically distinct so that it could be identified by type. Thus, the Gold Hill Leaf points, the Small Foliate points, the Thick Narrow Unstemmed points, and the Triangular Blanks (see Chapter 13 for definitions) were excluded form the selection process.

Gold Hill Leaf Points appear at present to be rather poor time markers. Although length-weight ratios were used to separate large vs. small foliate points (see Chapter 13, Fig. 13-1), there is no clear stratigraphic separation of these forms evident at Nightfire Island (Fig. 13-1, Table 13-3). Similarly, there was no clear stratigraphic support for the use of Small Foliate Points as time markers. Sampson considers them small versions of Gold Hill Leaf Points.

While Thick Narrow Unstemmed Points and Triangular Blanks may be valid morphological categories, they carry no stratigraphic significance at Nightfire Island and may in fact represent production-stage materials intended for later reduction into notched projectile points.

All non-obsidian points were also culled from the collection before sampling began.

The remaining projectile points were sorted by stratigraphic occurrence and specimens were selected for analysis using a simple random sampling procedure. After non-obsidian points and untypable specimens were culled, a minimum sample of 20% was drawn from each of the 15 strata identified at the site.

Each sample was then subdivided according to eight projectile point classes, and the distribution of specimens by stratum and class is presented in Table 11-3. The typological sorting of these samples was conducted by Hughes, following the criteria proposed by Thomas (1981, 1983) and without reference to the criteria employed by Sampson in this monograph (see Chapter 13). Consequently, specimens placed in one of the categories in Table 11-3 do not invariably find a place in the same category used by Sampson (see Table 13-1). Specifically, I have classified some of Sampson's "Rose Spring" specimens as "Gunther series"; my "Desert Side-Notched" points are subsumed in his "Siskiyou Side-Notched" class, as are most of my smaller "Northern Side-Notched" and a few of my "Elko series"; my "Rosegate" points occur in Sampson's "Rose Spring Corner Notched" class and in some of his "Elko Corner-Notched" variants; my "Gatecliff series" specimens were classed by Sampson as "Surprise Valley Split-Stem" points; our "Humboldt" categories contain the same specimens.

After discussion, we decided to retain my classification here as it has considerable bearing in the next step in my analysis, and consequently on my interpretation of the results. Furthermore, my

Table 11-2

Obsidian source/source group representation by stratum. Figure at left in each column represents percentage frequency by stratum; numbers enclosed in parentheses denote number of projectile points analyzed.

MEDICINE LAKE HIGHLAND

	GFLIWRS		EMEDLK		CUGRBT		CALOBSFL		RRGR		EGLASMT		M.L.H. TOTAL	
15-UAL	68.6	(23)	5.9	(2)	2.9	(1)	–		–		2.9	(1)	79.4	(27)
14-MAL	59.1	(13)	18.2	(4)	9.1	(2)	–		–		–		86.4	(19)
13-LAL	50.0	(22)	11.4	(5)	2.3	(1)	2.3	(1)	2.3	(1)	–		68.2	(30)
12-TSFL	63.6	(7)	–		–		–		18.2	(2)	–		81.8	(9)
11-USFL	47.2	(17)	13.9	(5)	–		11.1	(4)	–		–		72.2	(26)
10-MSFL	53.8	(28)	9.6	(5)	3.8	(2)	–		–		–		67.3	(35)
9-LSFL	58.9	(20)	5.9	(2)	2.9	(1)	–		–		–		67.6	(23)
8-LFL	60.0	(12)	–		–		–		–		–		60.0	(12)
7-GraCl	75.0	(6)	12.5	(1)	–		–		–		–		87.5	(7)
6-S&B	85.7	(24)	–		–		–		–		–		85.7	(24)
5-Scaup	70.7	(7)	–		–		–		–		–		70.0	(7)
4-Mix	50.0	(2)	–		–		–		–		–		50.0	(2)
3-Grebe	28.6	(2)	–		14.3	(1)	–		–		–		42.9	(3)
2-Coot	33.3	(2)	–		–		–		–		–		33.3	(2)
1-Basal	–		–		–		–		–		–		–	
TOTAL	58.2	(185)	7.5	(24)	2.5	(8)	1.6	(5)	0.9	(3)	0.3	(1)	71.1	(226)

Table 11-2 (Continued)

	WARNER MOUNTAINS				DREWS CREEK/McCOMB		
	BLUMT	BUCKMT	SWARNER	W.M. TOTAL	DWSCKBF	MCMBT	D.C./M. TOTAL
15-UAL	2.9 (1)	2.9 (1)	-	2.9 (1)	5.9 (2)	2.9 (1)	8.8 (3)
14-MAL	-	-	-	-	4.5 (1)	-	4.5 (1)
13-LAL	6.8 (3)	9.1 (4)	-	9.1 (4)	-	-	-
12-TSFL	-	9.1 (1)	-	9.1 (1)	-	-	-
11-USFL	5.6 (2)	2.8 (1)	-	2.8 (1)	2.8 (1)	-	2.8 (1)
10-MSFL	7.7 (4)	5.8 (3)	-	5.8 (3)	7.7 (4)	-	7.7 (4)
9-LSFL	-	2.9 (1)	2.9 (1)	5.9 (2)	8.8 (3)	-	8.8 (3)
8-LFL	5.0 (1)	15.0 (3)	-	15.0 (3)	-	-	-
7-GraCl	-	-	-	-	-	-	-
6-S & B	-	-	-	-	10.7 (3)	-	10.7 (3)
5-Scaup	-	20.0 (2)	-	20.0 (2)	-	-	-
4-Mix	-	-	-	-	-	-	-
3-Grebe	-	-	-	-	28.6 (2)	-	28.6 (2)
2-Coot	16.7 (1)	16.7 (1)	-	16.7 (1)	-	-	-
1-Basal	-	-	-	-	50.0 (1)	-	50.0 (1)
TOTAL	3.8 (12)	5.3 (17)	0.3 (1)	5.7 (18)	5.3 (17)	0.3 (1)	5.7 (18)

Table 11-2 (Continued)

SPDUMT	SPODUE/SYCAN		SLKSYM		S./S. TOTAL		UNKNOWN		TOTAL	
15-UAL		-	2.9	(1)	2.9	(1)	2.9	(1)	100.0	(34)
14-MAL		-		-		-	9.1	(2)	100.0	(22)
13-LAL	13.6	(6)	2.3	(1)	15.9	(7)		-	100.0	(44)
12-TSFL	9.1	(1)		-	9.1	(1)		-	100.0	(11)
11-USFL	13.9	(5)	2.8	(1)	16.7	(6)		-	100.0	(36)
10-MSFL	7.7	(4)		-	7.7	(4)	3.8	(2)	100.0	(52)
9-LSFL	11.8	(4)	2.9	(1)	14.7	(5)	2.9	(1)	100.0	(34)
8-LFL	10.0	(2)		-	10.0	(2)	10.0	(2)	100.0	(20)
7-GraCl		-		-		-	12.5	(1)	100.0	(8)
6-S & B	3.6	(1)		-	3.6	(1)		-	100.0	(28)
5-Scaup	10.0	(1)		-	10.0	(1)		-	100.0	(10)
4-Mix	50.0	(2)		-	50.0	(2)		-	100.0	(4)
3-Grebe	28.6	(2)		-	28.6	(2)		-	100.0	(7)
2-Coot	16.7	(1)	16.7	(1)	33.3	(2)		-	100.0	(6)
1-Basal		-	50.0	(1)	50.0	(1)		-	100.0	(2)
TOTAL	9.1	(29)	1.9	(6)	11.0	(35)	2.8	(9)	100.0	(318)

Table 11-3

Stratigraphic distribution of projectile point types sampled for X-ray Fluorescence Analysis

Stratum	Gunther series	Desert Side-Notched	Rose-gate	Elko series	Gatecliff series	Humboldt	Northern Side-Notched	Untype-able	Total
15-UAL	32	1	-	-	-	-	-	1	34
14-MAL	17	-	-	2	-	-	-	-	19
13-LAL	26	-	-	12	-	1	3	1	43
12-TSFL	2	-	-	8	-	-	1	-	11
11-USFL	11	1	1	17	1	2	6	-	39
10-MSFL	-	-	-	15	-	5	32	1	53
9-LSFL	2	2	-	17	2	2	8	1	34
8-LFL	-	-	-	6	2	-	12	-	20
7-GraCl	-	-	-	2	-	-	4	-	6
6-S&B	-	-	-	10	-	3	15	-	28
5-Scaup	-	-	-	2	-	1	8	-	11
4-Mix	-	-	-	3	-	-	1	-	4
3-Grebe	-	-	1	5	-	-	2	-	8
2-Coot	-	-	-	2	-	-	-	4	6
1-Basal	-	-	-	1	-	-	1	-	2
Totals	90	4	2	102	5	14	93	8	318

Note: Criteria for separating these types were not identical to those used by Sampson in Chapter 13. These counts are not comparable with those in Table 13-1, therefore.

classification allows these results to be compared with a larger regional study (Hughes 1983) with which Sampson's typology is not compatible. This issue is taken up again by Sampson in Chapter 13, and by Hughes (1986).

Obsidian Sources of the Projectile Point Types

While 318 projectile points were analyzed from the midden at Nightfire Island, only three types--Northern Side-Notched, Elko series, and Gunther series--occurred in adequate frequencies in the sample to consider in detail here. These three types together accounted for 92% of the midden sample analyzed (n = 285), while the remaining 25 specimens (ca. 8% of the sample) were divided among four projectile point types.

Only four Desert Side-Notched points were represented in the sample, and these show a scattered distribution probably reflecting post-depositional mixing. All four specimens were fashioned from obsidian of the Grasshopper Flat/Lost Iron Well chemical type. Two Rosegate series specimens were identified--too few to consider assigning them a temporal span. One specimen was made from Spodue Mountain material and the other was manufactured from Grasshopper Flat/Lost Iron Well type glass.

Five Gatecliff series points were identified in the x-ray fluorescence sample. Although these frequencies are small, and the stratigraphic context is clouded, radiocarbon ages proposed for the 8-LFL and 9-LSFL are consonant with the time range proposed for the Gatecliff series in the western and central Great Basin (Thomas 1981:22-24, 36). It is of particular interest that none of these specimens was made from nearby southern volcanic glasses; two were made from northeast (Spodue Mountain) material, and the other three were fashioned from obsidian from the Warner Mountains to the east. Notwithstanding the extremely small sample size, this distribution pattern is at variance with that observed for Northern Side-Notched, Elko series and Gunther series points, and is clearly discordant with what would be expected on the basis of proximity to source. Inquiry into the potential significance of this pattern at other sites in the region definitely is warranted.

Fourteen Humboldt series points were identified in the sample. Sample size again is regrettably small, but these specimens nonetheless appear to be concentrated in "early" (pre-1250BC) deposits at the site. Eleven specimens were fahsioned from nearby Medicine Lake Highland glasses, two were made from Buck Mountain obsidian to the east, and the remaining artifact was manufactured from material from Drews Creek/Butcher Flat to the northeast. More detailed consideration of the results begins with Northern Side-Notched points.

Table 11-4 presents the distribution of Northern Side-Notched points by source direction from Nightfire Island, while their stratigraphic distribution appears in Table 11-3. However, because of the disturbance documented in pre-5-Scaup strata (see Chapter 4) and small sample size, any trends detected here probably are more apparent than real. Similarly, emphasizing stratigraphic occurrences of Northern Side-Notched points redeposited into upper strata would yield misleading results. Because finer stratigraphic relationships cannot clearly be upheld (see Hughes 1983, Chapter 5), Northern Side-Notched points will be considered only by type and obsidian sources. Table 11-5 shows that 80% of the Northern Side-Notched points analyzed in the present sample were manufactured from nearby, southerly Medicine Lake Highland obsidian. Fourteen percent of the sample total was made from volcanic glass source materials located to the northeast of the site, while the remaining 6% were fashioned from more distant obsidians situated to the east.

Table 11-4

Approximate distance from Nightfire Island to Obsidian Sources (Chemical Groups) Represented in the Projectile Point Assemblage

	Distance			Projectile Point Type						
Obsidian Source	kilometers	miles	Direction	Gunther series	Elko series	Northern Side-notched	Humboldt series	Gatecliff series	Desert Side-notched	Rosegate series
Grashopper Flat/ Lost Iron Well/ Red Switchback	34-60[a]	21-37	South	50	51	63	9	--	4	1
Railroad Grade	37	23	South	1	3	--	--	--	--	--
Callahan Obsidian Flow	37	23	South	2	2	1	--	--	--	--
Cougar Butte	47	29	South	4	--	3	--	--	--	--
East Glass Mountain	56	35	South	1	2	--	--	--	--	--
East Medicine Lake	56	35	South	13	7	6	2	--	--	--
Blue Moutain	79	49	East	3	7	1	--	--	--	--
Spodue Mountain	58-89	36-55	Northeast	5	15	5	--	2	--	1
Drews Creek/ Butcher Flat	93	58	Northeast	3	6	7	1	--	--	--
McComb Butte	122	76	Northeast	1	--	--	--	--	--	--
Sugar Hill	127	79	Northeast	--	1	--	--	--	--	--
Silver Lake/ Sycan Marsh	113-129[b]	70-80	Northeast	1	4	--	--	--	--	--
Buck Mountain	134	83	East	4	3	4	2	2	--	--
Tucker Hill	135	84	Northeast	--	--	--	--	--	--	--

Table 11-4 (Continued)

Coglan Buttes	145	90	Northeast	--	1	--	--	--	--	--
South Warners	177	110	East	--	--	1	--	--	--	--
Quartz Mountain	193	120	Northeast	--	--	1	--	--	--	--
				90*	102**	93***	14	5	4	2

[a] Red Switchback is about 34 km (ca. 21 miles) south, Grasshopper Flat is about 55 km (ca. 34 miles) south, and Lost Iron Well is about 60 km (ca. 37 miles) south of Nightfire Island.

[b] The Silver Lake locality is about 129 km (ca. 80 miles) northeast of Nightfire Island, but obsidian of this same geochemical type also occurs at Long Creek, about 113 km. (ca. 70 miles) northeast of the site.

* total includes two specimens from "unknown" sources
** total includes one specimen from an "unknown" source
*** total includes two specimens from "unknown" sources

Table 11-3 also presents the distribution of Elko points by stratum, while obsidian source direction from Nightfire Island appears in Table 11-4. As with Northern Side-Notched points, the disturbance recorded in the middle and lower layers of Nightfire Island deposits required that Elko series points be discussed only by type and obsidian source.

Inspection of Table 11-5 shows that during Elko times, about 63% of the specimens were manufactured from obsidians derived from the Medicine Lake Highland, 26% were made from source material located to the northeast, and the remaining 11% were fahsioned from volcanic glass source materials located to the east of Nightfire Island.

Perhaps the best case for stratigraphic integrity of a portion of the Nightfire Island sequence can be made using Gunther series points, as these were distributed in such a way that they were subject to less disturbance than either Elko or Northern Side-Notched specimens (Table 11-3). As this table shows, Gunther series points apparently were introduced suddenly at Nightfire Island sometime during the early portion of the Arrowhead Loams accumulation, i.e., the 13-LAL.

During Gunther series times, 81% of the projectile points in the sample were fashioned from nearby Medicine Lake Highlands obsidians, 11% were made from obsidian source material situated to the northeast, and the remaining 8% were dervied from eastern volcanic glass sources.

Variability in Obsidian Source Use through Time

These results provide evidence to suggest pronounced shifts in obsidian source representation through time in the Nightfire Island projectile point assemblage. During the period when Northern Side-Notched points were in use, the vast majority of specimens was being fashioned from nearby source occurrences to the south in the Medicine Lake Highland.

The inception of Elko series projectile point use signalled a concomitant shift in obsidian source representation. During this time (ca. 1,350BC-250AD), percentage frequencies of obsidian points made from more distant northeastern source materials nearly double from the totals observed during the preceding period. Absolute frequencies of Drews Creek/Butcher Flat material do not vary significantly between Elko and Northern Side-Notched periods, but Elko times witnessed the first occurrences of distant source material from the Silver Lake/Sycan Marsh area to the northeast. Blue Mountain source frequencies also are greatest during Elko times. Computation of a chi-square test on counts in Table 11-5 indicates a difference between these distributions at the 0.05α level ($x^2 = 6.67$, df = 2); thus projectile point type and obsidian source acquisition direction clearly are not independent during these two periods. Specifically, a greater number of Elko points were manufactured from northeastern source materials than would have been expected on the basis of chance.

When Elko series points were replaced by Gunther series projectiles, another dramatic shift occurred in obsidian source representation. Percentage frequencies of nearby, southerly Medicine Lake Highland obsidian increased markedly from the preceding Elko series period (up 18%), while the percentage of more distant northeastern source materials declined (down 15%). A chi-square test computed on the counts in Table 11-5 indicates that these distributions are significantly different at the 0.05α level ($x^2 = 7.50$, df = 2).

Table 11-5

Counts and percentage frequencies of Gunther series, Elko series and Northern Side-notched points by geographic direction.

	Geographic Direction from Nightfire Island					
Point Type	South		Northeast		East	
Gunther Series	71	(81%)	10	(11%)	7	(8%)
Elko Series	64	(63%)	26	(26%)	11	(11%)
Northern Side-notched	73	(80%)	13	(14%)	5	(6%)

Geographic direction from Table 11-4 and Figs. 1-17 and 1-18 frequencies computed from data in Hughes 1983, Appendix 3a-f, excluding specimens from unknown sources.

Table 11-6

Frequency of Gunther series points from Pits J, P, Z, and V by stratum and geographic direction.

	Geographic Direction from Nightfire Island		
Stratum	South	Northeast	East
15-UAL	20	3	2
14-MAL	10	1	-
13-LAL	9	4	2

Geographic direction from Table 11-4, type totals from Hughes 1983, Appendix 3a.

Finally, comparison of the counts in Table 11-5 shows that the distributions of Gunther series and Northern Side-Notched points are essentially those expected by chance at the 0.05α level ($x^2 = 0.70$, df = 2). In short, the same frequencies of source materials from different geographic directions were observed during Gunther series and Northern Side-Notched times.

Discussion and Interpretation

Because Nightfire Island is located in such close proximity to the copious obsidian deposits in the Medicine Lake Highland (see Fig. 1-17), it was anticipated that these nearby sources would predominate in the obsidian projectile point assemblage. While there is no question that the majority of points, during all periods represented, were fashioned from nearby source materials, the temporal variability in source use is of considerable interest.

The Northern Side-Notched period source representation is in line with what would be expected on the basis of proximity; that is, the nearest sources of artifact-quality glass were the ones most accessible and therefore most frequently used to manufacture projectile points. This distribution is consistent with what would be anticipated if groups had direct access to the Medicine Lake Highland sources. The few distant northeast and eastern sources represented probably resulted from occasional exchanges with peoples living in these areas, or they may have been introduced by in-marrying males from adjacent social groups (cf. Hughes and Bettinger 1984). Certainly there is no good evidence in the Northern Side-Notched point assemblage to suggest sustained interaction or strong exchange ties with any area other than the Medicine Lake Highland. Even here, given the inclement weather from late fall through early spring in the Highland, it is unlikely that people actually lived year-round in the immediate vicinity of the obsidian sources, thereby controlling access. It seems more probable that Nightfire Island folk had a direct access to the Highland sources in the summer, when hunting and other collecting activities were undertaken (cf. Hardesty and Fox 1974).

From around 1,350BC-250AD, however, a rather different pattern is represented at Nightfire Island which diverges sharply from the preceding period. The contrast results primarily from the dramatic increase in Elko series points manufactured from obsidian of the Spodue Mountain chemical type[2]. Three times as many Elko series points were made from this glass than were registered in Northern Side-Notched totals, and this discontinuity may monitor broader sociocultural changes taking place in the region during Elko times.

One account for the high northeastern source totals during Elko times is that centuries of occupation around the shores of Lower Klamath Lake may have begun to deplete local resources so that, through time, people were forced to extend their previous hunting range. These more distant excursions would have resulted in more frequent contact with hunters from neighboring social groups where exchanges, which included obsidian points, were transacted. If population increases occurred during this period (a fact as yet undemonstrated), it would be expected that new settlements would be found during this time in areas not significantly exploited during Northern Side-Notched times. Thus, population "budding" (cf. Binford 1968), triggered by expanding lakeside populations, would have resulted in the establishment of settlements in previously unused or little-used areas. Because of inclement weather (heavy snowfall in late fall through early spring), these settlements would not be expected to be permanent. Rather, they most likely would be base camps occupied when weather conditions permitted, and when local resources were available. During winter months, people may have returned to the large lakeside villages. This suggestion parallels, to a considerable extent, the ethnographic Modoc (Ray 1963:180-183) and Klamath (Spier 1930:145-147) seasonal round.

If settlement expansion in fact occurred, the least complicated way to account for the high frequency of northeastern obsidians during this time is to suggest that the settlement expansion was directional. Simply stated, if these new base camps were established primarily to the north of Nightfire Island to exploit fish and other resources near Lost River, the inhabitants would have been in closer proximity to Spodue Mountain. Higher frequencies of this glass would thus be anticipated due to articulation of people living at these camps with Nightfire Island.

However, comparison of the material patterning of projectile point source use between Gunther series and Elko series times does not provide convincing support for this position. If Gunther series points were used by the ancestors of the ethnographic Modoc (which seems quite likely), using locational criteria recorded for the ethnographic settlement-subsistence cycle as a guide, we would expect these systems to exhibit essentially similar projectile point source distributions. If proximity to Spodue Mountain during these seasonal rounds was the most important variable, the same frequencies of this glass should appear in both periods. In short, given that the seasonal rounds were roughly the same, Spodue Mountain should have exerted the same "pull" during both periods. This clearly is not what has been observed in the archaeological record at Nightfire Island.

Since proximity does not appear adequately to account for this change, it may be that the increase in northeast source material occurred for other reasons. The change in projectile point style (Northern Side-Notched replaced by Elko series) with a concomitant three-fold increase in the number of points fashioned from more distant volcanic glasses suggests the possibility that, sometime during 1,350BC-250AD, Nightfire Island may have been inhabited by a new group of people, either coming from the north or having strong social ties with this area. It is worth noting that the inception of Elko series point use at Nightfire Island also is concurrent with a proposed hot-dry climatic episode registered between ca. 1,500BC-1,200BC in the bristlecone pine record from the White Mountains (see Fig. 4-1).

The coincidence, of course, does not provide unimpeachable evidence that these changes actually occurred in the Lower Klamath Basin (cf. Bryan and Gruhn 1964), but Grayson's (1976) avifuanal data (see Chapter 8) suggest that lake levels may have been lower during part of this interval.

This population replacement (assuming it occurred) may have been stimulated by climatic deterioration, and intensive exploitation of lacustrine resources might not have produced adequate caloric returns necessary to sustain the high population levels achieved during the preceding period. If lake levels lowered sufficiently during part of this time, previously abundant wocus and marsh adapted waterfowl, which were the dietary staples during the previous period (Chapter 9), may well have disappeared or retreated drastically, thus requiring some adaptive shift. These environmental preconditions may have set the stage for the incursion of a new group of people whose broad-spectrum procurement strategy would have been favored over one more specialized toward intensive use of dwindling lacustrine resources. Thus, a "travelling" strategy may have replaced a "processor" strategy (cf. Bettinger and Baumhoff 1982) during this time at Nightfire Island.

It also is possible that the higher frequencies of northeast source materials may not reflect wholesale occupation of Nightfire Island by a new group, but may signal a change of post-marital residence patterns brought on by changing climatic conditions. If the Lower Klamath Basin climate degenerated around the beginning of Elko times, it may have been to the advantage of the resident population to encourage males from the north to marry local women and to take up residence at Nightfire Island. By establishing marriage alliances with northerners who controlled the abundant resources of the Sprague River, the impact of local resource shortages would have been alleviated.

However, the material correlates of these hypotheses, insofar as they would be reflected in obsidian source representation frequencies, may well be the same. If a population replacement occurred at Nightfire Island, and people from the north moved south into the Lower Klamath Basin, higher frequencies of northeastern source materials would be expected as males brought points with them fashioned from source materials situated in their previous home territory. Once settled at Nightfire Island, reciprocal kin obligations and marriage alliances may have continued with relatives still living in the Sprague River area, thus accounting for the higher than expected frequencies of Spodue Mountain obsidian at the site.

Alternatively, these frequency changes may better be accounted for by positing that they signal the inception of a more widespread phenomenon--regional exchange networks. One of the consequences of this expansion would have been that resources and information also would have moved through the networks, thus serving to buffer the effects of postulated climatic deterioration in the Lower Klamath Basin. To a certain extent, this suggestion is a corollary of an earlier one (see above), in that marriage alliances also would have encouraged the flow of goods and information across social boundaries.

If this occurred, higher frequencies of points fashioned from more distant source materials should begin to appear at sites in the region between ca. 1,350BC-250AD, and these frequencies should stand in contrast to source-specific point assemblage composition in the preceding period. Thus, if that is correct, the Nightfire Island pattern is but a special case illustrating a more general phenomenon occurring at the regional level.

Sometime around 2-300AD, Elko series points appear to have been supplanted by Gunther series points at Nightfire Island. This replacement was rather different from the one involving Northern Side-Notched and Elko series points, in that it involved technological differences and evidence of violent social conflict (see Chapter 19).

First, it seems likely that the change from Elko to Gunther points signals a technological, not simply stylistic, replacement. It is commonly held that Eklo points were used primarily as tips on atlatl darts, while Gunther points were used as tips for arrows. Thus, the change from Elko to Gunther can be hypothesized to mark the transition from the atlatl and dart to the bow and arrow. Recall that it was suggested earlier that the replacement hypothesized at the beginning of Elko times may have been precipitated in part by climatic factors resulting in the selection of a more efficient broad-spectrum adaptation over a system less well able to cope in the face of change. In this case, both groups are assumed to have possessed similar weapon systems (atlatl and dart); thus, technology was held constant. By contrast, there is no good evidence to support advancing climate as the causal agent for the change from Elko to Gunther series points; this period is marked only by a moderately warm blip in the moist/temperature curve (see Fig. 4-1). The apparently rapid eclipse of Elko series points by Gunther series specimens at Nightfire Island might then be interpreted as technological selection, rather than one grounded in subsistence factors. Although it is not possible to anticipate the full range of sociocultural changes ushered in by this change, it would be expected that the increased accuracy afforded by the bow and arrow might have opened new habitats (i.e., thick chaparral, high stands of <u>Artemisia</u> sp. and mountain mahogany) for utilization.

As the Arrowhead Loams accumulation at Nightfire Island was restricted primarily to the eastern portion of the site, it was in this area (specifically in Pits J, P, Q, and V) where finer subdivisions in this zone (13-LAL, 14-MAL and 15-UAL) could be recognized (Chapter 3). Consequently, more detailed examination of the frequencies of different obsidian sources represented in Gunther series points from these pits might provide a clue to the geographic area from whence the new technology came.

When the frequencies in Table 11-6 are compared with those registered during Elko times, some interesting contrasts emerge. Computation of a chi-square test shows that there is no significant difference (at the 0.05α level) between obsidian source representation during Elko times and those observed for the first appearance of Gunther points in the 13-LAL in Pits J, P, Q, and V ($\chi^2 = 0.10$, df = 1, Yates' Correction for Continuity applied; excluding specimens from eastern sources). However, there is a significant difference at the 0.05α level between Elko series point source representation and that observed for Gunther points from these same pits during 14-MAL and 15-UAL times ($x^2 = 4.22$, df = 1). In short, there is no real contrast in the distribution of southern and northeastern sources during Elko times and the first appearance of Gunther points in the 13-LAL. Combined 14-MAL and 15-UAL frequencies, however, are different from those registered during Elko times[3].

These contrasts appear consistent with the hypothesis that Gunther points may have been introduced at Nightfire Island during the 13-LAL by groups from the north or northeast. Although the 13-LAL sample size is regrettably small, continuities between Elko times and the first appearance of Gunther points support this suggestion.

Data from burials in the Southwestern Cemetery at Nightfire Island (Chapter 19), however, conflict with this interpretation.

Obsidian Sources of the Points with Burials

Twenty-nine obsidian projectile points were recovered with nine burials; 19 of these were recorded in direct association with skeletal material, while the remaining ten were either in uncertain association or recovered from fill surrounding the graves (see Table 11-7). Three of seven burials were accompanied by single projectile points; two of these points (in direct association with burials R-IV and S-1) were fashioned from nearby Medicine Lake Highland glass, while the third (in uncertain association with burial E-X; Fig. 19-7k) was manufactured from Drews Creek/Butcher Flat source material.

Burial R-X was accompanied by five projectile points, but only three (Fig. 19-7ghi) were in direct association; two (Fig. 19-7 gh) were made from Medicine Lake Highland obsidian and the third (Fig. 19-7i) was fashioned from Drews Creek/Butcher Flat glass. Two additional points (Fig. 19-7ef), manufactured from Drews Creek/Butcher Flat material, were recovered from the fill surrounding R-X.

One specimen (Fig. 19-4m), made from Medicine Lake Highland glass, was found in direct association with burial R-VII but the mixed fill from burials R-VII and R-VIII yielded another five projectile points. One of these (Fig. 19-7a) was made from raw material originating in the Massacre Lake region (see Fig. 1-18) more than 185 km (ca. 115 miles) to the east from the site, but otherwise this mixed fill was dominated by Medicine Lake Highland obsidians.

Points and fragments associated with burial R-XIII also were manufactured from Highland obsidians, although single occurrences of Blue Mountain and Spodue Mountain source materials are represented.

Table 11-7

Obsidian sources of projectile points in association with burials

Burial	Projectile point type	Association with Burial	Obsidian Source
R-II	Elko series	in grave fill	Buck Mountain
	Elko series	near pelvis	Callahan Obsidian flow
	Elko series	in pelvic girdle	Spodue Mountain
R-III	Gunther series	near left humerus	East Medicine Lake
	Gunther series	from rib cage	Grasshopper Flat/Lost Iron Well
R-IV	Gunther series	lodged between ribs	Grasshopper Flat/Lost Iron Well
R-VII	Gunther series	in left elbow	Grasshopper Flat/Lost Iron Well
	Gunther series	in fill?	Grasshopper Flat/Lost Iron Well
R-VII & R-VIII	Elko series	mixed fill	Callahan Obsidian Flow
	Gunther series	mixed fill	Grasshopper Flat/Lost Iron Well
	Elko series	mixed fill	Grasshopper Flat/Lost Iron Well
	Elko series	mixed fill	Massacre Lake/Guano Valley
R-IX	Gunther series	close to hip joint	East Medicine Lake
	Leaf shaped	in fill	East Medicine Lake
R-X	Gunther series	in fill	Drews Creek/Butcher Flat
	Gunther series	in fill	Drews Creek/Butcher Flat
	Gunther series	near right humerus	Cougar Butte
	Gunther series	next to lumbar vertebrae	East Medicine Lake
	Gunther series	embedded in neck	Drews Creek/Butcher Flat
R-XIII	Gunther series	in pouch?	Spodue Mountain
	Elko series	in pouch?	Grasshopper Flat/Lost Iron Well
	Elko series	in pouch?	Cougar Butte
	Gunther series	in pouch?	Grasshopper Flat/Lost Iron Well
	Elko series	in pouch?	Grasshopper Flat/Lost Iron Well
	Gunther series?	in pouch?	Railroad Grade
	Biface midsection	in pouch	Blue Mountain
	Leaf shaped	in pouch	Grasshopper Flat/Lost Iron Well
S-I	Elko series	near left shoulder	Grasshopper Flat/Lost Iron Well
E-X	Gunther series	in fill	Drews Creek/Butcher Flat

Thus, the Southwestern Cemetery, of 13-LAL date, contains male and female burials with Gunther points associated in such a way as to suggest that these projectiles inflicted fatal wounds. It is consequently tempting to agree that this period of violence was the result of a massive attack, or series of attacks, by an intrusive group using bows and arrows tipped with Gunther series points on the resident population at the site. Although at least one Gunther point made from northeast source materials was found lodged in an individual here, the majority of these specimens in direct assocation with burials were fashioned from southerly Medicine Lake Highland volcanic glasses. These data suggest an alternative hypothesis to that proposed in the preceding section: that the attacks might have been launched by a rival village situated elsewhere on Lower Klamath Lake. Feuds between nearby villages resulted in similar episodes of violence during ethnographic times (Spier 1930:26), but the practice of decapitation (see Chapter 19) might not be expected unless these villages were inhabited by different ethnic groups. If this had been the case, and the hypothesized rival village was situated to the east or northeast of Nightfire Island, higher frequencies of Medicine Lake Highland obsidian with these burials could easily be explained because these villagers also would have had access to Medicine Lake Highland glasses, and their route to the Highland would not have had to pass through territory occupied by Nightfire Islanders.

Nonetheless, following the violence during 13-LAL times, the frequencies of obsidian sources represented in the projectile point assemblage in the remainder of the Arrowhead Loams accumulation (14-MAL and 15-UAL) are remarkably similar to those registered during Northern Side-Notched times ($x^2 = 0.23$, df = 2, data from Tables 11-5, 11-6). This reorientation, marked by greater amount of nearby southern Medicine Lake Highland materials in the projectile point inventory, may reflect a lessening of hostilities signifying that mutually respected territorial boundaries resembling those recorded during the ethnographic period became fixed around this time, with the home range of Nightfire Island being reduced.

Termination of Sustained Occupation of Nightfire Island

Obsidian source data raise questions about the terminal date for occupation of Nightfire Island in the 15-UAL stratum. Since Medicine Lake Highland sources dominated in the Arrowhead Loams, it was anticipated that Glass Mountain obsidian from the Highland would be represented. However, if Nightfire Island had been abandoned before the eruption of Glass Mountain (1,360 ± 240BP; Chesterman 1955), the absence of Glass Mountain obsidian would be expected (cf. Hughes 1982). It is of some note, therefore, that not a single projectile point analyzed from Nightfire Island was manufactured from Glass Mountain material, thus suggesting a terminal date sometime before 400-870AD.

Further support for this position comes from limited x-ray fluorescence analysis of projectile points recovered from Mod-27, a small, shelter situated on the southern base of the Peninsula near the western shore of Copic Bay (Fig. 1-17). Although four Elko series points were recovered from the site, the bulk of the projectile point assemblage indicates a very late prehistoric occupation (Squier and Grosscup 1955). The projectile point types recovered included Desert Side-Notched, Cottonwood Triangular and at least one classic Gunther Barbed variant along with numerous projectile point preforms. The classic Gunther Barbed variant is considered a marker type for the 15-UAL at Nightfire Island (see Chapters 3 and 13), and therefore the late component at Mod-27 would appear to be coeval with the 15-UAL.

However, four projectile points from Mod-27 were manufactured from Glass Mountain obsidian (see Hughes 1983: Table 5-10 and Appendix 4) indicating that this late component accumulated after the eruption of the source. It would seem quite likely that Glass Mountain obsidian would have been used to fashion projectile points during 14-MAL and 15-UAL times if it had been available, especially since this source is represented at other sites in the area. Consequently, these observations would appear to support the case that regular visits to Nightfire Island ceased prior to the Glass Mountain eruption.

Summary

Detailed examination of the temporal variability in obsidian source use at Nightfire Island led to the formulation of a series of alternative hypotheses to account for these observed changes. While Northern Side-Notched times were characterized as reflecting patterns to be expected if direct procurement from the nearest available outcrop had obtained, the pattern observed during the succeeding Elko period was discordant with this model. Several alternatives were advanced to account for Elko distributions, among them: directional settlement-subsistence reorientation by the resident population; population replacement triggered by environmental change; changes in post-marital residence patterns; and the inception of regional exchange networks. Insofar as it was feasible to assess the consequences of these hypotheses using obsidian projectile point data, the strongest case could be made against directional settlement-subsistence orientation. The other alternatives would well have quite similar material consequences, and they all remain possibilities. The abrupt shift in source frequencies following the advent of Gunther series arrow points coincided with an episode of violent conflict which may have been a reflex of the repercussion of this technological change on the existing settlement-subsistence system. Sociocultural realignments may have precipitated establishment of territorial boundaries reflected in obsidian point distributions by higher frequencies of nearby volcanic glasses, and a concomitant dimunition of more distant source materials.

Regardless of how one assesses these alternatives, it is clear that they cannot be evaluated solely on the basis of data from one site. Further evidence must be obtained using independent data generated from sites situated elsewhere in the region (see Hughes 1983, 1986).

ENDNOTES: CHAPTER 11

1. Other obsidian sources are known to exist in northeastern California, southern Oregon and northwestern Nevada, but data on these are not presented because they were not identified in the Nightfire Island projectile point sample. Details on these sources appear elsewhere (Hughes 1983).

2. Although small obsidian nodules of the Spodue Mountain chemical type occur near the Sprague River, about 58km (36 miles) north of Nightfire Island (see Fig. 1-18), the majority of the nodules observed and collected for source analysis were too small to have served as raw material for Elko series points. Consequently, this locality could hardly have contributed significantly to the Spodue Mountain source totals.

3. These contrasts are supported by chi-square statistics even if all Gunther points attributed to 13-LAL, 14-MAL and 15-UAL layers in the site are included: i.e., Gunther (all 13-LAL specimens) vs. Elko, $x^2 = 9.64$, df = 1; Gunther (all 14-MAL and 15-UAL specimens) vs. Elko, $^2 = 5.59$, df = 1.

CHAPTER TWELVE

STONE FLAKING TECHNOLOGY

Figure 12-1 summarizes the reduction sequence most likely to account for the entire range of shaped and unshaped flaked stone produced at Nightfire Island. In this diagram, the primary block is decorticated (Stage I), flaked down by arbitrary stages (II, III) until it becomes too small to handle (Stage IV) at which point it is split on an anvil (V) and the fragments further shattered by the same method to produce a terminal, bipolar shatter cone (VI). Flakes, fragments of flakes and small chunks are produced from each stage--becoming progressively smaller as the reduction sequence proceeds. Many of the larger whole flakes taken from the earlier stages are used as blanks for projectile point production. This is Track _a_. Along this track, the recognizable substages are: the roughout--producing mainly thick flared flakes; the preform--producing elongated curved bifacial shaping flakes; the finished shape--producing mainly biface thinning flakes; and the finished notched points--producing small flared flakes. Many of the flakes snap during production, and the biface itself will occasionally break during reduction. Roughouts or preforms are also occasionally aborted because of flaking errors--and some of these are converted to makeshift drills. Track _b_ entails the direct use of whole flakes and large fragments as cutting tools, some of which are repeatedly resharpened and reduced. Track _c_ involves the use of flake fragments as small cutting chisels and wedges to produce the _outils ecailles_ of conventional typological language. Track _a_ is more commonly initiated in Stage I, while Track _b_ can be initiated from any stage, with increasing numbers of small flakes (rather than fragments) entering Track _c_ from the later stages. Reduction can be stopped at any stage, or at any point along a track, so that all the items figured in the diagram will be represented in the assemblage.

A reduction sequence of this kind is typical for a site at which (a) the dominant flakablstone is b brittle obsidian, (b) obsidian outcrops are distant from the site, (c) the techniques of blade production (maximum cutting edge per weight of obsidian) are not understood, (d) the cultural heritage of the inhabitants constrains experimental flaking to the production of bifacial projectile points, and (e) cutting edges of any kind are in exceptionally high demand because so many utensils and constructions require shredded tule and cattail fibres for twine, cordage, rope, and basketry. Emphasis on Track _c_ reflects an attempt to take advantage of every available sharp edge. Continuation of the reduction sequence to Stages V and VI must reflect a similar urge to derive as many sharp splinters and chips as possible from the obsidian at hand. It follows that an unusually high proportion of all flakes from any stage or track will show clear traces of use-damage and refurbishing (see Chapter 14). It also follows that old obsidian pieces brought up to the surface of the site during pit-digging operations will very likely be recycled, if large enough. Also, older pieces of suitable size will be scavenged from abandoned chipping stations located closer to the site than the natural obsidian flows. One consequence of this will be a set of wildly variable obsidian hydration readings from different surfaces of individual pieces (see Chapter 4).

Taken as a whole, the sample of flaked stone from Nightfire Island displays all these characteristics and it is reasonably certain, therefore, that the diagram in Fig. 12-1 is a close approximation of the actual reduction sequence of a single block of material. However, it is a generalized diagram which fails to account for the relative numbers or sizes of the different pieces produced. It also represents an idealized, complete reduction. In reality, the reduction sequence might have been stopped at any point along the stages and tracks. Likewise, a partly reduced core or a scavenged

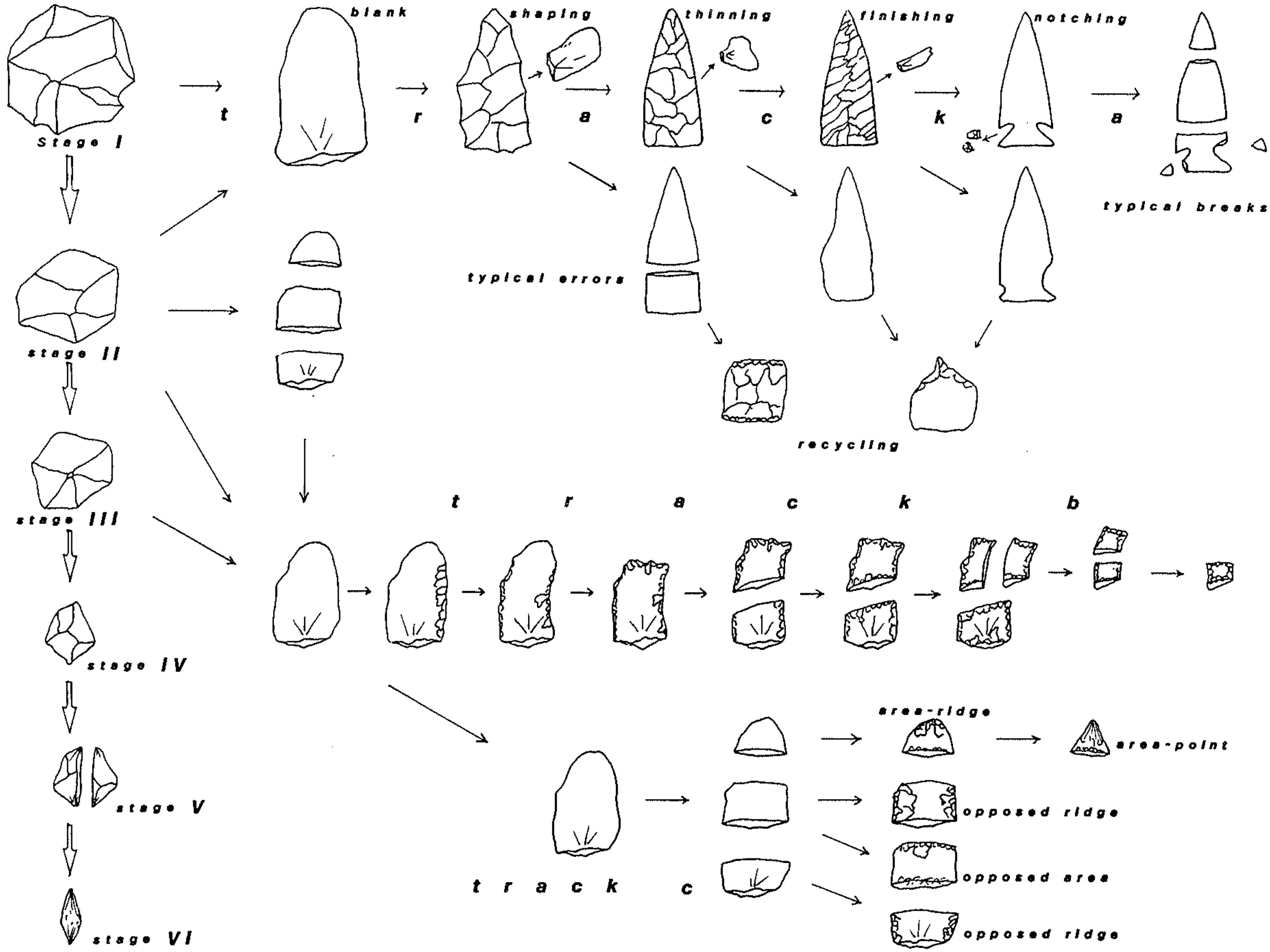

Fig. 12-1 Intuitive reconstruction of the complete Reduction sequence used at Nightfire Island.

artifact could have been brought to the site for further reduction--in which case the sequence could also beginat about any stage or at any point along a track.

Although crude and generalized, the diagram nevertheless provides a convenient framework for more detailed analysis of certain of its parts. By selecting aspects of the reduction sequence for closer inspection, it can be shown that the history of flaking technology at the site passed through several interesting shifts in emphasis within the framework outlined above. The first of these to be examined will be the cores.

Core Reduction - Stages I to IV

Although unflaked blocks of obsidian and chert were undoubtedly brought on to the site--as numerous cortical flakes testify--none has survived. However, C. B. Howe recovered a massive, partly flaked block from the NOUT area. Its maximum length is about 40cm, and it must have required considerable effort to carry it to the site. Perhaps this anomalous piece was buried in a cache and forgotten, but its context was not recorded during the uncontrolled excavations. Little else can be said about this piece except that it was certainly not typical of the Stage I blocks normally brought to the site. These probably varied from fist-size to head-size.

Surviving cores are relatively scarce, because so many were split and further reduced. Table 12-1 gives their distribution by stratum and by raw materials. Only one basalt core was recovered from above the First Marker Horizon, and chert cores increased briefly in the 11-USFL, mainly at the northern end of the site (Fig. 12-2).

The overall size of cores also varies by stratum and by raw material. Size was calculated volumetrically; max. length x max. breadth (at right angles to the length axis) x max. thickness (at right angles to the breadth axis). "Volume" is thus the cube containing the core rather than the actual (i.e. liquid displacement) volume of the core. The diagram in Fig. 12-3 gives the cubic volume for each specimen, per stratum and rock type. Basalt cores were abandoned relatively early in the sequence (Stage II-III) and are much larger than those of chert and obsidian. Chert blocks were only very rarely reduced to the size of Stage IV, which was more commonly reached with obsidian cores. Basalt flakes were never in great demand, as will be shown below. Chert cores become difficult to handle beyond Stage III because the material is relatively tough, requiring hard accurate blows to detach further flakes. Obsidian, being more brittle, is more manageable even when the core has become very small indeed. More significantly, the size of obsidian cores varies by stratum. The habit of abandoning obsidian cores while still relatively large was quite common during the accumulation of deposits in the Large-Flake zone. The practice stopped after the 8-LFL, when obsidian cores were routinely reduced to Stage IV.

This shift does not seem to have accompanied any significant change in core reduction strategies, however. Normally, the Stage II reduction seems to have followed an opportunistic pathway, starting with a single platform, then exploiting whatever available edges presented themselves. Alternate flaking followed, to produce a sinuous platform margin (Fig. 12-4f) which was continued around the block wherever possible. Whenever a discoidal core outline could be achieved (Fig. 12-4e), radial flaking was continued for as long as possible, until control of the edge was lost (Fig. 12-4bd) or the core became too small (Fig. 12-4c). At this point (Stage IV), one of three options was chosen: either (a) the core was abandoned; (b) it was worked down to a small, unusable, multiplatform core of globular shape (Fig. 12-4a); or (c) it was deliberately broken into fragments which were then converted into single platform cores (Fig. 12-5). Failure to achieve a discoidal form in Stage II often led to some compromise

Table 12-1

Whole Cores: Raw Materials

Stratum	Obsidian	Chert	Basalt	Total cores
15-UAL	3	-	-	3
14-MAL	2	-	-	2
13-LAL	7	2	-	9
12-TSFL	1	2	-	3
11-USFL	6	14	-	20
10-MSFL	19	5	1	25
9-LSFL	3	-	-	3
8-LFL	10	1	2	13
7-GraCl	-	1	-	1
6-S&B	11	-	-	11
5-Scaup	9	2	2	13
4-Mix	1	-	1	2
3-Grebe	7	-	1	8
2-Coot	-	-	-	-
1-Basal	-	3	-	3
Lakebed *	2	1	1	4

* ?Derived from Scaup in O and U

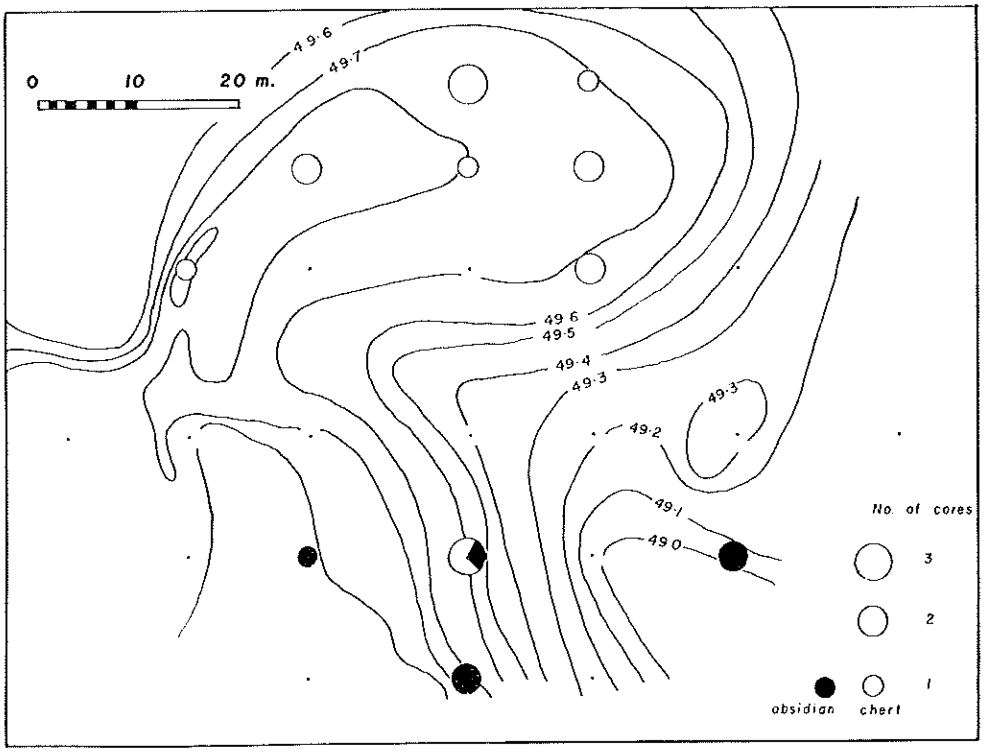

Fig. 12-2 Distribution of chert and obsidian cores in the 11-USFL.

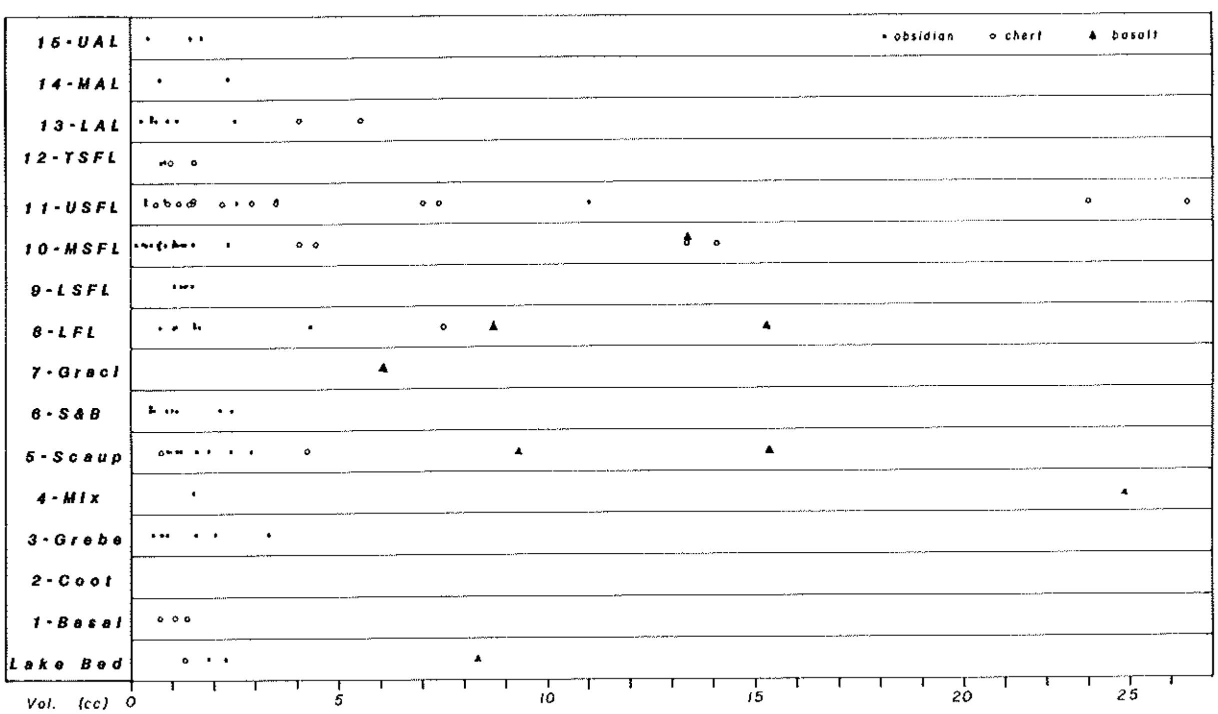

Fig. 12-3 Cubic volumes of individual cores, by stratum and rock type.

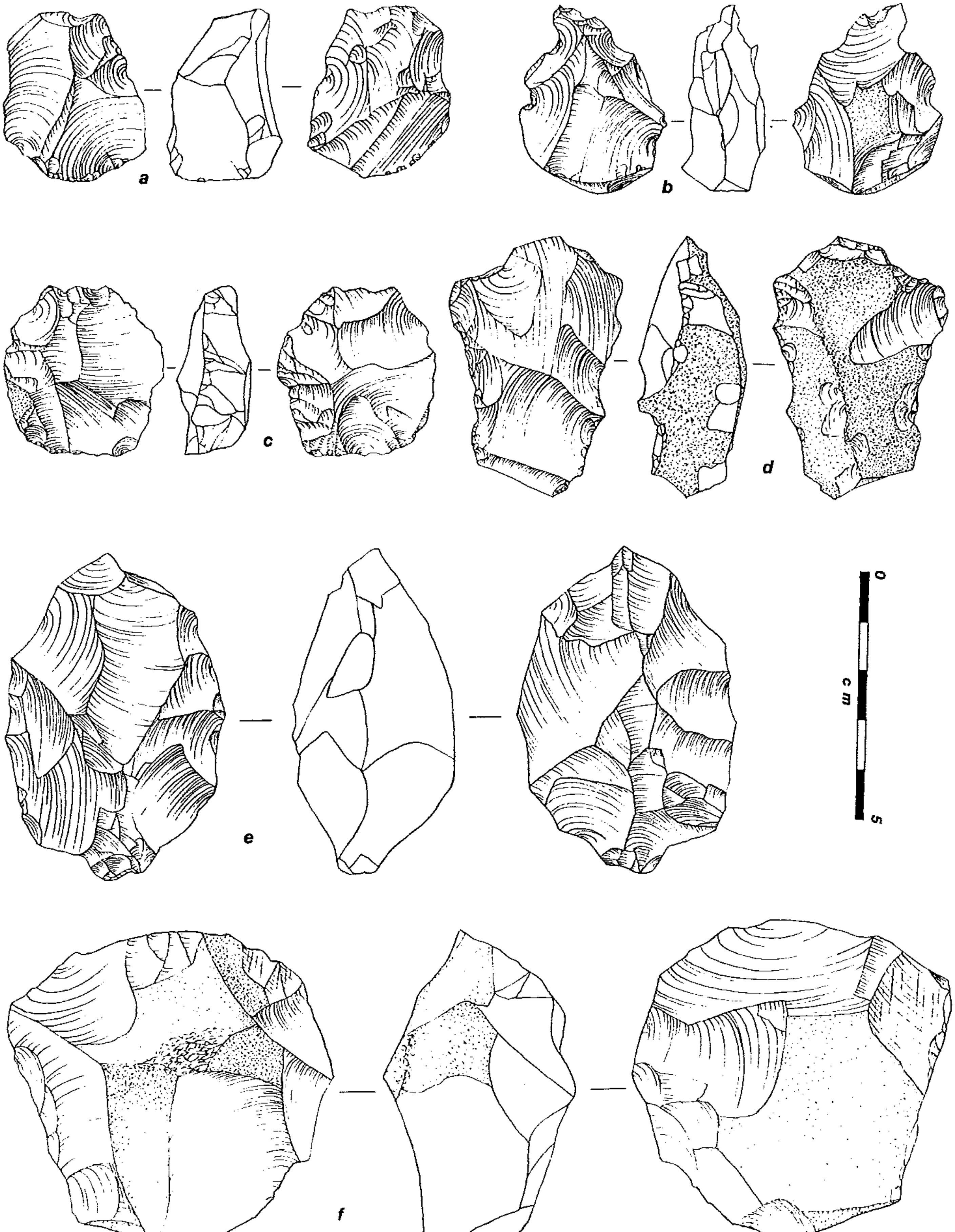

Fig. 12-4 Cores: (a) polyhedral, obsidian, 14-MAL in Q2; (b) alternate flaked, obsidian, Lake Bed derived from 5-Scaup in O7; (c) discoidal, obsidian, 10-MSFL at T3; (d) aborted discoid, obsidian 5-Scaup at Y8a; (e) Stage III large discoid, basalt, Lake Bed derived from 5-Scaup in U4b; (f) alternate flaked, basalt, 5-Scaup in P11a.

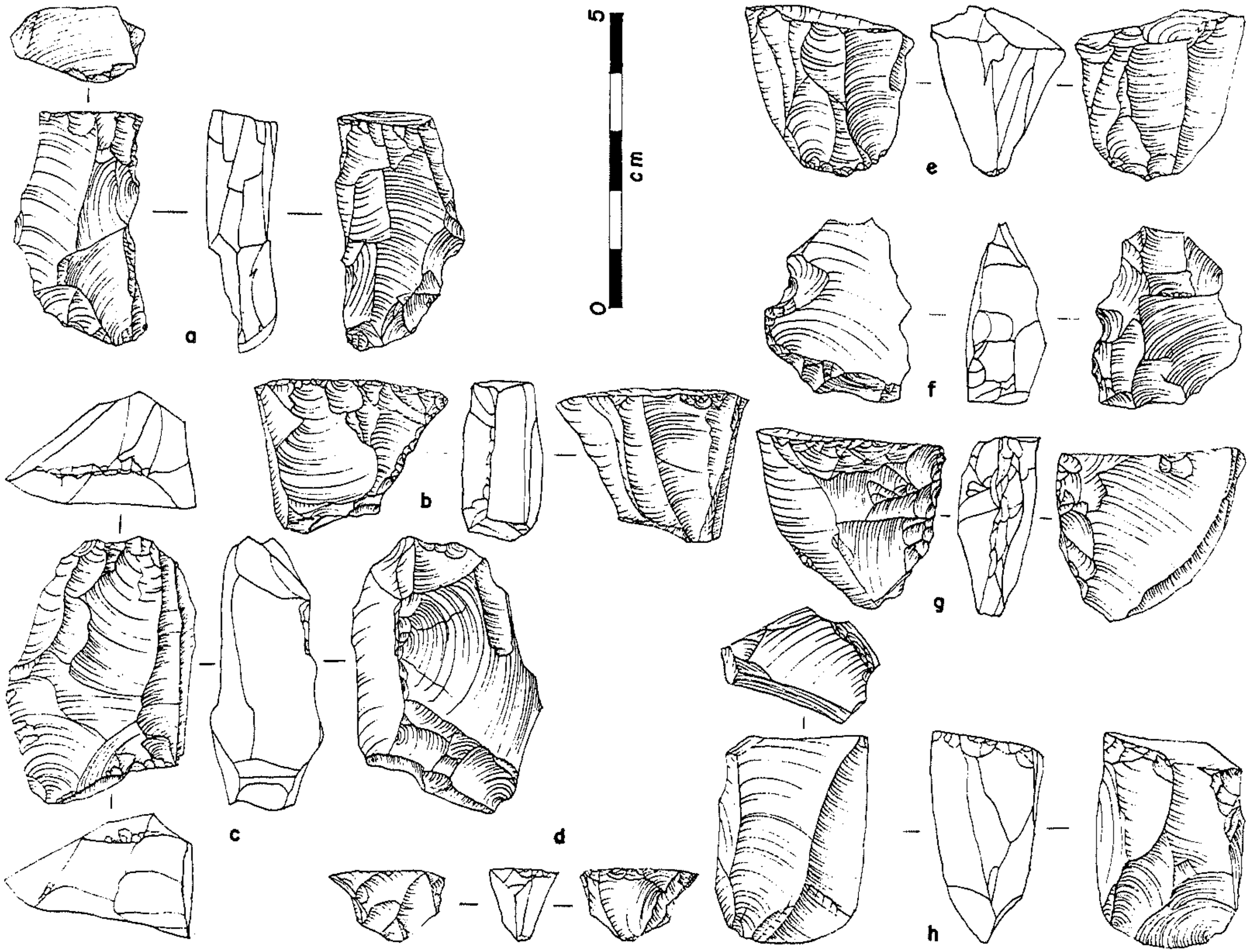

Fig. 12-5 Cores: (a) single platform, obsidian, 5-Scaup in U4a; (b) single platform, obsidian, 5-Scaup in I9b; (c) adjacent platform, obsidian, 6-S&B in V5c; (d) small single platform, obsidian, 10-MSFL in Q5; (e) single platform, chert, 11-USFL in A8; (f) single platform, chert, 11-USFL in E4a; (g) single platform, obsidian, 10-MSFL in T3a; (h) single platform, obsidian, 9-LSFL in T4.

involving two or more adjacent platforms or, less freuqently, opposed platforms. Altogether, seven core types emerge from these various flaking sequences (Fig. 12-6). There is no evidence from this small sample that the basic core reduction sequence was altered or developed in any way during the entire span of the site's formation. The only change of any consequence was the more thorough reduction of obsidian cores, starting in the 9-LSFL. However, this should not be interpreted as an improvement in overall flaking skills among the inhabitants. Prior to this event, larger obsidian cores were being abandoned before exhaustion of all platform angles, usually in Stage II-III. As their typology would suggest (Table 12-2), there are no discoids in this group, and only one polyhedral. Reasons other than improved knapping skills must be sought to explain this change, therefore.

Bipolar Reduction of Cores - Stage V and VI

After a core has been reduced to about 5cc in volume through the opportunistic pathways described above, it becomes difficult to grasp. Further reduction becomes possible only if it is placed on a flat rock (anvil) and struck from above. Depending on the velocity of the blow and the mass and shape of the core, this can produce a bipointed core, crushed at both ends (Fig. 12-7a-d), or a shatter cone devoid of any clear flake scars (McPherron 1967). Generally, blows of intermediate force will tend to split the core (Fig. 12-7e-h).

Although introduced during the 6-S&B buildup, routine bipolar reduction of small cores did not become a regular practice until the 9-LSFL. Thereafter, it persisted throughout the Small-flake Loams, becoming less common in the Arrowhead Loams (Table 12-3). Chert cores were seldom treated this way, presumably because this material is more resistant than obsidian. Most of the surviving chert specimens are shatter cones--indicating that massive blows were needed to reduce chert cores.

The increase in bipolar reduction, which starts in the 9-LSFL, coincides with the trend towards the more complete reduction of whole cores discussed above (Fig. 12-3). Both trends must surely reflect a response to an increased need for more flakes and sharp splinters, no matter how small these might have been.

Track c - Bipolar Scaled and Crushed Flakes and Fragments

Bipolar edge damage also occurs on numerous flake fragments and small chunks. Although some of these specimens may have resulted from anvil-work like that described above, the same damage can be replicated when a flake or fragment is held with one edge resting on a stick, bone or other material and the opposite edge is pounded with a hammer. Similar damage can be induced if the fragment is used as a wedge for splitting wood. Replication experiments to explore possible differences in edge-damage during anvil reduction, cutting, and splitting are beyond the scope of this project. However, various attempts to differentiate types of crushed pieces (e.g. Binford and Quimby 1963) have led to functional labels such as "gouge" (e.g. McPherron 1967; Brose 1970) which may have some validity. The basic assumption is that pieces with opposed ridges are more likely to be gouges or chisels (Fig. 12-8a-h); this may also apply to specimens with a point-ridge configuration (Fig. 12-8ij). Wedges, on the other hand, are more likely to display a broader battered area opposite the crushed ridge, point, or area (Fig. 12-9).

The distribution of subtypes (Table 12-4) shows that they were certainly in use from the very beginning of the site's depositional history. Like the bipolar cores, they proliferated in the 9-LFSL and 10-MSFL, but were less frequently used during the Arrowhead Loams accumulation. There are no significant fluctuations between the

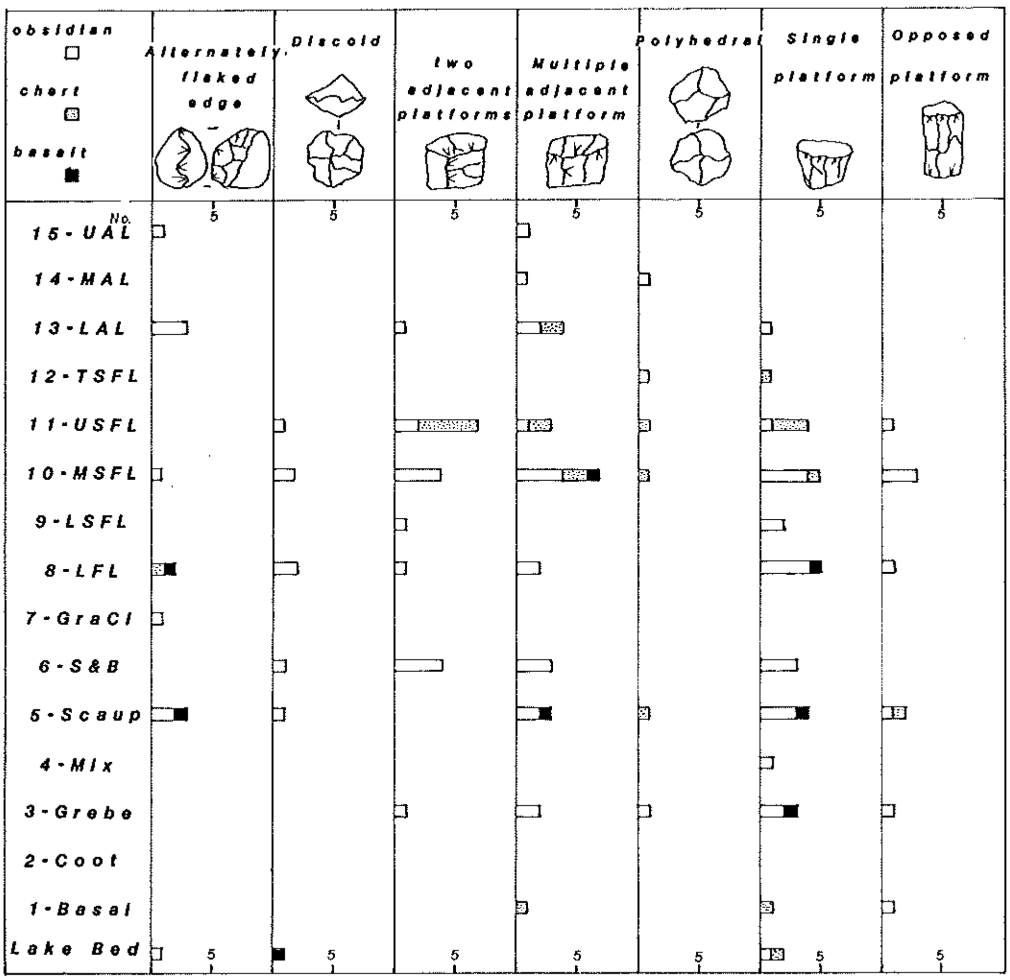

Fig. 12-6 Distribution of core types by stratum and rock type.

Table 12-2

Typology of Obsidian cores > 2cc from the Large-flake Zone

Stratum	Alternate flaked edge	Discoid	Double-adjacent platform	Multiple-adjacent platform	Polyhedral	Single platform	Opposed platform
8-LFL	-	-	1	1	-	1	-
6-S&B	-	-	1	1	-	2	-
5-Scaup	2	-	-	-	-	-	1
3-Grebe	-	-	1	-	1	-	-

Table 12-3

Byproducts of Stages V and VI of the Core reduction sequence

Stratum	Opposed Points	Split core halves	Shatter cones	Total V-VI	Total II-IV (whole cores)
15-UAL	3	1	-	4	3
14-MAL	-	-	-	-	2
13-LAL	2	1	1	4	9
12-TSFL	1	1	2*	4	3
11-USFL	7	4	2**	13	20
10-MSFL	17*	14*	14*	45	25
9-LSFL	15	10	2	27	3
8-LFL	3	3	-	6	13
7-GraCl	-	-	-	-	1
6-S&B	-	3	-	3	11
5-Scaup	-	-	-	-	13
4-Mix	-	-	-	-	2
3-Grebe	-	1	-	1	8
2-Coot	-	-	-	-	-
1-Basal	-	-	-	-	3
Lake Bed	-	-	-	-	-

* = 1 chert specimen

Table 12-4

Bipolar scaled and crushed flake fragments (after Binford & Quimby 1963)

Stratum	Grand Total	"Chisels" Opposed Ridge	"Chisels" Point Ridge	Total Chisels	"Wedges" Area Ridge	"Wedges" Area Point	"Wedges" Area-Area	Total Wedges
15-UAL	6	1	1	2	4	-	-	4
14-MAL	2	-	1	1	1	-	-	1
13-LAL	17	6	4	10	3	2	2	7
12-TSFL	8	2	1	3	3	1	1	5
11-USFL	31	6	3	9	9	10	3	22
10-MSFL	103	26	24	50	30*	19*	4	53
9-LSFL	57	15*	12	27	18	7	5	30
8-LFL	24	6	2	8	11**	2	3	16
7-GraCl	-	-	-	-	-	-	-	-
6-S&B	16	6	1	7	3	3	3	9
5-Scaup	5	1	-	1	1	1	2	4
4-Mix	-	-	-	-	-	-	-	-
3-Grebe	7	1	2	3	2	1	1*	4
2-Coot	1	-	1	1	1	-	-	1
1-Basal	3	-	1	1	2	-	-	2
Lake Bed	-	-	-	-	-	-	-	-

* = 1 chert specimen

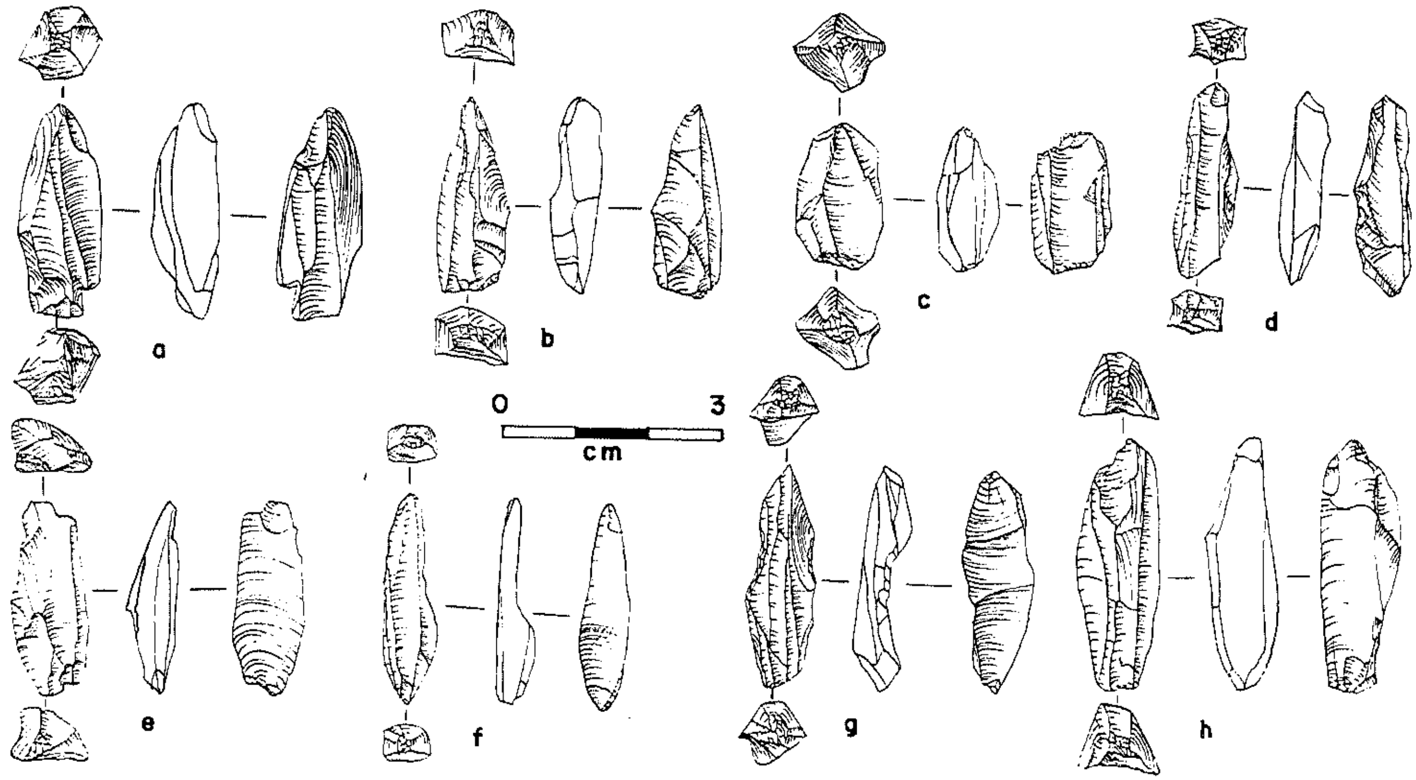

Fig. 12-7 Bipolar crushed pieces: (a-d) bipointed cores: (a) 11-USFL in I6b (b) 13-LAL in Q3b (c) 11-USFL in U1b (d) 9-LSFL in T4; (e-h) split cores: (e) 10-MSFL in J5b (f) 9-LSFL in U2a (g) 8-LFL in J6 (h) 3-Grebe in L3-4. All obsidian.

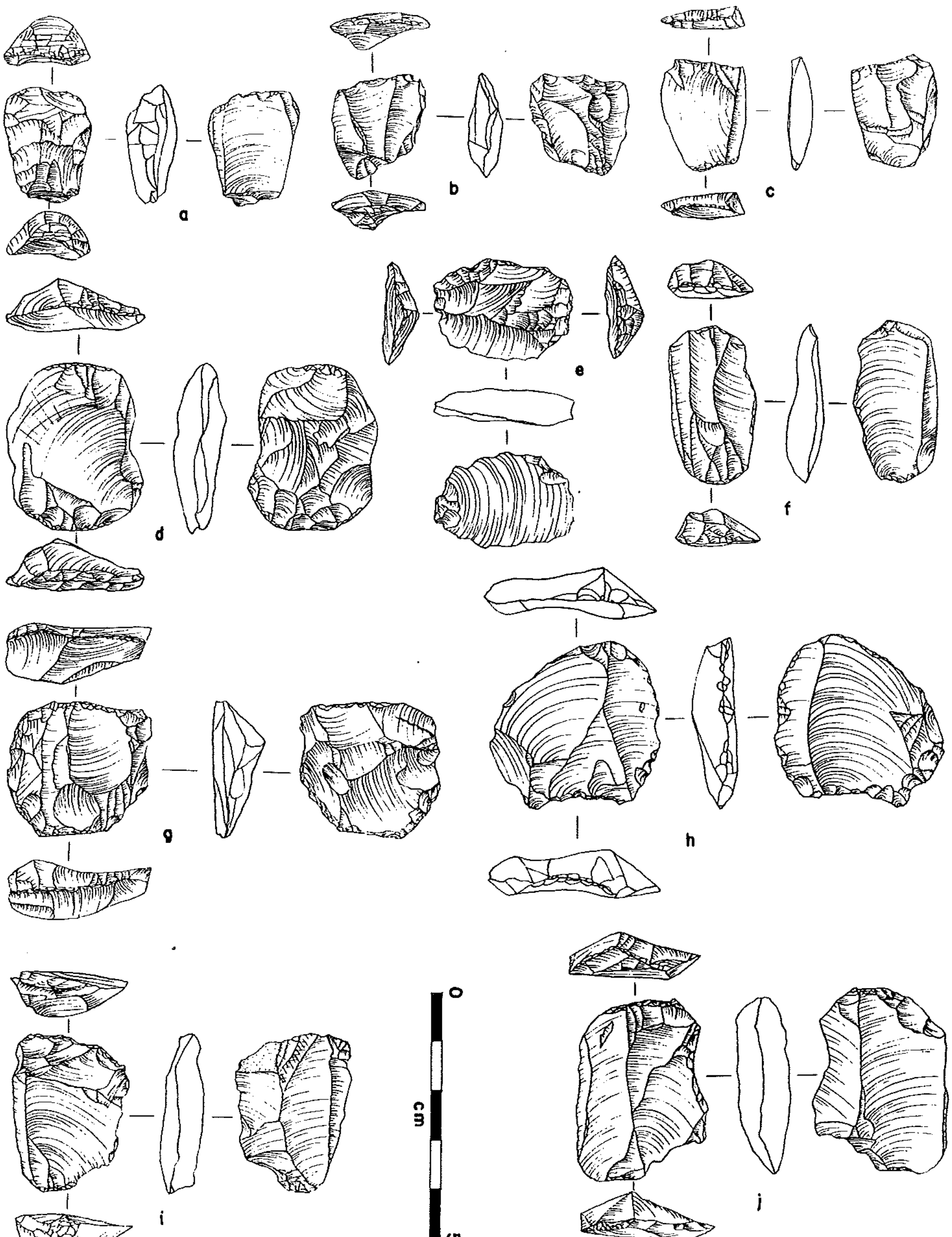

Fig. 12-8 Bipolar crushed flake fragments: (a-h) gouges or chisels: (a) 10-MSFL in I7 (b) 8-LFL in F2b (c) 10-MSFL in O1c (d) 11-USFL in U1b (e) 10-MSFL in Q5 (f) 15-UAL in P2 (g) 3-Grebe in F2d (h) 6-S&B in Y7; (ij) pointed-ridge chisels; (i) 6-S&B in U2c (j) 8-LFL in B5. All obsidian.

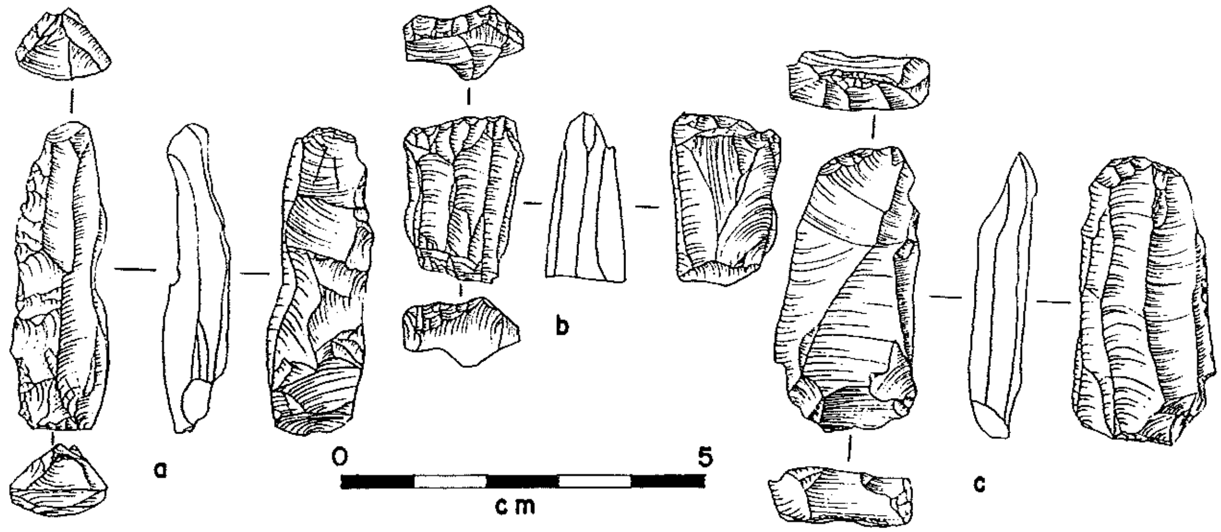

Fig. 12-9 Bipolar crushed pieces, possibly used as wedges: (a) 10-MSFL at Q6; (b) 11-USFL in A8; (c) 10-MSFL in O1c. All obsidian.

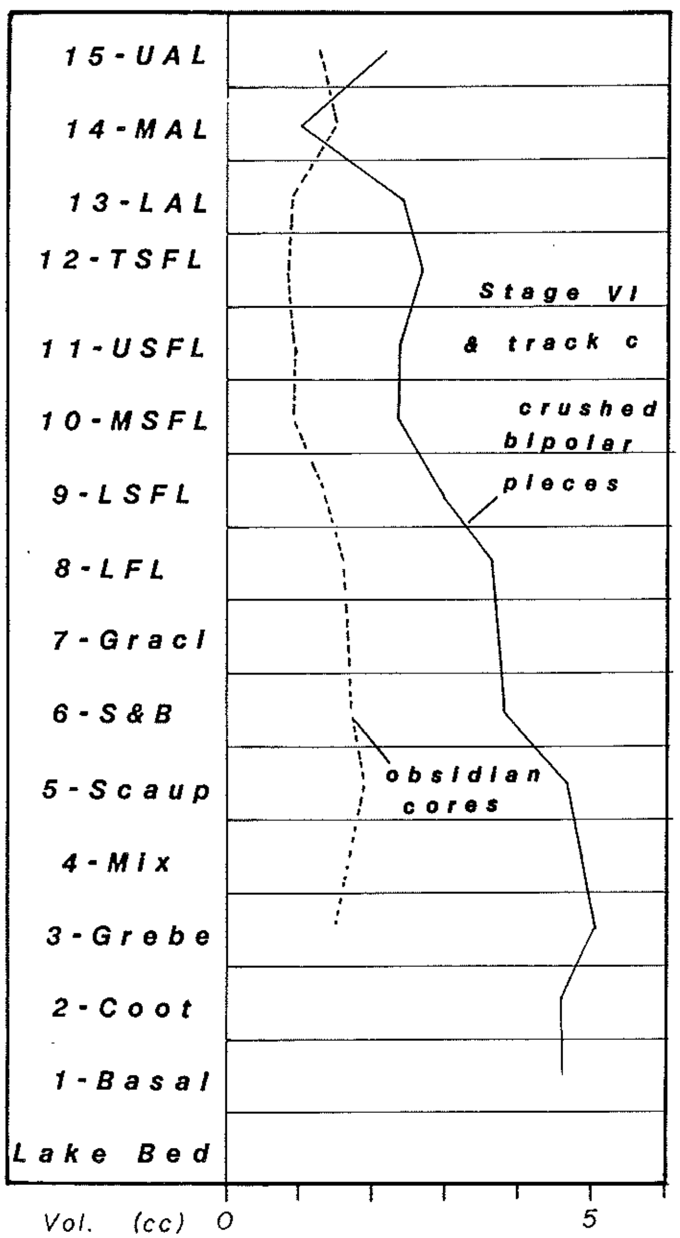

Fig. 12-10 Mean cubic volumes by stratum of obsidian cores and of bipolar crushed pieces from Stage VI & Track c of the Reduction sequence.

various sub-types through time, however. Overall, their frequency distribution strongly resembles that of the bipolar crushed cores--including the rare occurrence of chert specimens, mainly among the "wedge" categories. Obviously, the boundary between chisel/wedge and bipolar core is blurred here, and it is quite possible that many specimens served as both. Nevertheless, it is reasonable to assume that the increased use of chisel/wedges in the 9-LSFL was yet another indication that the supply of obsidian to the site could not keep up with the demand for cutting edges during the 9-LSFL.

Also of interest is the change in the size distribution of specimens within all bipolar crushed categoreis (Fig. 12-10): cubic volume is calculated in the same manner as that for the whole cores, and there is again a marked increase in the number of smaller specimens at the onset of the 9-LSFL--a trend identical to that in the whole cores (Fig. 12-3).

Track a - Projectile Point Production

Flake blanks to be converted into bifacially trimmed points could have come from any of the four stages of core reduction. Obviously, Stage I flakes were needed for larger points, whereas Stage III-IV flakes would have formed adequate blanks for smaller arrowheads. Although the length of a finished point is usually shorter than the maximum length of the original flake blank, it is a rough indicator of blank size. The first drop-off in mean point length occurs in the 5-Scaup (Fig. 12-11) and again in the 6-S&B, after which it seems relatively stable until the 12-TSFL which shows an anomalous spike. As expected, there is another decrease in the Arrowhead Loams. Before the 6-S&B, cortical Stage I flakes were undoubtedly preferred as blanks. However, cortex has survived on so few points (see Table 12-6) that this cannot be conclusively demonstrated.

However, non-cortical relict surfaces of the orignial blank have survived on many points. Some of these allow a reconstruction of the position of the original percussion cone on the flake blank before trimming began (Table 12-5). When elongated flake blanks were chosen, the cone was used to form the base about twice as often as it was used to form the tip of the point. Flared flakes were seldom chosen as blanks (about one flared for every three elongated flakes), but when this occurred, the blank was trimmed so that the cone occurred at the side of the point. These ratios seem to have held steady throughout the period of the Small-flake Loams and Arrowhead Loams. Samples from strata in the Large-flake zone are too small to evaluate. When these are combined (see base of Table 12-5) they suggest no significant difference from the later zones.

The trimming of the flake blank varied in extent and position. More than half the resulting points were entirely covered by secondary retouch scars, as mentioned above, but parts of the flat bulbar surface often went untrimmed, with the dorsal surface less often so (Table 12-6). There were significant spikes in the ratios of completely trimmed points in the 8-LFL and again in the 15-UAL. Also, bulbar surfaces were less frequently trimmed away in the Large-flake zone. No other trends are apparent.

Table 12-5

Track a - orientation of the preform blank: position of original percussion bulb relative to finished projectile point outline

Stratum	Point Base	Point Side	Point Tip	Total
15-UAL	6	8	1	15
14-MAL	2	3	4	9
13-LAL	25 (53.2)	14 (29.8)	8 (17.0)	47 (100)
12-TSFL	6	3	1	10
11-USFL	35 (55.6)	14 (22.2)	14 (22.2)	63 (100)
10-MSFL	37 (53.6)	18 (26.1)	14 (20.3)	69 (100)
9-LSFL	24 (51.1)	12 (25.5)	11 (23.4)	47 (100)
8-LFL	4	8	4	16
7-GraCl	2	1	1	4
6-S&B	15	4	5	24
5-Scaup	2	2	3	7
4-Mix	1	-	-	1
3-Grebe	3	2	2	7
2-Coot	1	1	1	3
1-Basal	-	-	-	0
Lake Bed	1	-	-	1
Combined large-flake zone	29 (46.0)	18 (28.6)	16 (25.4)	63 (100)

Values in brackets = percentages of totals per stratum

Table 12-6

Track a -- Secondary Trimming of the Flake Blank

Stratum	Both surfaces fully trimmed	Bulbar surface Incompletely trimmed	Dorsal surface Incompletely trimmed	Both surfaces Incompletely trimmed	Totals
15-UAL	42 (65.6)	6 (9.4)	1 (1.7)	15 (23.3)	64 (100)
14-MAL	16	4	1	10	31
13-LAL	71 (55.0)	17 (13.2)	6 (4.7)	35 (27.1)	129 (100)
12-TSFL	27	1	-	9	37
11-USFL	119 (58.9)	27 (13.4)	*6 (3.0)	**50 (24.7)	202 (100)
10-MSFL	90 (52.6)	19 (11.1)	*2 (1.2)	**60 (35.1)	171 (100)
9-LSFL	73 (56.6)	13 (10.1)	4 (3.1)	39 (30.2)	129 (100)
8-LFL	38 (62.3)	9 (14.7)	3 (4.9)	11 (18.0)	61 (99.9)
7-GraCl	3	1	-	3	7
6-S&B	37 (53.6)	15 (21.7)	1 (1.4)	*16 (23.3)	69 (100)
5-Scaup	9	5	2	*5	21
4-Mix	6	1	-	1	8
3-Grebe	10	4	1	3	18
2-Coot	5	1	-	2	8
1-Basal	4	-	-	-	4
Lake Bed	2	-	-	3	5
Lake Bed to Scaup Combined	36 (56.25)	11 (17.2)	3 (4.7)	14 (21.9)	64

Values in brackets are percentages of totals

* = 1 specimen with cortex

The preform was normally shaped by direct percussion flaking with an antler billet or a relatively soft sandstone hammer, leaving direct-percussion scar patterns which are readily distinguished from the later thinning and finishing scars, which overlay them. Occasionally, percussion-shaped preforms were abandoned before thinning and finishing was complete (Table 12-7). Unfinished bifaces were relatively numerous in the Large-flake zone, but dropped to only a few percent of all points in the Small-flake zone. The 12-TSFL period saw a resurgence of unfinished pieces, and there is a slight overall increase in the Arrowhead Loams.

Many flake blanks were shaped by pressure flaking, without passing through preliminary percussion flaking. About one-third of all recovered points can be shown to have been started in this way because pressure-flake scars are seen running over the primary surfaces of the blank (Table 12-8). Although the combined samples from the Large-flake zone contain relatively fewer specimens which were started in this way, there is some variability between strata within the zone, and there is no clear-cut change through time. Specimens with traces of preform percussion scars beneath the cover of finishing scars are relatively scarce in all strata. All other points in each sample are completely masked by finishing scars, so that their earlier flaking histories cannot be seen.

Some specimens were finished by sequential pressure-flaking which resulted in groups of more-or-less parallel scars. These serial scars were arranged in three basic patterns--upper (tip end) left to lower (butt end) right; lower left to upper right; and convergent. Combinations of these patterns occurred only rarely (Table 12-9). About one-third of all finished points in the Large-flake zone have serial scars. The only exception is the 6-S&B which has relatively fewer specimens. In the Small-flake zone, only the 10-MSFL has frequencies comparable to the Large-flake zone. Serial flaking was practiced throughout the site's history, therefore. Although there may have been an overall decrease in its use after the 8-LFL, this long-range trend is disrupted by anomalies in the 6-S&B and again in the 10-MSFL. Serial flaking requires considerable skill and experience, and it is reasonable to expect that not every Nightfire Island knapper had perfected this technique. It is all the more surprising, therefore, that any trace of a long-term trend is visible at all. Perhaps the decrease in serial flaking in the 9-LSFL is related to an overall increase in the number of knappers represented in the sample.

The final step in Track a is the notching of the base of sides of the finished biface. Three types of notch outline were formed: (a) parallel-sided notches; (b) convergent notches, wider at the point rim; and (c) expanding notches which are wider at the interior end than at the point rim. Convergent notches, being the simplest to accomplish, are dominant in all strata (Table 12-10). Parallel-sided notches increase in the 6-S&B, remain at about 20% of all notch types up to the 10-MSFL, after which they decline to little more than a trace. Expanded notches also become significant in the 6-S&B, persist in low frequencies through the 10-MSFL, and disappear after one point in the 11-USFL.

Two notching techniques are evident in the collections: the usual crushing process during which the pressure-flaker is used to crumble the projectile edge, and a more demanding technique by which serial flaking is applied to the notch in such a way that a relatively sharp margin is maintained in the notch itself. Although the second technique requires considerable skill, it was practiced throughout the site's history, again rising to prominence during the 6-S&B buildup, increasing again in frequency in the 10-MSFL, and once again in the 12-TSFL to become the predominant technique in the Arrowhead Loams.

Table 12-7

Percussion-shaped preforms and partly finished points

Stratum	Preforms: only direct percussion scars on both surfaces		Partly finished points: direct percussion scars on one surface		Totals	
			dorsal	ventral		
15-UAL	5	(7.8)	-	-	5	(7.8)
14-MAL	2	(6.5)	-	-	2	(6.4)
13-LAL	4	(3.1)	5	3	12	(9.3)
12-TSFL	5	(13.5)	-	1	6	(16.2)
11-USFL	6	(3.0)	6	3	15	(7.4)
10-MSFL	2	(2.3)	2	9	13	(7.6)
9-LSFL	4	(1.6)	1	1	6	(4.6)
8-LFL	2	(3.3)	-	1	3	(4.9)
7-GraCl	-		-	-	-	
6-S&B	6	(8.7)	5	1	12	(17.4)
5-Scaup	-		-	1	1	
4-Mix	-		-	-	-	
3-Grebe	4	(22.2)	1	-	5	(27.8)
2-Coot	-		-	-	-	
1-Basal	-		-	-	-	
Lake Bed	-		-	-	-	

Values in brackets are percentages of total bifacial points

Table 12-8

Pressure-flaking of Bifacial Points

Stratum	Pressure-flaking scars on primary surface of blank		Pressure-flaking scars over preform percussion scars	
15-UAL	20	(31.2)	5	(7.8)
14-MAL	13	(41.9)	2	(6.4)
13-LAL	39	(30.2)	6	(4.7)
12-TSFL	11	(29.7)	4	(10.8)
11-USFL	59	(29.2)	10	(4.9)
10-MSFL	62	(36.2)	5	(2.9)
9-LSFL	50	(38.7)	3	(2.3)
8-LFL	10	(16.4)	3	(4.9)
7-GraCl	4		0	
6-S&B	24	(34.8)	5	(7.2)
5-Scaup	7	(33.3)	1	(4.8)
4-Mix	1		0	
3-Grebe	3		3	
2-Coot	2		1	
1-Basal	0		0	
Lake Bed	2		0	
Large-flake zone combined	53	(26.4)	13	(6.5)

Values in brackets are percentages of total bifacial points

Table 12-9

Patterning of Pressure-flake scars on Projectile Points

Stratum	Total Specimens	No. of serially flaked specimens	Serially flaked: % of Total	Serial Flaked Patterns (nos.): upper l. to lower r.	lower l. to upper r.	convergent	other
15-UAL	78	8	10.3	7	-	1	-
14-MAL	32	5	15.6	2	-	2	1
13-LAL	109	18	16.5	11	-	6	1
12-TSFL	41	3	7.3	3	-	-	-
11-USFL	203	40	19.7	22	-	15	3
10-MSFL	181	50	27.6	42	2	4	2
9-LSFL	131	25	19.1	14	1	8	2
8-LFL	67	21	31.3	18	-	2	2
7-GraCl	6	2	-	2	-	-	1
6-S&B	71	13	18.3	9	1	2	-
5-Scaup	23	8	-	6	1	1	1
4-Mix	8	2	-	2	-	-	-
3-Grebe	17	3	-	2	-	-	1
2-Coot	8	2	-	1	-	1	-
1-Basal	4	3	-	2	-	1	-
Lake Bed	5	3	-	3	-	-	-
Lake Bed to Scaup	65	21	32.3	16	-	-	-

Table 12-10

Notch Formation on Projectile Points

Stratum	Total Notched Points	Shapes: Parallel-sided	Shapes: Convergent	Shapes: Expanded	Edges: Sharp	Edges: Crushed	Edges: Combined
15-UAL	58	-	58 (100)	-	29 (50.0)	29 (50.0)	-
14-MAL	29	2 (6.9)	27 (93.1)	-	20 (69.0)	11 (37.9)	2 (6.9)
13-LAL	93	6 (6.4)	87 (93.5)	-	40 (43.0)	52 (55.9)	1 (1.1)
12-TSFL	22	1 (4.5)	21 (95.4)	-	10 (45.4)	12 (54.5)	-
11-USFL	145	20(13.8)	124 (85.5)	1 (0.7)	55 (37.9)	84 (57.9)	6 (4.1)
10-MSFL	120	24(20.0)	87 (72.5)	9 (7.5)	49 (40.8)	66 (55.0)	5 (4.2)
9-LSFL	113	22(19.5)	86 (76.1)	5 (4.4)	33 (29.2)	74 (65.5)	6 (5.3)
8-LFL	51	10(19.6)	36 (70.6)	5 (9.8)	17 (33.3)	30 (58.8)	4 (7.8)
7-GraCl	7	2	4	1	1	4	2
6-S&B	61	13(21.3)	42 (68.8)	6 (9.8)	18 (29.5)	38 (62.3)	5 (8.2)
5-Scaup	12	1	10	1	2	8	2
4-Mix	6	-	5	1	-	6	-
3-Grebe	13	2	11	-	2	10	1
2-Coot	5	-	5	-	-	5	-
1-Basal	2	-	2	-	1	1	-
Lake Bed	4	1	3	-	1	3	-
Lake Bed to Scaup Combined	42	4(9.5)	36 (85.7)	2 (4.8)	6 (14.3)	33 (78.6)	3 (7.1)

Aspects of the Flaking Byproducts

Flaking byproducts include whole flakes, flake fragments and small chunks. As many of these display edge damage (Chapter 14) they cannot be classified as debitage in the strict sense, and the distinction between utilized flake and "waste" flake (without visible edge-damage) serves no useful purpose in this study. Byproducts are produced along all Stages and Tracks of the reduction sequence, and the excavated samples reflect varied mixtures of flaking residue--impossible to classify according to Stage or Track position without an elaborate refitting program. The information to be gained from refitting was judged to be too little to justify the effort and cost[1]. Nevertheless, these mixtures from individual strata do reveal a few interesting general trends through time.

It has already been determined that the mean length of whole flakes decreases abruptly in the 9-LSFL (Fig. 12-11), i.e. later than the size decrease registered for projectile points. This must mean that core reduction began to be pressed forward more frequently in the 9-LSFL beyond the production of flake blanks for points. Stage III-IV flakes were produced in greater quantities. When whole flake shape is examined (Fig. 12-12) it is also apparent that small thick elongated flakes reach a peak in the 9-LSFL. These were mostly produced from small single-platform cores and are not typical of serial pressure-flakes. Few such cores have survived, however, due to the bipolar splitting and shattering which also became prevalent at this time. The change to small arrowhead production in the 13-LAL also fails to register any clearcut trends in the whole flake size or shape; except perhaps the initial increase in blades in the 15-UAL reflects the production of pressure-flakes from large, serially flaked ritual knives found in this stratum (Chapter 14).

One last strategy for the production of more cutting edges from this sequence would be the deliberate snapping of whole flakes. Snapped edges were frequently used and show extensive edge damage, but it remains impossible to tell whether a particular snap facet was caused during flake production, when the flake hit the ground, when it was trodden upon, or when it was deliberately broken by hand after the edges of the flakes were dulled from use. It may be that the rate of fragmentation increased in the 9-LSFL (Fig. 12-13), but this may reflect increased damage underfoot as the settlement platform became more frequently inhabited. Curiously, the number of snap facets on the fragment tends to increase in the 10-MSFL rather than the 9-LSFL (Fig. 12-14) indicating more intense breakage of individual pieces. Again, the exact cause of breakage cannot be determined, but the result--more working edges--is beyond dispute.

Conclusions

All the flaking strategies practiced by the last inhabitants of Nightfire Island were already known to its earliest occupants. The only significant changes in flaking technology through successive strata were shifts in emphasis from one part of the basic reduction sequence to another. Up to the 5-Scaup, core reduction was more often halted early, giving rise to higher frequencies of larger cores, larger bipolar crushed chisels and wedges, larger points, and larger flake byproducts. Another consequence of this was that bifacial thinning and finishing flakes predominate over other shapes, even though projectile points were quite often left incompletely trimmed. This particular emphasis may well reflect the needs of knappers making short-term visits to the waterfowling station as part of a seasonal round which incorporated relatively frequent contact with obsidian flows. Such temporary visits required no large dwelling structures with all their attendant maintenance problems--particularly the processing of tule and cattails for matting and twine. Consequently, there was relatively less need to make use of every available sharp-edged piece of obsidian: broken flakes were relatively less

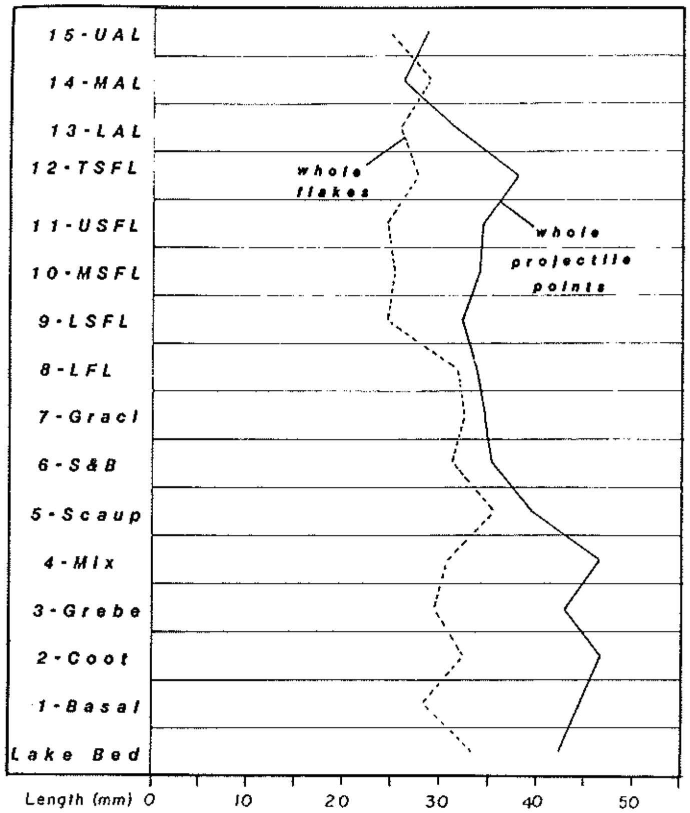

Fig. 12-11 Mean lengths of whole flakes and of whole projectile points.

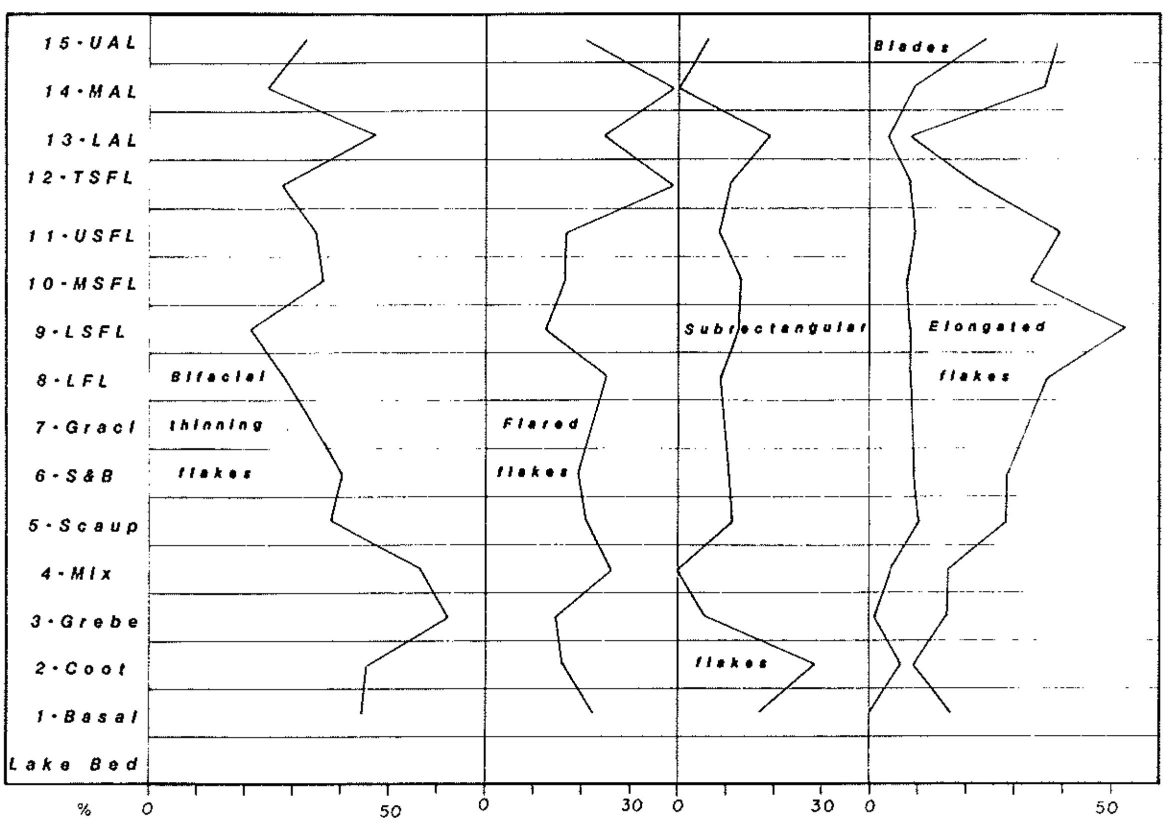

Fig. 12-12 Distributions of five basic flake shapes by stratum.

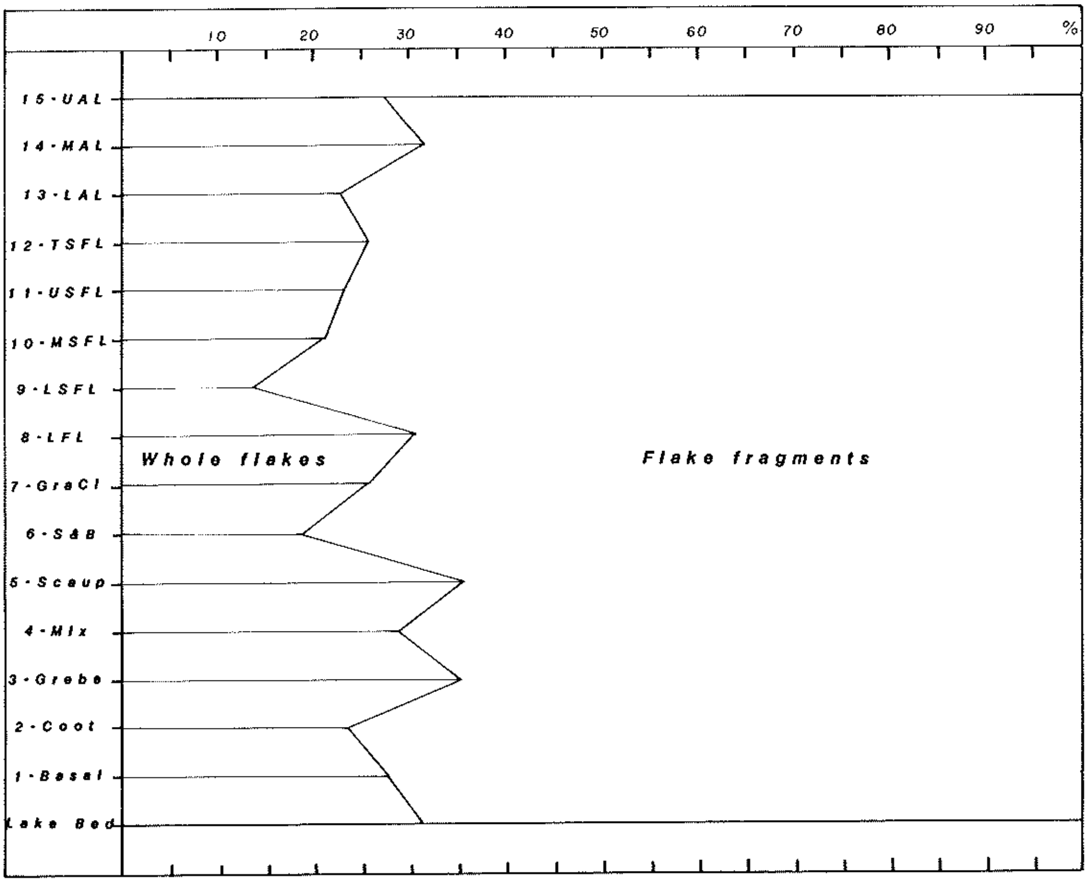

Fig. 12-13 Fluctuations in the ratios of whole flakes to flake fragments.

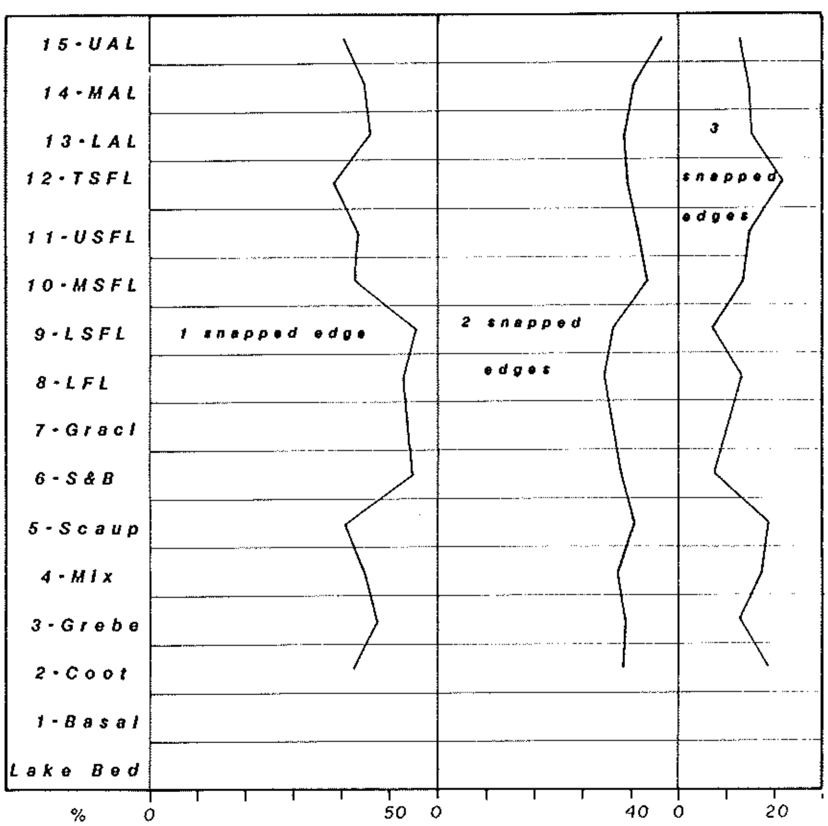

Fig. 12-14 Fluctuations in the ratios of broken flake fragments, classified by numbers of snap facets.

common, and multiple breaks were also fewer. The higher frequencies of incompletely trimmed points and percussion-flaked preforms among the points suggest that the production of preforms may have been a characteristic knapper's activity during these brief visits.

During the 5-Scaup accumulation, there was a decline in the number of larger bifacial points abandoned here, and a further decline during the 6-S&B platform construction. A similar trend occurred in the large bipolar crushed pieces, but whole flakes do not reflect any overall size decrease for the same period. Unfinished points and preforms continue to be relatively abundant and it may be that the larger of these were being carried off the site more frequently during these times.

With the 7-GraCl and the subsequent 8-LFL, we see the first traces of semi-permanent dwellings (Chapter 18), which coincides with the trend toward increased frequencies of bipolar crushed chisels and wedges--possibly connected with the needs of house construction (log splitting?). There is also a marked decline in the number of incomplete points and preforms after the site switches its role to a semi-permanent village and more finished work is produced on the spot. Coupled with this trend is the marked increase in perfectly finished points with sharp-edge, parallel-side or internally expanded notching. Apart from these shifts, the technology remains extremely stable throughout the 6-S&B, 7-GraCl and 8-LFL.

The abrupt shift in emphasis to the terminal end of the core reduction sequence during the 9-LSFL must equate with an episode of more intense occupation which continued to the end of the 11-USFL. Obsidian shortages, for whatever reasons, were the cause of this shift, and of the decline in core size, in the size of bipolar crushed pieces, and in the increased fragmentation of flakes. Once establihsed, this modification of the reduction sequence remained relatively stable through the Small-flake Loams. This shift had virtually no effect on the size of projectile points, however.

The next shift was an increase in the number of ready-made points brought on to the site in the 11-USFL (Table 12-11), a trend which apparently persisted throughout the Arrowhead Loams.

The 12-TSFL marks another shift within the reduction sequence--this time a reversal to the format practiced during the Large-flake zone accumulation. The small sample of points includes a higher frequency of large unfinished specimens and percussion-flaked preforms. Given that the site had switched roles once more--this time to a temporary fishing village--this trend is quite predictable. Knappers were once again mass-producing preforms as part of their equipment maintenance activities on their seasonal round. The scenario is further supported by the drop in serially-flaked points, and the virtual disappearance of the sharp-edged parallel notch. Although bipolar splitting and shattering of cores was less often practiced, wedges and chisels were still in use and the decrease in flake breakage was relatively slight. One possible explanation for this continuity might be that tule and cattail processing persisted at the site for maintenance of mat-covered temporary shelters.

The advent of the bow and arrow in the 13-LAL must have caused another minor adjustment in the reduction sequence. The abrupt drop in the required size of biface blanks for the production of arrowheads ought to have stimulated an increase in Stage III-IV cores and flakes. However, this is not evident from the analysis. Probably most of the arrowheads recovered were made elsewhere, as there were far too few cores and flakes found in the Arrowhead Loams[2]. Thinning flakes increased somewhat in the 13-LAL, but mean flake length remained unaffected. Convergent notching became the dominant procedure for producing the small stemmed points, and serial pressure-flaking dropped off markedly. Otherwise, no major technical innovations were required to accomplish the shift from the dart to the arrowpoint.

Table 12-11

Projectile Points : Flaking byproduct ratio

Stratum	a - Total whole Projectile points	b - Total whole flakes and fragments	a : b ratio
15-UAL	56	307	1 : 4.8
14-MAL	26	102	1 : 3.9
13-LAL	77	333	1 : 4.3
12-TSFL	28	134	1 : 4.78
11-USFL	146	916	1 : 6.2
10-MSFL	119	1882	1 : 15.8
9-LSFL	77	1129	1 : 14.7
8-LFL	40	499	1 : 12.5
7-GraCl	7	46	1 : 6.5
6-S&B	44	554	1 : 12.6
5-Scaup	28	273	1 : 9.75
4-Mixed-bd.	4	79	1 : 19.75
3-Grebe	15	336	1 : 22.4
2-Coot	9	102	1 : 11.3
1-Basal	2	64	
Lake Bed	4	57	

In the 15-UAL, one final adjustment was the selection of huge flake blanks for the production of obsidian "dance knives" (Chapter 14). Again, the basic Track a sequence was applied, except on an enlarged scale, so that the serial pressure-flakes produced during the finishing phase resembled true blades--the advantages of which were never fully understood by the site's inhabitants.

It thus appears that the modest shifts in emphasis within the reduction sequence through time were only very distantly connected with the short-term oscillations in climate and catchment configuration presented in Chapter 9. Perhaps the rise in finished points with their diverse notching methods in the 8-LFL can be most readily linked to ecological factors: it was during this period (dietary Step II) that the village was perforce more dependent on hunting.

When the marsh re-established itself around the village in the 9-LSFL, the proximity of cattail and tule stands would no doubt have encouraged more on-site production of reed matting and fibre cordage. Increased cutting and shredding activities would have led to a rising demand for suitable obsidian cutting edges to do this work. It follows that almost every available piece would be broken down to the smallest possible size in order to produce as many working edges as possible. The question remains, however, why this trend began in the 9-LSFL rather than in the earlier 6-S&B when substantial houses were introduced and the demand for more cordage and matting would have increased. Although it may be argued that building activity intensified in the 9-LSFL, there is no support for this (Chapter 18). Although the increase in obsidian "wedges" thought to be used for splitting logs for planking, may be taken as a clue to such intensification, this is a dubious line of argument at best. The antler wedges used for this purpose did not increase until the 10-MSFL (Chapter 15).

The simplest explanation for an obsidian shortage would be that the 9-LSFL villagers were denied access to nearby obsidian flows and were obliged to obtain their glass from farther away. Alas, this scenario is utterly without support (Chapter 11). Thus, the most conspicuous technical shift in the site's entire depositional history--and the basis for the First Marker Horizon--is also the most difficult to explain.

ENDNOTES: CHAPTER 12

1. It should be obvious that any sample from a single stratum (or even from a single layer in a pit) will be a mixture of several reduction sequences. Although some of these could be partly restored by refitting flakes to cores, etc., none will be completely rebuilt. Each reduction sequence represented in the sample could have starting and stopping points which cannot be determined without complete rebuilding of the original block. Because the size of each pit is so small, the chances of recovering enough pieces to rebuild a single reduction sequence are remote indeed. Replication experiments must fail for the same reasons.

2. Obviously many of the smaller thinning flakes would have passed through the screens, but there is a dense patch of these in A1-4, which were successfully retrieved. Such patches were not encountered elsewhere in the Arrowhead Loams.

CHAPTER THIRTEEN

PROJECTILE POINTS

Wherever possible, the definitions used in this chapter are taken from those currently applied in the surrounding region. However, many of these vary from one authority to the next and most published definitions ignore the overlap between related point types. Boundaries between similar-looking types will have to be determined in some cases. It is not the purpose of this analysis to revamp or even to tighten up existing published definitions, but rather to pinpoint overlapping type boundaries and to redefine them in metrical terms[1] whenever this procedure appears to shed more light on the NFI material. In the following sections, therefore, each type will be introduced with a short review of the problems generated by its published definition. Those types without stems or side/corner notches are reviewed first.

Gold Hill Leaf Points

Unstemmed leaf-shaped points are the most numerous design found at NFI. The diagram in Fig. 13-1 summarizes the distribution of weights and lengths of all whole specimens from all strata in the site. No very obvious clustering occurs in the diagram except for a group of four thick, heavy specimens which many authorities would classify as knives rather than points, in spite of their modest lengths. The weight distribution (horizontal axis) isolates these four, but fails to separate the sample into larger and smaller subtypes. When these are plotted at 0.5gm intervals, however, a bimodal curve is achieved with a separation at about 3.3-3.2gm. The length distribution (vertical axis) produces a bimodal curve separated at about 37mm. This preliminary breakdown of the foliate points suggests three categories: knives, large foliate points, and small foliate points.

The rest of this section concerns the choice of an appropriate label for the large foliate points. Some confusion surrounds that choice because they overlap with the published descriptions for Cascade Points, the Parman Series, Cottonwood Leaf Shaped Points, and Gold Hill Leaf Points. It will be argued below that the latter term is the most appropriate, and that the others should be excluded. The Cascade category will be considered first.

Butler's (1961) Cascade Point allows wide variation in size and shape: bases may be rounded or pointed, and cross-sections may be lenticular or diamond shaped. Slight shouldering is also permitted. There are no specific limitations placed on length, weight or other metric ratios. This is broad enough to accommodate almost any bifacially worked unstemmed point, and it can be used as a catch-all category for any but the smallest and broadest specimens. Its breadth/length ratio grades into the Blade/Knife categories, and specimens as short as 37mm have been admitted to the category (Layton 1972).

Cascade points have been dismissed as sensitive time-markers in Great Basin prehistory (e.g. Heizer and Hester 1978), because they remained in use over too long a period. However, Cowles' (1960) assertion that Cascades tended to decrease in size with time has been partly supported by Obsidian Hydration dates (Layton 1972). Figure 13-2 shows the length/weight distribution of Cascade-like points from NFI compared with OH dated Cascade points from Cougar Mountain Cave. Of the eight CMC points which fall inside the range of the NFI length/weight distribtuion, only the smallest two have rind thicknesses less than 5.1 , i.e. within the range of reliable NFI

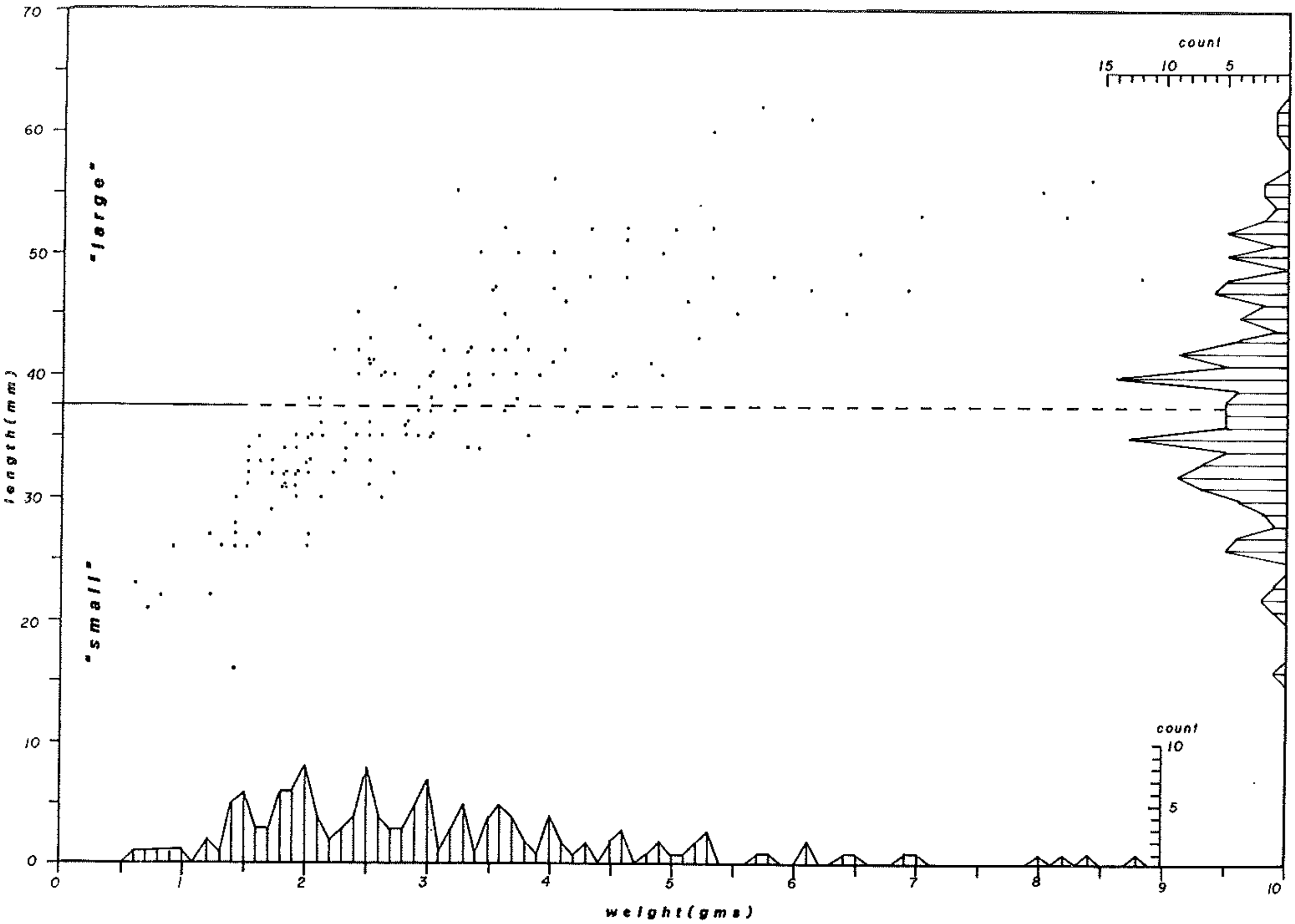

Fig. 13-1 Distributions of weights and lengths of whole foliate points from all strata of Nightfire Island, showing the arbitrary metric boundary between "large" and "small" points.

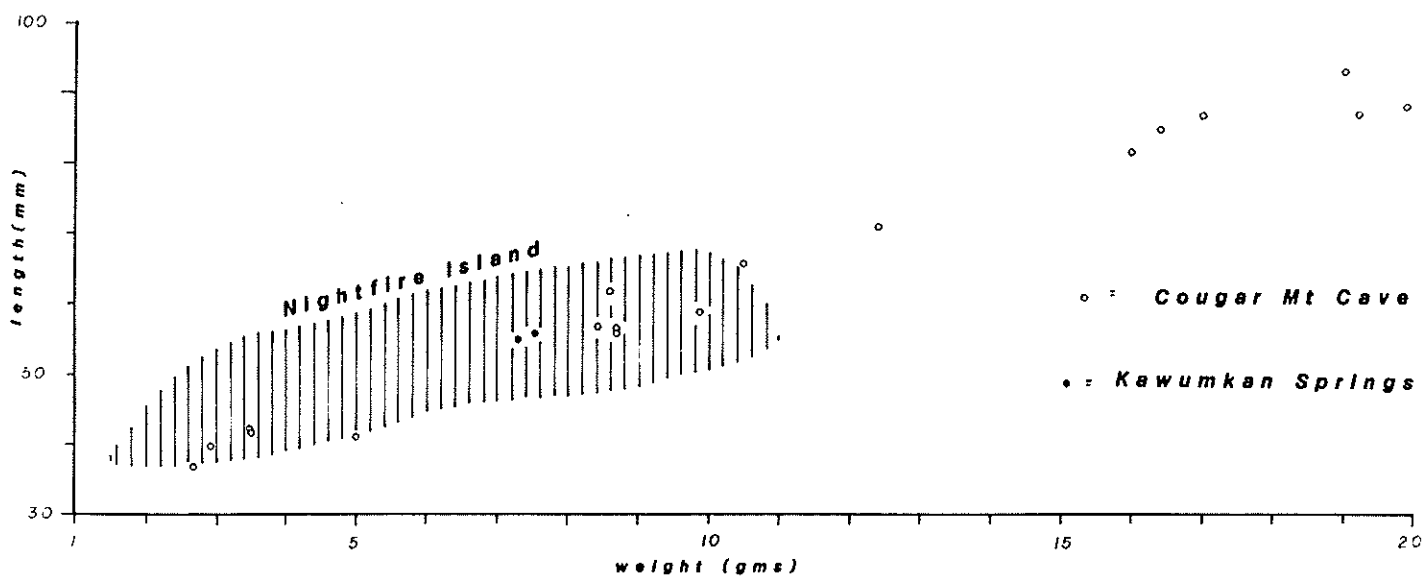

Fig. 13-2 The weight/length range of all large foliate points from Nightfire Island, compared with individual Cascade Points from Cougar Mt. Cave, after Layton (1972) and from Kawumkan Springs, after Aikens and Minor (1978).

rind measurements. However, two larger specimens from Kawumkan Springs midden (Aikens and Minor 1978) have rind thicknesses inside the NFI range.

This diagram appears to support Cowles' view that the average weight/length of Cascade points decreased with time, but isolated points cannot be dated thus. Large samples, on the other hand, could be broadly dated. When this approach is used for the large foliates from individual strata at NFI (Fig. 13-3), the predicted trend fails to emerge. If a few of the longer specimens are discounted as knives, then the uniformity of foliate length-range through time is even more striking. These cannot be viewed as late, small Cascades, therefore. Finally, their finishing flake scars do not apparently resemble those of classic Cascade Points (R. Nisbet pers. comm.). Two specimens may need to be further considered, however. Figure 13-4b is of interest because the obsidian surface is dulled and the tip has been burinated and reworked to form a steep edge. A similar specimen from the 5-Scaup (Fig. 13-4d) retains the perfect dihedral burin. Tuohy (1974) has pointed to this technique as an essentially late Paleo-Indian phenomenon, at least in Nevada. It is of interest, therefore, that both the NFI specimens are so hydrated (not stream-rolled) as to suggest that they may have been brought on to the site from an earlier lithic scatter elsewhere. Although these two might be considered as Cascade Points, they were probably not in proper context, therefore.

The second category to be considered is the Parman Series. Because most of the NFI foliate points fall between 30-45mm long (Fig. 13-1), they do indeed fall within the size range of the series. However, their shapes are too well rounded and lack the slight shoulders so characteristic of the Parman Series (Layton 1970), although some of them fall into the Parman #5 group. Apart from some probable Parman #2 points (see below), the NFI sample fails otherwise to conform.

The Cottonwood Leaf Shaped Points can be safely discounted on the grounds that the NFI sample falls outside the size range of the category. Some specimens as long as 35mm have been admitted to the category, with a few up to 40mm long allowed (Heizer and Clewlow 1968), but these are exceptions that tend to prove the rule. This type label is far better suited to the small foliate points from NFI than to the large ones.

Finally, the Gold Hill Leaf Point may be considered. This term was coined by Davis (1968, 1970) to describe a small to medium-sized leaf-shaped point of thick lenticular cross-section, first reported by Cressman (1933) at the Gold Hill site. It has been adopted more recently by Mack (1982), although a detailed description (with minimax weight and metric limits) has yet to appear. Apparently the maximum width of the point should be about midway on the length axis but can also occur as far as one-third of its length from the base. The few available illustrations suggest that the base should be rounded, and the edges should be convex.

Imprecise as this description may be, it nevertheless fits the NFI sample with the least ambiguity. Given that it is being applied to areas surrounding the Klamath basin, it seems the most appropriate label under the present confusing circumstances.

There are no other significant shifts in the shape or manufacture of Gold Hill Leaf Points through the sequence. Specimens with irregular bases, serrated edges, or slight shoulders occur in most strata, but the samples are too small to allow an enquiry into the changes in frequency of these attributes through time. Shoulders appear to become more pronounced in the Arrowhead Loams. As these specimens fit closely with Layton's (1970) definition of a Parman #5 point, it may be that the whole collection of NFI Gold Hill Leaf Points grade into the Parman Series.

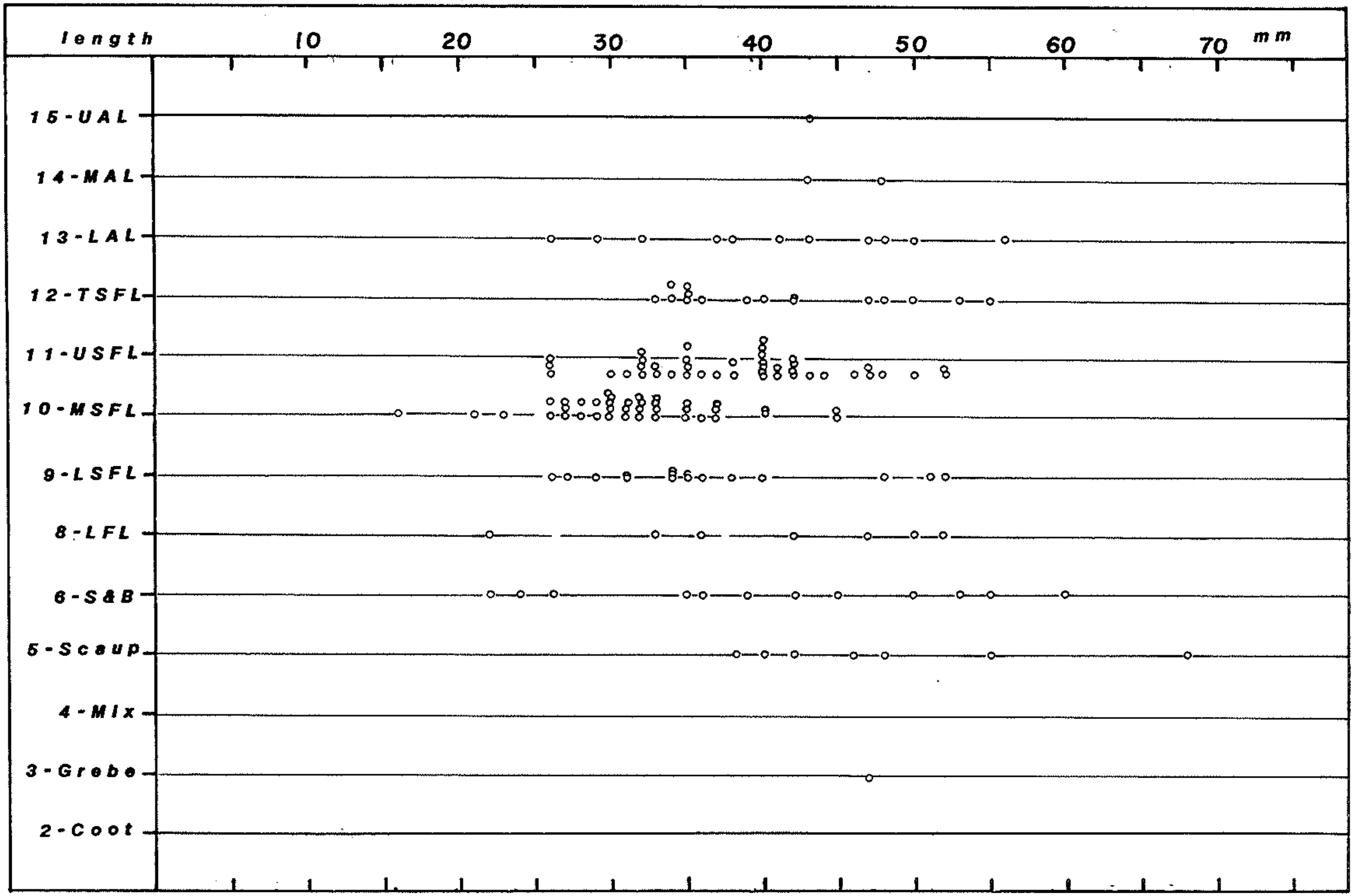

Fig. 13-3 Lengths of large foliate points by stratum.

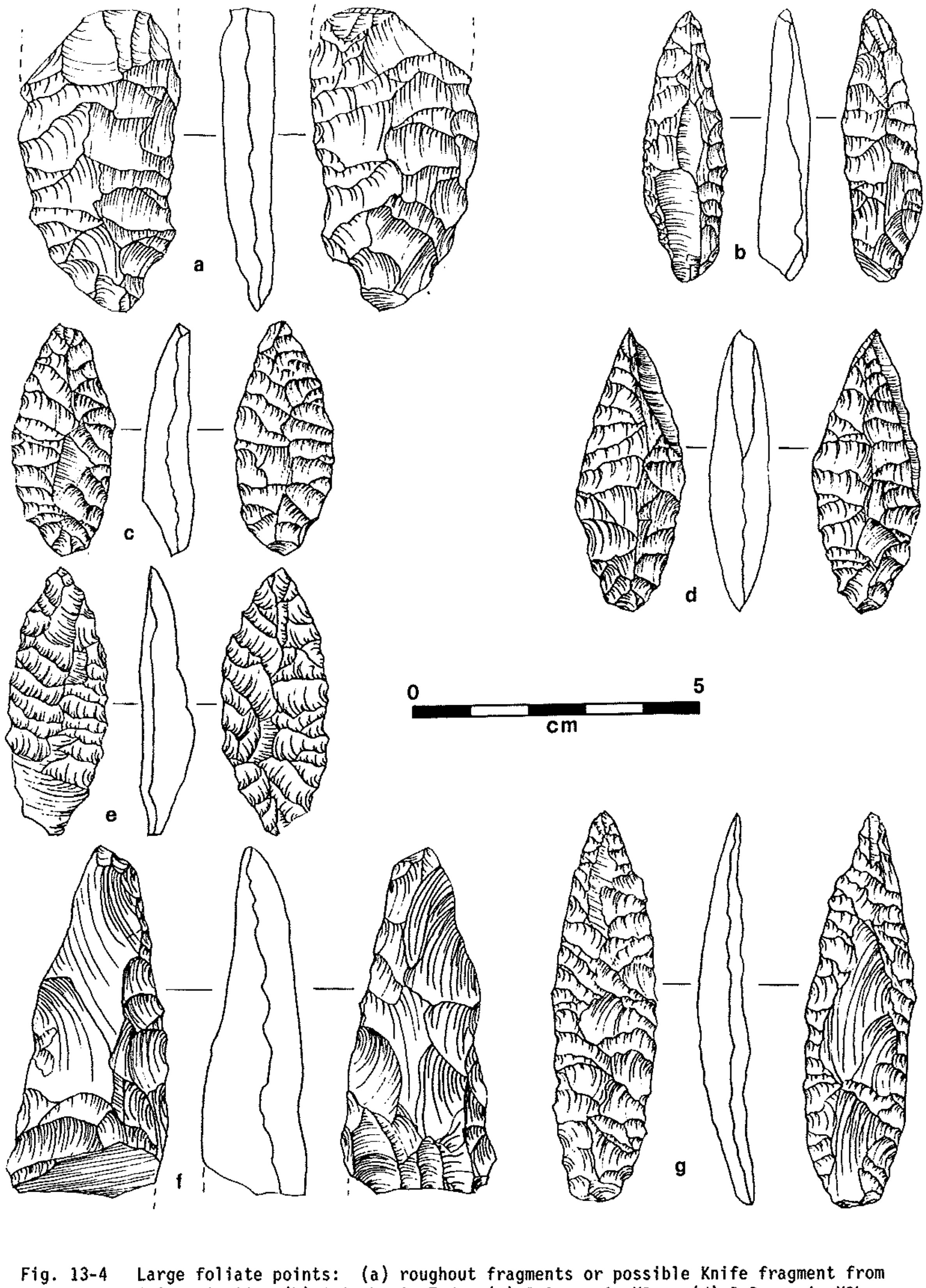

Fig. 13-4 Large foliate points: (a) roughout fragments or possible Knife fragment from 2-Coot in S6; (b) 3-Grebe in T5d; (c) 5-Scaup in Y8a; (d) 5-Scaup in Y8b; (e) 5-Scaup in U4a; (f) roughout or possible Knife tip fragment, 5-Scaup in O6; (g) 5-Scaup in U3. All obsidian, (bdf) all dull surfaces.

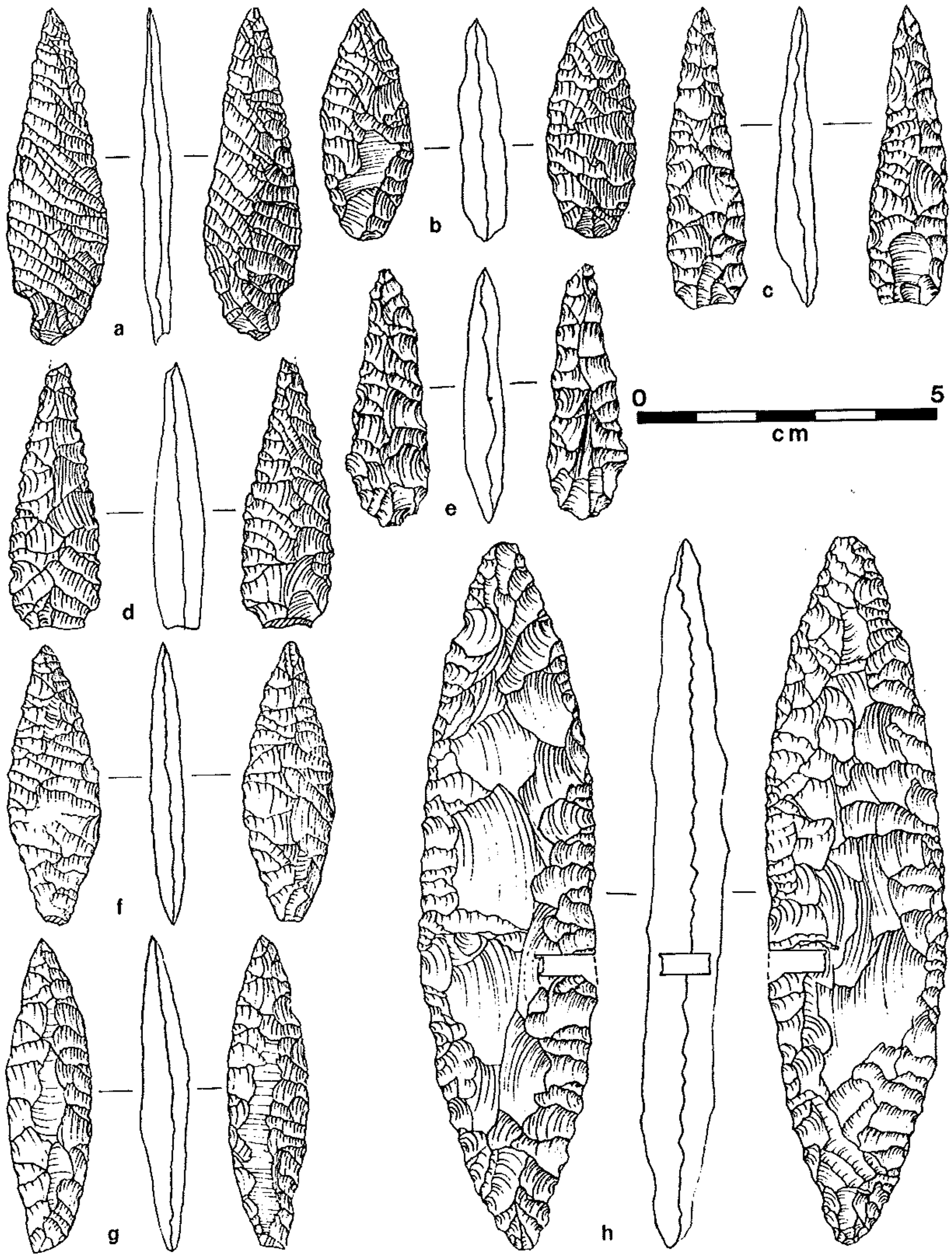

Fig. 13-5 Gold Hill Leaf Points (a-e) 6-S&B (a) in D5, notch caused by impurity in the obsidian (b) E11 (c) Y7b (d) D5 (e) Y7a; (fg) 7-GraCl in B8; (h) Knife, probably 8-LFL, C.B. Howe collection, OH rind 3.9μ.

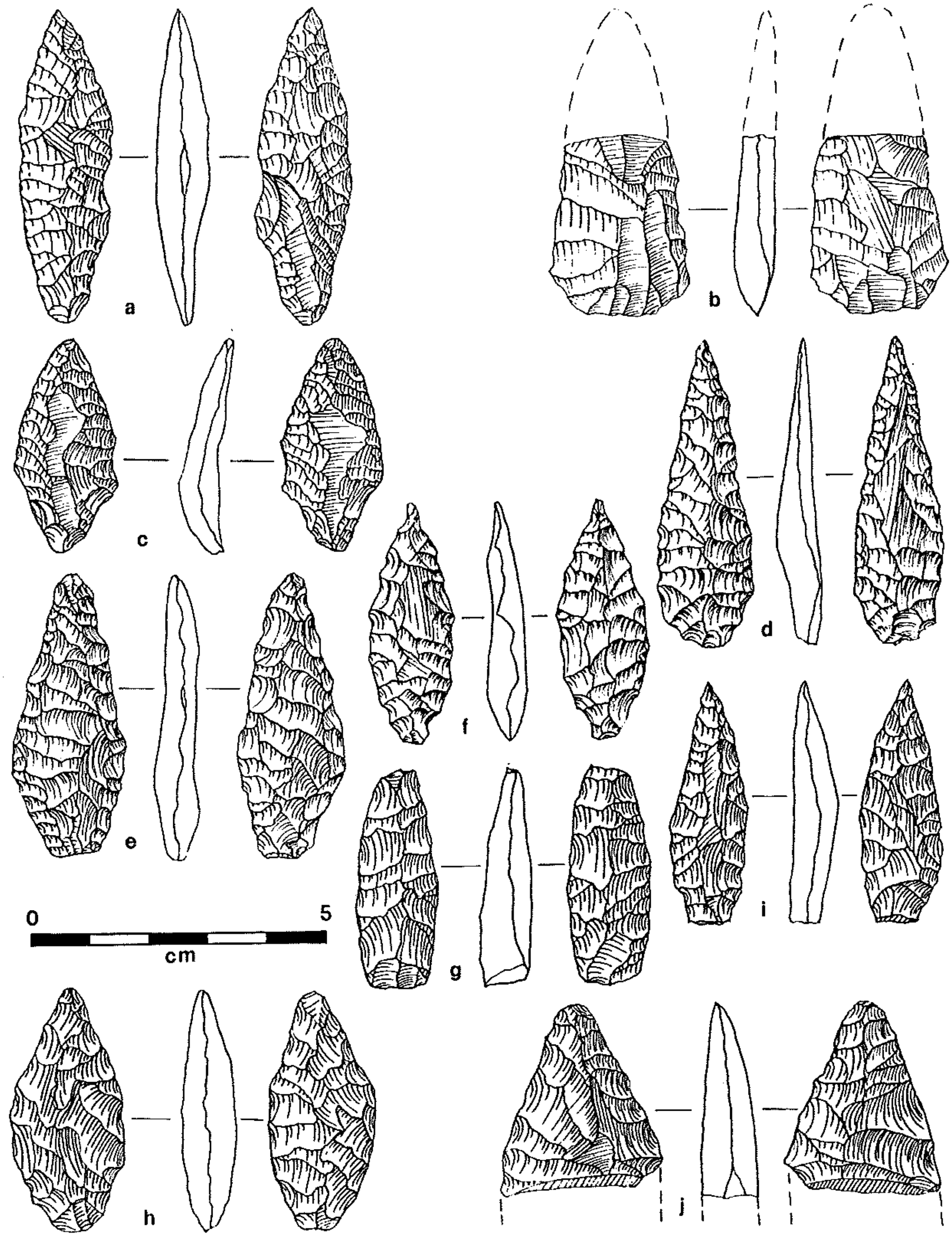

Fig. 13-6 Gold Hill Leaf Points (a) 8-LFL in B7; (b) 7-GraCl in A7; (c) 7-GraCl in E10; (d-g) 9-LSFL (d) in W5 (e) in T4 (f) in W5 (g) in J5c; (h) 10-MSFL in N2; (i) 11-USFL in K3; (j) 11-USFL in I6, possible Knife fragment. All obsidian.

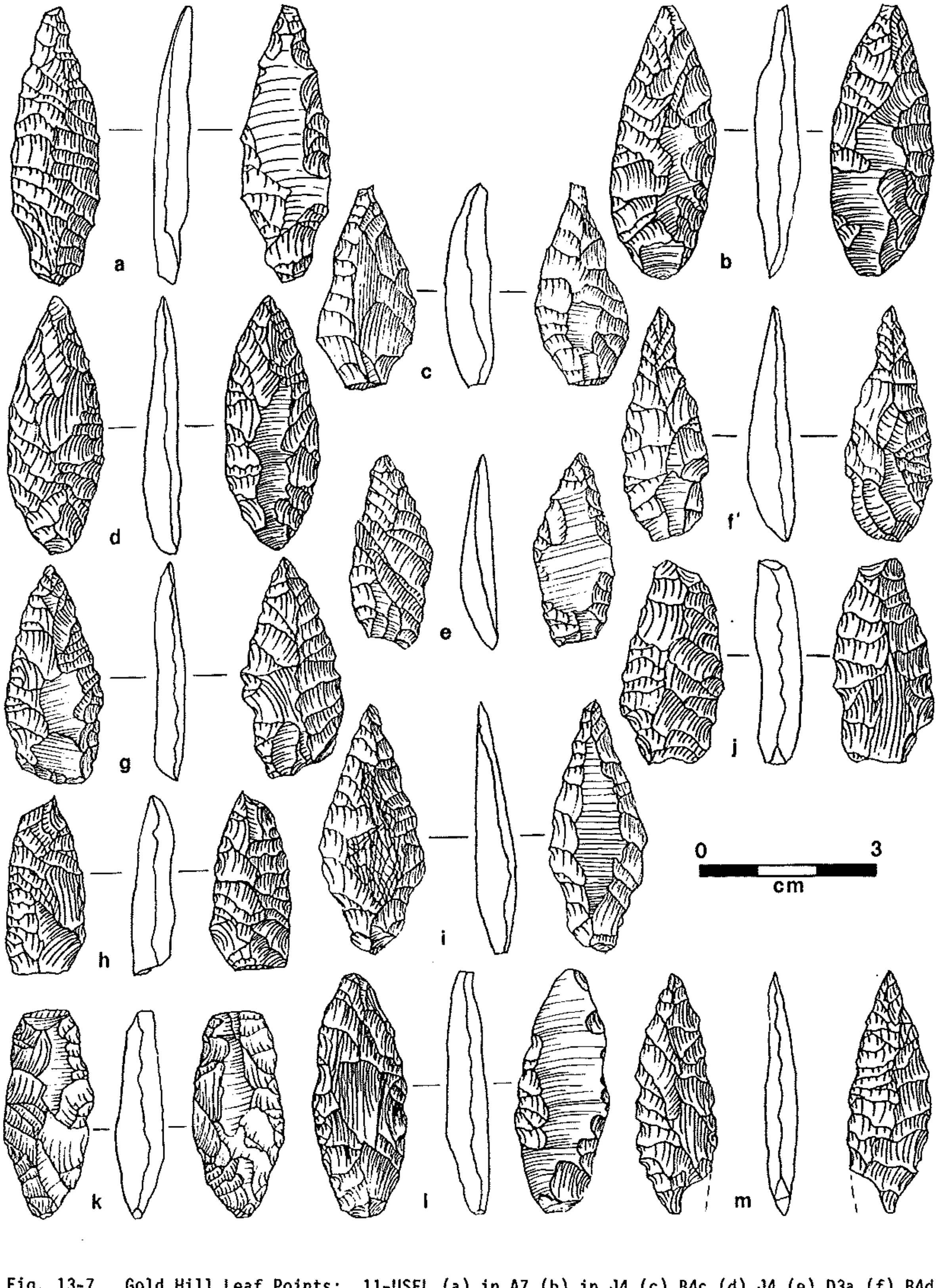

Fig. 13-7 Gold Hill Leaf Points: 11-USFL (a) in A7 (b) in J4 (c) B4c (d) J4 (e) D3a (f) B4d (g) D3a (h) I6 (k) D3b (l) J4 (m) Efa. All obsidian.

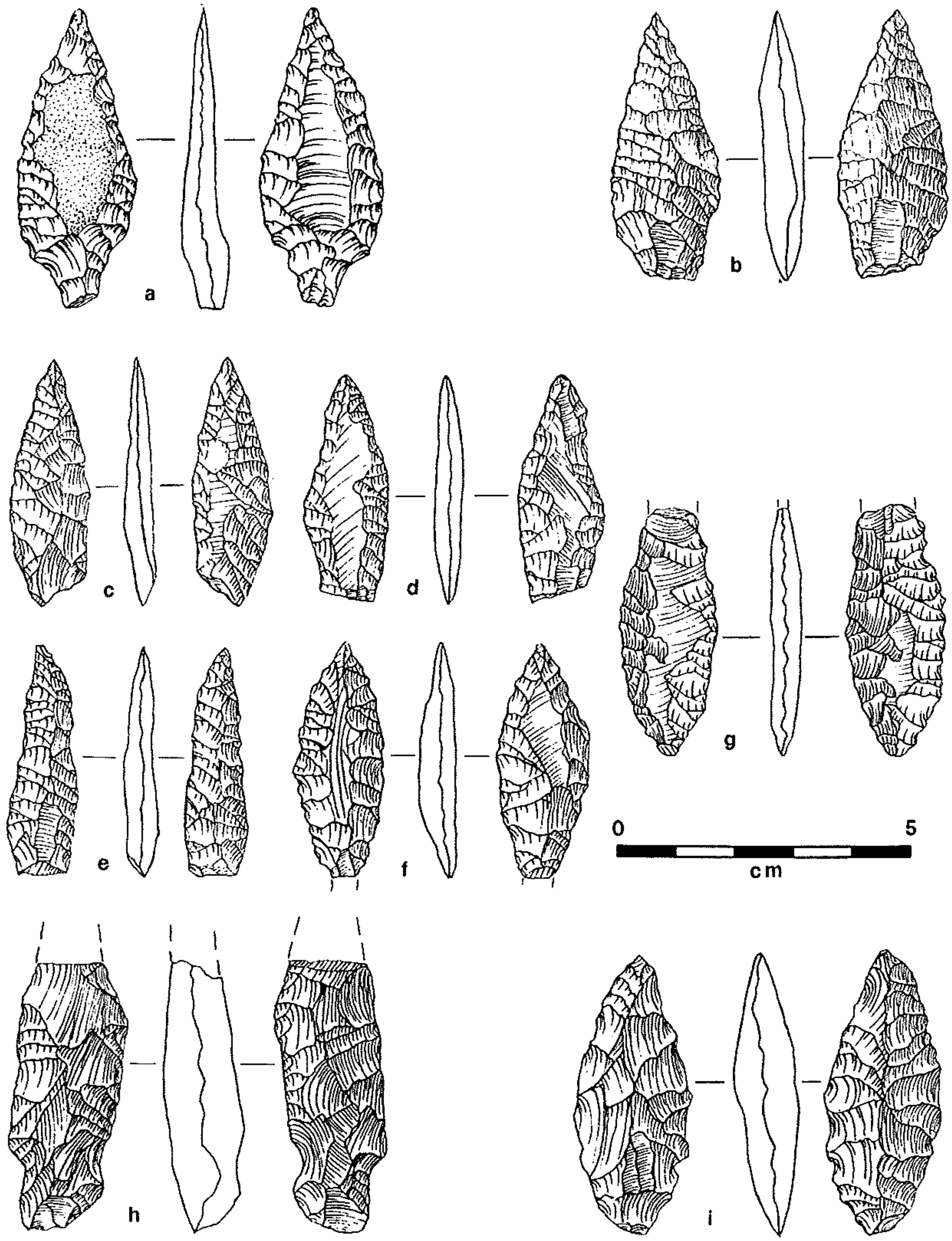

Fig. 13-8 Gold Hill Leaf Points (a-d) 11-USFL (a) V4a, shouldered (b) C3 (c) C4b (d) C4a; (e) 13-LAL in D1b; (f-i) 12-TSFL: (f) E3 (g) E3 (h) J3 (i) E3. All obsidian.

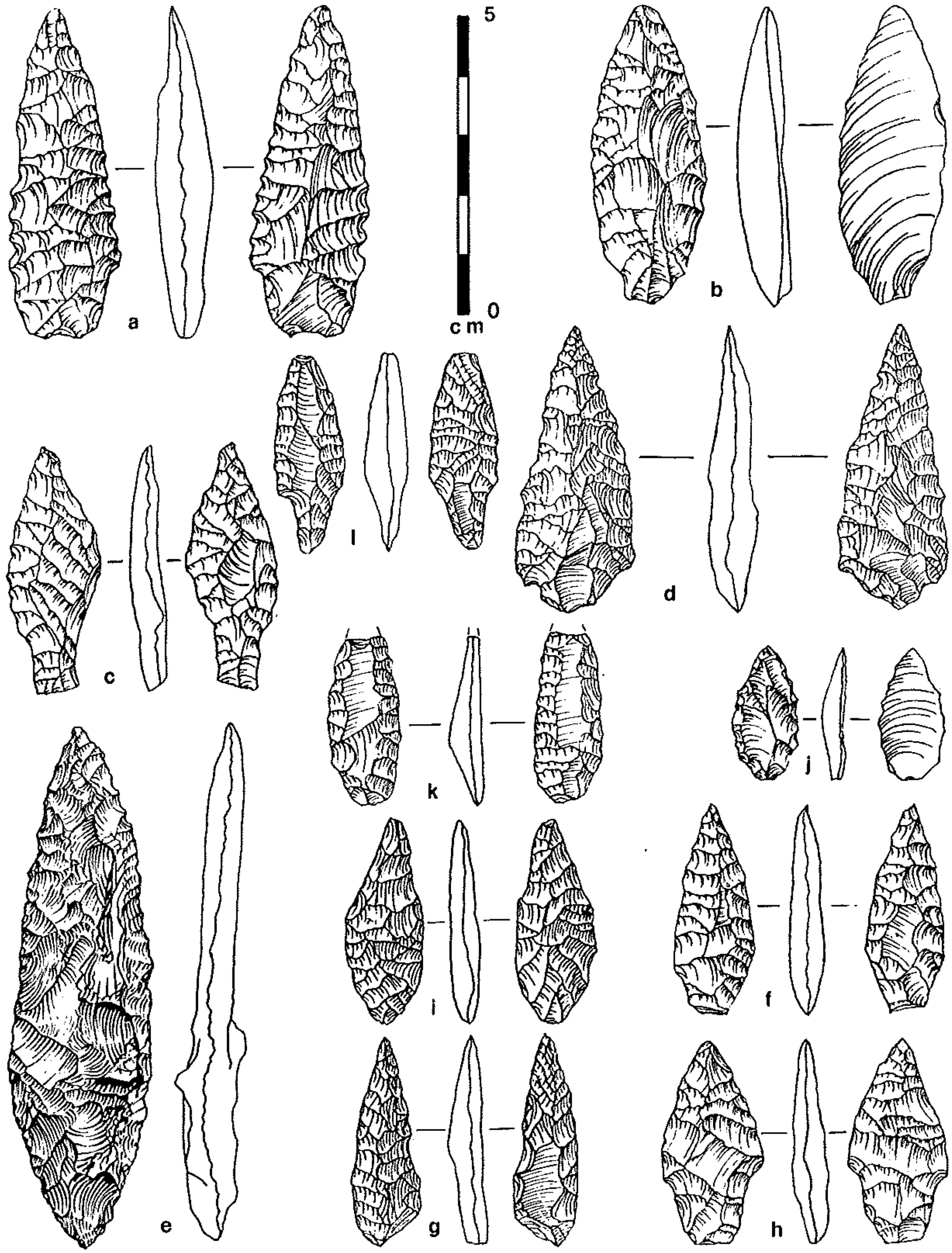

Fig. 13-9 Gold Hill Leaf Points: 13-LAL (a) V2/3, chert, notched (b) V2/3 unifacial (c) V3 (d) E2; (e) Knife 15-UAL in V1b; (f-h) small foliate points: (f) 9-LSFL in J5c; (h) 9-LSFL in T4; (i) 6-S&B in P10; (j) 6-S&B in V5c; (k) 7-GraCl in V5c; (l) 10-MSFL in Q6. All obsidian, except (a).

The Small Foliate Points

Lanning's (1963) definition of the Cottonwood Leaf Shaped Point calls for a small convex sided point with round base and the maximum breadth nearer to the base. However, he also allows a straight-based variety--although it is not explained how this might differ from his Cottonwood Triangular type d. He also allows a bipointed variety. Only two specimens from the type collection were illustrated; Heizer and Clewlow (1968) illustrated 11 more from elsewhere. Based on their metric criteria, and on the bimodal curve in Fig. 13-1, all the small foliate points shorter than 37.5mm could be designated Cottonwood Leaf Shaped at NFI, but they are really just smaller versions of the Gold Hill Leaf Points already described. Fig. 13-3 shows that they, too, pass through the same length changes through time, and disappear after the 13-LAL. Furthermore, they tend to co-occur with Gold Hill Leaf Points in the same excavated units, and their shape range largely overlaps that of the large points, with the very small specimens tending to be broader and thinner. Also, the slight shouldering found sporadically through the Gold Hill Leaf (?Parman) sample recurs among the smaller specimens.

The earliest of these smaller specimens came from the 6-S&B and they are most abundant in the 9-LSFL to 12-TSFL sequence.

Thick Narrow Unstemmed Points

A small sample of points, with weight/length distributions similar to those of the Gold Hill Leaf Points has been grouped separately because they fall outside the acceptable shape range for the others. Fig. 13-10 gives the shape ratios for whole specimens, and several are illustrated in Fig. 13-12. Although the group in fact may represent a distinctive type, the available sample is too small to justify setting up a new type name. In spite of their thick, diamond-shaped cross section, none of these specimens show any trace of rotary wear, nor do they grade into true drills. It is far more likely that they were used as projectile heads in the same manner assumed for the Gold Hill Leaf Points.

The earliest specimen at NFI is a fragment from the base of the 5-Scaup in O. This, and all those in the 8-LFL and 9-LSFL were recovered from layers in which no Gold Hill Leaf Points occurred. Thereafter, these types invariably co-occur up to the 12-TSFL when the thick narrow form disappears from the sequence. At present, the use of this point as a time marker cannot be evaluated.

Parman #2 Points

Following Layton (1970), five large slightly shouldered butt fragments are ascribed to this type with some reluctance. Maximum width range is 15-20mm, and edges are not ground. They conform closely with the complete specimens illustrated by Layton (1970) and are too large to be ascribed to the "Slightly shouldered foliate" category of Aikens and Minor (1978). The NFI specimens came from M7 in the 2-Coot, I11 in the 3-Grebe, U4a in the 5-Scaup, and A15 in the 8-LFL. There is no other trace of this type higher up the sequence, except for a single, well-made specimen in Q3c, which straddles the USFL/TSFL boundary. However, this should not be taken as reliable evidence for the late survival of the type--the fluviatile origins of much of the Q3 deposits make this a somewhat suspect context.

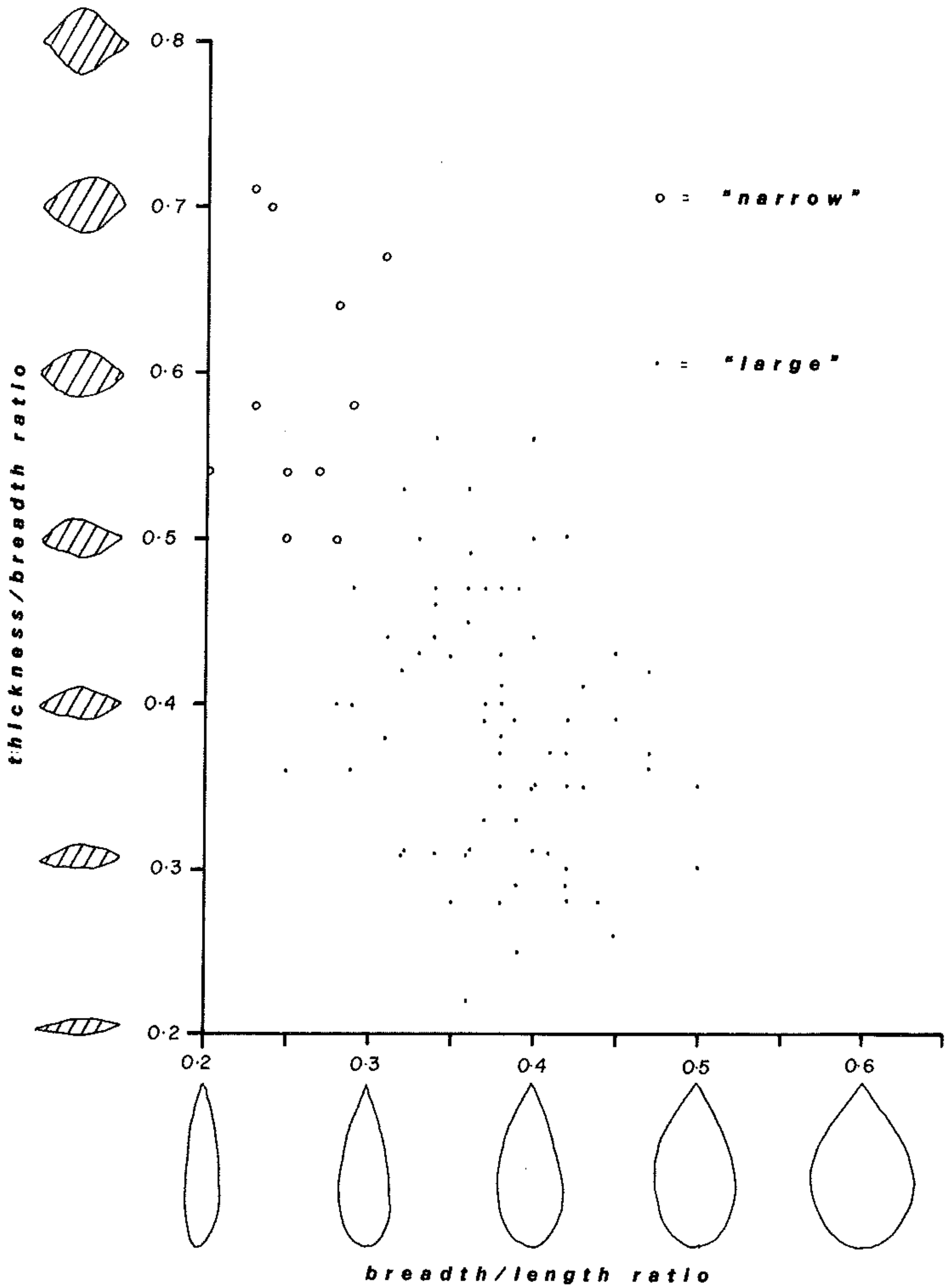

Fig. 13-10 Breadth/length ratios and thickness/breadth ratios, showing arbitrary separation of thick narrow foliate points.

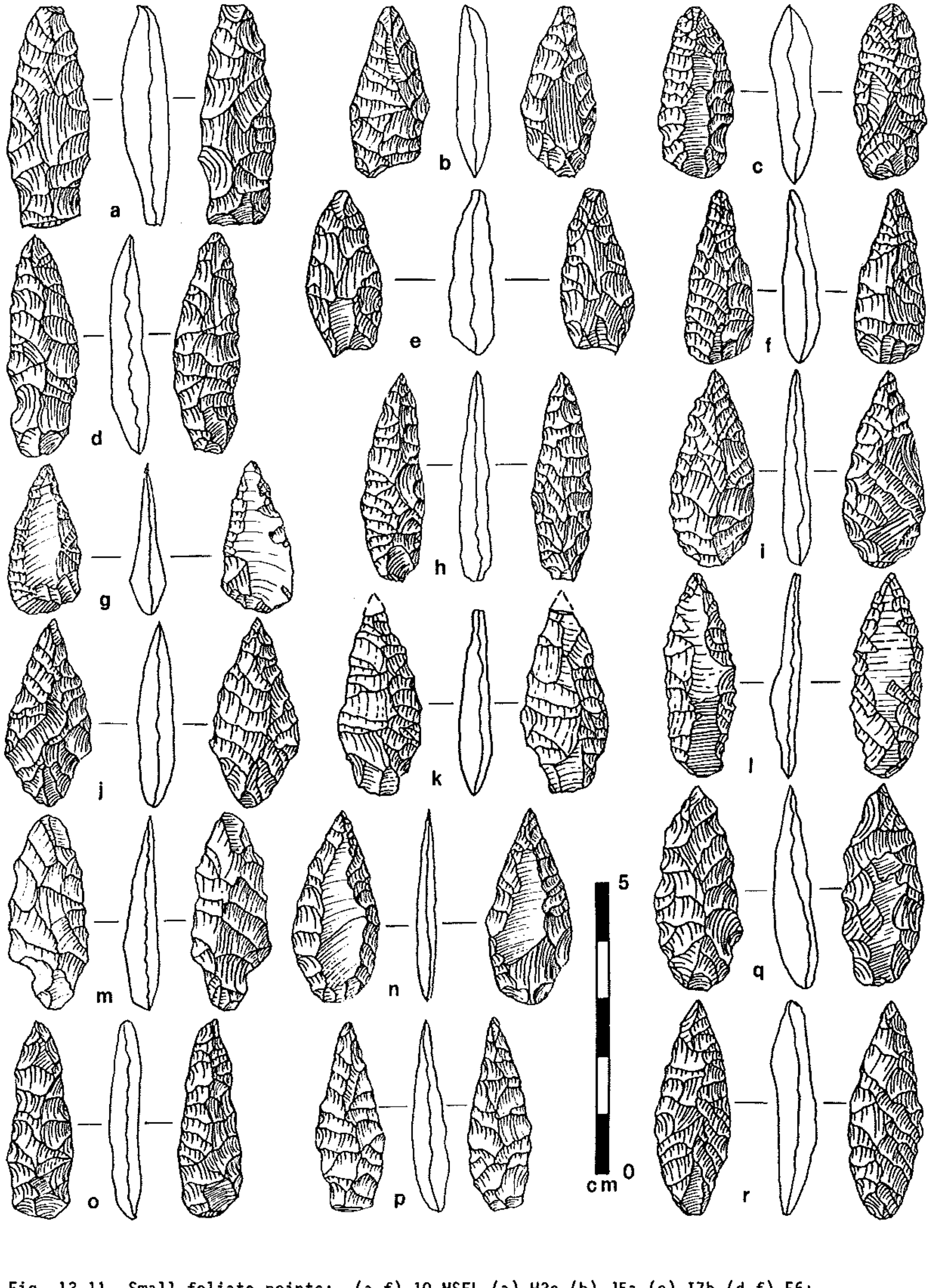

Fig. 13-11 Small foliate points: (a-f) 10-MSFL (a) H3c (b) J5a (c) I7b (d-f) E6; (g-i) 11-USFL (g) B4d (h-j) J4; (k-o) 12-TSFL (kl) A6 (m) B4a (n) E3 (o) I5; (p) 11-USFL or 12-TSFL in S2-3; (q) 14-MAL in J2b; (r) 13-LAL in G1a. All obsidian.

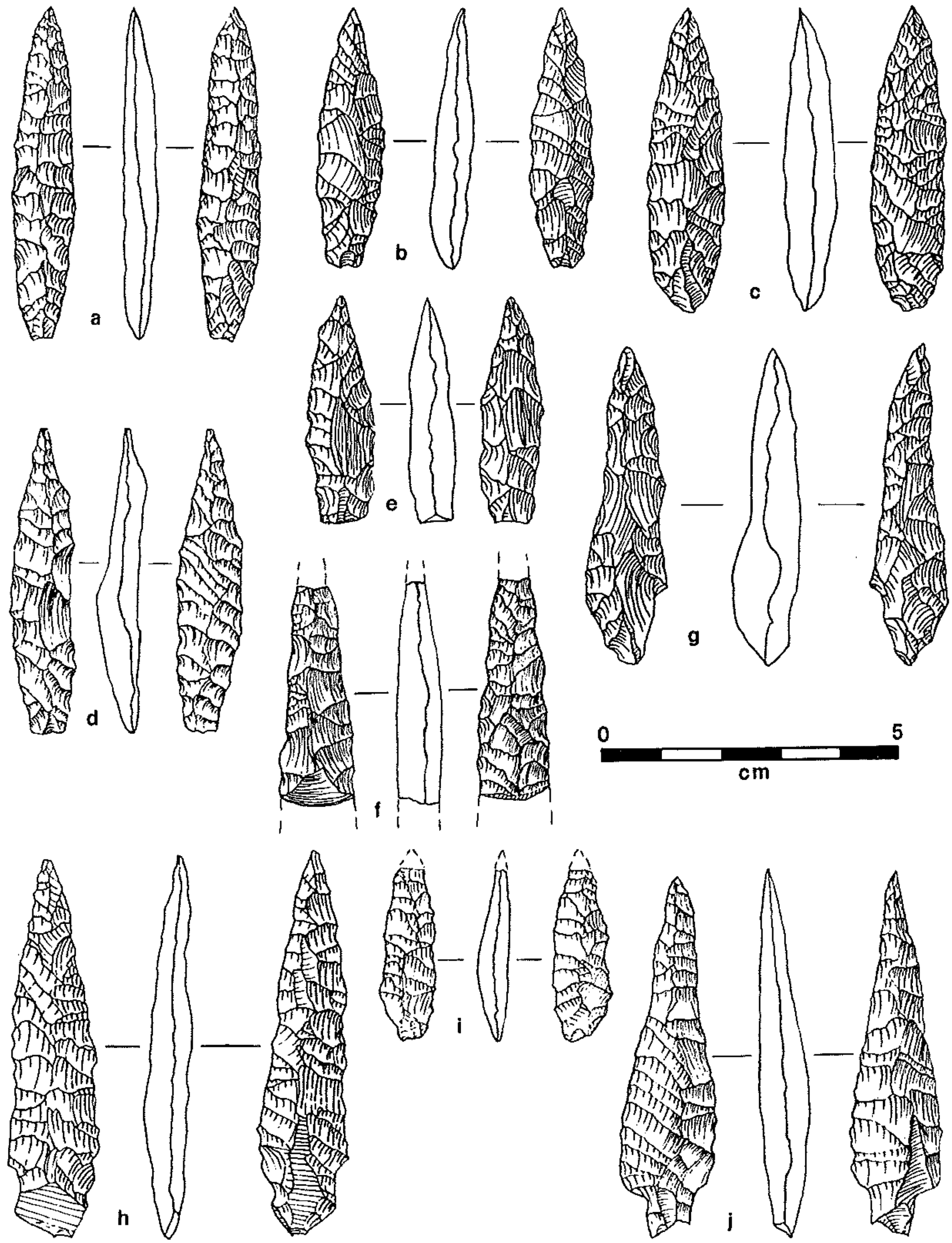

Fig. 13-12 Thick Narrow unstemmed points: (a) 10-MSFL in D4a; (b) 11-USFL in A7; (c) 11-USFL in J4; (d) 11-USFL in U1b; (e) 9-LSFL in J5c; (f) 8-LFL in H3e; (g) 11-USFL in E4b; (h) 12-TSFL in A6, proto-stemmed; (i) 11-USFL in A8; (j) 12-TSFL in B4a, proto-stemmed. All obsidian except (a) red chert.

Humboldt Points

The Humboldt Concave Base A of Heizer and Clewlow (1968) is clearly defined, but the separation of the A from B varieties may be an artificial cut across a continuous weight/length gradient. Layton (1970) recognizes this difficulty and has grouped both categories in his Humboldt No. 1 variety.

The earliest specimen at NFI comes from the top of the 5-Scaup (Fig. 13-13a) which means that it could have been pressed down from the overlying 6-S&B. It has the fine parallel-oblique pressure-flaking, so typical of that horizon. The type persists sporadically through the sequence, usually in the form of base fragments. Two Basal Notched specimens come from the 10-MSFL (e.g. Fig. 13-13j). In the 12-TSFL and 13-LAL, the fragments are from somewhat smaller specimens, lending support to Roust and Clewlow (1968) who suggest that the type persisted in a shorter form until quite late in Great Basin prehistory. However, there is also a small (1.27mm) specimen in the 8-LFL.

A recurrent feature of the NFI specimens is the presence of slightly developed ears at the base. These appear on nine of the 26 specimens recovered in situ, of which the most complete examples are shown in Fig. 13-13a-d.

Cottonwood Triangular Points

Lanning (1963) defined these as small, thin, delicate, light, nonstemmed points, frequently pressure-flaked and serrated, with a triangular shape which is often asymmetrical. Originally, four varieties were proposed, but examples of each were not illustrated, and Heizer and Baumhoff (1961) chose not to adopt the subdivision. It is difficult to distinguish Lanning's type d (convex base) from the Cottonwood Leaf Shaped variety, but all illustrated examples show that the Triangular should have straight or slightly concave sides, whereas all Leaf Shaped (including the straight-based variety) have convex sides. This attribute has been used to distinguish the two in the following analysis. Also, the Cottonwood Triangular type-collection (37 specimens from the Rose Spring site) has a maximum allowable length of 36mm and a base width of 22mm. These cut-off measurements have also been used to separate Cottonwoods from other large triangular blanks which are probably unfinished large side/corner notched specimens.

Cottonwood Triangulars at NFI are rare and restricted between the 8-LFL and 11-USFL. Two specimens are slightly eared (e.g. Fig. 13-13f) and four approach the pentagonal shape of the "Type J" of Heizer and Clewlow (1968) like those in Fig. 13-13g-i. As Aikens and Minor (1978) have suggested, most specimens are probably unfinished blanks for small side- or corner-notched points and, as such, cannot be used as time-markers.

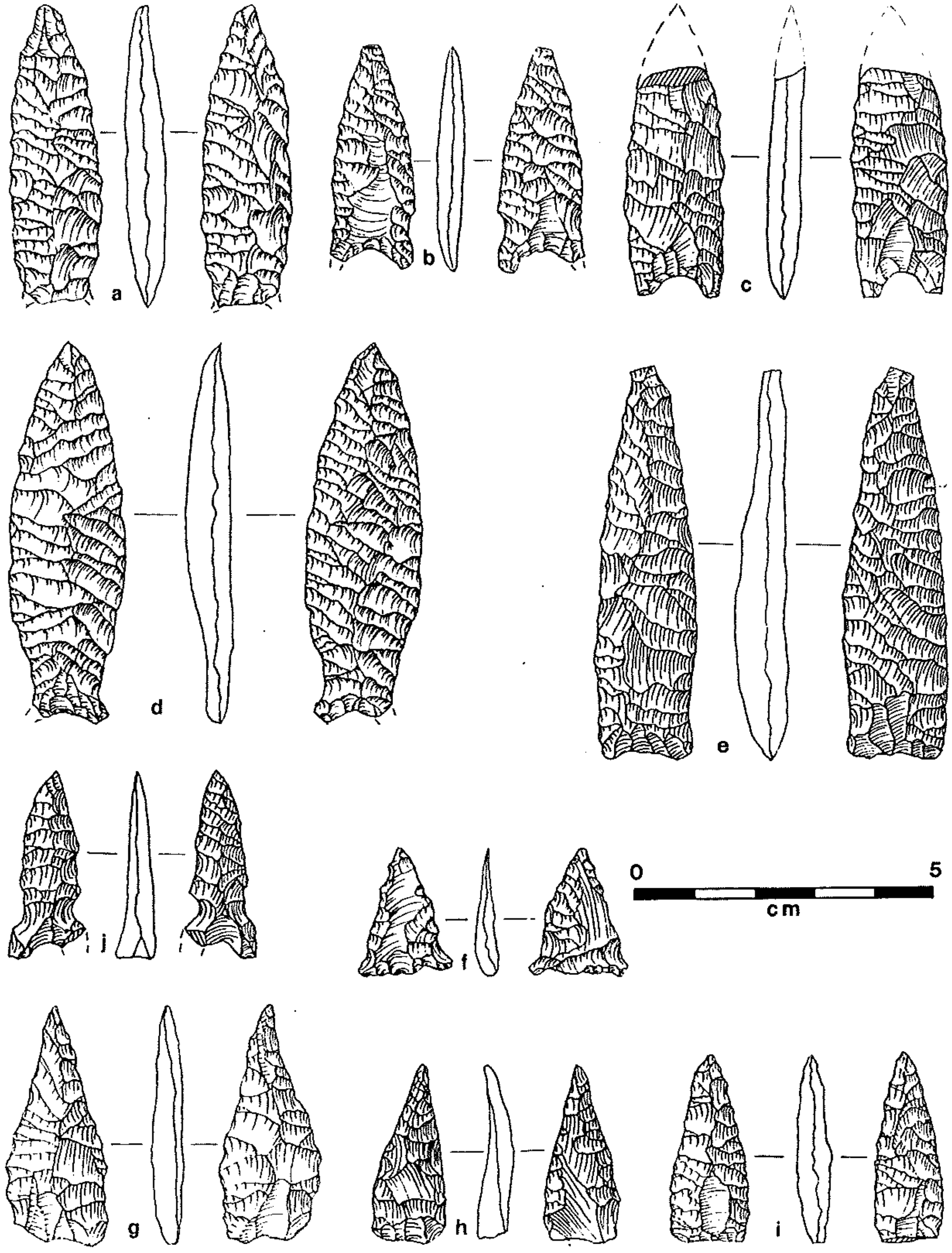

Fig. 13-13 (a-e) Humboldt concave based points: (a) 5-Scaup in U4a; (b) 9-LSFL in U2a; (c) 11-USFL in A8, variegated red/yellow chert; (d) 10-MSFL in X3c; (e) stratigraphic context not recorded; (f-i) Cottonwood triangular points from the 11-USFL: (f) V4a (g) D2 (h) O1b (i) D3a; (j) ?Humboldt Basal Notched point, 10-MSFL in I7a. All obsidian except (c).

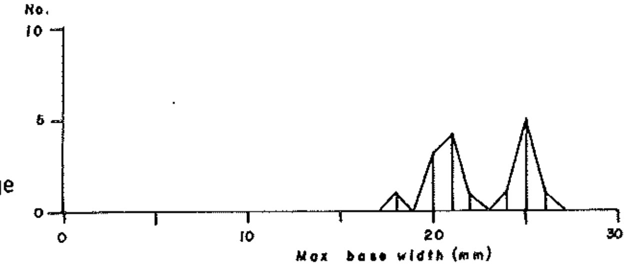

Fig. 13-14 Distribution of basal widths for large triangular points.

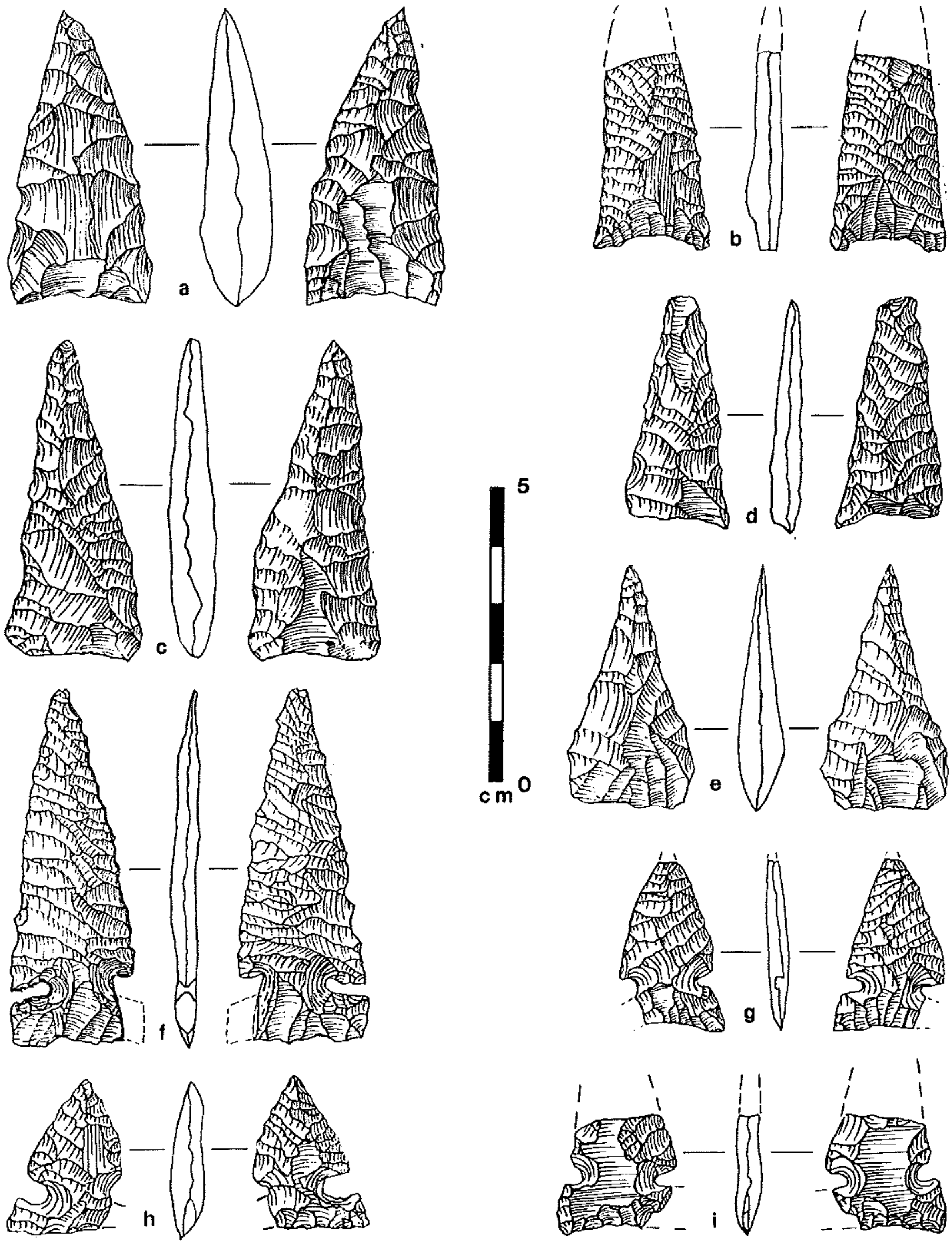

Fig. 13-15 (a-e) Large Triangular blanks: (ab) 8-LFL in H3e; (c) 9-LSFL in J5c; (d) 11-USFL in J4; (e) 12-TSFL in B4a; (f-i) Northern Side-Notched Points: (f) 4-Mix in N7a; (g) 6-S&B in D5; (h) 6-S&B in I8; (i) 8-LFL in H3e. All obsidian.

Large Triangular Points

As suggested above, these are probably unfinished blades. There are only three complete specimens, and 13 base fragments. Maximum width at the base can be measured for the whole sample, and two clusters around 21mm and 25mm emerge (Fig. 13-14) hinting at different standard blank forms. Specimens of both sizes co-occur in strata between the 6-S&B and the 12-TSFL. Bases vary from slightly convex, through straight to concave (Fig. 13-15a-e).

Discussions of the various Side-Notched types follow.

Northern Side-Notched Points

The orignial definition (Gruhn 1961) calls for a large triangular point with straight-sided or convex blade, rounded to narrow side notches relatively high on the blade, and with a concave base. At NFI, points fitting this descripion tend to grade into a smaller, narrower SN point of similar design. There are also many specimens with straight or convex bases which tend to grade into the Elko Side-Notched type. Criteria for separating Northern Side-Notched points from the smaller type are reviewed in this section.

Because so many of the NFI specimens are broken, length/weight distribution cannot be used to establish a cut-off point. Instead, maximum width is taken as a reflection of overall point size. Fig. 13-16b gives this measure for all side-notched points with concave bases. Peaks at 15 and 18mm width emerge. Following Clewlow's (1967) definition, the minimum allowable width for Northern Side-Notched is accepted here as 17.5mm. However, specimens at or close to this boundary may be reclassified according to length and/or weight, and/or thickness. Hence, three specimens classified as Northern Side-Notched on length/weight fall just short of the max. breadth boundary.

Unfortunately, the earliest specimens are base fragments without intact necks which means that their identity remains in doubt. However, there are exceptionally large specimens (Fig. 13-16a) like the earliest intact point in the 6-S&B that persist up to the 10-MSFL. Wider points also persist through the same strata, but they are consistently shorter than the earliest example. Unfortunately, only one whole specimen of this short broad variety has beeen recovered (Fig. 13-17a), but several others with missing tips must have been made to a comparable length and weight.

The single specimen from the 11-USFL has a dull surface and is probably derived. The other stray point from the 13-LAL came from just below the surface in Ula and should not be accepted as coming from a reliable context.

Siskiyou Side-Notched Points

The narrow side-notched points with maximum widths less than 17.5mm (Fig. 13-16b) present yet another problem of classification. Like the Northern Side-Notched Points, too many of these specimens are broken so that weight/length data cannot be compared with assemblages elsewhere. When maximum width is compared with Desert Side-Notched samples, like the one shown in Fig. 13-16c, it appears that the NFI specimens could be forced into this category. However, even a cursory glance at the illustrated specimens (Fig. 13-18) suggests that many of these are too long to fit comfortably with the classic descriptions of the Desert Side-Notched Point (Baumhof 1957, Baumhof and Byrne 1959). Furthermore, it is now quite well established that the DSN type

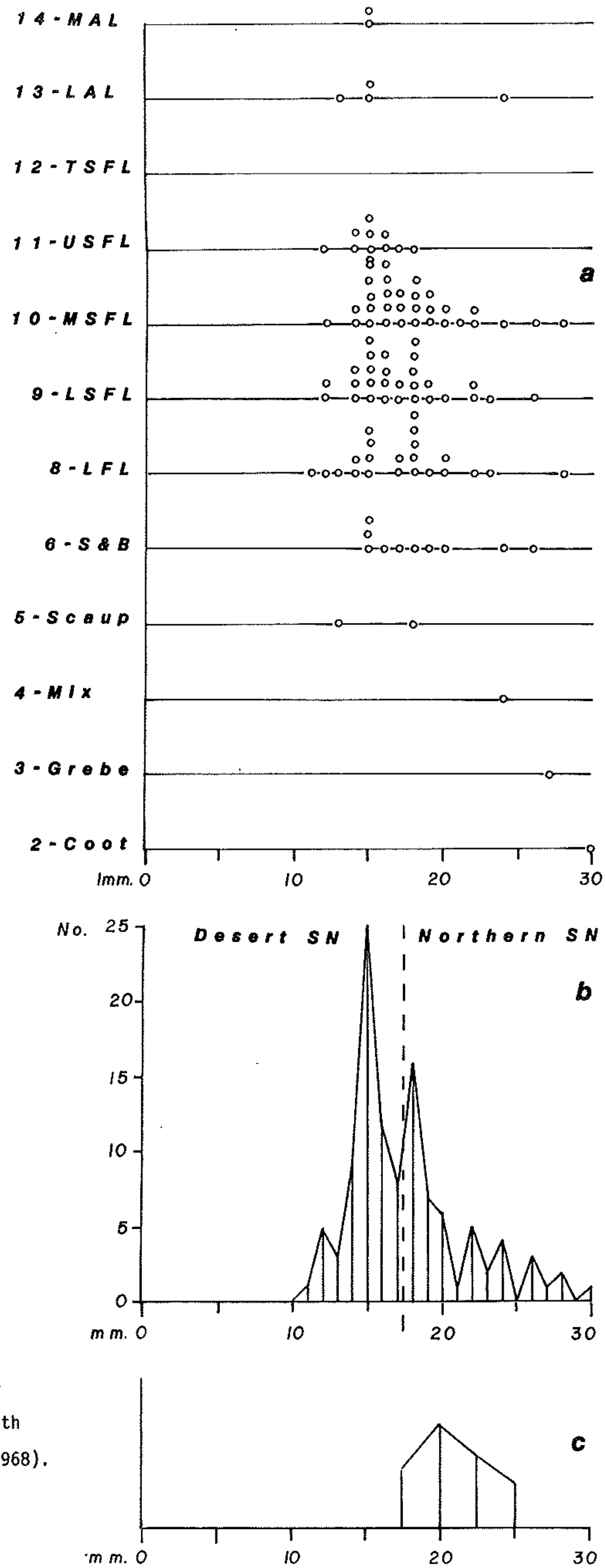

Fig. 13-16 (a) Distribution of maximum breadths of all side-notched points with concave base, by stratum; (b) maximum breadth distribution, all strata combined, with suggested arbitrary subdivision between Desert and Northern types; (c) maximum width of Northern Side-Notched points from Nv-Hu-21, after Clewlow (1968).

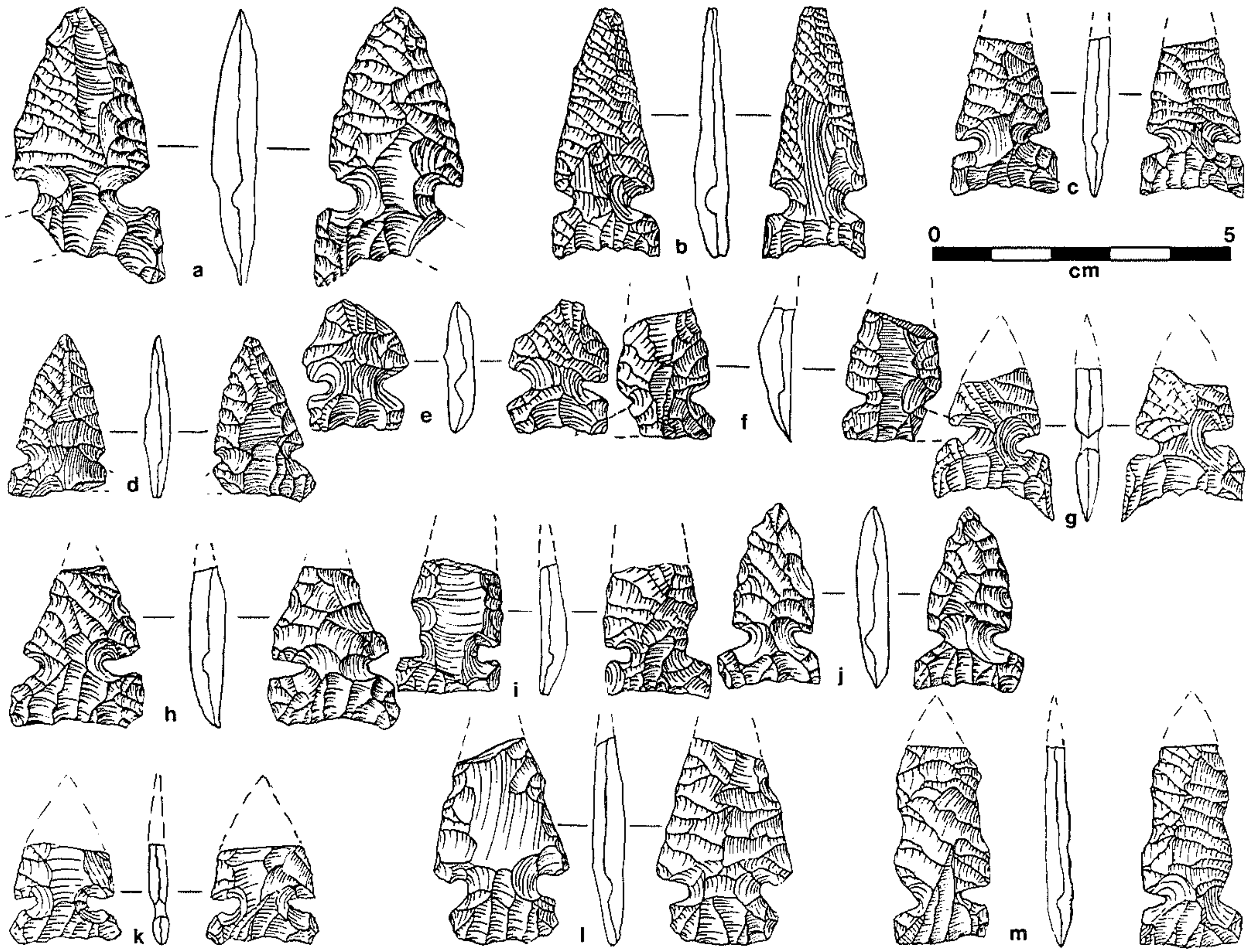

Fig. 13-17 Northern Side-Notched Points: (a-g) 8-LFL (a) Y5 (b) K4a (cd) H3d (e) K5 (f) H3e (g) A14; (h) 9-LSFL in X5b; (i) 10-MSFL in O1c; (j) 10-MSFL in X3c; (k) 10-MSFL in A10; (lm) Elko Side-Notched Points - Hogup variety: (l) 5-Scaup in Q7; (m) 6-S&B in C5b. All obsidian.

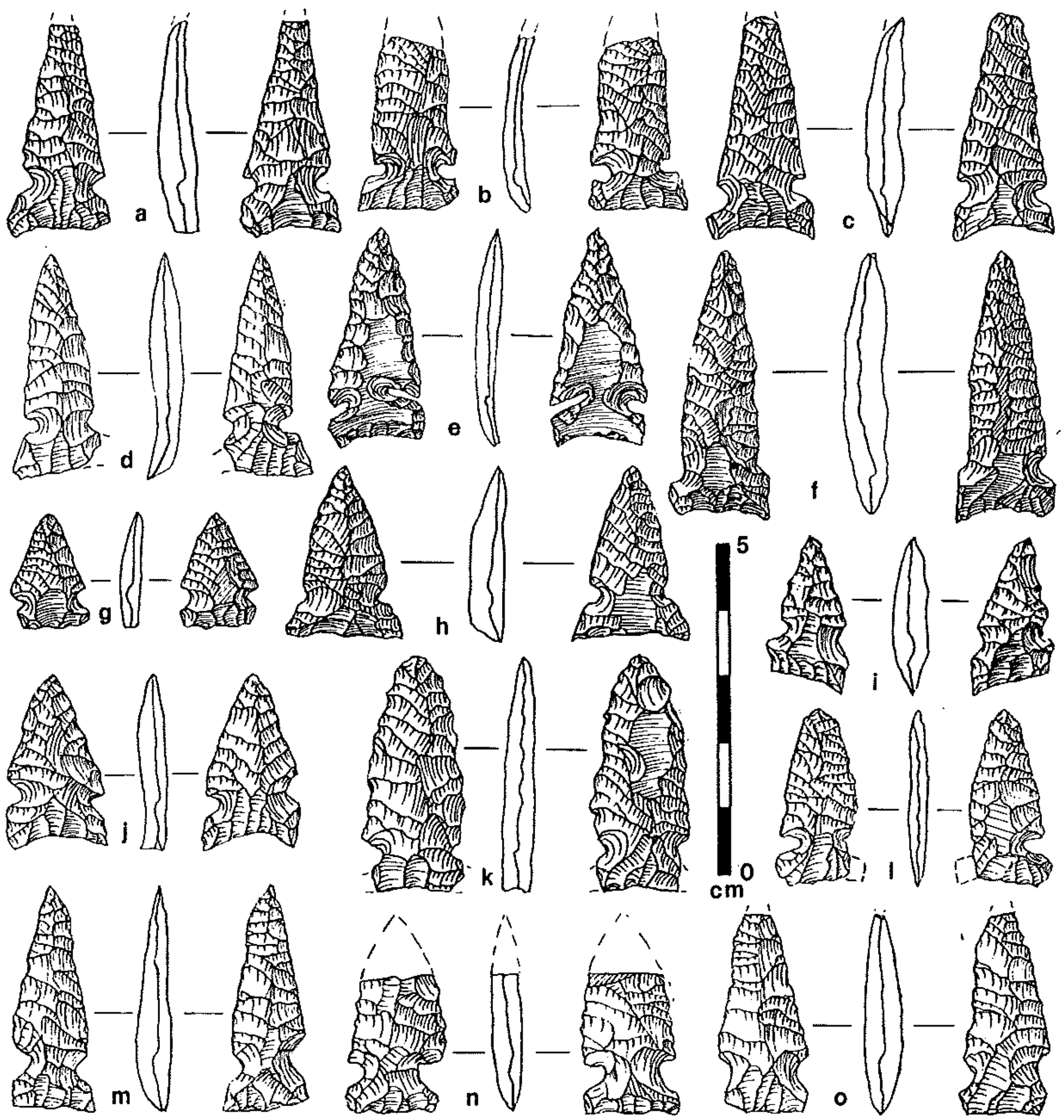

Fig. 13-18 Siskiyou Side-Notched Points: (a-c) 6-S&B (ab) G3 (c) I9b; (d-h) 8-LFL (d) A15 (e) H3d (f-h) H3e; (ij) 9-LSFL (i) W3 (j) S4a; (k) 11-USFL in E4b; (l) 10-MSFL in B4e; (m) 8-LFL in C5a; (no) 11-USFL in B4d. All obsidian except (g) red chert.

appears at about 1100-1200AD (Heizer and Hester 1978). If the NFI sample is ascribed to this category, then we should not expect it to appear anywhere lower than the 15-UAL. As all the specimens in question come from strata lower than this (Fig. 13-16a) they obviously fall outside the DSN time-range, but overlap with the later half of the Northern Side-Notched time-range. Although DSN specimens predating 1100AD have been reported from Hogup Cave--Stratum 9 (Aikens 1970) and Kawumkan Springs--Stratum I (Aikens and Minor 1978), both are solitary specimens that inspire little confidence in the notion of a pre-1100AD DSN. An alternative label for the NFI sample seems the wiser course.

The Siskiyou Side-Notched type has been proposed by Mack (1982) in order to resolve an identical problem at sites in the upper Klamath River valley, and her label will be adopted here. The definition calls for a straight to concave based side-notched point with U-shaped notches, that is "consistently smaller than the Northern Side-Notched and larger than the Desert Side-Notched". Given the ambiguity in the published upper and lower size/weight limits of both--for example Heizer and Clewlow (1968) allow specimens as long as 40mm into the DSN class--this is a difficult definition to pin down metrically. Mack has used a max. width/neck width ratio to achieve a separation of her own material. Nevertheless, her strategy is both clear-cut and sensible: to create a third type, thus removing the need to force awkward samples into one or other existing class, and allowing the DSN type to retain its integrity as a chronological marker.

Under these terms, then, there are no DSN Points at all at NFI--only Northern Side-Notched and Siskiyou Side-Notched types. What then was the developmental relationship between these two types? Returning again to Fig. 13-16a, we see that the Siskiyou SN makes its first appearance in the 5-Scaup and is definitely established by the 6-S&B at about 3,000BC, and it remains in use until the end of the 11-USFL (ca. 300BC), perhaps persisting for another millennium as a minor component in 13-LAL through 14-MAL times.

Baumhoff and Byrne (1959:39-40) first speculated that the Northern Side-Notched type was the prototype of Desert Side-Notched and that peoples using the Northern form for dart points retained the overall shape but reduced the size when they first began to use the bow-and-arrow. The NFI evidence would suggest that the transition from Northern to Desert forms may have been rather more gradual in the Klamath Basin, and Mack's (1982) data would back this up. Inspection of the Kawumkan Springs material suggests that something similar was occurring here also, but the stratigraphic contexts are somewhat harder to interpret. There is little reason to suppose, however, that Siskiyou Side-Notched represents an early form of arrowhead--the Gunther type is a far more convincing candidate--and we are forced to assume that the shift in size of side-notched dart points took place in response to a shift in the size of quarry.

<u>Elko Side-Notched Points</u>

Heizer <u>et al.</u> (1968) called this type a simple leaf-shaped, round-based point with wide notches placed well down toward the base. Although they concede that they are related to the Elko Corner-Notched type, they also point out that they occurred stratigraphically above the corner-notched form at South Fork Shelter. This definition is followed closely by Heizer and Clewlow (1968) and others, but has been somewhat expanded by Aikens (1970) whose definition includes specimens with rounded side-notches relatively high on the blade, and a straight base. This extended definition was used for Kawumkan Springs (Aikens and Minor 1978). Because points fitting both descriptions occur at NFI, a Hogup variety and a South Fork variety will be recognized in the following description.

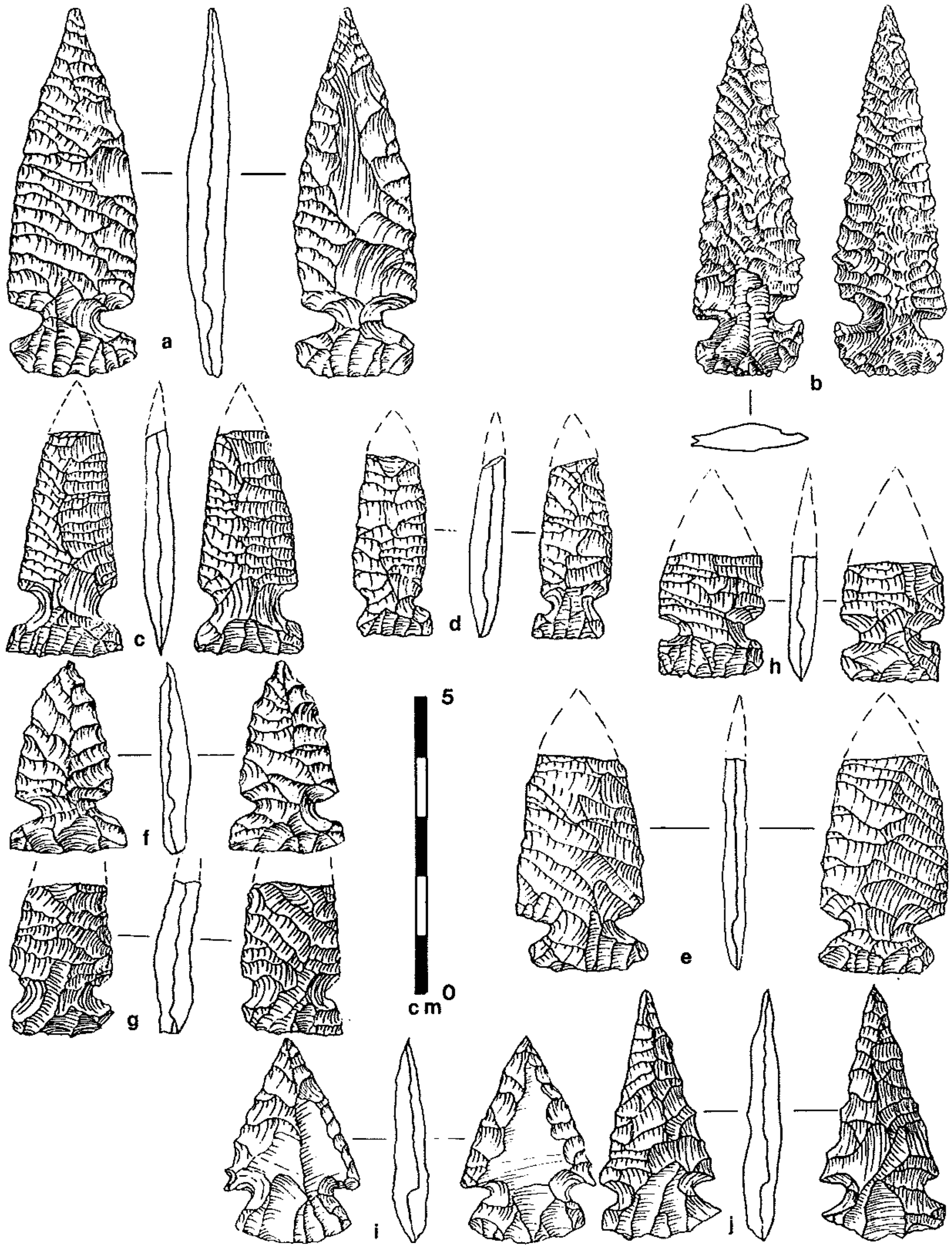

Fig. 13-19 (a-j) Elko Side-Notched Points - Hogup variety: (a-d) 6-S&B (a) U2b (b) O5 (c) C6 (d) C5b; (e-g) 8-LFL (3) C5a (f) Y5 (g) I7b (h) 11-USFL in A7; (i-j) Elko Side-Notched Point - South Fork variety: (i) 13-LAL in T1; (j) 11-USFL in A8. All obsidian.

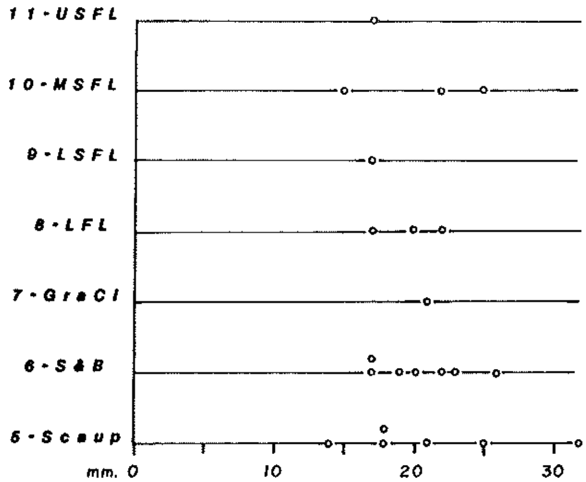

Fig 13-20 Maximum widths of Elko Side-Notched Points - Hogup variety, by stratum.

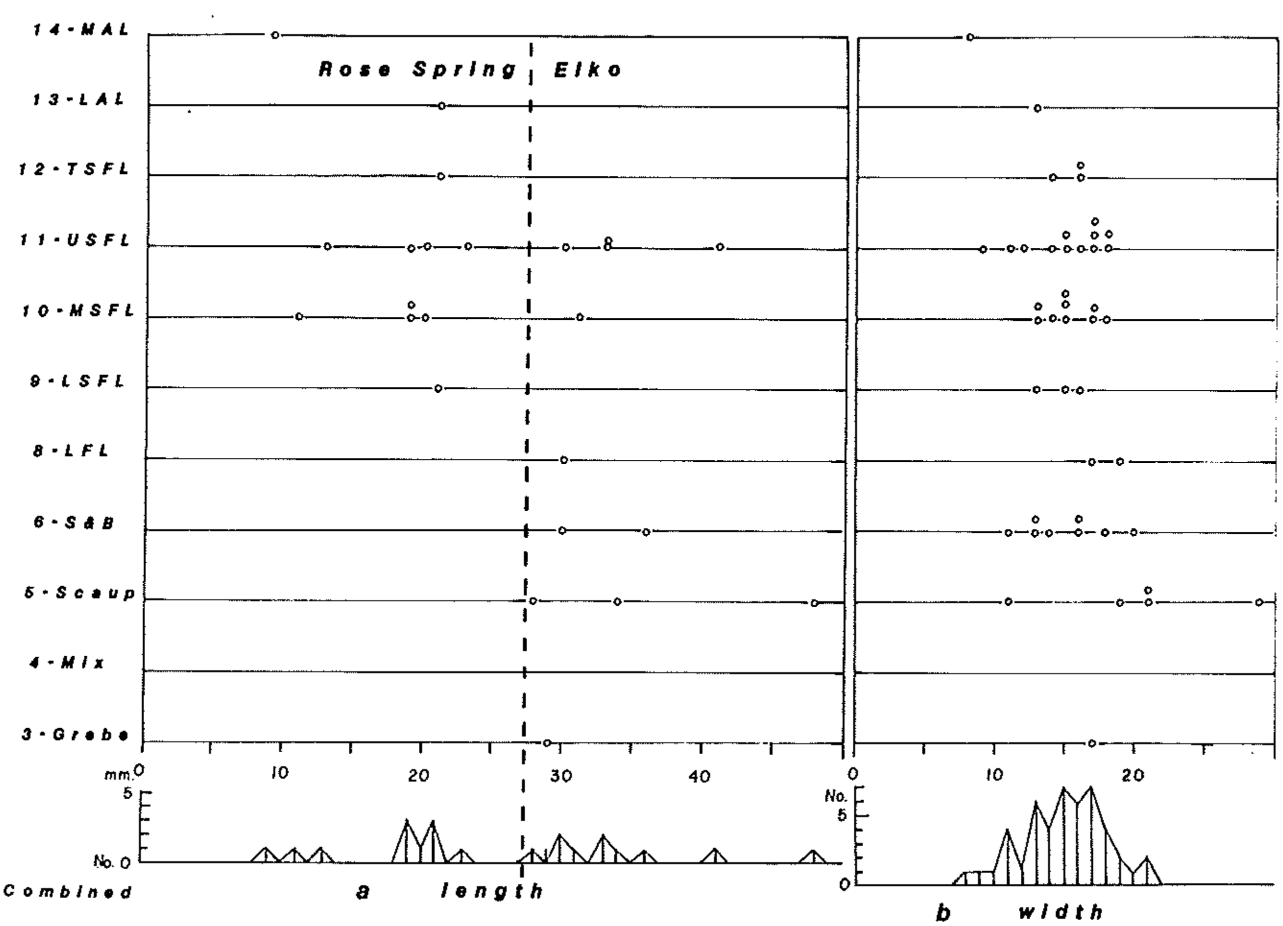

Fig. 13-21 (a) Maximum lengths of whole specimens, showing arbitrary separation of Elko Side-Notched Points - Round-based variety from Rose Spring Round-stem Points: (b) similar display of maximum widths of the same specimens, showing no separation.

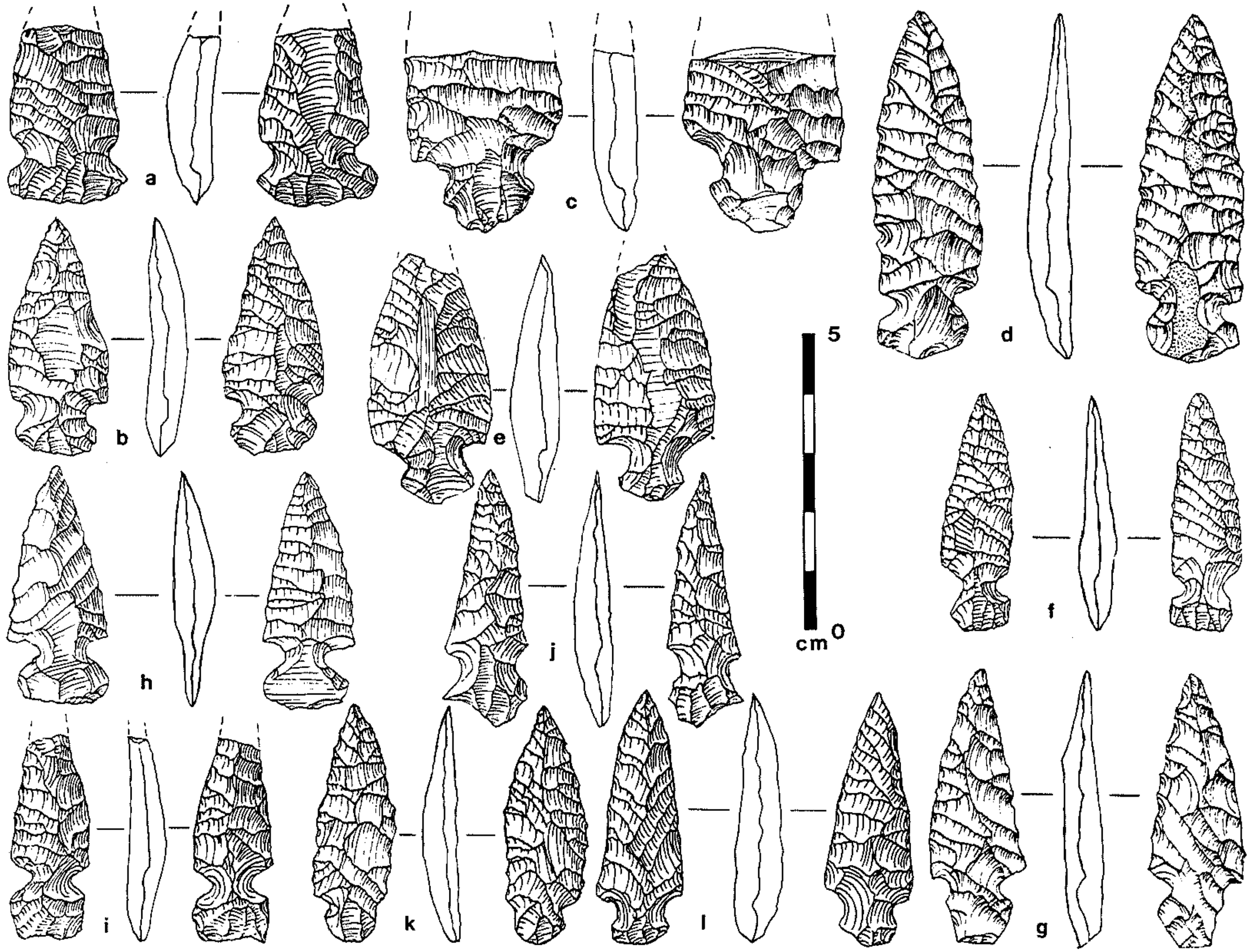

Fig. 13-22 (a) Elko Side-Notched - Hogup variety, 5-Scaup in I9b; (b-l) Elko Side-Notched - Round-based variety (b) 3-Grebe in D6a (c-e) 5-Scaup (c) in U4b (d) Y8b (e) O7b (f) 6-S&B in C6 (g) 6-S&B in Y7 (h) 8-LFL in A15 (i) 9-LSFL in J5c (j-l) 11-USFL (j) in E4 (k) C3 (l) J4.

The Hogup variety (Aikens 1970) shares all the characteristics of the Northern Side-Notched Point, except that the base is straight or slightly convex, instead of concave. Specimens of this design have in fact been classified as Northern Side-Notched elsewhere (e.g. Heizer and Hester 1978:Fig. 6K). At NFI, the two types occur together in the same pits and layers, and have similar maximum width dimensions (Fig. 13-20). It is suggested that this type could be better classified as a straight-based variety of the Northern rather than of the Elko Side-Notched Point. In the NFI sample, four base fragments are so narrow that they could be regarded as straight-based versions of the Siskiyou Side-Notched type. As in the Northern form, the longest specimens occur early in the sequence (Figs. 13-17l, 13-19a-c) with short broad specimens appearing later (Fig. 13-19f).

The South Fork variety (Heizer et al. 1968) holds to the original definition of the type, and recognizes the extended definition of Heizer and Clewlow (1968) to accommodate specimens with narrow notches placed higher on the sides than in the type collection. The few available illustrations suggest that the term was intended for relatively broad squat points with breadth-length ratios between 0.45 and 0.8. Although NFI produced many specimens conforming to the original definition, almost all of them are narrower than this range and have much narrower neck widths. Only two specimens approach the typical dimensions (Fig. 13-19i, j).

The remainder have been relegated to a third subcategory: the Round-based variety. It must be emphasized that this is not being proposed as a formal subtype name, but is applied purely for descriptive convenience to NFI specimens which grade into other varieties, but do not fit their descriptions. The Round-based variety is a narrow, foliate point with a well-rounded base and large, wide side notches relatively low on the sides. The neck-width is relatively narrow and the maximum width of the point is above the notches. This variety is a larger version of Lanning's (1963) Rose Spring Round-stemmed Point. The maximum dimensions set for the type collection of that small point are: 38mm length, 15mm width and 1.8gm weight.

The NFI collection of all round-based, side-notched specimens includes sufficient numbers of whole points to plot length distributions. Fig. 13-21a shows a clustering of specimens in the 38-58mm range, and in the 32-29mm range. The distribution of maximum width, however, fails to produce any clear bimodal distribution (Fig. 13-21b). All specimens 38mm or longer are designated Elko Side-Notched (Round-based variety), and several examples are illustrated in Fig. 13-22, and 13-23a.

Rose Spring Round-stemmed Points

Although Lanning (1963) called this an aberrant form of the Rose Spring Series, there are sufficient numbers of points which fit this description at NFI to suggest that the term can be applied here also. The criterion for distinguishing this form from the Elko Side-Notched (Round-based variety) is described above, and examples are illustrated in Fig. 13-23b-g). Although it co-occurs with the larger form, it persists into later strata than the Elko variety, which was the prototype of the smaller point.

Rose Spring Side-Notched Points

The type description calls for a small, generally triangular shaped blade with a straight or slightly convex base, straight or slightly convex sides, frequently serrated, but not invariably so. The notches are low on the sides. The illustration of the type

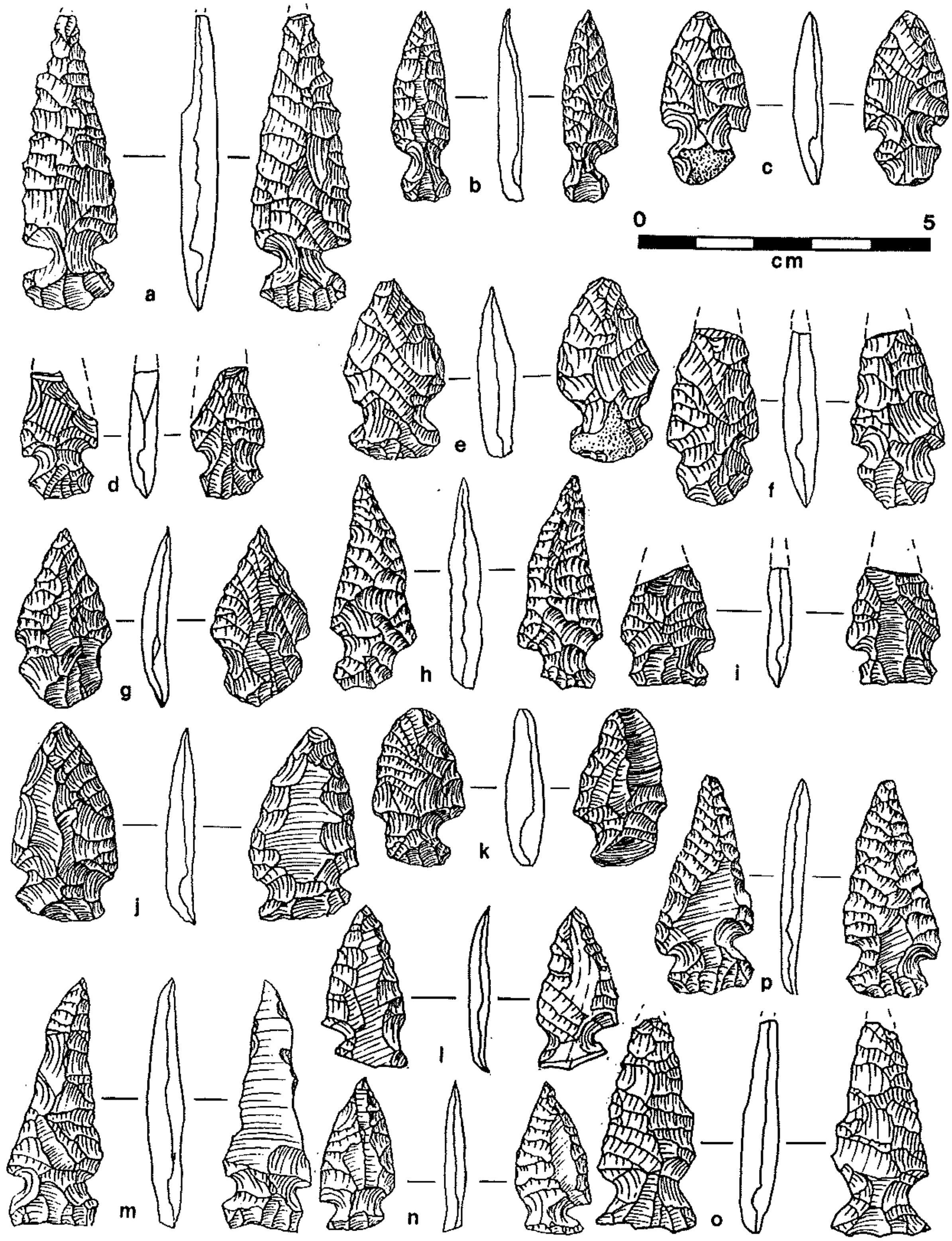

Fig. 13-23 (a) Elko Side-Notched - Round-based variety, 11-USFL in A8; (b-g) Rose Spring Round-stem (b) 6-S&B in G3 (cd) 10-MSFL (c) N2 (d) I7a (e) 11-USFL in D2 (f) 12-TSFL or later in O1 (g) 10-MSFL in E6; (h-p) Rose Spring Side-Notched (h) 9-LSFL in V5b (i-k) 10-MSFL (i) H3c (j) N2 (k) I6 (l-o) 11-USFL (l) A6 (m) E4 (n) D3b (o) A6 (p) 13-LAL in U1a. All obsidian.

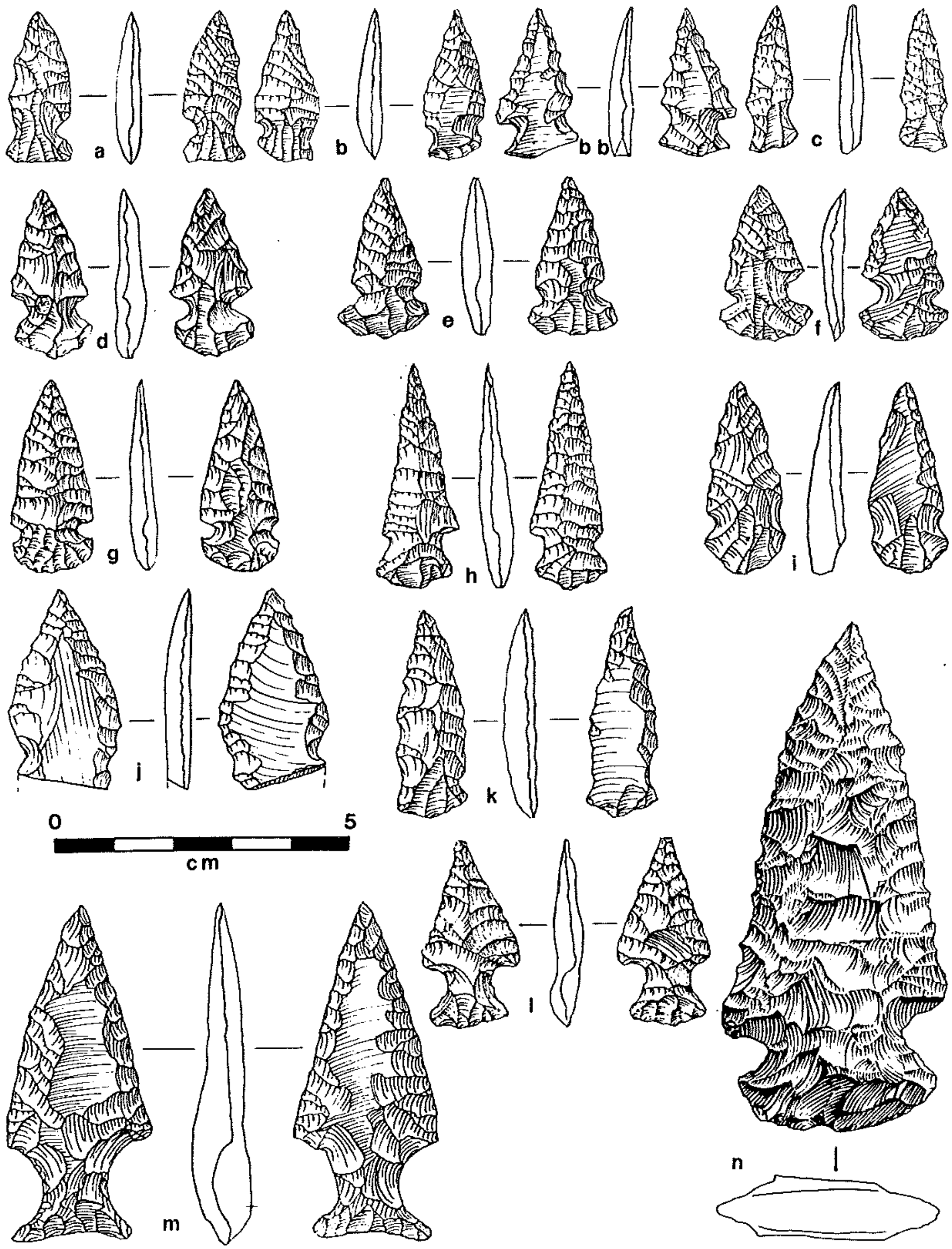

Fig. 13-24 (a-c) Rose Spring Side-Notched: (a-b) 8-LFL (a) C5 (b) A14 (bb) 11-USFL in A8 (c) 11-USFL in C4a; (d-i) Side-Notched Type A (d) 5-Scaup in U3 (e) 8-LFL in H3d (f) 7-GraCl in D4c (g) 9-LSFL in W3 (h) 11-USFL in C3 (i) 11-USFL or 12-TSFL in Q3c; (jk) Side-Notched Type B, 10-MSFL (j) A10 (k) B4e; (lm) Side-Notched Type C (l) 9-LSFL in X5b (m) 10-MSFL in N2; (n) Large Side-Notched Point, 3-Grebe in L4. All obsidian.

collection (Lanning 1963:Pl.7) show that the notches are invariably wide and medium-shallow, with the lower margin of the notch intersecting the basal corner of the triangular blank. Thus the stem width is always less than the maximum width, which occurs above the notch. Complete specimens are frequently asymmetrical and plano-convex sections are common. Points fitting this description are readily separated from the Elko Corner-Notched type on size, width, depth and care of manufacture, in spite of the superficial resemblance in outline between the two.

The Rose Spring Side-Notched type appears for the first time in the 9-LSFL and persists in diminishing frequency to the 13-LAL. Examples are shown in Fig. 13-23h-p and 13-24a-c.

Side-Notched Type A

This point has a small, broad, foliate form with a rounded base and medium-shallow, wide notches placed relatively high on the sides. Maximum width is invariably on the basal side of the notch. The ten unbroken specimens from NFI have the following ranges: Length 37-26mm; width 14-16mm; weight 1.2-2.3gm. Nine of the 13 recovered points share a width of 15mm--a clustering tendency which strongly suggests that this could be a convex-based variety of the Narrow Side-Notched Point. Examples are illustrated in Fig. 13-24 d-i.

Side-Notched Type B

This point is formed on the snapped tip fragment of a convergent flake. The margins of the blank are minimally trimmed to shape it to a triangular form, and small shallow notches occur low on the sides. Maximum width is on the basal side of the notches. The snap facet forms a straight or slightly concave base which may be slightly thinned by retouch on some specimens. Twelve whole specimens from NFI have the following ranges: length 34-22mm; width 19-10mm; weight 2.1-0.6gm. These are invariably crude and asymmetrical, with only rare invasive retouch. They are probably a variety of the Rose Spring Side-Notch, restricted to the Small-flake Loams (Fig. 13-24jk). Two specimens made on broken projectile point tips rather than on flake fragments have been included in this category.

Side-Notched Type C

This rare point has a subtriangular form with slightly convex sides. The base may be concave or slightly convex, with very large side notches which take up the lower third of the sides, forming an elongated eared stem (Fig. 13-24 lm). This is probably a rare variation of the Elko Side-Notched or Elko Eared Point.

Side-Notched Type D

A single specimen (Fig. 13-24n) from the 3-Grebe in sqaure L4 approaches the description of Heizer and Clewlow (1968) for their Type B at the Humboldt lake bed site. It is basically an outsize form of the Elko Side-Notched (South Fork variety). Although symmetrical and serrated, its massive form is more in keeping with the crude unifacial component from the bird-rich clays at the base of the sequence--discussed later in this chapter.

Corner-notched types will be reviewed next.

Rose Spring Corner-Notched Points

Lanning (1963) called these small stemmed points. The sides of the blade may be convex through concave, the base of the stem may be straight or convex, and the shoulders may be slightly flared (when the sides are straight or concave). Edge serration may also occur on the sides. The stem should expand only slightly. This original description places no restrictions on the shape of the shoulders or notches, nor on dimension/weight limits given for the 48 specimens in the type collection. However, Heizer and Baumhoff (1961) specify that the shoulders are more frequently horizontal than sloping (i.e. drooping). They also allow for the stem to be parallel-sided or expanding. The ranges given for seven specimens are 33-24mm length; 17-12mm width; 0.6-1.4gm weight, but Heizer and Clewlow (1968) permit specimens up to 45mm long, and permit relatively poorly made specimens into the type. Clewlow (1967) allowed a further modification by admitting specimens with slightly concave-based stems. This repeated broadening of the type-definition has brought it almost to the status of a catch-all category for specimens which do not readily fit any of the other established corner-notched types. It can now embrace so many specimens that Aikens and Minor (1978) were able to produce no less than six varieties of the point[2]. Another consequence of these repeated modifications is that the type now grades into the Eastgate Expanding Stem type (Heizer and Hester 1978).

It should be stressed that the NFI collection contains no specimens which approach the classic Eastgate form. It therefore appears that the site is definitely outside the known geographical range of that design.

The point first appears in numbers in the 9-LSFL. Solitary fragments from the 8-LFL in Y5 and from the 5-Scaup in V6 can be safely dismissed as derived specimens. Although the type persists into the Arrowhead Loams sequence, it continues only as a specialized variety. This is a relatively long narrow point with straight or concave sides, drooping shoulders, and serrated edges (Fig. 13-25j-1). This variety is sufficiently far removed from the original type description that it may eventually be renamed when its distribution and chronology are better known. Meanwhile it will be retained under the Rose Spring rubric.

It is reasonably certain that the Rose Spring Series of points made their first appearance at NFI in the 9-LSFL. Although this is considerably earlier than the accepted age range for the Series in the Great Basin, it is by no means anomalous as specimens of comparable age have been reported at Hogup cave (Aikens 1970), Swallow Shelter (G. Dalley in Heizer and Hester 1978) and the High Rock area (Layton 1970).

Elko Corner-Notched Points

Heizer and Baumhoff (1961) called Elko Corner-Notched a large triangular point with sloping shoulders, a stem widening towards the base and deep parabolic corner notches. The configuration of the base was not specifically defined, but three of the original illustrated type specimens are straight based, and five are slightly concave. Lanning (1963) allowed specimens with shoulders varying from drooping to almost nonexistent, with notches likewise variable from deep to quite shallow and broad. These modifications were rejected by Heizer et al. (1968) when applying the definition to a large collection from South Fork Shelter, which remains the clearest description available. Although they concede that this type grades into the Elko Eared form, they recommend that the distinction should be retained as is the criterion for separation.

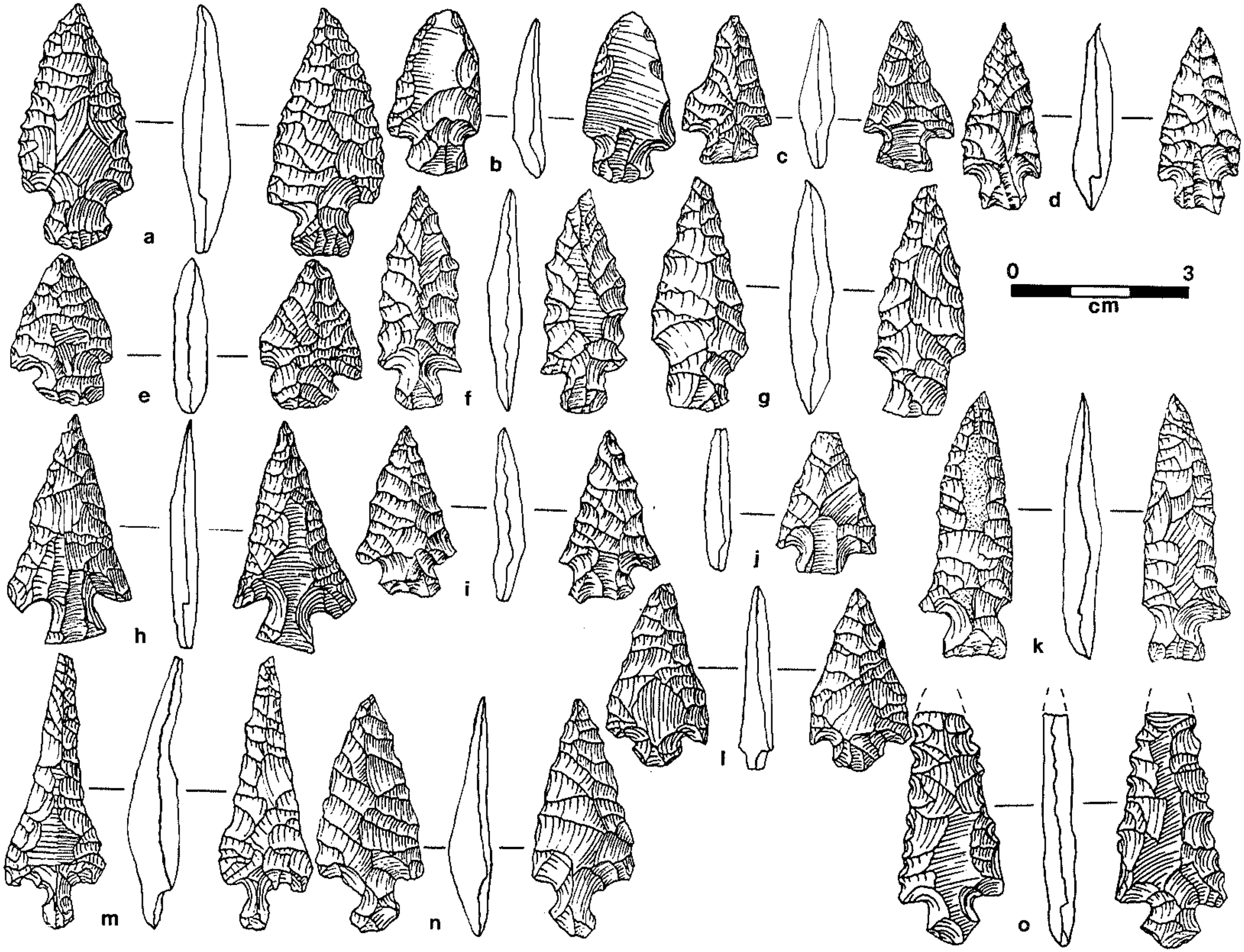

Fig. 13-25 Rose Spring Corner-Notched Points: (a-e) 10-MSFL (a) in G2b (b) N2 (c) M1-2 (d) Y3 (e) E5; (fg) 11-USFL (f) C4a (g) D3a (h) 12-TSFL in J3 (i-l) 11-USFL (i) U:b (j) B4d (k) D3a (l) M1-2; (mn) 13-LAL (m) A5 (n) B3; (o) 14-MAL in J2b. All obsidian except (d) yellow chert.

The first typical specimens appear at NFI in the 3-Grebe with a possible proto-type in the 1-Basal (Fig. 13-26a), and they dwindle in the 13-LAL to a few, possibly derived specimens.

In the 9-LSFL, there is a diminutive form of Elko Corner-Notched which may eventually emerge as a discrete type when more is known about its chronology and distribution. It is provisionally referred to a Nightfire variation of the Elko Corner-Notched Point. Although it has the characteristic large corner notches of the original type, the overall size of the point is so small that the neck appears relatively narrow. Of the 33 specimens placed in this category, only three could perhaps be the retrimmed stubs of the regular corner-notched form. All the others are too thin to fit the standard definitions of the type, and must have been consciously designed in this diminutive form. Dimensional ranges for the collection are: 31-17mm length; 25-14mm width; 2-8mm thickness; 2.8-0.7gm weight. Examples are shown in Fig. 13-28h-o.

Layer T4 produced 17 (51.5%) of all the specimens recovered. One came from T5a immediately below, and others were scattered through the 9-LSFL in Pits N, X, U, V, and W surrounding it. The T4 concentration may have been from a cache, the contents of a pouch, or even from a bundle of complete projectiles from which the shafts had decayed.

Elko Eared Points

These were defined by Heizer and Baumhoff (1961) as large triangular points with two large nubs or ears projecting diagonally from the base. The type collection (19 or 20 specimens) also contains stemmed and corner-notched points with the base of the stem sufficiently concave to give it an eared appearance. However, these grade into the Elko Corner-Notched type and a precise metrical boundary between the two could not be established.

Lanning's (1963) definition allows corner or side notches, and markedly expanding stems bifurcated by means of a deep V-notch in the base, with shoulders usually not prominent. His illustration of three fragmentary specimens includes one with a slightly concave base rather than the V-notch called for by his definition and it certainly falls outside the range of the illustrated type collection (pace O'Connell 1967). Heizer et al. (1968) emphasized that the Elko Eared type differed from the Elko Corner-Notched type in having a notched stem which gives it a split-stem or eared appearance. The eight specimens which accompanied this new definition include one (ibid:Fig. 3j) which has an almost parallel-sided stem, which fits the revised definition (i.e. split stem) but not the previous two. The same illustration, however, also fits well within the type-description for the Pinto-Square Shoulder (O'Connell 1967). Thus, the Elko Eared type definition has been expanded to the point where it can accommodate specimens from two other types, depending on whose type illustrations are used as a standard. Although most specialists would agree that the difficulty could be resolved by lumping the Eared and Corner-Notched categories, this may be a premature solution, as the Elko Eared type terminates at Hogup Cave (Aikens 1970) and Danger Cave (Fry and Adovaso 1970) long before the Corner-Notched type disappears. Although the two types are thought to covary regionally, they do not occur in similar frequencies, one to another, in all parts of their area of distribution.

At NFI, however, the two covary in frequency throughout the sequence, both terminating in the 13-LAL. It is of interest to note that the earliest specimen from the 2-Coot is the thickest specimen in the entire sample of this type (Fig. 13-29a).

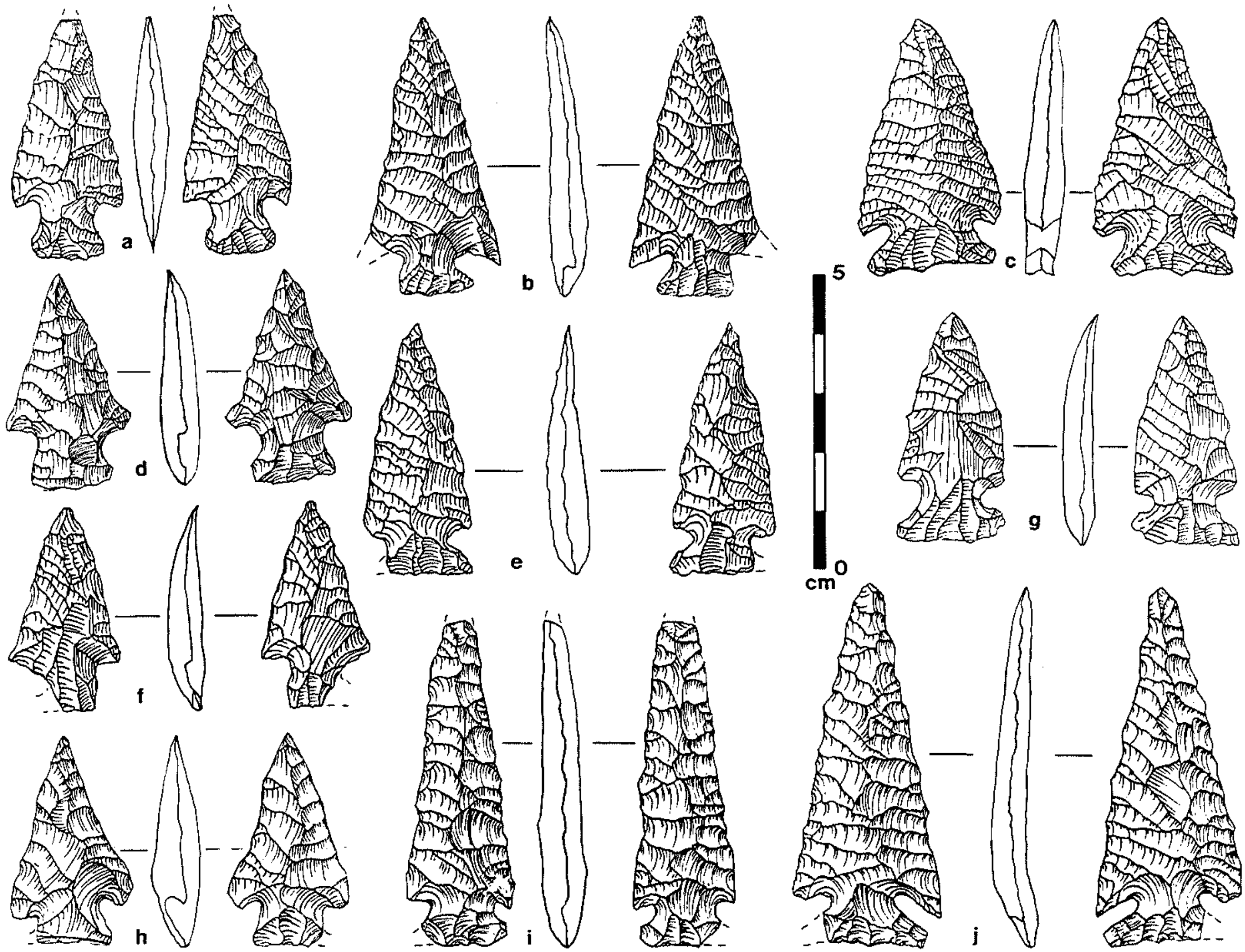

Fig. 13-26 Elko Corner-Notched Points: (a) 1-Basal in C7b; (b-e) 6-S&B (b) J7 (c) K7 (d) G3 (e) J7; (f) 8-LFL in E9; (g-j) 9-LSFL (g) A15 (h) S4a (ij) X6. All obsidian except (d) white chert.

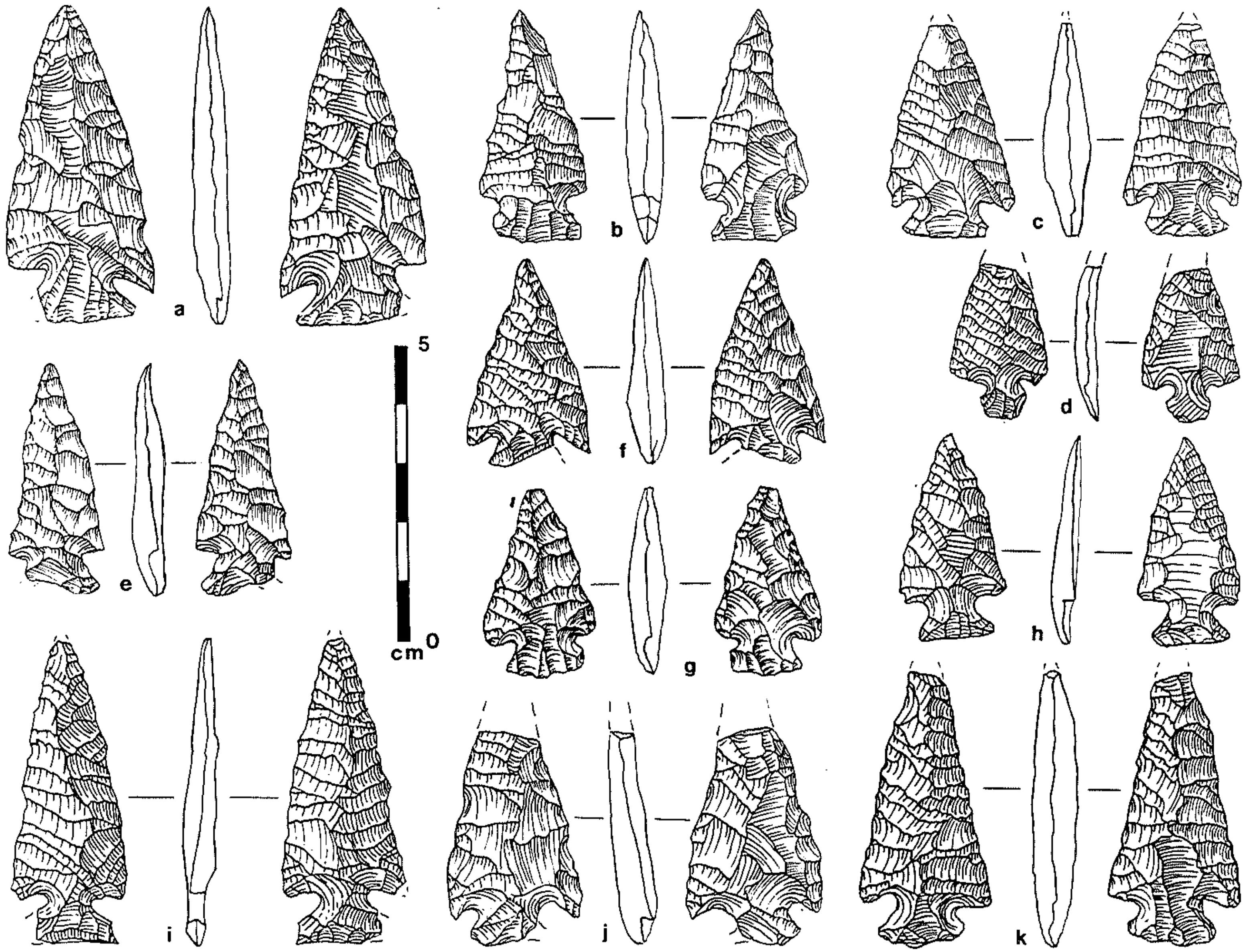

Fig. 13-27 Elko Corner-Notched Points: (a-d) 10-MSFL (a) Q3d (bc) A10 (d) I7a; (e-k) 11-USFL (e) S3a (f) J4 (g) X3a (hi) A7 (j) P5a (k) J4.

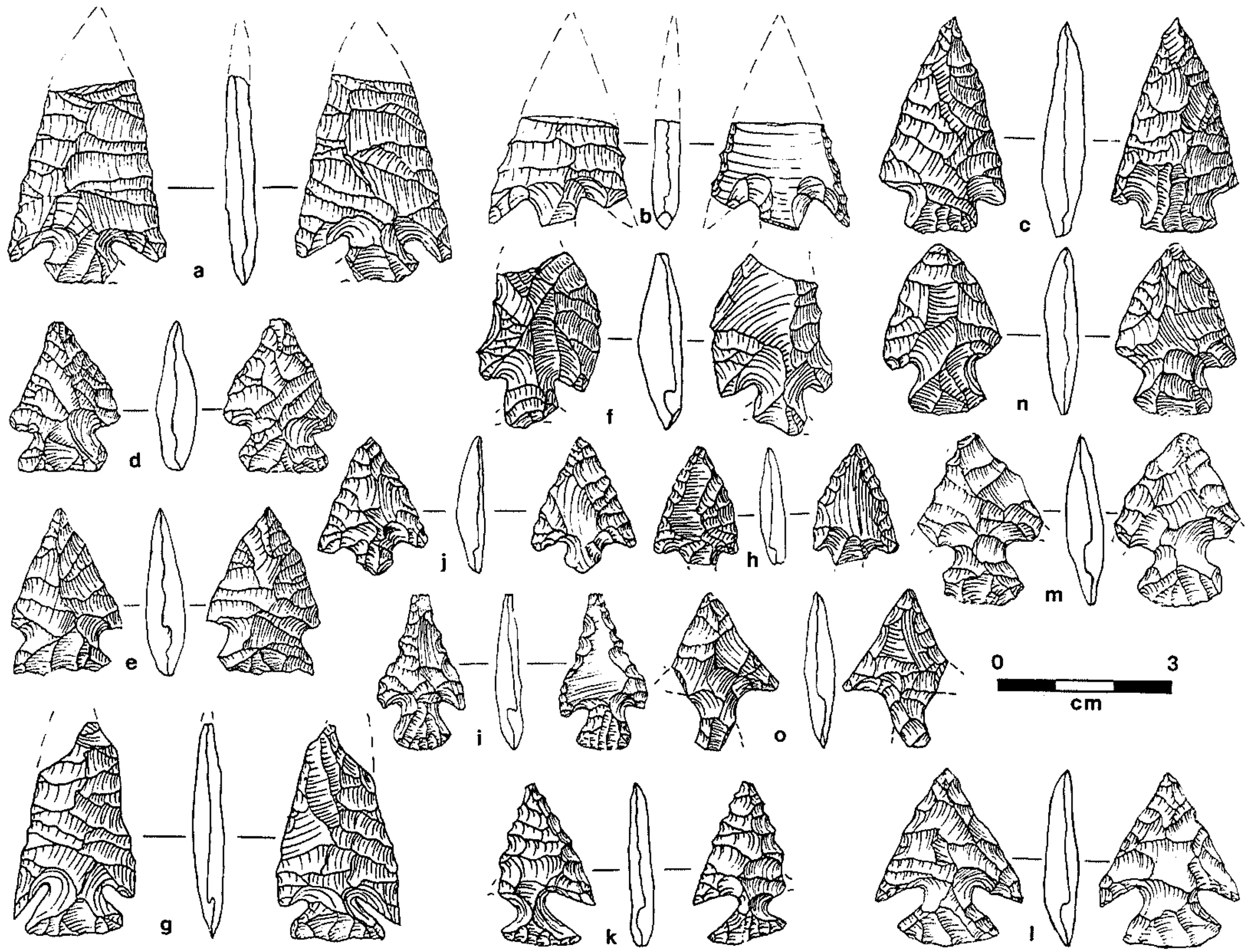

Fig. 13-28 (a-g) Elko Corner-Notched Points, 11-USFL: (a) C3 (b) A8 (c) J4 (d) D3b (e) H3a (f) I6; (g) 12-TSFL in E3; (h-o) Elko Side-Notched - Nightfire variety (h) 5-Scaup in O6a (i) 8-LFL in T5b (j-m) 9-LSFL (j) V5b (k) W5 (lm) T4; (no) 10-MSFL (n) N2 (o) Q5. All obsidian.

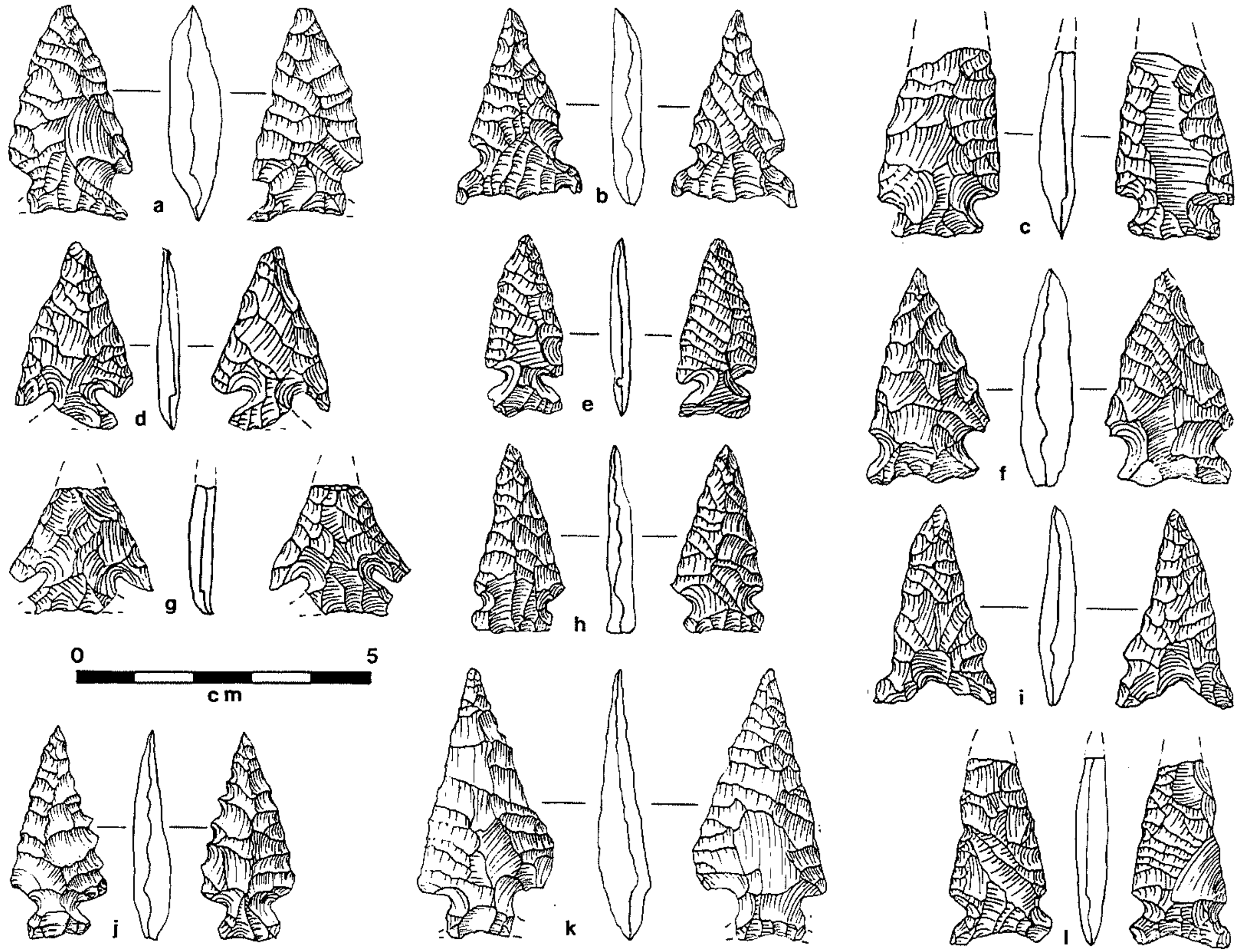

Fig. 13-29 Elko Eared Points: (a) 2-Coot in R8; (b) 3-Grebe in T5d (cd) 6-S&B in P10; (e) 7-GraCl in E10 (fg) 8-LFL in J6; (h-j) 9-LSFL (hi) J5c (j) S4a; (kl) 10-MSFL (k) A10 (l) Q6. All obsidian.

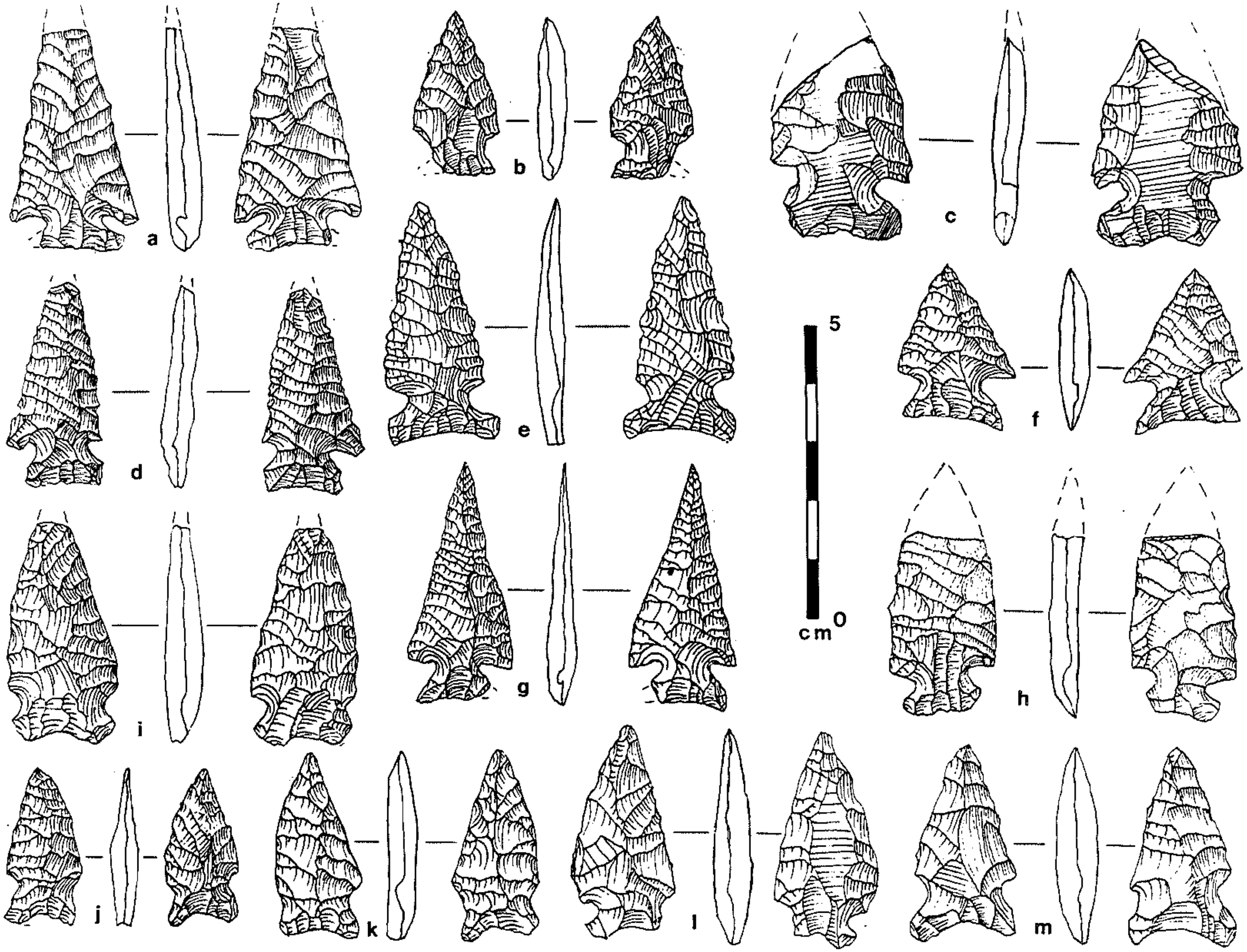

Fig. 13-30 (a-h) Elko Eared Points: (ab) 11-USFL (a) Q6b (b) E5 (c-h) 11-USFL (c) A7 (d) A8 (e) A7 (f) E4a (g) G2a (h) C4a; (i-m) Type D Eared Points: (i) ?TSFL in O1a (j) 8-LFL in H3e (k-m) 11-USFL (k) T2 (lm) B4d. All obsidian.

Type D Eared Points

This rubric is borrowed from Heizer and Clewlow (1968) who used it to describe a small counterpart of the Elko Eared form, with a relatively thick cross-section and shallow side notches which create only slight shoulders. Examples are shown in Fig. 13-30i-m and 13-31ab. They have a similar distribution to the Elko Eared and are simply a variation of the type. Ranges are: 40-26mm; 19-12mm; 10-4mm thick; 5.0-1.2gm weight.

Large Stemmed Points

These are medium to large triangular points with straight to slightly convex blades, square or slightly drooping shoulders and parallel-sided or contracting stem. The range from eight whole specimens is: 60-34mm length; 26-19mm width; 9-4mm thickness; 7.1-3.2gm weight. Aikens and Minor (1978) separated this category into contracting- and parallel-sided types. The NFI collection contains only two specimens with contracting stems (Fig. 13-31dg)--too few to justify a distinct category.

This small sample hints at stratigraphic concentrations of the type in the 6-S&B, LSFL/MSFL and again in the 13-LAL. Three of the 13 specimens recovered (23%) are made of exotic rocks other than obsidian.

Pinto Square Shouldered Points

Following the recommendations of Heizer and Hester (1978), this term is retained here to describe a single specimen from the bottom of the 9-LSFL in U2b. It is a triangular blade with slightly convex sides, square shoulders, parallel-sided stem, and a straight base with the characteristic notch. Flaking is parallel-oblique on both sides; 47mm long; 21mm wide; 6mm thick; 4.5gm weight.

Rose Spring Contracting Stem Points

Although Lanning (1963) indicated that this form is an arbitrary morphological separation of a continuum from the Rose Spring Corner Notched, it appears to be a valid distinction at NFI. The type collection (18 specimens) is on medium-small triangular blanks ranging between 25-31mm length. Blades vary from convex to slightly concave. Shoulders are horizontal or slightly drooping, sometimes slightly flared. The stem varies from pointed to straight-sided, and the base is straight or round. Heizer and Clewlow (1968) admit specimens with only slight shouldering.

The NFI specimens are all relatively large, compared to the type collection, and most points are quite narrow. A single point from the 2-Coot (Fig. 13-32j) is placed in this category by default, although it is broader than any other piece in the category.

Rose Spring Single-Shouldered Points

Following Lanning (1963) these are small triangular forms with straight or convex blades, straight or convex bases, with only one horizontal shoulder. They are probably unfinished blades for other Rose Spring variations. At NFI, they are a relatively scarce variety with a similar distribution to the rest of the Series.

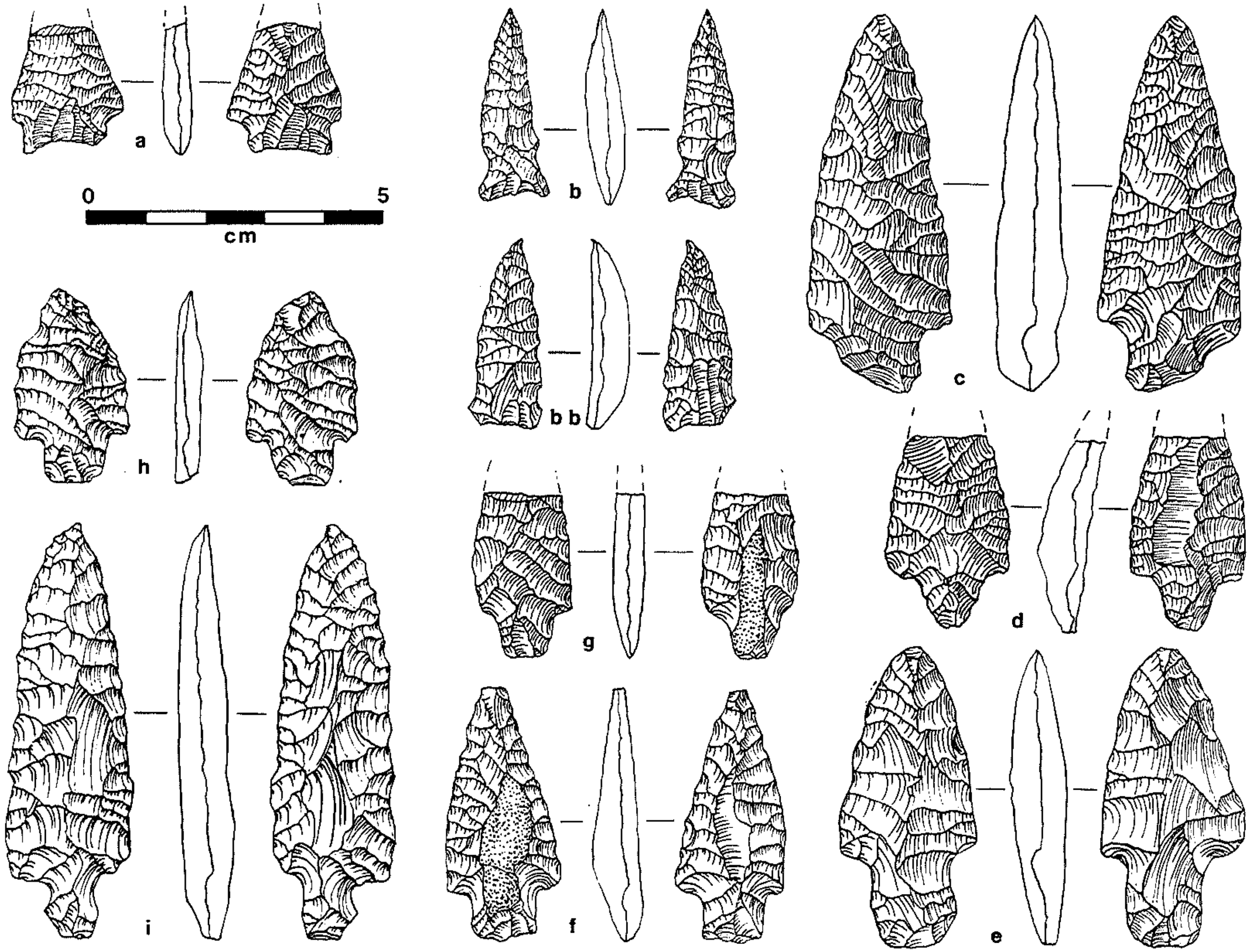

Fig. 13-31 (a-bb) Type D Eared Points: (a) 12-TSFL in J3 (b) 13-LAL or 14-MAL in E1-2 (bb) 6-S&B in D5; (c-i) Large Stemmed Points: (cd) 6-S&B in I8 (eh) 10-MSFL (e) P5b (f) Q6 (g) J5c (h) X5a (i) 13-LAL in V2-3. All obsidian except (c) chert (e) jasper (g) white opal.

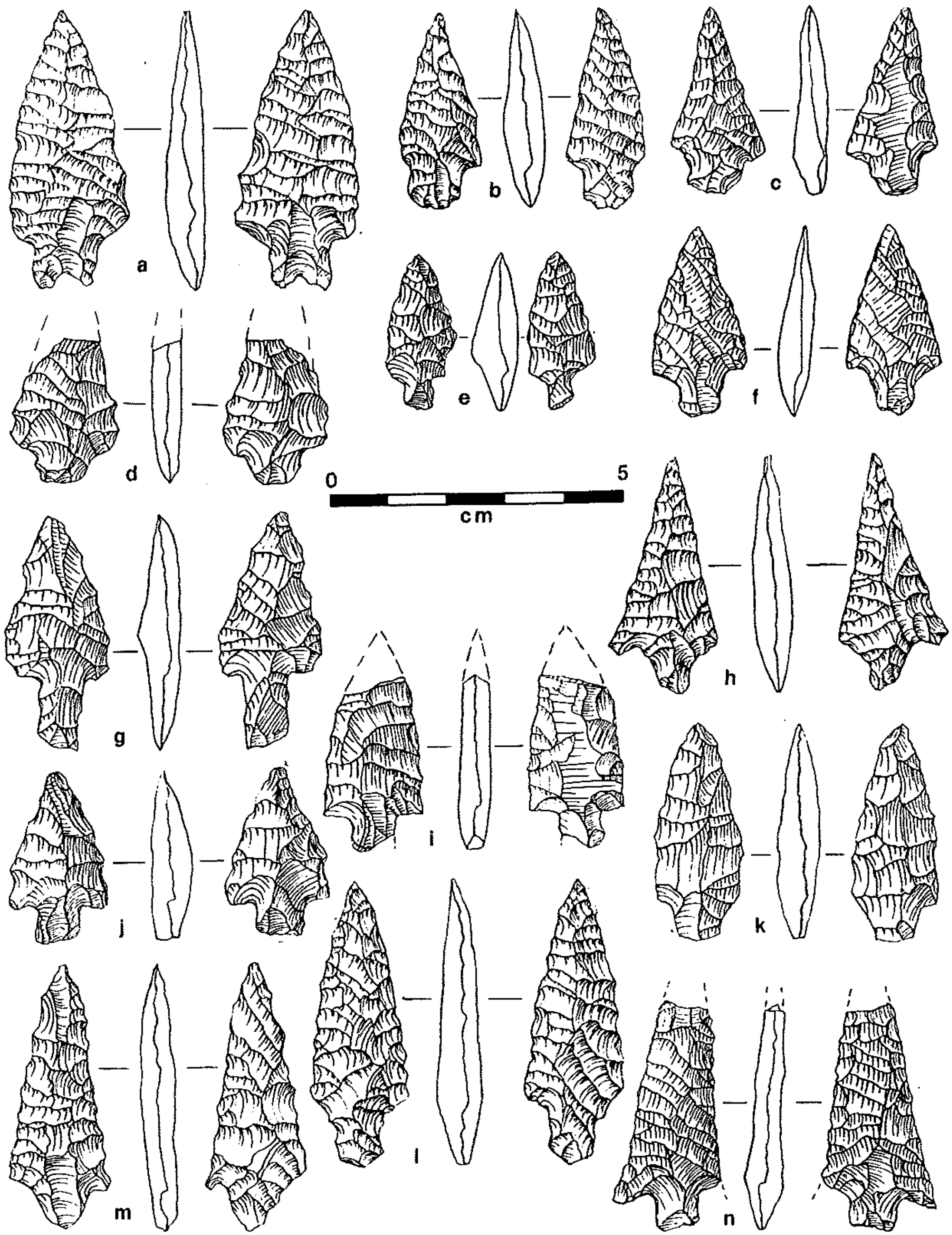

Fig. 13-32 (a) Pinto Square-shouldered Point, 9-LSFL in U2b; (b-n) Rose Spring Contracting Stem Points: (b) 6-S&B in U2c (c) 9-LSFL in P9 (d) 10-MSFL in E5 (e) 12-TSFL in J3 (f) 13-LAL in A5 (g) 14-MAL in B2 (h) 15-UAL in X2 (i) 11-USFL in A8 (j) 2-Coot in G4 (k) 12-TSFL in B4a (l) 11-USFL in V3-4 (m) 11-USFL in T2 (n) 11-USFL in A7. All obsidian.

Surprise Valley Split-stem Points

Following O'Connell (1975), this term is used to describe three points recovered in the NFI excavations. Two are illustrated in Fig. 13-33ab, showing a small narrow triangular form, straight blades, square shoulders, very slightly expanded stem, and basal notch. The NFI specimens are widely dispersed and appear to have little to offer as marker specimens.

Double-Notched Points

Six specimens from the NFI collection have both side- and corner-notches. Unfortunately, only one has part of the base preserved, all the others having lost this portion (Fig. 13-33b-c). No formal name for this category has been proposed in the literature, but it is similar to the Type K of Heizer and Clewlow (1968). The two 9-LSFL specimens are from S and W and the LSFL/TSFL group are from the northeast of the site in E, I, and J.

Large Notched Points

This small group of ill-made points is confined to the lower part of the sequence, in the bird-rich clays. Of the ten specimens recovered, five are complete and one other point is slightly damaged. The remainder are basal fragments. This type is based on a large, thick foliate blank with irregular outline and varying control of symmetry. Only one specimen (Fig. 13-34a) might be termed corner-notched, and the remainder are side- notched. The ranges for six specimens are: 49-32mm length; 23-20mm width; 9-6mm thickness; 7.6-3.6gm weight. Some of these may be poorly finished Elko Side-Notched points, but their limited stratigraphic range and lack of true Elko notching suggests that they should be classified separately from the Elko series.

Unifacial Points

These are the dominant forms in the 2-Coot and 3-Grebe. There are nine complete specimens displaying extreme variability in size: from 100+mm length (e.g. Fig. 13-35f) down to 40mm (Fig. 13-35e). Midsection and tip fragments in the 3-Grebe indicate specimens even larger. They are basically elongated flakes trimmed unifacially to produce a foliate shape but there are also variations on this: bipointed (Fig. 13-34g), slightly shouldered (Fig. 13-34e), and serrated (Fig. 13-35d). Flaking is steep and uneven on all specimens. There are two burinated edge fragments (Fig. 13-35g) but no actual burinated points have been recovered. There are no obvious analogs for these specimens in the available literature.

cf. Martis (?) Corner-Notched Points

Six specimens from the 2-Coot and 3-Grebe have been provisionally referred to this category on morphological grounds only. Three are complete specimens. Given the early dates of the NFI points, and given the paucity of adequate illustration of the type specimens, this label should be taken as a descriptive convenience only--no connection with the Lake Tahoe area need be inferred. Following Heizer and Elsasser (1953) and Elston (1971), they are small, squat, thick triangular blanks with broad medium-shallow notches low on the sides. Blades are markedly convex, with a slightly constricted tip. Bases are straight. One of the three whole specimens is slightly shouldered

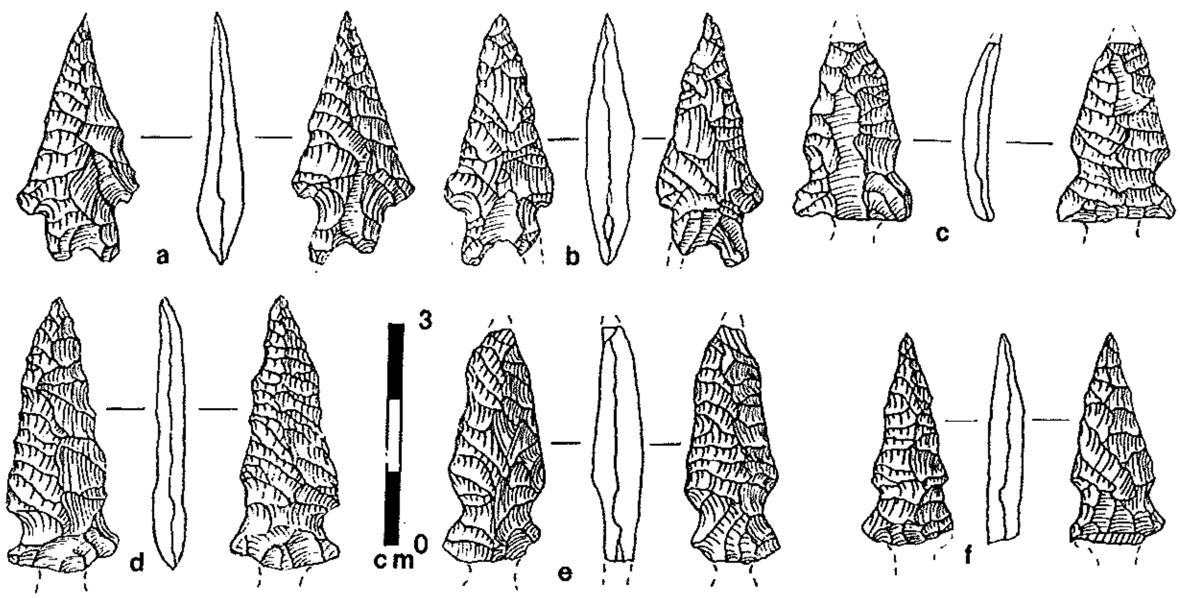

Fig. 13-33 (ab) Surprise Valley Split-stem Points: (a) 8-LFL in G2c (b) 11-USFL in D2; (c-f) Double-notched Points (c) 7-GraCl in D4c (de) 11-USFL (d) E4a (e) I6 (f) 12-TSFL in J3. All obsidian.

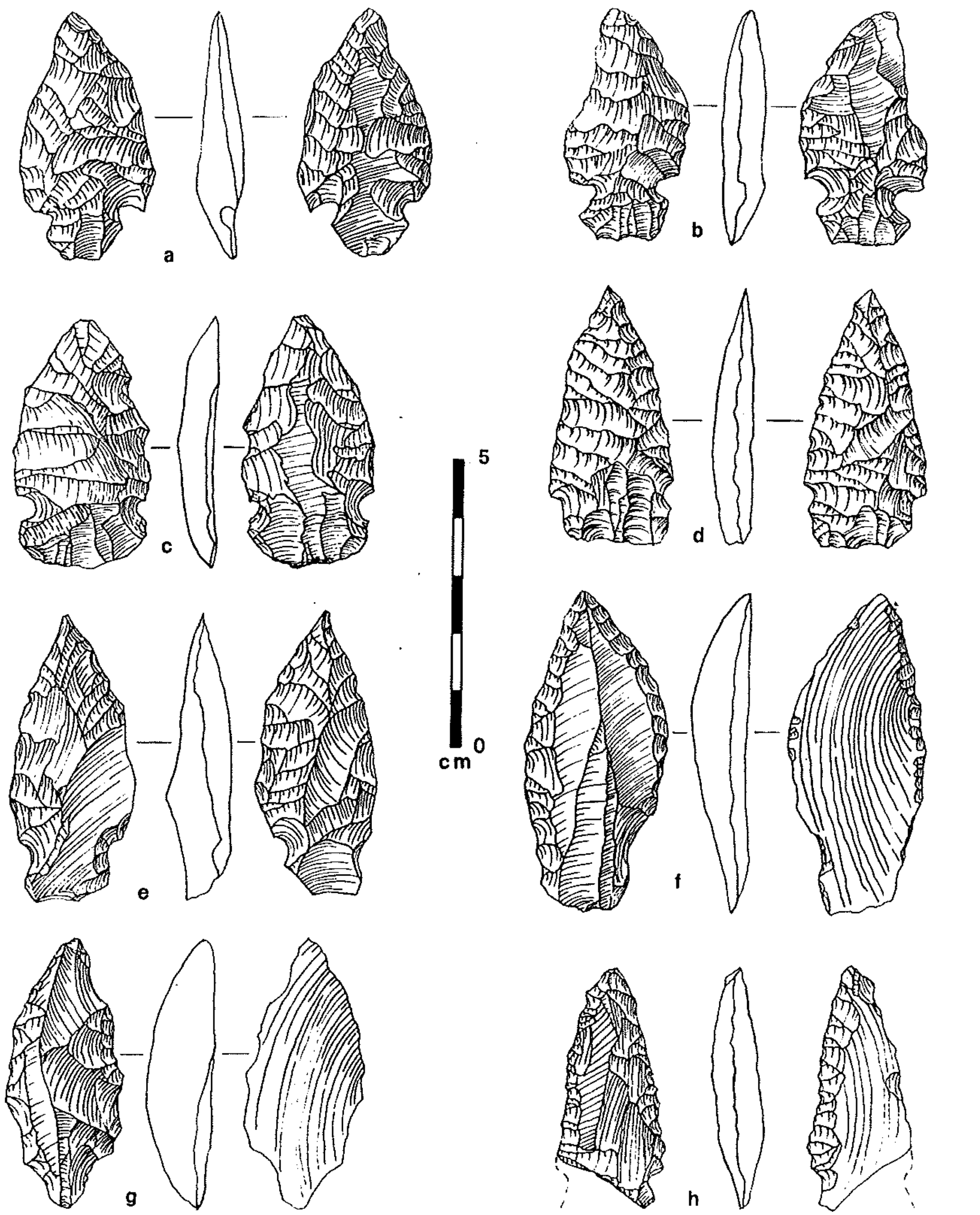

Fig. 13-34 (a) Large Corner-notched Point, 4-Mix in N7a; (b-d) Large Side-notched Points: (b) 3-Grebe in M3b (c) 2-Coot in M8 (d) 1-Basal in W6; (e-h) Unifacial Points: (ef) slightly shouldered, 3-Grebe (e) M3b (f) M3a; (g) bipointed, M3b (h) tip fragment, 2-Coot in C7a. All obsidian.

with a contracting stem, and approaches the Martis Stemmed Leaf Variety. Ranges are: 40-22mm length; 26-19mm width; 8-6mm thickness; and 6.1-2.1gm weight. Until the distribution and chronology of these small points is better known, any discussion of their significance would be premature.

Gunther Points

The separation of these small points from the remainder of the projectiles at NFI presents few problems. So distinct are they, and so numerous in the deposits, that they have been exploited as a marker for correlating the upper layers of many of the pits (see Chapter 3), and the three strata labelled "Arrowhead Loams" in recognition of the abundance of these points which they contain.

Treganza (1958) defined the type as a small triangular form with a definite stem (of variable shape) with characteristic barbs or tangs formed by deep basal notching, such that the tang length often exceeds that of the stem. Five variations were recognized: two longer-stemmed forms (serrated and unserrated); an essentially untanged form with straight or slightly drooping shoulders; and two "Classic" variations with tangs longer than stems (serrated and unserrated).

At NFI, specimens of the Classic variation are quite rare and appear at the end of the sequence. In fact, they have been used as markers to designate the presence of the 15-UAL in each pit. The most complete examples are shown in Fig. 13-36a-h. Two unillustrated fragments lack serrations, but all others are serrated.

While most archaeologists are willing to recognize the distinctiveness of the Classic variation, there is no concensus on how best to subdivide the residual specimens which do not fit that category. Treganza's subdivision is based on tang length, but it has also been suggested that stem shape could be used to separate subcategories (Strong et. al. 1930; Baumhoff and Olmstead 1963; Elsasser and Heizer 1966). Attempts to combine these two approaches quickly lead to a dozen or more "variations" which may be of some descriptive value, but do nothing to explain the significance of the designs actually intended by the arrowhead makers.

The goal of the present analysis is to isolate attribute-clusters in the NFI collection of Gunther points which might serve as time-markers in the stratigraphic subdivision of the Arrowhead Loams. If we apply the subclassification of Treganza, we find the short-tanged attribute increased in frequency through time at the expense of the square shouldered attribute (Table 13-1). If stem shape is taken as the separating attribute (Table 13-2), there are no changes through time. Parallel-stemmed points remain dominant throughout and increase slightly in the 15-UAL at the expense of contracting stems. Stem shape is therefore not particularly valuable as a marker attribute at the site. Attempts to use other discrete attributes such as flared barbs are equally unsuccessful. Serration tends to increase with time, but is never prevalent in any stratum. Several attempts to use attribute clusters have also created mechanical "types" which do not serve as useful markers, with one exception:

This is a small, broad point with convex blades, parallel stem, shoulders slightly drooping or square and a width/length ratio of 0.6 or higher (Fig. 13-36i-m). This Broad variation is virtually restricted to the 13-LAL where it comprises 16% of the Gunther points.

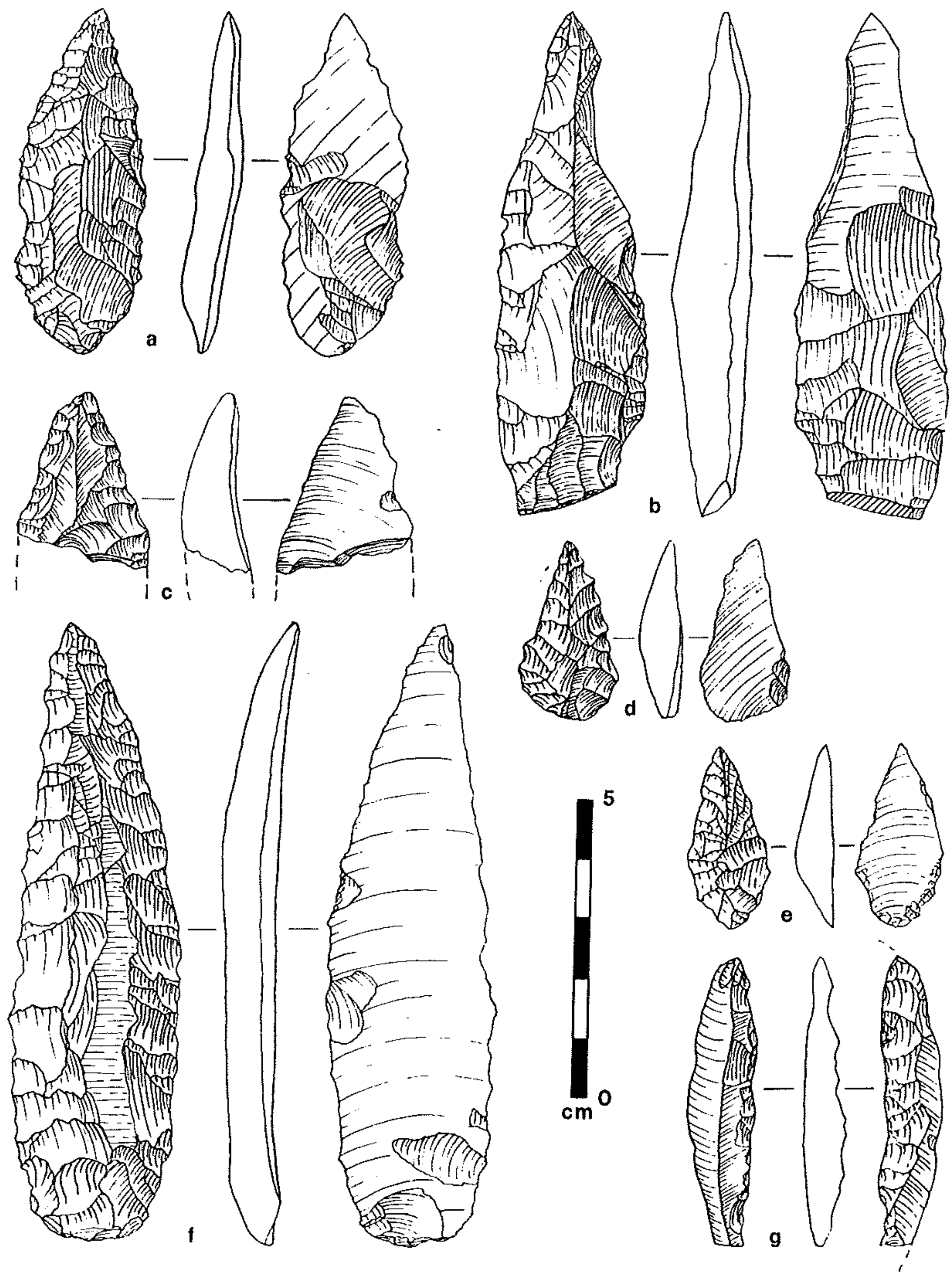

Fig. 13-35 Unifacial Points: (a) 2-Coot in M8; (b) 3-Grebe in T6; (c) tip fragment, 8-LFL in B7; (d) 3-Grebe in M3b. All obsidian.

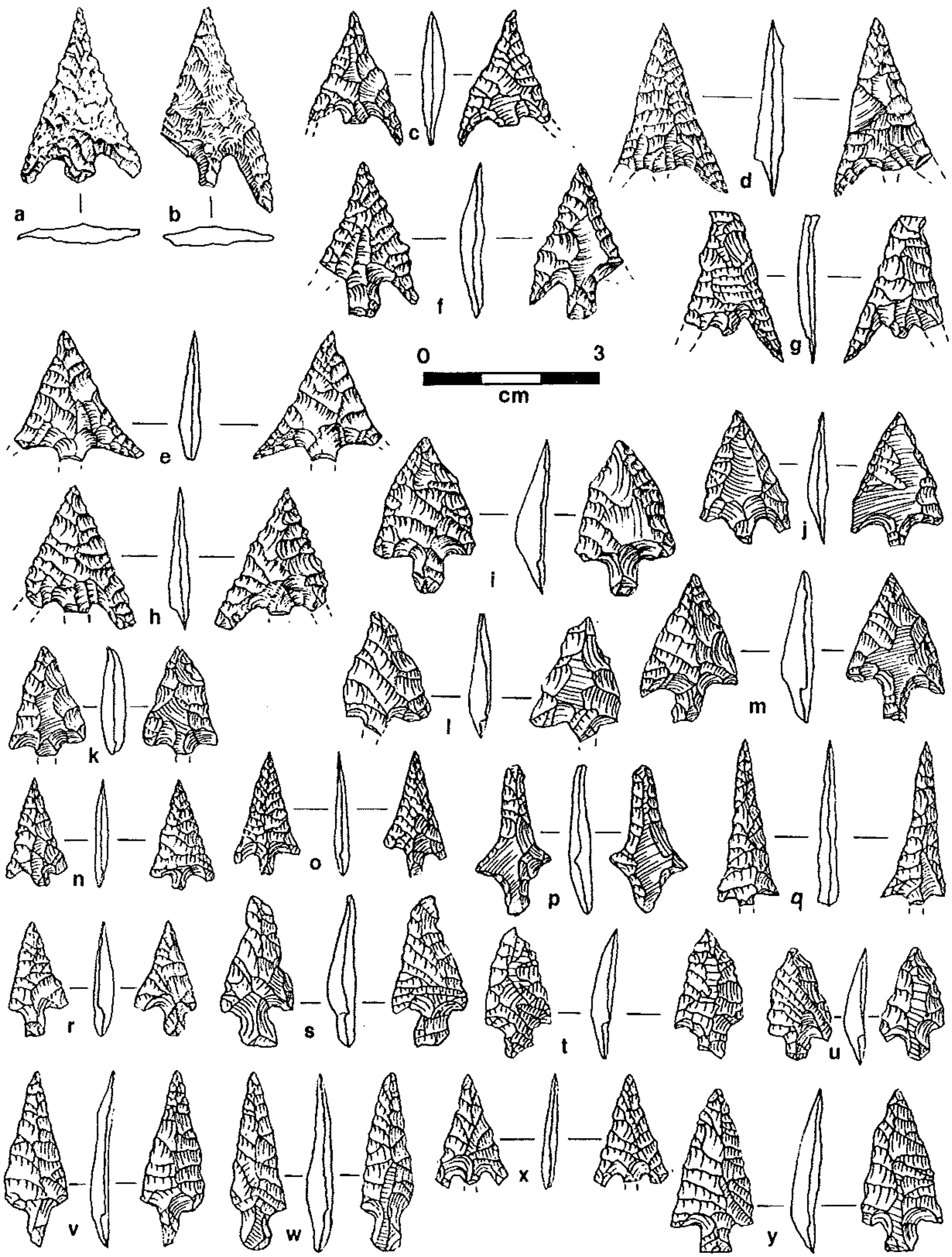

Fig. 13-36 Gunther Points: (a-h) Classic variation, 15-UAL (a) P1 (b) V1a (cd) Q1b (e) X2 (f) V1b (g) Q1b (h) V1b; (i-m) Broad variation, 13-LAL (i) V2-3 (j) Q2-3 (k) P4 (l) B3 (m) H1; (n-y) Others (n) 11-USFL, presumed derived, in D2 (o) 12-TSFL in J3 (p) 11-USFL? in Q3c (q) 12-TSFL in E3 (r) 11-USFL? in C3 (s-y) 13-LAL (st) A5 (u-y) B3. All obsidian.

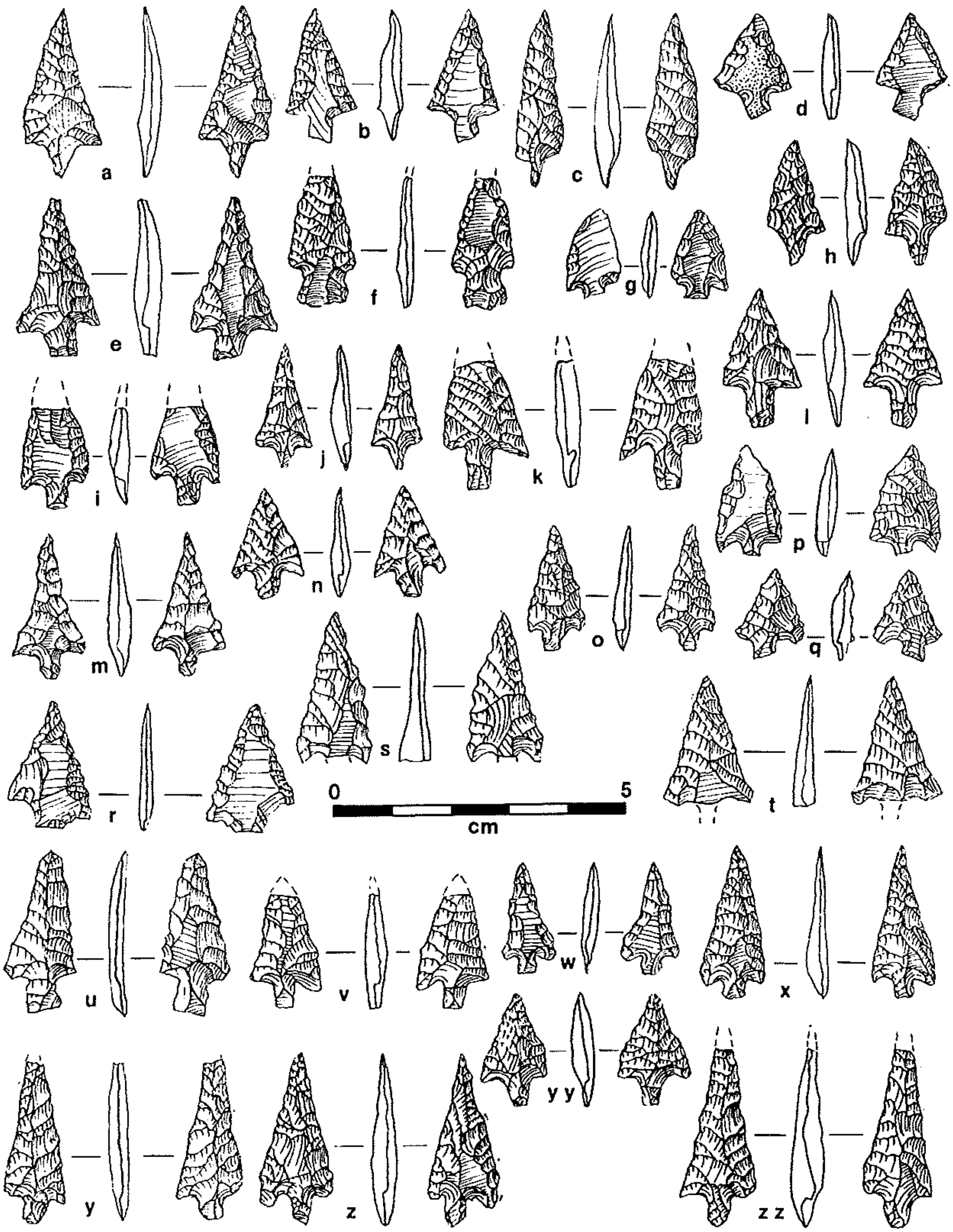

Fig. 13-37 Gunther Points: (a-n) 13-LAL (a-c) D1b (d) G1a (e) H2 (f) I3-4 (g-i) P3-4 (j) Q3b (k) O3a (l) S1 (m) T1 (n) V2-3; (o-zz) 14-MAL (o-q) A1-4 (r) B1 (s-w) B2 (x-y) E1-2 (yy-zz) J2b. All obsidian.

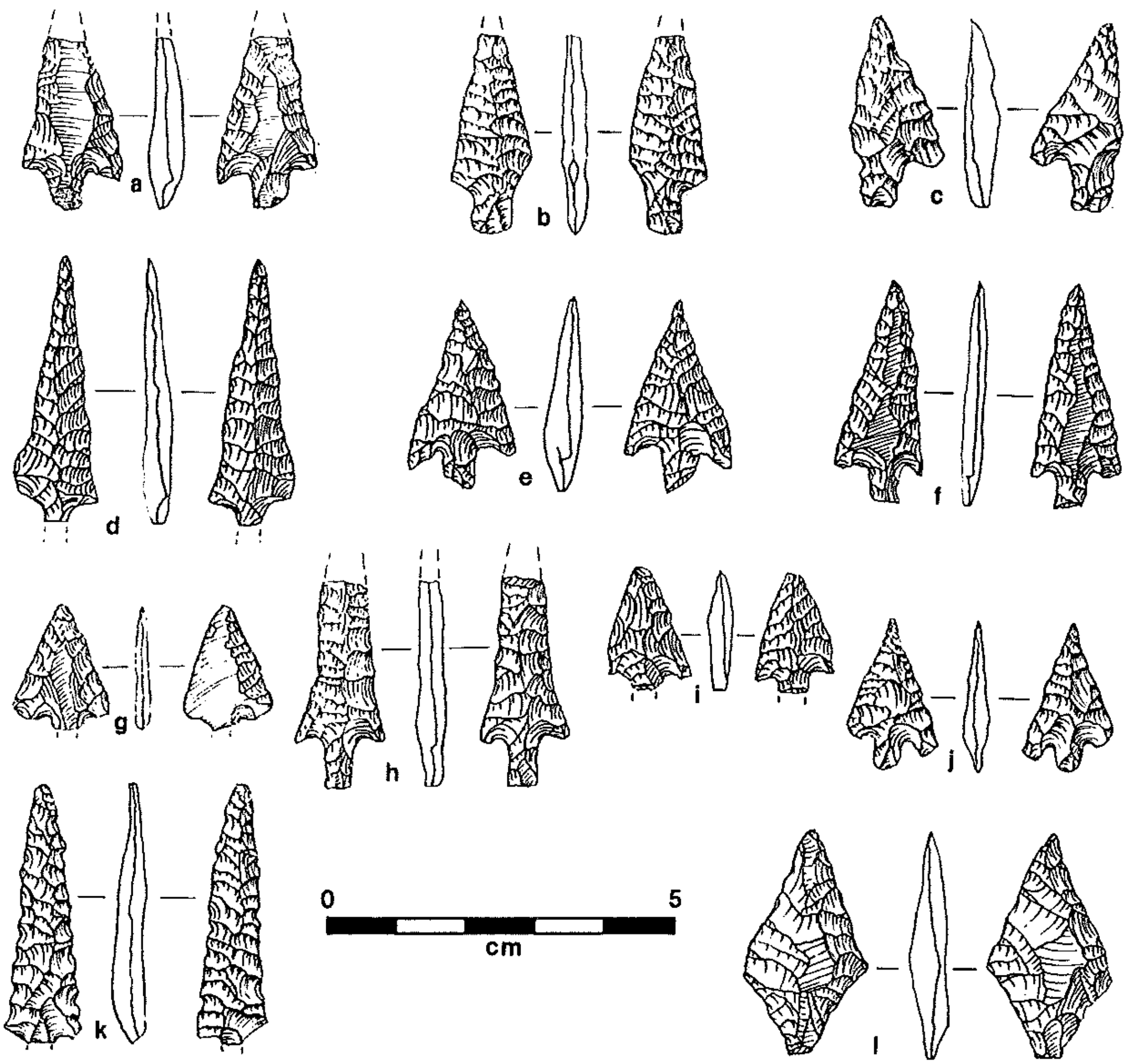

Fig. 13-38 Gunther Points: (a-c) 14-MAL (a) P2c (bc) V2; (d-k) 15-UAL (d) J2a (ef) J1-2a (g) P1 (hi) P2b (j) V1a (k) V1a; (l) Diamond-shaped point, 15-UAL in D1b. All obsidian.

Although other variations can be created by combining various attributes, it is doubtful whether any purpose is served by this at present. Future research will no doubt reveal the significance of these subtypes when their geographical distribution and chronology is better understood at the regional level.

At NFI, there are a few specimens recovered from the topmost layers of the 11-USFL. One specimen occurs in this situation at Pits C, P, Q, U, and X--all of which have the Arrowhead Loams dir- ectly overlying the 11-USFL surface. All of these specimens can therefore be safely discounted as derived from the overlying layers. Of the four specimens from the 12-TSFL, only one in Pit J is derived in this way.

Two others are derived by accumulated mixing during excavation.

The following conclusions may be drawn: (1) Gunther barbed points first appeared at NFI in patterns already evolved elsewhere; (2) during the first few centuries of this use here (13-LAL), small broad straight-stemmed points with convex blades were popular. Also short tangs and square shoulders were made in about equal numbers. By about 500AD (14-MAL) the broad variety was abandoned and short tangs were produced with far greater frequency, as were serrated edges; (3) the classic variation was introduced to the site during its closing years--probably as a trade item because no prototype of this form was found in the preceding strata.

As adequate dates for the 15-UAL have not been obtained (Chapter 4), it is useful to review the radiocarbon dates of this variation from elsewhere. Two dates from house floors with these points at Salt Cave Locality fall around 1400AD[3] (Mack 1982), and Leonhardy (1967) has two dates from house floors likewise associated at 1415AD and 1440AD. Such points are also dated to 1480AD at Clikapudi Creek (Clewitt and Sundahl 1981). It seems reasonable to assume, therefore, that the 15-UAL is no older than 1400AD.

Diamond-Shaped Points

The term is taken from Treganza (1958) who used it to label a small collection of seven specimens from the Frank Pierce Site (Tri-58). NFI produced only one specimen (Fig. 13-381) from the 15-UAL, confirming that this is a late form generally found in association with Gunther barbed points.

Discussion: The Vertical Distribution of Point Types

The distribution of each type by stratum is given in Table 13-3. A brief inspection of these counts makes it painfully clear that very few types are restricted to any single part of the site's depositional history. The most convincing stratigraphic cluster is the Gunther Series at the top of the sequence, but these are not absolutely restricted to the Arrowhead Loams, there being a few in the 12-TSFL and even in the 11-USFL. As both the radiocarbon dates and OH dates have shown (Chapter 4), there has been some localized mixing across the Second Marker Horizon, so that this is to be expected. Churning across this horizon has not been so severe as to negate the stratigraphic integrity of the upper portion of the sequence, however, in spite of the fact that most of the human burials took place during this interval. As Hughes (1983, Chapter 5) has pointed out, the paucity of pit house floors in the Arrowhead Loams may have saved this part of the site from more drastic mixing.

This raises further questions about the validity of procedures for the three-part subdivision of the Arrowhead Loams. If the

Table 13-1

Tang attributes in Gunther Barbed Points (after Traganza, 1958)

	Long Tang	Short Tang	Square Shoulder	Broken
15-UAL	11	30	13	1
14-MAL	-	22	7	1
13-LAL	-	40	38	-

Table 13-2

Attribute Frequencies in Gunther Barbed Points through Time

	Total stems	Expanding stem %	Parallel stem %	Contracting stem %	Broken stem	Single Shoulder/ tang	Blade Serrations
15-UAL	38	6 (15.8)	26 (68.4)	6 (15.8)	18	1	19
14-MAL	25	4 (16.0)	16 (64.0)	5 (20.0)	6	1	5
13-LAL	82	13 (15.8)	52 (63.4)	17 (20.7)	10	3	6

12-TSFL/13-LAL subdivision is more or less acceptable, can the same be said for the 13-LAL/14-MAL and 14-MAL/15-LAL separations, in the light of such poor support form the radiocarbon and OH dates? Further inspection of Table 13-3 reveals that there has been no visible downward migration of Classic Gunther barbed points from the 15-UAL, but that there may have been some slight upward migration of Broad variation Gunthers from the 13-LAL. In the balance, it seems that the stratigraphic integrity of the 13-LAL to 15-UAL sequence holds up reasonably well. However, we should never lose sight of the fact that this "integrity" is itself the product of typological manipulations, as the point types define the strata. Because of this built-in tautology, the correlation remains somewhat tainted.

The other stratigraphic cluster of point types comprises those roughly made items in the lowermost four strata, i.e. the large notched points, unifaces, and the cf. ?Martis Corner-Notched points. While this cluster upholds the integrity of the 4-Mix/5-Scaup disconformity, they do nothing to support the internal subdivisions of the lowermost four waterfowl-rich clays. Although the latter subdivision draws some support from the radiocarbon dates, the OH readings bespeak quite thorough mixing of obsidian flakes across these boundaries. There are grounds for suspecting that some of the points from these strata may be mixed as well. The only circumstances under which the fuana and charcoal could be <u>in situ</u> while the obsidian items appeared to be out of context would be if obsidian was being frequently scavenged and recycled. This would of course result in the upward migration of older obsidian through the sequence, but there should be little or no downward migration of younger pieces.

More troublesome is the middle portion of the sequence (5-Scaup through 12-TSFL). The only point types restricted to this part are the Thick Narrow Unstemmed Points, Humboldts, and the Triangulars. Again, there is nothing in the point typology to justify the stratigraphic separations within the Loams sequence. Particularly disturbing is the failure of the Northern Side-Notched and Elko series to separate out along stratigraphic lines. It is axiomatic in Great Basin cultural/stratigraphic procedures that Elkos are later than NSN's--a relationship that has been demonstrated repeatedly. By rights, then, Elkos should not appear at the site until the 10-MSFL, yet they are present in the lowermost strata, and covary with the NSN's all through the sequence up to the 12-TSFL.

Hughes (Chapter 11; also 1983) has opted for a scenario in which the Loams have become so badly churned through house pit excavations that the two series are now totally mixed. Thus he takes all Elkos and NSN's from each stratum, regroups them, and refers thereafter to "NSN and Elko times" as the framework for further analysis. One important consequence of his assessment of the stratigraphy is that the faunal and pollen data become mixed as well as the points, thus rendering all the fluctuations, and their correlations with the bristlecone record, entirely spurious.

Not surprisingly, I must take issue with this view. While I have expressed doubts about the perfection of the correlation (Chapter 3) and concede that there must have been some localized mixing of layers in certain pits (Chapters 2 and 4), I am not persuaded that churning in the middle portion of the sequence is so bad that the stratigraphy can be dismissed altogether. Certainly, some projectile points must have moved from where they were originally dropped, but I do not believe that this applies to all of them, nor even to a majority of them.

If so, then why do the Elkos and NSNs overlap? First, I do not believe that the NSN/Elko dichotomy necessarily applies in the Lower Klamath area in the same clear-cut way that it appears to apply in the Great Basin. Serious problems arise over the correct way to separate the two series on typological grounds in the Lower Klamath Basin, because so many of the NSNs are "too small" to properly fit the original definitions. Given the data at hand, there is every reason

Table 13-3 <u>Distribution of Projectile Point Types</u>

	Gold Hill Leaf	Small Foliate	Thick Narrow Unstemmed	Parman #2	Humbolt	Cottonwood Triangular	Triangular blanks	Northern Side Notch	Siskiyou Side Notch	Elko (Hogup) Side Notch	Elko (South Fork) Side Notch	Elko (Round Based) Side Notch	Rose Spring Round Stem
15-UAL	2	–	–	–	–	–	–	–	1	–	–	–	–
14-MAL	–	1	–	–	–	–	–	–	2	–	–	–	1
	2												
13-LAL	8	4	–	–	2	–	–	1	3	–	1	–	1
					1								
12-TSFL	12	7	4	–	–	–	1	–	–	–	–	1	3
				1					1				
11-USFL	30	18	8	–	4	6	1	1	9	1	1	10	4
												1	
10-MSFL	8	35	9	–	8	3	4	17	16	3	–	5	6
9-LSFL	9	10	4	–	4	5	1	13	15	1	1	2	1
8-LFL	2	2	1	1	4	1	4	11	10	4	–	4	–
7-GraCl	5	1	–	–	–	–	1	–	–	1	–	–	–
6-S&B	10	6	–	–	3	–	4	5	5	7	–	7	2
5-Scaup	11	–	1	1	1	–	–	1	1	7	–	5	–
4-Mix	2	–	–	–	–	–	–	1	–	–	–	–	–
3-Grebe	3	–	–	1	–	–	–	1?	–	–	–	–	–
2-Coot	1	–	–	1	–	–	–	1?	–	–	–	1	–
1-Basal	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 13-3 (Continued)

	Rose Spring Side Notch	Side Notch Type A	Side Notch Type B	Side Notch Type C	Side Notch Type D	Rose Spring Corner Notch	Elko Corner Notch	Elko C.N. small	Elko Eared	Type D Eared	Large Stemmed
15-UAL	1	-	-	-	-	1	-	-	-	-	-
14-MAL	1	-	-	-	-	1	-	-	-	-	-
13-LAL	4	-	-	-	-	6	2	-	7	1	3
12-TSFL	4	-	-	-	-	1	3	-	4	2	-
11-USFL	15	3	3	1	-	13	21	-	10	7	-
10-MSFL	17	2	9	1	-	19	19	4	18	4	5
9-LSFL	23	3	6	2	-	9	13	25	20	-	3
8-LFL	2	1	-	1	-	1	4	2	6	1	-
7-GraCl	-	1	-	-	-	-	1	-	1	-	-
6-S&B	-	1	-	-	-	-	8	1	2	3	3
5-Scaup	-	2	-	-	-	1	4	2	1	-	1
4-Mix	-	-	-	-	-	-	-	-	1	-	-
3-Grebe	-	-	-	-	1	-	3	-	1	-	-
2-Coot	-	-	-	-	-	-	-	-	1	-	-
1-Basal	-	-	-	-	-	-	1	-	-	-	-

Table 13-3 (Continued)

	Pinto Square Shoulder	Rose Spring Contrac-ting Stem	Rose Spring Single Shoulder	Surprise Valley Split Stem	Double Notch Points	Large Notch Points	Uni-facial Points	?Martis Corner Notch	Gunther Classic var.	Gunther Broad var.	Gunther Other var.	Diamond shaped points
15-UAL	-	1	-	1	-	-	-	-	11	1	44	1
14-MAL	-	3	-	-	-	-	-	-	-	1	30	-
13-LAL	-	4	-	-	-	-	-	-	-	14	78	-
12-TSFL	-	4	-	-	1	-	-	-	-	-	4	-
11-USFL	-	9	4	1	2	-	-	-	-	-	6	-
10-MSFL	-	2	2	-	-	-	-	-	-	-	-	-
9-LSFL	1	2	-	-	2	-	-	-	-	-	-	-
8-LFL	-	-	1	1	-	-	-	-	-	-	-	-
7-GraCl	-	-	-	-	1	-	-	-	-	-	-	-
6-S&B	-	1	-	-	-	-	-	-	-	-	-	-
5-Scaup	-	-	-	-	-	-	-	-	-	-	-	-
4-Mix	-	-	-	-	-	4	-	-	-	-	-	-
3-Grebe	-	-	-	-	-	3	11	4	-	-	-	-
2-Coot	-	1?	-	-	-	2	7	2	-	-	-	-
1-Basal	-	-	-	-	-	1	-	-	-	-	-	-

to suppose that a diminutive NSN-like point persisted in the Lower Klamath region long after it had disappeared in the Great Basin. Under these circumstances, the presence of NSN's in the Nightfire Island sequence during "Elko times" (i.e. the 10-MSFL through 12-TSFL) need not be construed as stratigraphic mixing. Likewise, several of the Elko specimens have been forced into this category although they are "too narrow" to conform exactly with published illustrations (see above). These could fit equally well with the definition of the Tucannon Point from the Plateau (Leonhardy and Rice, 1970) and several others would fit into the earlier range of the Harder Phase of the Plateau[4]. Had I opted for a Plateau typological framework for the analysis, then most of the Elkos seen to be present at Nightfire Island in "NSN times" would have been eliminated. Thus there are reasons to suppose that the site may have been linked to Plateau cultural-stratigraphic events, and not necessarily to the NSN-to-Elko event of the Great Basin. Consequently, the presence of Elko-like specimens in the lower strata of the NFI sequence cannot be automatically dismissed as evidence of stratigraphic mixing.

My second line of argument in defense of the site's stratigraphic integrity concerns covariance in the size of the NSN's and Elkos through time at Nightfire Island. Fig. 13-39 shows the percentage fluctuations of seven lumped categories of projectile points by stratum. To circumvent the controversies over definitions and labels, the NSN's and various Elko Side-Notched categories are combined as "Side Notched--large" and the Elko Eared and Corner-Notched points are lumped as "Corner Notched--large". A brief inspection of the diagram reveals that large side-notched points diminish in frequency between the 8-LFL and 9-LSFL, i.e. across the First Marker Horizon. Increases in large corner-notched points across the same boundary are too slight to be of any consequence, however. When both large and small specimens of each category are combined, then it becomes apparent that corner-notched points do indeed increase and side-notched points decrease in the 9-LSFL. While it is tempting to suppose that this change echoes the NSN-to-Elko change of the Great Basin, nothing more can be done with the comparison without a great deal more field research.

More compelling is the comparison of ratios of large to small points in each of the two categories. Within both the Side- Notched and Corner-Notched blocks of the diagram in Fig. 13-39, the small types increase from the 8-LFL to the 9-LSFL, decrease again in the 10-MSFL, again in the 11-USFL, and once again in the 12-TSFL. The large types show only slight decreases in frequency from the 9-LSFL to the 12-TSFL. I am persuaded that these parallel trends in the sizes of the two categories must be real and could not have come about as the result of severe stratigraphic mixing.

At this stage of archaeological research in the Klamath Basin, I am not yet ready to sacrifice the stratigraphic integrity of the NFI sequence in the interests of imposing a cultural-stratigraphic shibboleth from the Great Basin. When the NSN/Elko dichotomy is unambiguously demonstrated at another Lower Klamath Basin site, I will happily entertain the rejection of the Loams sequence. Meanwhile, it appears to me that Hughes has been overly manipulative in his rearrangement of specimens from the sequence. Consequently, his conclusions do not match the data presented in Table 11-6 which is open to alternative interpretations. These will be addressed in Chapter 21. I hasten to add, however, that his foray into the complexities of the Loams stratigraphy is entirely welcome as it has forced me to clarify my own thinking about this troublesome topic.

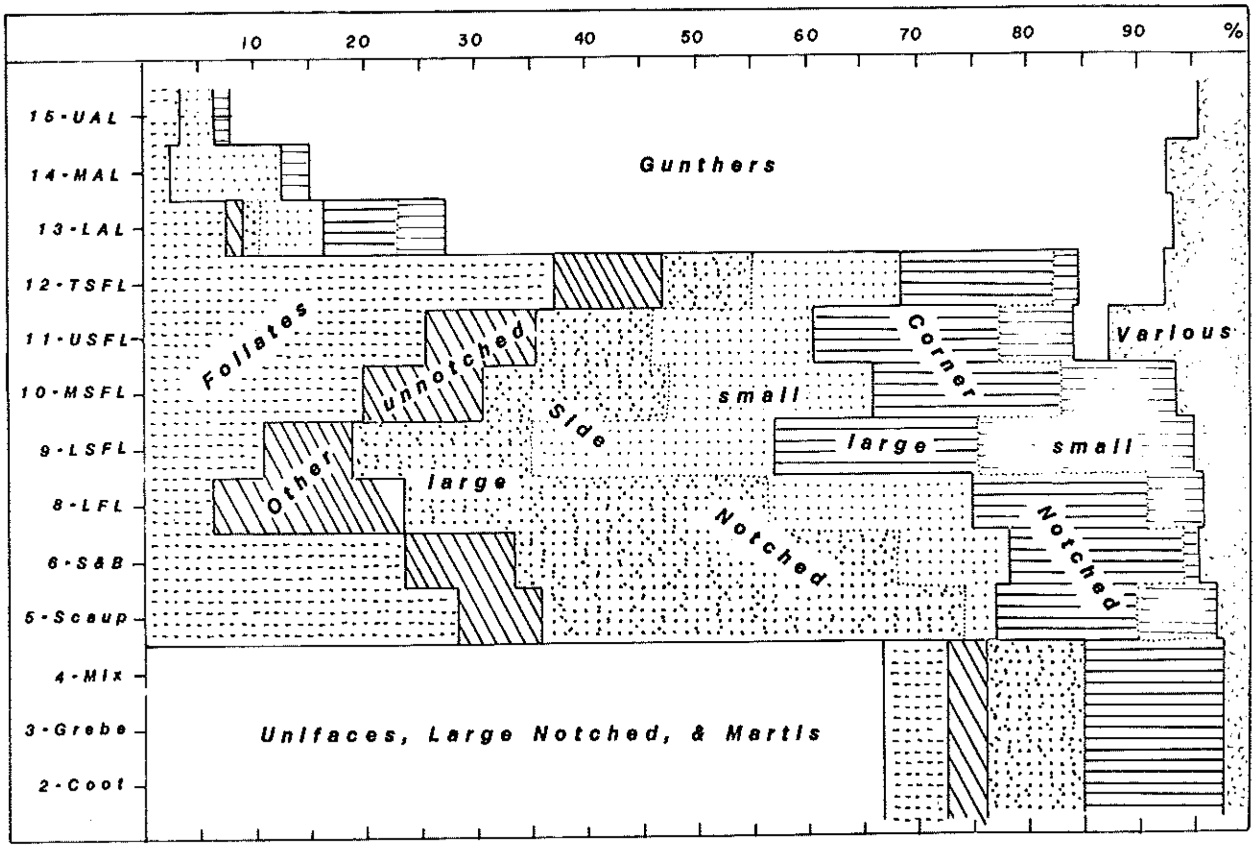

Fig. 13-39 Percentage frequencies by stratum of simplified categories of projectile points. Foliates include Gold Hill Leaf Points plus Small Foliate Points; Other unnotched includes the Thick Narrow Unstemmed, Parmans, Humboldts, and Triangulars; Side Notched - large includes all side-notched points except the Siskiyou and Rose Spring types; Side Notched - small includes the Siskiyou and Rose Spring types only; Corner Notched - large includes the Elko Corner-Nothced, Elko Eared and Type D Eared; Corner Notched - small includes the Rose Spring Corner-Notched, and small Elko Corner-Notched Points. The samples from 1-Basal through 4-Mix have been combined.

ENDNOTES: CHAPTER THIRTEEN

1. The acronym NFI will be used for Nightfire Island throughout this chapter. It should be noted that at the time that this analysis was conducted (Early 1979), I depended heavily on the definitions of Heizer and Hester (1978), and was not aware of the importance of Thomas's Key which led later to its widespread use, especially in its refined versions (Thomas 1981, 1983).

2. I have been hesitant to apply their criteria here, for want of enough illustrated examples of each of the varieties.

3. Dates quoted here are calibrated.

4. I value the advice of W. L. Singleton, whose firsthand knowledge of these materials allowed him to draw comparisons with illustrated specimens from Nightfire Island.

CHAPTER FOURTEEN

OTHER FLAKED STONE TOOLS

Included in this chapter are descriptions of all flaked stone tools other than projectile points. These comprise the bifacial knives, drills, saws and the large residue of miscellaneous retouched pieces under which various scraper types are subsumed.

'Dance' Knives

Very large bipointed obsidian knives were used in what Kroeber (1925) called "dances of wealth display" among the tribes of the downstream reaches of Klamath River in the late 19th century. Large black obsidian knives between 20cm and 65cm long, and somewhat shorter specimens of red obsidian were brandished in the White Deerskin Dance along with other regalia by the Yurok (Kroeber 1925:26-7), Karok (e.g. Howe 1979:72), Hupa (Powers 1877; Goddard 1903-4), Wiyot, and Tolowa (Hughes 1978). Although the dance was not recorded for the Shasta, it is possible that some of the knives purchased by Rust (1905) came from Shasta villages in 1898. However, Spier (1930:173) stated categorically that they were not used by the Klamath, and Barrett (1910:252) emphasized that large stone knives were no longer in use by the Modoc in 1907.

Their reported absence from the upstream tribes of the Klamath River drainage is of interest because specimens have been found in the territories of the Shasta, Modoc, Klamath and Achomawi (Howe 1968). Kroeber (1925:418) also mentioned a specimen from the territory of the Maidu to the south of the Achomawi, but he suggested that this was a part of a shaman's paraphernalia rather than a dance knife. Mention of large bipointed knives cannot be found in the literature on tribes to the south of the Maidu.

Prehistoric use of this implement in Modoc territory is demonstrated at Nightfire Island. End fragments of two dance knives were recovered from the 15-UAL in X1 (Fig. 14-1). Both were made of red-brown obsidian with black streaks in a distinctive patterning peculiar to many dance knives of known ethnographic contexts. The flow-pattern reflected in the streaks indicates that the two ends could not have come from the same specimen. Both knives were of the smaller variety, about 20-30cm long.

Fragments from the mid-section of a large black obsidian dance knife were recovered by Mr. C. B. Howe from the area south of Pit U (Fig. 14-2). They came from a thin rubble relatively deep in the deposit, but the provenience remains uncertain. All were heat-crazed and spalled and may have come from a small crematory used at the south end of the site in 15-UAL times (see Chapter 19). The original must have been at least 40cm long. Several burned dance-knife fragments from Modoc crematories are housed in the Klamath County Museum (Howe 1968) suggesting that the dance knife was sometimes considered as personal property (to be destroyed at death). This practice conflicts with the pattern reported for the downstream Yurok and Hupa who placed great value on dance knives as family heirlooms. Rust (1905) reported that the greatest care was taken not to drop them accidentally; they were hidden in secret places, wrapped in barkcloth and handled during the dance only when attached to the wrist by a loop of cloth. Breakage must have been considered a major calamity. At least some of these attitudes also pertained in the territories of the upstream tribes using dance knives in prehistoric times. One complete specimen (Howe 1979:Fig. 185) about 20cm was recovered from the NOUT area of Nightfire Island. This has two shallow notches on opposite edges midway along the specimen, to facilitate suspension by a thong,

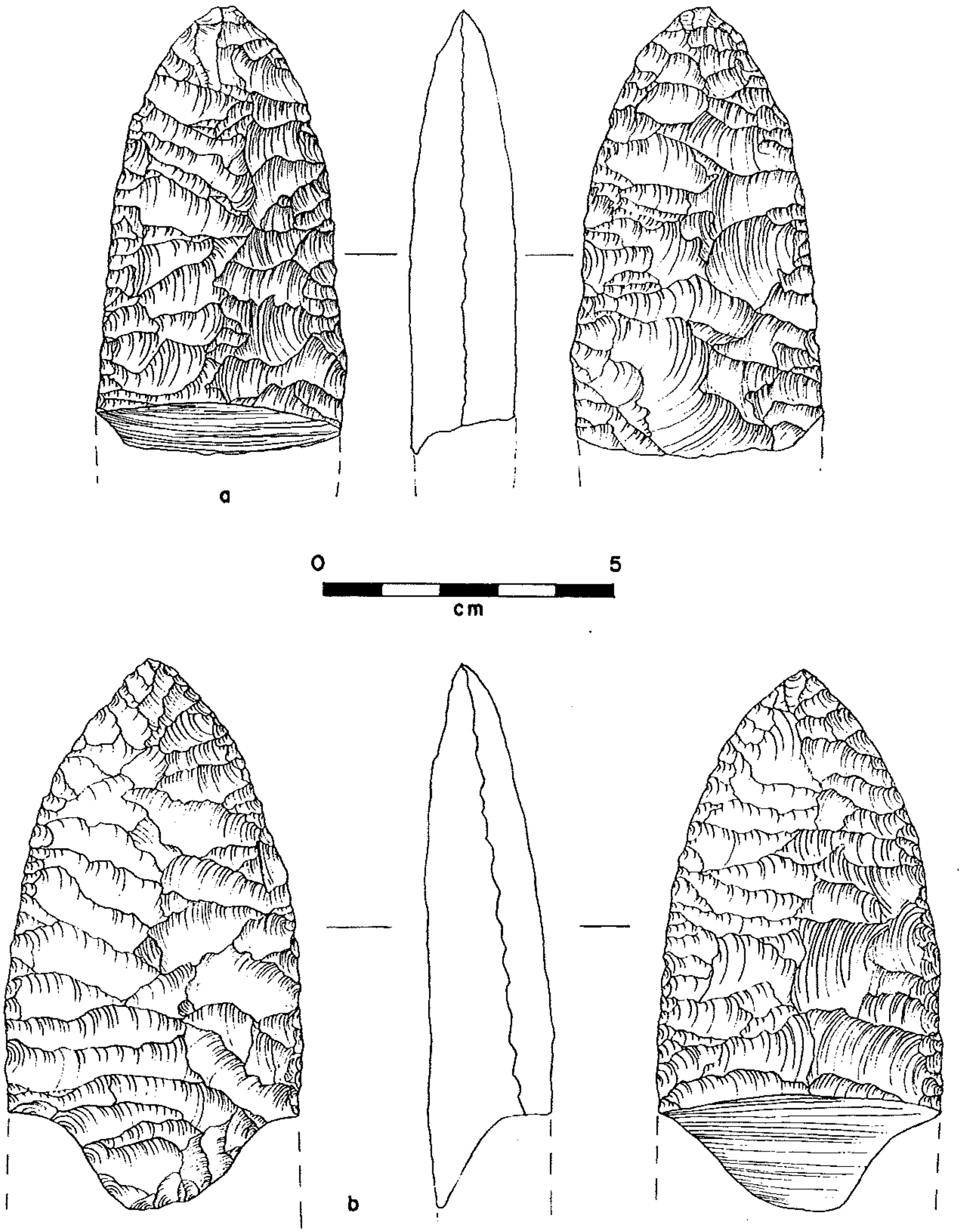

Fig. 14-1 (ab) End fragments of two "dance" knives of reddish-brown obsidian with black flow streaks. Both from the 15-UAL in X1.

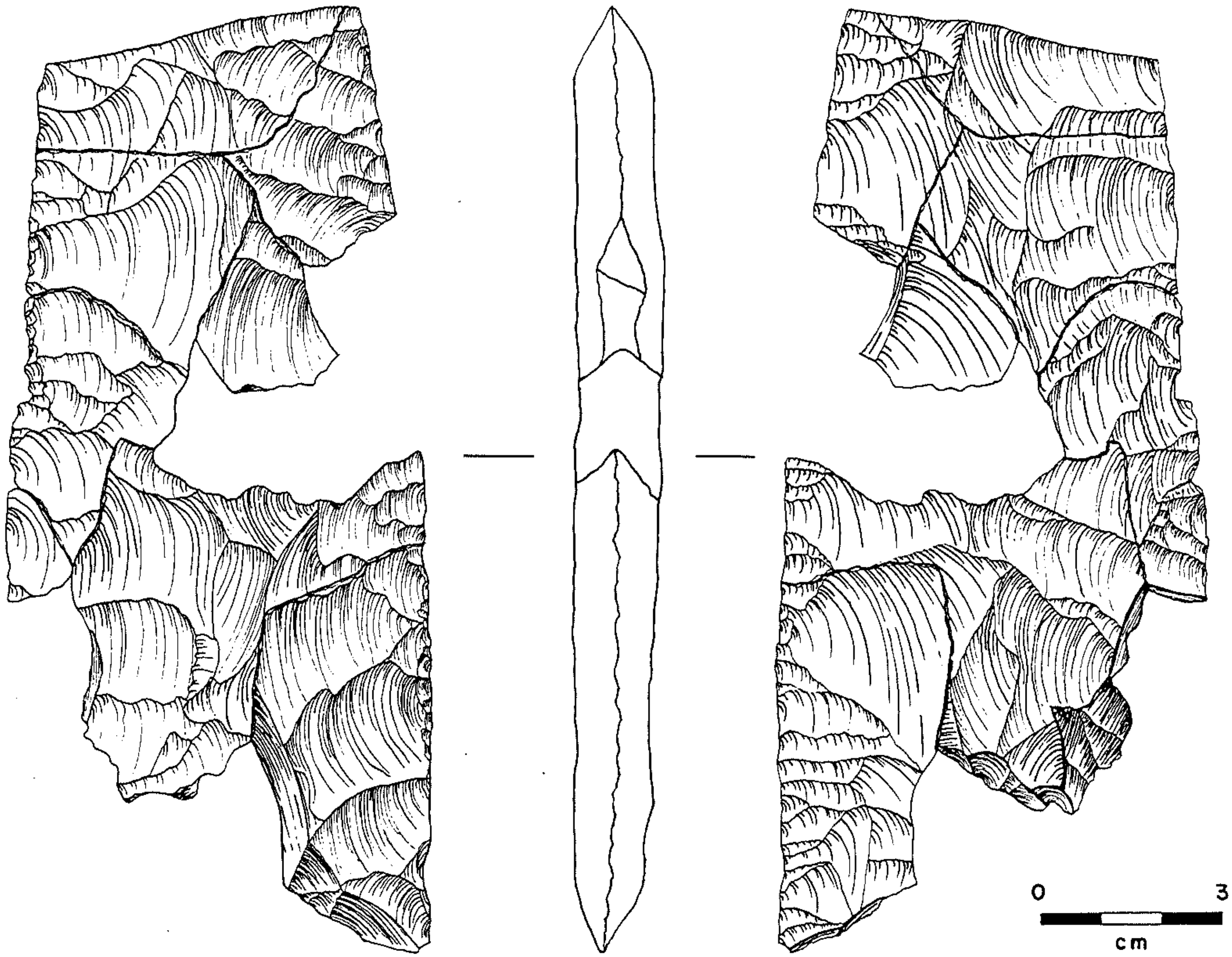

Fig. 14-2 Fire-cracked black obsidian fragments refitted to form part of the mid-section of a very large "dance" knife. Recovered by C.B. Howe from south of Pit U, probably from a cremation in the 15-UAL.

recalling the Maidu specimen described by Kroeber (1925). Also, Howe (1968) lists a series of discovered knife caches (some of them marked) from surrounding territories, indicating the use of secret hiding places.

Two other mid-section fragments of large black obsidian specimens in the 30-40cm length range were recovered by Howe in the NOUT area. One unburned specimen yielded an obsidian hydration rind of 1.5u (L. R. Kittleman pers. comm.), suggesting a 15-UAL context.

Thus, the accumulated evidence favors a 15-UAL date for the introduction of the dance knife to Nightfire Island. There is a strong possibility that the manufacture of the red dance knife only became possible after the formation of a suitable obsidian flow, with red obsidian boulders large enough to provide suitable blade blanks. Although this may go some way to explain the appearance of red dance knives in the Klamath Basin and adjacent valleys, it is of no help in explaining the disappearance of its manufacture and use before white contact. A future project aimed at source tracking and hydration dating museum specimens along the line of Hughes (1978), would no doubt serve to widen our understanding of the life history of this impressive implement and possibly of its accompanying rituals.

Other Knives

Large bifacially worked obsidian pieces with shapes differing from the dance knife form, yet too large to be classified as Gold Hill Points, are combined in this category. While it is recognized that some of the largest specimens placed in the Gold Hill category (esp. Figs. 13-4af, 13-5h, 13-6j, and 13-9e) would be called knives by some typologists, they were excluded from this category either because they were bipointed (Figs. 13-5h and 13-9e) or because they were rough-out fragments which, if finished, would have been reduced to Gold Hill dimensions.

Few specimens were recovered from the controlled excavations. The earliest is a fragment resulting from a manufacturing break (Fig. 14-3a) found in the 8-LFL at F2b. The next oldest is an apparently snapped and reused blade (Fig. 14-4f) found among the burned poles of a collapsed house structure in the 11-USFL of E4b (see Fig. 18-8). The next in sequence is an unfinished specimen on a pointed flake blank of the same red-brown obsidian used to make the dance knives in Fig. 14-1; this specimen was found in the 14-MAL at Q2 (or 3). Also from the 14-MAL (or possibly 13-LAL) is the seemingly unfinished knife (Fig. 14-3c) found in layer 2 of Pit E. Last in sequence is the finely finished midsection (Fig. 14-3b) from the 15-UAL at V1b.

These last two specimens conform to descriptions of knives used either in lesser dances or by poorer families in one of the great status dances performed by the downstream tribes mentioned above. Such smaller knives were hafted on short handles. However, the function of these need not have been restricted to rituals, as bifacial knives were used for skinning and butchering (Spier 1930:173) and as short javelin points in warfare (Barrett 1910:246). We may tentatively conclude that this functional knife has a longer history at Nightfire Island than the larger ritual form, but there are no knives predating the 8-LFL[1]. Howe recovered several complete specimens (1979:Figs. 67, 68) without clear stratigraphic provenience, plus three other complete specimens (1979:Fig. 74) from a crematory to the west of the site, which could date the 15-UAL (Chapter 19).

Large Biface

A massive roughout on a flat obsidian slab (Fig. 14-5) was recovered by C. B. Howe in the lake bed, and its provenience has been

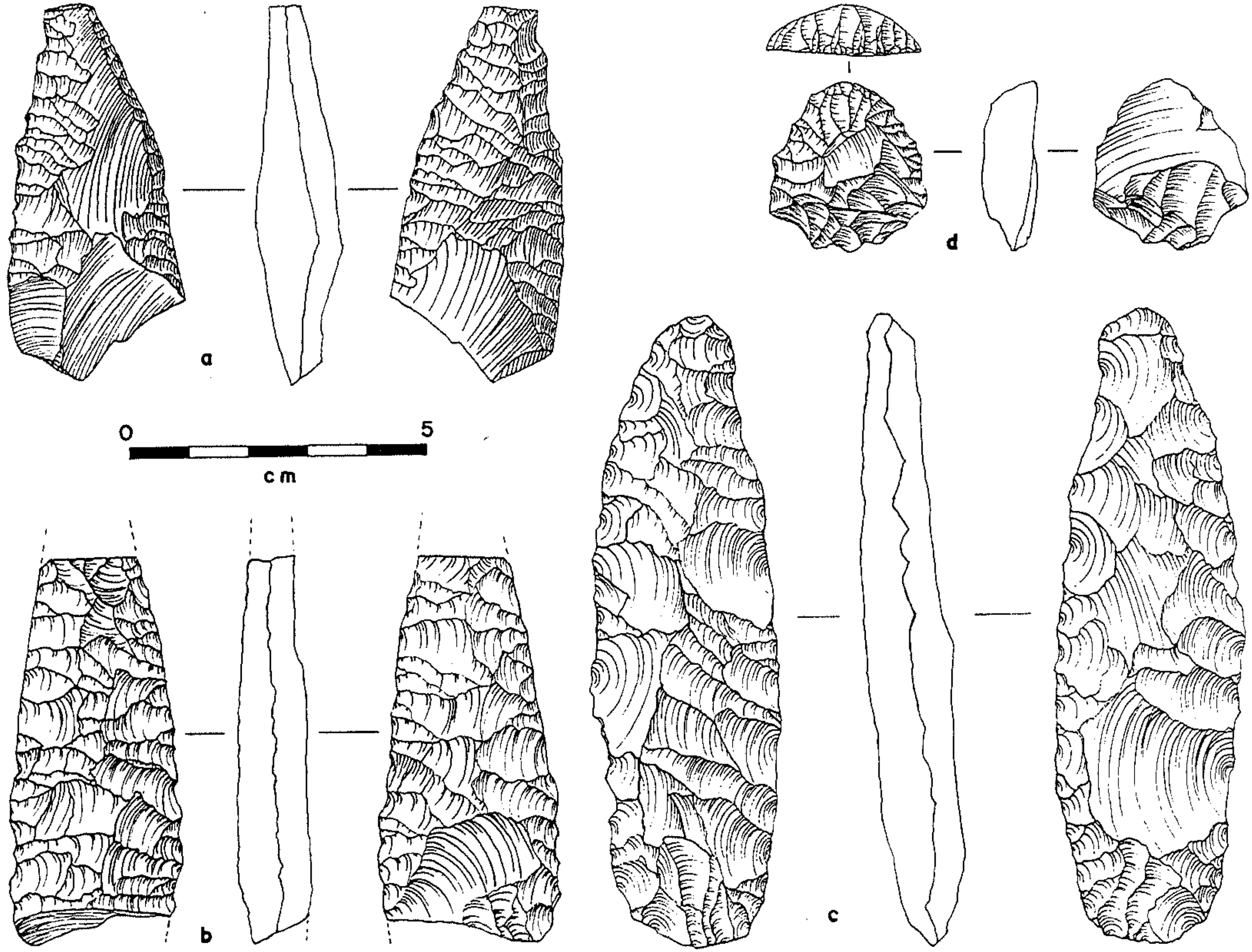

Fig. 14-3 (a) Unfinished tip fragment of a knife, 8-LFL in T5b; (b) mid-section of a knife, 15-UAL in V1b; (c) unfinished (?) knife, 13-LAL or 14-MAL in E2; (d) convex scraper with bulbar thinning, 9-LSFL in J5c. All obsidian.

confirmed by an OH rind of 4.6u (L. R. Kittleman pers. comm.). This is the only specimen of its kind recovered at the site. Its size and shape suggests that it was a very rough preform for a large biface blade which, if completed from this blank, would be more than 15cm long. Black obsidian boulders large enough to provide material for such blades were available, therefore, by the time that Nightfire Island was first occupied. The source of this piece has not been determined, however.

Drills

Remarkably few drills were recovered from the controlled excavations, given the abundance of flaked stone artifacts in the site. Their proveniences are listed in Table 14-1. Many are best described as unusually thick-sectioned side-notched points (e.g. Fig. 14-4b-e). All but two specimens have snapped tips and none has the heavy rotary grinding seen on several specimens recovered by C. B. Howe (e.g., Fig. 14-4a). Only one specimen (from O2) has a well developed flared base, and two have no side notches at all. The proportions are reflected in Howe's somewhat larger collection (1979:231-3) without stratigraphic provenience. These specimens may have served for drilling of beads, bone or pipes, but it seems reasonable to conclude that these activities were not a major industry at the site.

Serrated Cutting Tools

Thin slivers of basalt with natural sharp edges were occasionally used for cutting. The edges of some specimens were delicately serrated to achieve a saw-like edge (Fig. 14-6abcd). Minimal shaping was applied to the rest of the sliver (e.g. Fig. 14-6c). Only four specimens were recovered from the 3-Grebe and 5-Scaup.

Saw

The mid-section of a long narrow saw blade of thin tabular chert (Fig. 14-6e) was found in the 10-MSFL (or 11-USFL) of W1-2. Both parallel edges of the thin tabular piece were delicately trimmed to achieve a saw-tooth edge. Both the edge and the ridges between flake scars have been worn smooth by use-wear.

Retouched Flakes and Fragments

Table 14-2 demonstrates that most flakes and broken flake fragments at Nightfire Island display some form of retouch and/or edge damage. Furthermore, the frequency of apparently unaltered pieces varies very little from one stratum to the next--between 15% and 25%. The possibility that even these were used cannot be ruled out. Microwear analysis of the unaltered edges was judged to be unfeasible on this collection, without replication experiments in order to develop control samples. Such samples would be needed to identify wear-patterns associated with non-human edge-damage--particularly post-depositional treadage under foot by the prehistoric villagers, and box-damage during transport and handling of the collection. As most of the specimens are obsidian, the edges are especially prone to these effects. The existing collections are not ideally suited to microwear studies, which were beyond the scope and budget of this project.

Given the distance that obsidian had to be carried to the site (see Chapter 11) and given that the processing of tule reeds and

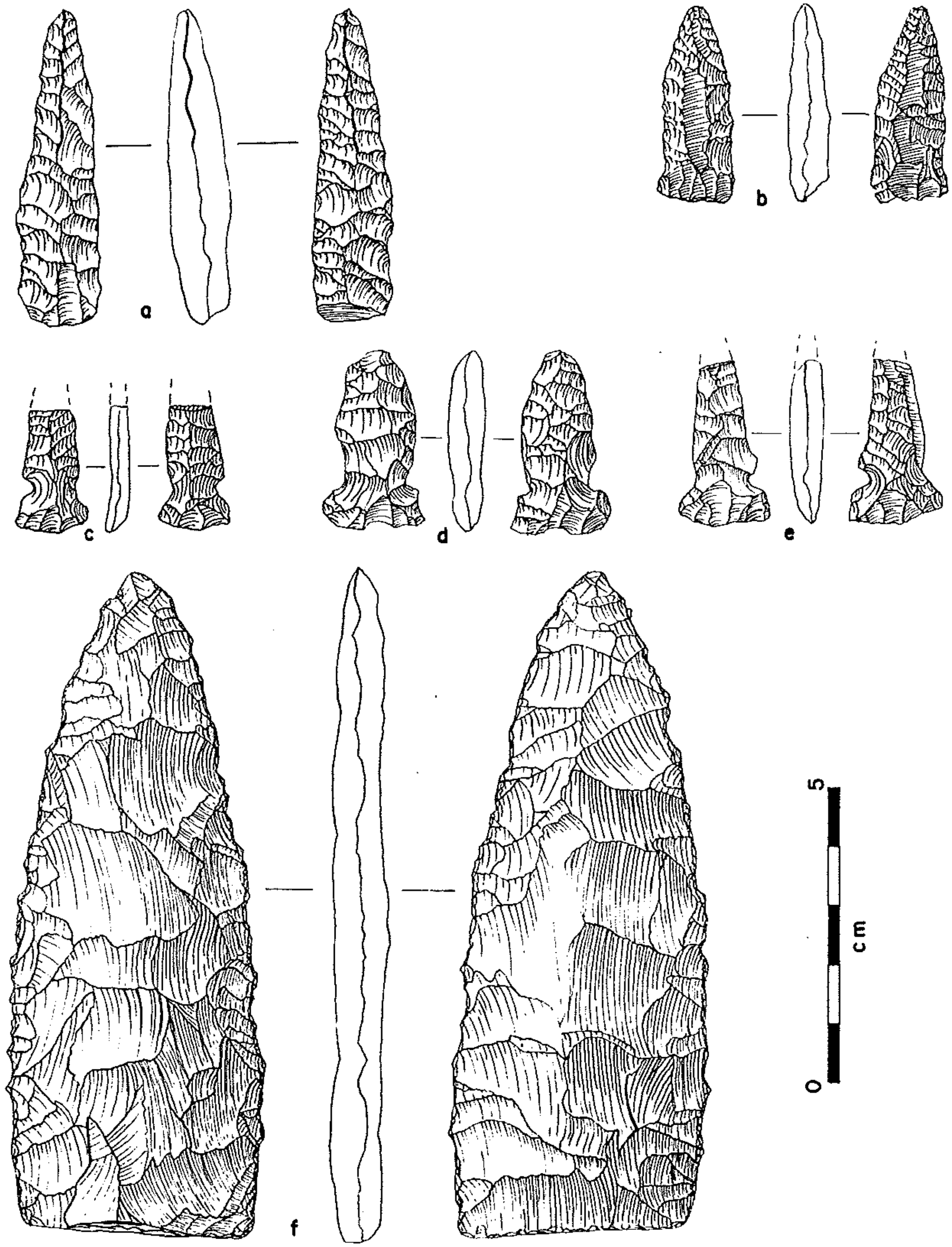

Fig. 14-4 (a-e) Drills: (a) ridge abrasion on four edges, C.B. Howe collection; (b) 8-LFL in H3e; (c) 2-Coot in I7a; (de) 10-MSFL in Q6; (f) large knife, with burned house structure (see Fig. 18-9) in E4b. All obsidian.

Table 14-1

Provenience of obsidian drills at Nightfire Island

Stratum	E	H	I	N	O	Q	R	S	T	U	V	W
13-LAL	-	-	-	-	-	-	-	-	1	-	-	-
12-TSFL	-	-	-	-	-	-	1-2a	-	-	-	-	-
11-USFL	4	-	-	-	-	3c	-	-	-	-	-	-
10-MSFL	-	3c	7a	-	-	6	-	-	-	-	-	-
9-LSFL	-	-	-	-	2	-	-	4a	-	-	4	3
6-S&B	-	-	8	-	-	-	-	-	-	-	-	-
4-Mix	-	-	-	7a	-	-	-	-	-	-	-	-
5-Scaup	-	-	-	-	-	-	-	-	-	4b	-	-

Note: One specimen in each of the above layers, except Q6 with two.

Table 14-2

Frequency of retouched pieces and unaltered flakes by stratum

Stratum	Unaltered Pieces no.	%	Misc. Retouch no.	%	Flake Knives no.	%	Side-Scrapers no.	%	Steep Scrapers no.	%	End-Scrapers no.	%	Totals no.	%
15-UAL	63	23.8	181	68.3	7	2.6	11	4.1	2	0.8	1	0.4	265	100
14-MAL	30	17.1	136	77.7	2	1.1	7	4.0					175	99.9
13-LAL	84	18.1	363	78.2	6	1.3	11	2.3					464	99.9
12-TSFL	22	21.5	76	74.5	2	2.0	2	2.0					102	100
11-USFL	228	25.4	637	71.0	9	1.0	19	2.1	2	0.2	2	0.2	897	99.9
10-MSFL	326	21.1	1143	73.9	38	2.4	37	2.4			1	0.1	1545	99.9
9-LSFL	191	16.0	940	78.8	12	1.0	44	3.7	3	0.3	2	0.2	1192	100
8-LFL	110	20.5	384	71.6	17	3.2	25	4.7					536	100
7-GraCl	9		31		5		8						53	
6-S&B	58	15.2	295	77.4	18	4.7	10	2.6					381	99.9
5-Scaup	42	16.2	205	79.1	3	1.1	8	3.1	1	0.4			259	99.9
4-Mix	11		45		1		3						60	
3-Grebe	14	9.1	123	79.8	2	1.3	9	5.8	6	3.9			154	99.9
2-Coot	22		48		4		3		3				80	
1-Basal	13		47				1						61	
Lake Bed	2		52		1		4		1				60	

cattails were the predominant manufacturing activities of the historic Modoc (Barrett 1910; Gatschet 1890; Spier 1930), it is hardly surprising that almost every available sharp-edged stone was used, resharpened and reused wherever possible. If the Nightfire Island occupants ever shaped formal stone tools for cutting, chopping, pulping, shredding or whittling, the original shapes are no longer apparent. Most pieces have some form of damage on every available edge, including the margins of snap facets. Evidently, many tools were deliberately broken to generate extra snap-edges useful for the shredding and processing of tule, bullrush and other plant fibres, for the manufacture of cordage.

It follows that any typological subdivision of this material is now difficult to achieve. Only rare pieces which were abandoned or lost early in their individual life histories have escaped the breakage and loss of their original form, and these are understandably few in number. Among the pieces more likely to survive were cutting tools on relatively large obsidian flakes labeled "flake knives" in Table 14-2. Apart from their overall size and the presence of a convenient grip, specimens in this category have little else in common and specific, patterned trimming is conspicuously absent. A slightly used example is shown in Fig. 14-7d together with a more typical example (Fig. 17-7c) which has gone through so many stages of use, breakage, and refurbishing as to be scarcely recognizable. No doubt this was a general purpose implement which could have been applied to whatever work was at hand, including butchery, woodwork, bonework and reed processing. Edges were adjusted according to need, and the present edge configuration of a piece probably reflects a complex overlay of different tasks of the moment. Thus, the piece in Fig. 14-7c may have started life as a skinning knife, and ended as a spoke-shave.

Other original shape categories which may have accidentally survived the reduction process are "sidescrapers" (e.g. Fig. 14-7b), "steep scrapers" (e.g. Fig. 14-7a) and "endscrapers" (e.g. Fig. 14-3d). None of these categories shows any significant changes in frequency through time--hardly surprising given the small numbers involved. The overwhelming proportion of retouched pieces has no shared morphological patterning which may be construed as the result of deliberate shaping. Furthermore, the kinds of edge-damage and their positions on various edges appears to be without any visible patterns. These have been lumped together, therefore, under the heading "retouched pieces" in Table 14-2.

All that can be learned from these figures is that obsidian continued to be used intensively throughout the sites' occupational history. Breakage of individual pieces was intensified in 9-LSFL times (Chapter 12) to achieve more cutting edge per weight of obsidian, and this response was sufficient to fill the needs of the inhabitants. No other changes in tool shaping strategies are apparent.

ENDNOTES: CHAPTER FOURTEEN

1. Unless the borderline Gold Hill fragments from the 2-Coot (Fig. 13-4a) and the 5-Scaup (Fig. 13-4f) are admitted to this category.

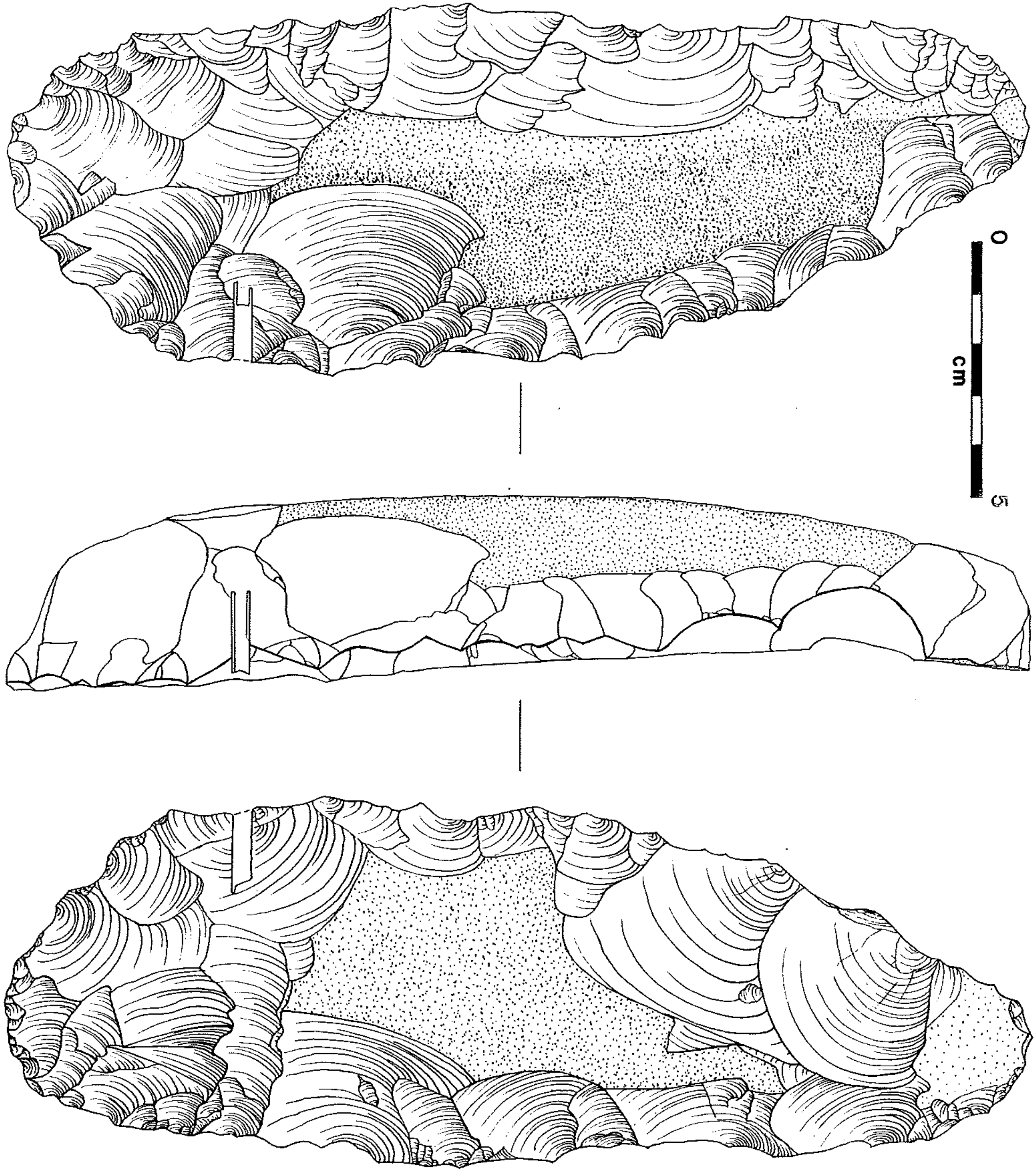

Fig. 14-5 Large bifacial roughout from the Lake Bed. OH rind thickness 4.6μ. C.B. Howe collection.

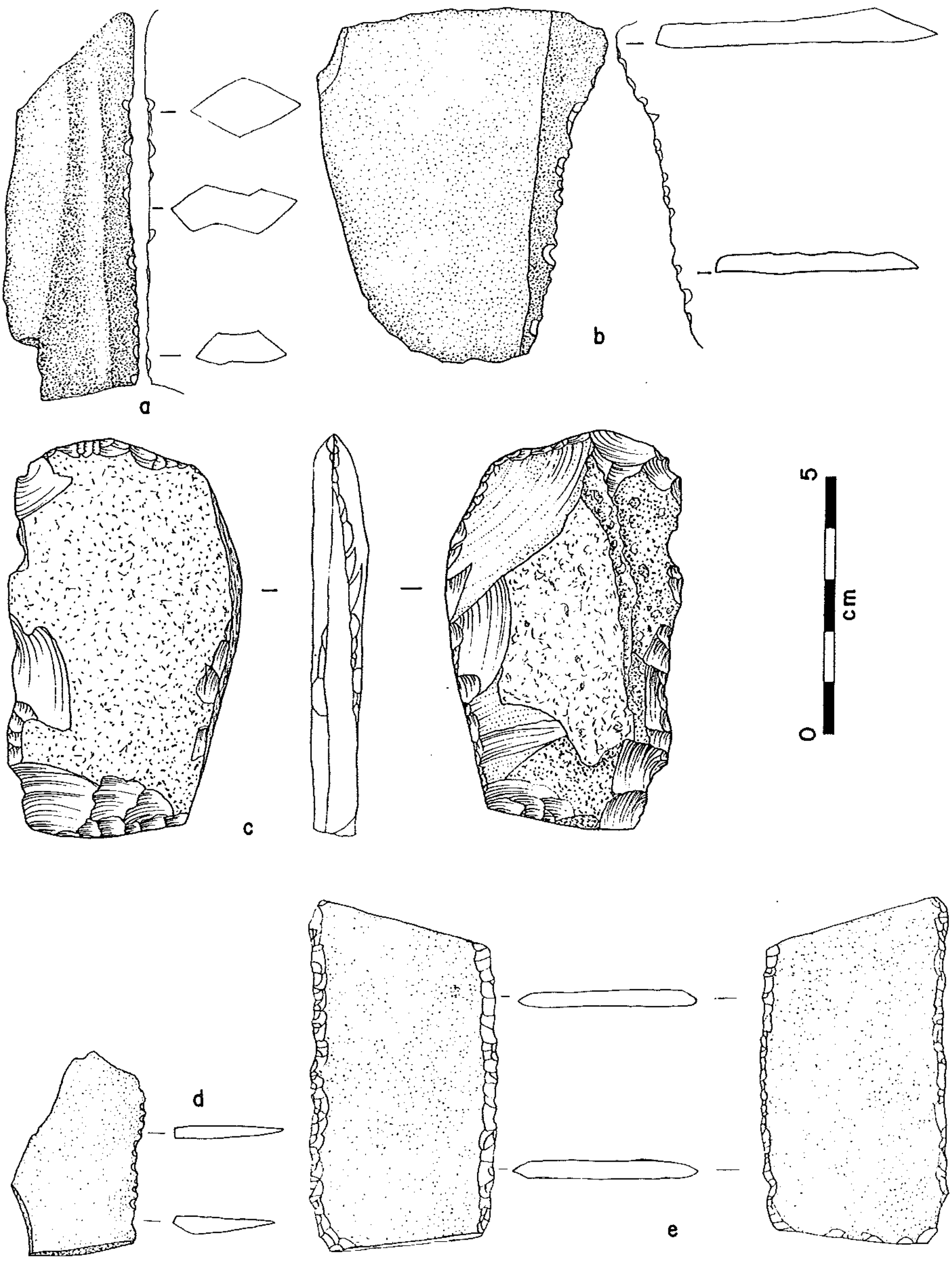

Fig. 14-6 (a-d) Serrated cutting tools on basalt slivers: (a) 5-Scaup in I10; (b) 3-Grebe in T5d; (c) 3-Grebe in X8; (d) 5-Scaup in U4b; (e) Saw on tabular chert, 10-MSFL or 11-USFL in W1-2.

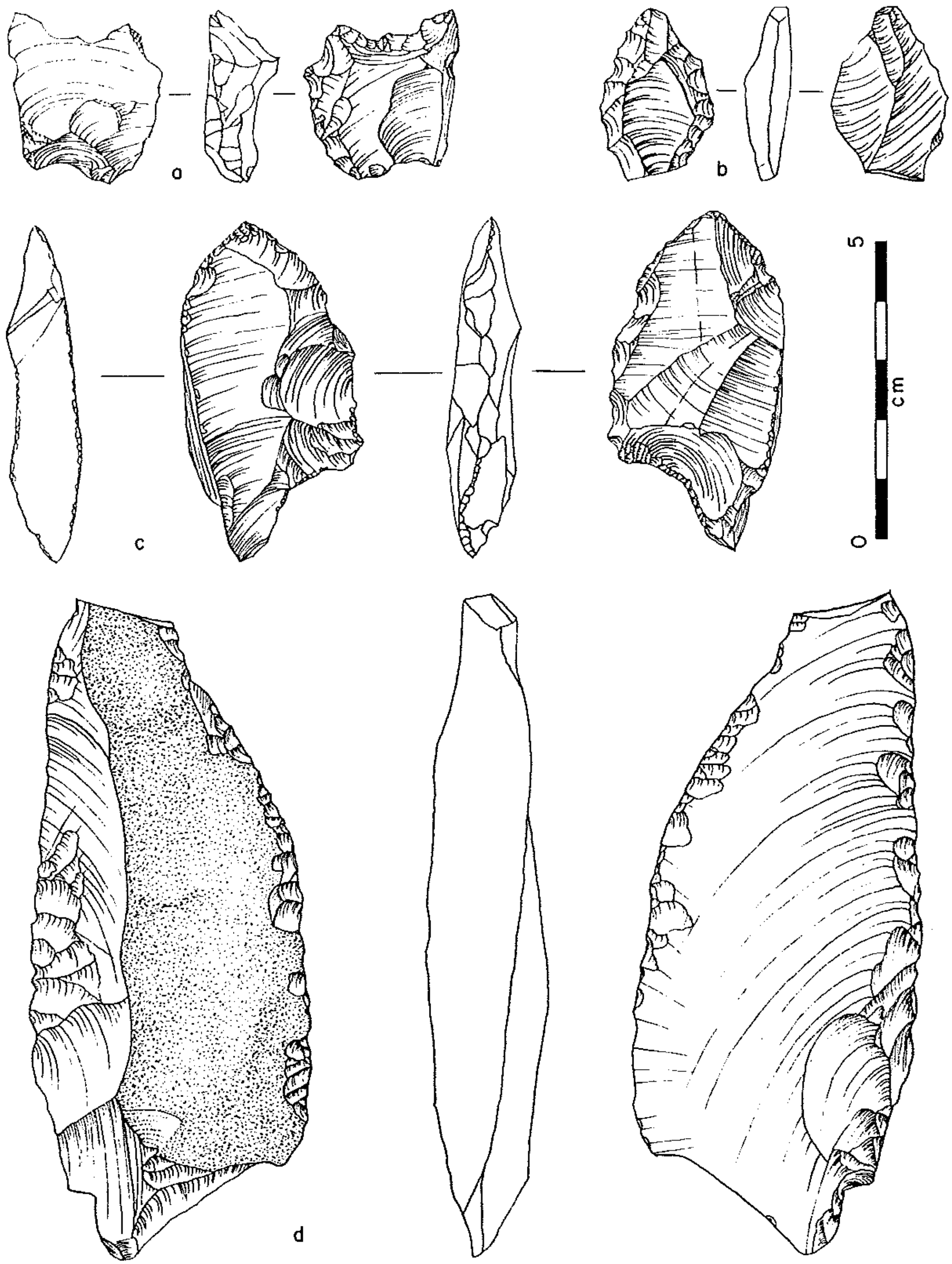

Fig. 14-7 Retouched pieces: (a) steep scraper, 11-USFL in E4b; (b) sidescraper 13-LAL in V2-3; (c) Flake knife, extensively altered, 14-MAL in A1-4; (d) Flake knife, slightly altered, 13-LAL in E2b. All obsidian.

CHAPTER FIFTEEN

BONE AND ANTLER ARTIFACTS

With few exceptions, worked bone and antler is restricted to the Loams sequence of strata. In the 8-LFL, four categories of equipment made their first appearance at the site: antler wedges and/or hide-working tools, large spatulate awls of bone or antler, irregular bone awls, and fine point-awls of birdbone. These four pieces of equipment continued to be made and used throughout the subsequent history of the site, without undergoing any further modifications. Prior to this time, a short, sturdy, cylindrical bone point was in use, at least during the period of 6-S&B deposition. Other miscellaneous pieces of worked bone were recovered lower in the sequence, but these have little diagnostic value and their significance cannot be appraised.

Even with the Loams sequence, the bone and antler tool sample is rather small (Table 15-1) and not amenable to percentage breakdown by stratum. Many of the recovered tools are fragmentary, suggesting that they were seldom if ever abandoned until broken. Furthermore, many tools tend to occur in isolated clusters in the deposits, so that most specimens from any one stratum came from only a few pits (Table 15-2). The most dense concentration was from the pit house floors in E where more material was preserved through accidental burning and subsequent infilling. The bulk of the sample comes from a narrow arc on the northeast rim of the site, running through ABEIJ. Because of the intensive pit house building activity in this same arc (see Chapter 18), the threat of stratigraphic mixing is greater in this area--for example, the missing tip of a scoop removed from the pithouse floor in the 10-MSFL of E was recovered in the 11-USFL of B (Fig. 15-9a), hinting that the latter was partly derived from pithouse diggings.

Obviously, interval sampling is not the ideal excavating strategy for recovery of materials which tend to cluster in this way within the site. Not only is the bone-and-antlerwork sample too small, but it does not represent the full range of types produced at the site. The large uncontrolled pit of Mr. C. B. Howe, between NOUT, has produced clusters of elaborately carved leister prongs and ?netting awls--no doubt further excavations would expand this list. For the present, our knowledge is restricted to the following types:

Antler Wedges and/or Hide-working Tools

These were made in the following manner: a length of reasonably straight antler shaft was selected for cutting into sections between about 90mm and 120mm long. Subsequent work and use damage obliterates all cut-marks, and the method remains uncertain--the antler was probably ring-cut. Occasionally, antler tines were selected, but produced a small working edge. Next, one end of the cut section was bevelled to form an acute-angled bit. One side of the cylinder was battered, whittled and ground into the appropriate shape. At this stage, the object usually came into use for softening hides--the obliquely ground surface was rubbed over the hide in such a way that the spongy tissue of the interior was worn down faster than the harder outer casing of the antler. This in turn developed a high sheen with striations aligned in many random directions, suggesting that the tool was held and moved across the hide without any set pattern. All manufacturing marks or scars were removed by this work from the oblique surface.

All but a few specimens recovered show signs of subsequent use as log-splitting wedges. The butts are heavily bruised and splintered by (stone) hammer-blows, and the bit-ends show extreme chipping, scaling, and breakage. Several specimens are split along their full lengths.

Table 15-1

Counts of Bone and Antler Tools by Stratum

Stratum	Antler wedges	Scoops	Billets	Handles	Spatulate Awls	Misc. Awls	Birdbone Points	Rammed Birdbone	O-sectioned Bone points
15-UAL	3	–	–	–	1	5	3	2	–
14-MAL	6	–	–	–	1	5	2	–	–
13-LAL	–	–	–	1	–	3	1	2	–
12-TSFL	1 1	–	–	–	1	1	1	– 3	–
11-USFL	11	–	1	–	2	4	4	–	1
10-MSFL	6	8	–	–	1	5	1	–	1
9-LSFL	1	–	–	–	–	3	1	–	–
8-LFL	3	–	–	–	3	1	1	–	2
6-S&B	–	–	–	–	–	–	–	–	3
5-Scaup	–	–	–	–	–	–	–	–	–
4-Mix	–	–	–	–	–	?	–	–	–
3-Grebe	–	–	–	–	–	–	–	–	–
2-Coot	–	–	–	–	?	–	–	–	–
1-Basal	–	–	–	–	–	–	–	–	–

Table 15-2

Distribution of worked bone and antler by Pit and Stratum (Counts)

	PITS																		
Stratum	A	B	C	D	E	G	I	J	K	L	O	P	R	S	U	V	W	X	Y
15-UAL	-	-	-	-	-	-	-	6	-	-	-	4	-	-	-	2	-	-	-
14-MAL	-	6	-	-	7	-	-	1	-	-	-	-	-	-	-	-	-	-	-
13-LAL	-	3	-	-	-	-	1	-	-	-	?	2	-	-	-	-	-	-	-
12-TSFL	1	-	-	-	6	-	1	-	-	-	-	-	-	-	-	-	-	-	-
11-USFL	4	1	1	1	-	-	7	-	1	-	-	-	1	-	-	-	-	-	-
10-MSFL	2	2	-	-	16	-	1	-	-	-	-	-	-	-	-	-	-	-	-
9-LSFL	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1	1	1
8-LFL	4	-	-	1	-	4	-	-	-	1	-	-	-	-	-	-	-	-	-
6-S&B	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
5-Scaup	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4-Mix	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
3-Grebe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2-Coot	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
1-Basal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Some bit fragments continued in use as hide-workers after they had broken off.

All recovered specimens have been illustrated in Figs. 15-1 through 15-6 in order to minimize verbal descriptions. It is apparent that this tool underwent no further modifications after its introduction onto the site. Its first appearance here follows the earliest pit house floors--suggesting that it was introduced by people already familiar with its use in splitting logs. Although both elk and other hide-bearing animals were present here before the 8-LFL, no polished wedges were recovered below this level.

Scoops

Seven bone and antler scoops were accidentally preserved by the pit house fill in pit E. It is unlikely that such delicate utensils would have survived had they not been covered over fairly rapidly. The largest (Fig. 15-7) is of antler and was from the lower floor, while six others (Figs. 15-8,9) came from between the buried and collapsed timbers on the overlying floors. The only other specimen found (Fig. 15-9b) came from the white clay floor in A. Their close association with pit houses as well as their overall morphology strongly suggest that these were ordinary household utensils, used for stirring, distributing, and eating mushy or semi-liquid foods.

Billets

A single antler specimen in I6 shows localized battering and cut marks, typical of flaking damage (Fig. 15-10b). In both size and weight it would be suitable for obsidian preform flaking or other primary flaking duties. Given the abundance of lithic debitage in the site (Chapter 12) we might expect more of these tools. However, good billets may have been personal property and carried off the site by their owners. This specimen may have been used only briefly for casual work, hence its abandonment in the site.

Handles

A single enigmatic antler specimen (Fig. 15-10a) from B3 is tentatively classified as a handle. The single large opening cut in its one side could accommodate the butt end of a digging stick, but the hole is too large to be reasonably expected to fit a fire-drill top.

Spatulate Awls

These are relatively large awls with variable cross-sections, tending to lenticular and becoming flat near the tip which displays a high use-polish. Their most likely use would have been in netmaking or in matting manufacture, although hide-working cannot be altogether ruled out. Howe (1979) suggests that some specimens may also have served as sweat-scrapers. Two one-of-a-kind specimens have been lumped with this category on the questionable assumption that they may have been used in similar tasks. One is a forked utensil (Fig. 15-11g) suggestive of a netmaking tool, and the other is a pressure-flaker (Fig. 15-11f) with traces of tip-polish suggesting that it doubled as an awl. The specimen shown in Fig. 15-10d is the earliest occurrence of antlerworking at the site and differs from the others in that it lacks the high tip polish. Although its context is not in doubt, its true function is uncertain and it is included in this category on morphological grounds only.

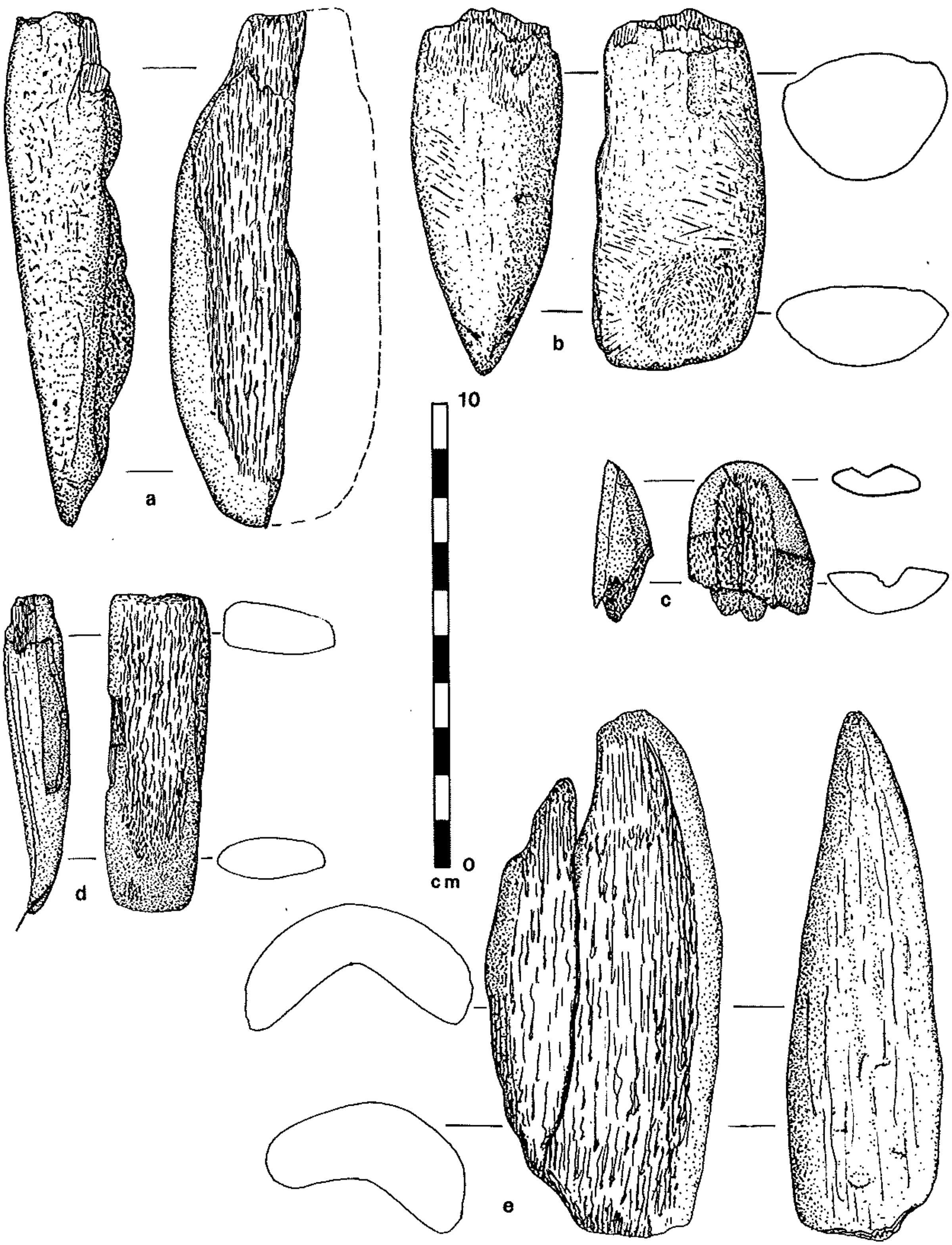

Fig. 15-1 Antler hide-working tools: (a) 9-LSFL in W5 top; (b) 8-LFL in D4b, butt suggests use as wedge; (c) 8-LFL in G2c, tip fragment; (d) 10-MSFL from pit house floor in E5, tip fragment; (e) 10-MSFL in B4e, split and weathered break.

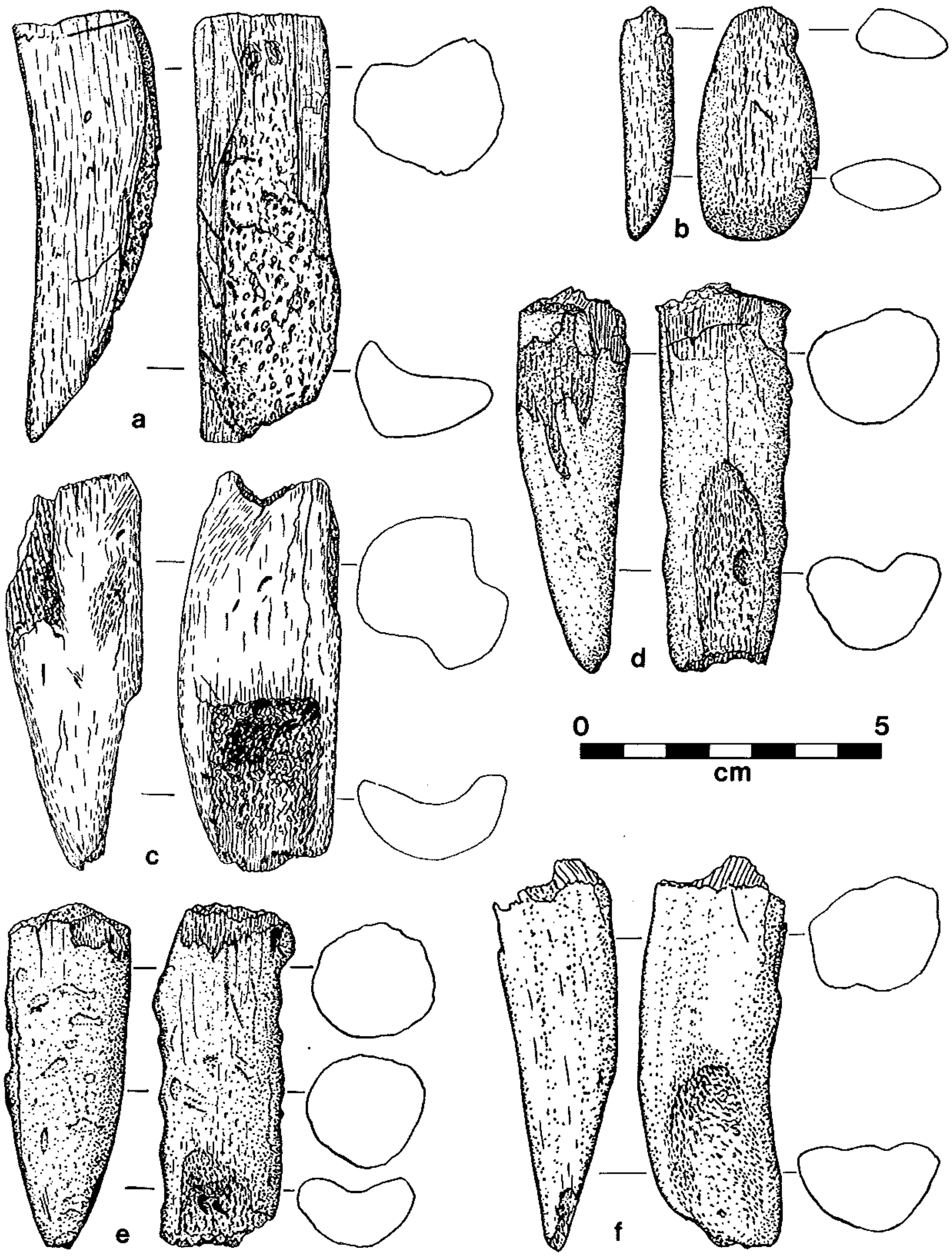

Fig. 15-2 Antler hide-working tools/wedges: (a) 11-USFL in E4b; ring-cut scar near butt; (b) 11-USFL in E4b, highly polished rim; (c) 10-MSFL in I7a, wedge; (d) 11-USFL in A7, with some polish on rim; (e) 11-USFL in I6a, wedge: (f) as (e), some polish on rim.

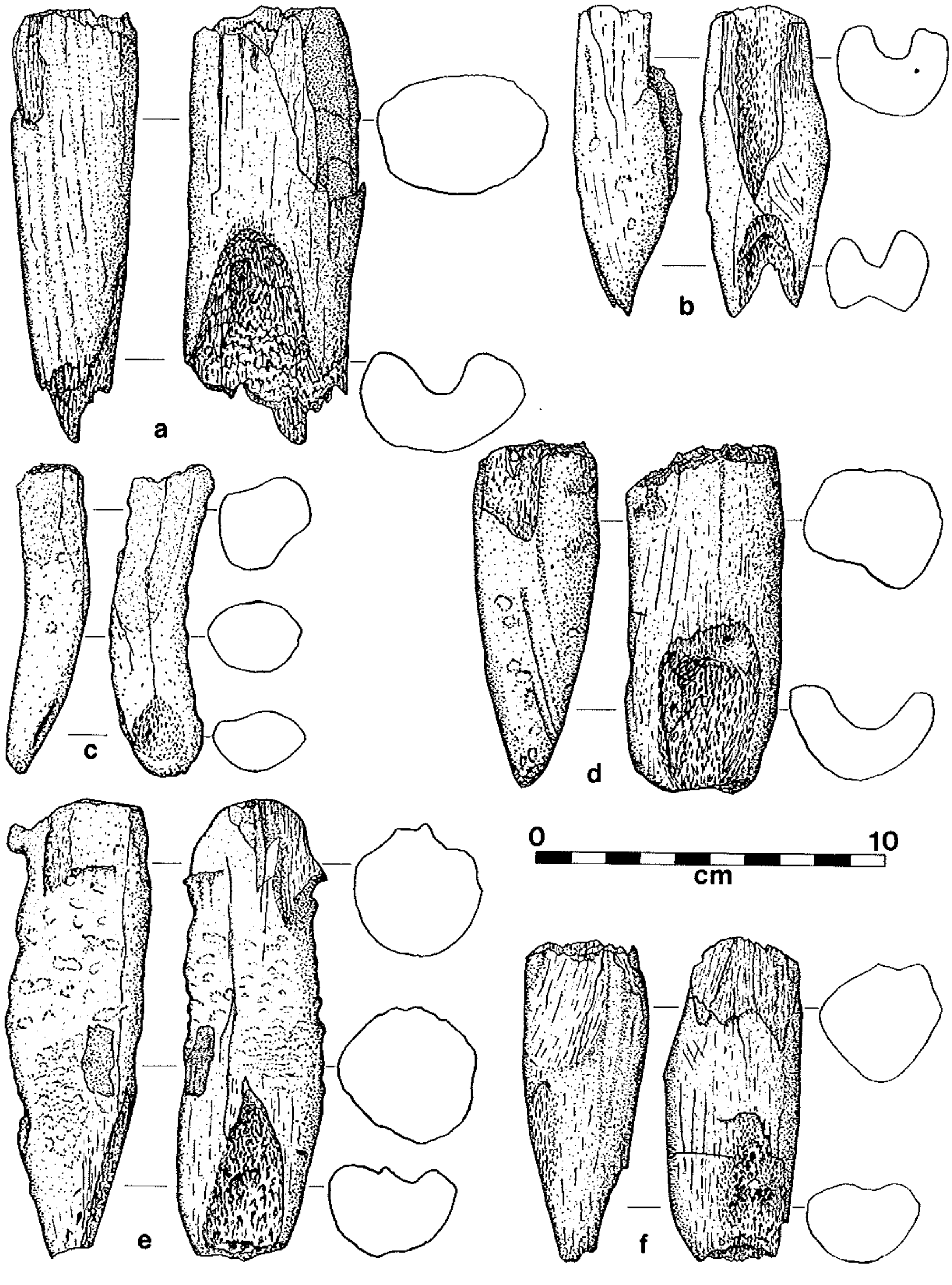

Fig. 15-3 Antler hide-working tools/wedges from the 11-USFL: (a) I6b, broken tip; (b) A7, broken tip and butt; (c) K3, hide-working tool; (d) A8; (e) C4a; (f) with cremation in Burial E-XI in the 15-UAL.

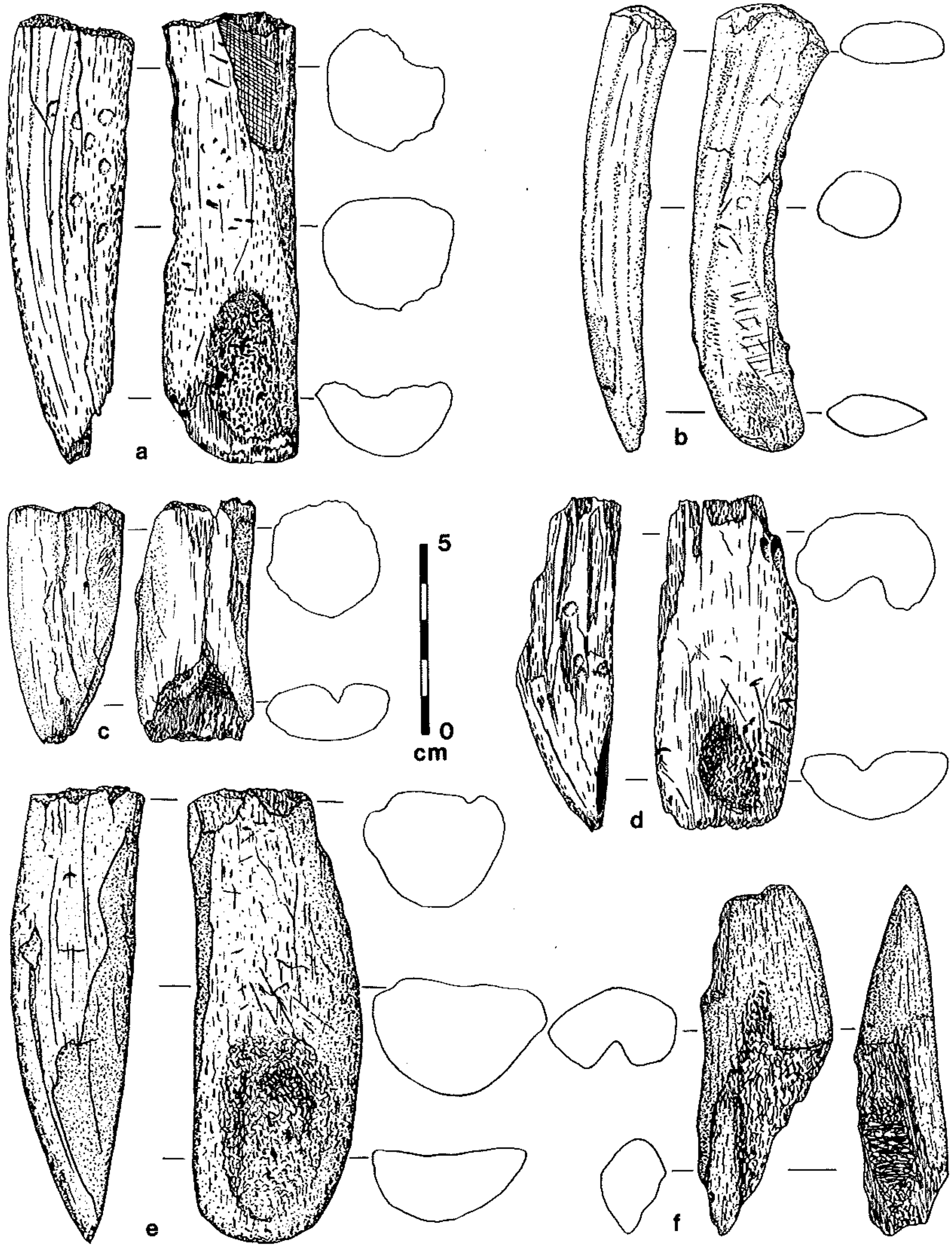

Fig. 15-4 Antler hide-working tools/wedges: (a) 11-USFL/12-TSFL in E3-4; (b) 12-TSFL in A6; (c-f) 14-MAL in E1-2.

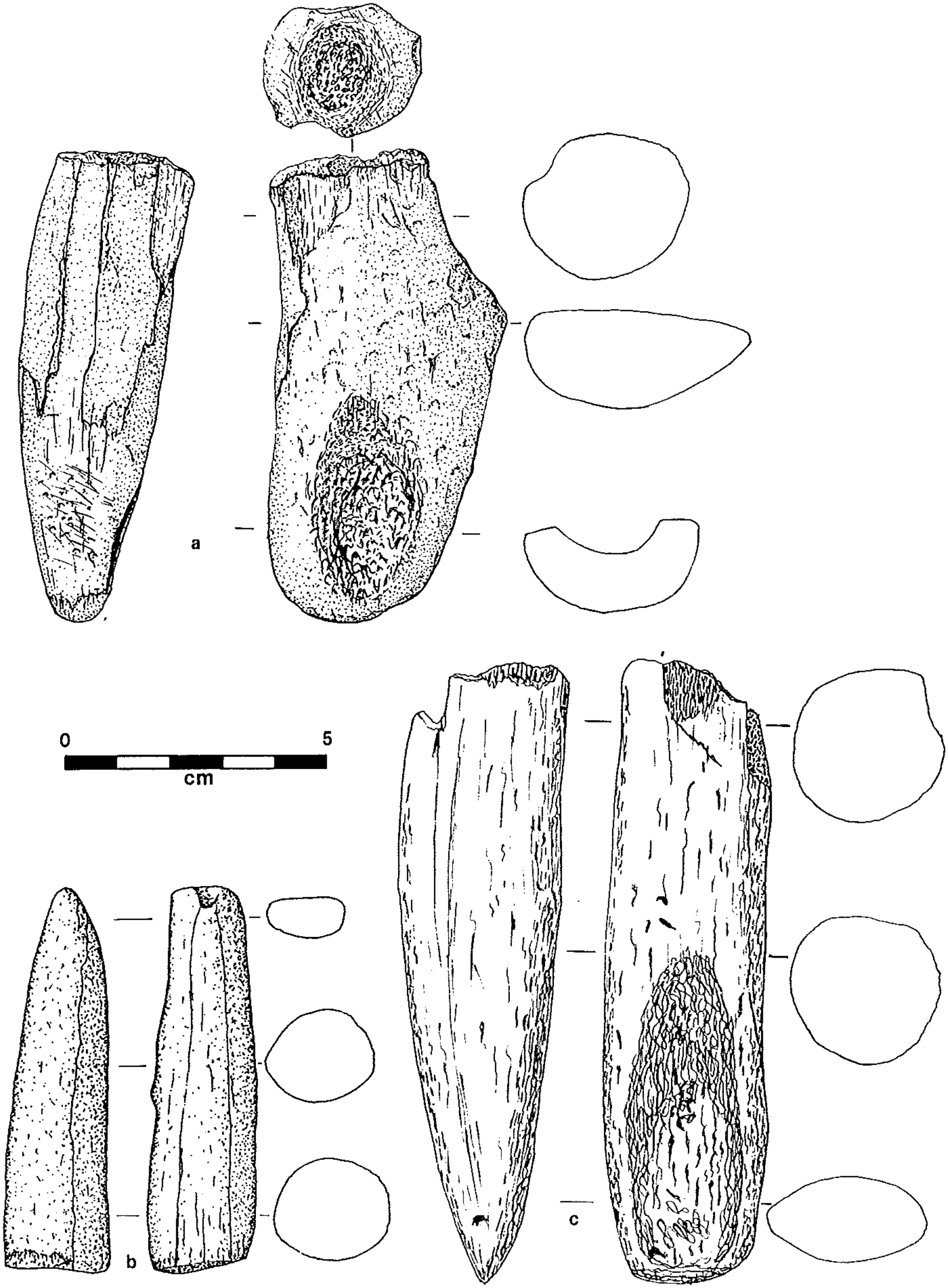

Fig. 15-5 Antler hide-working tools/wedges: (a) 14-MAL in B2; (b) 15-UAL in J1-2a; (c) 15-UAL in V1b.

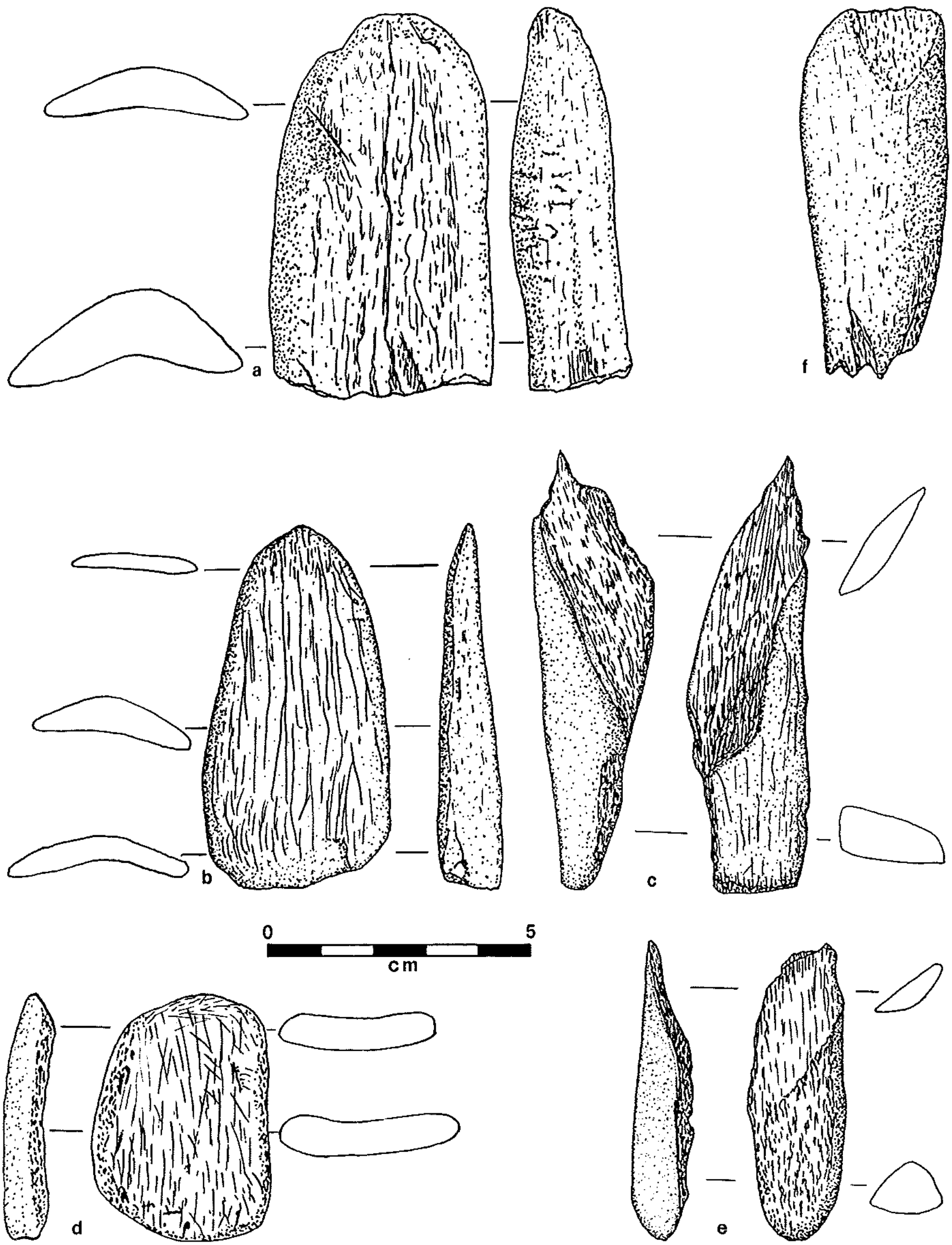

Fig. 15-6 Antler hide-working tools/wedges: (a) 8-LFL in G2c; (b) 15-UAL in J1-2a; (c) 14-MAL in E1-2; (d) 10-MSFL in I7b; (e) 11-USFL in I6; (f) 11-USFL in A7.

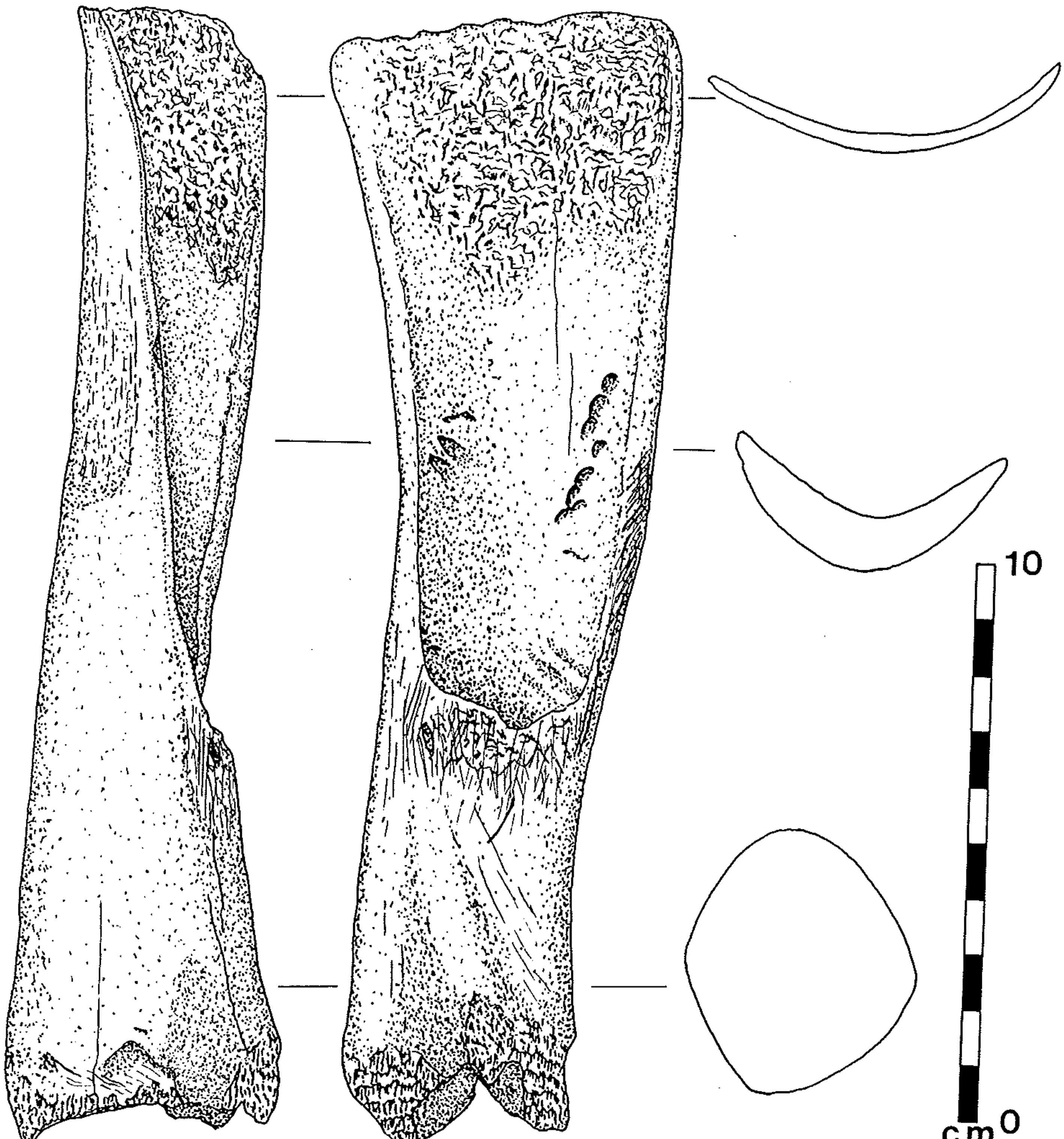

Fig. 15-7 Antler scoop from the 11-USFL burned house structure in E4b.

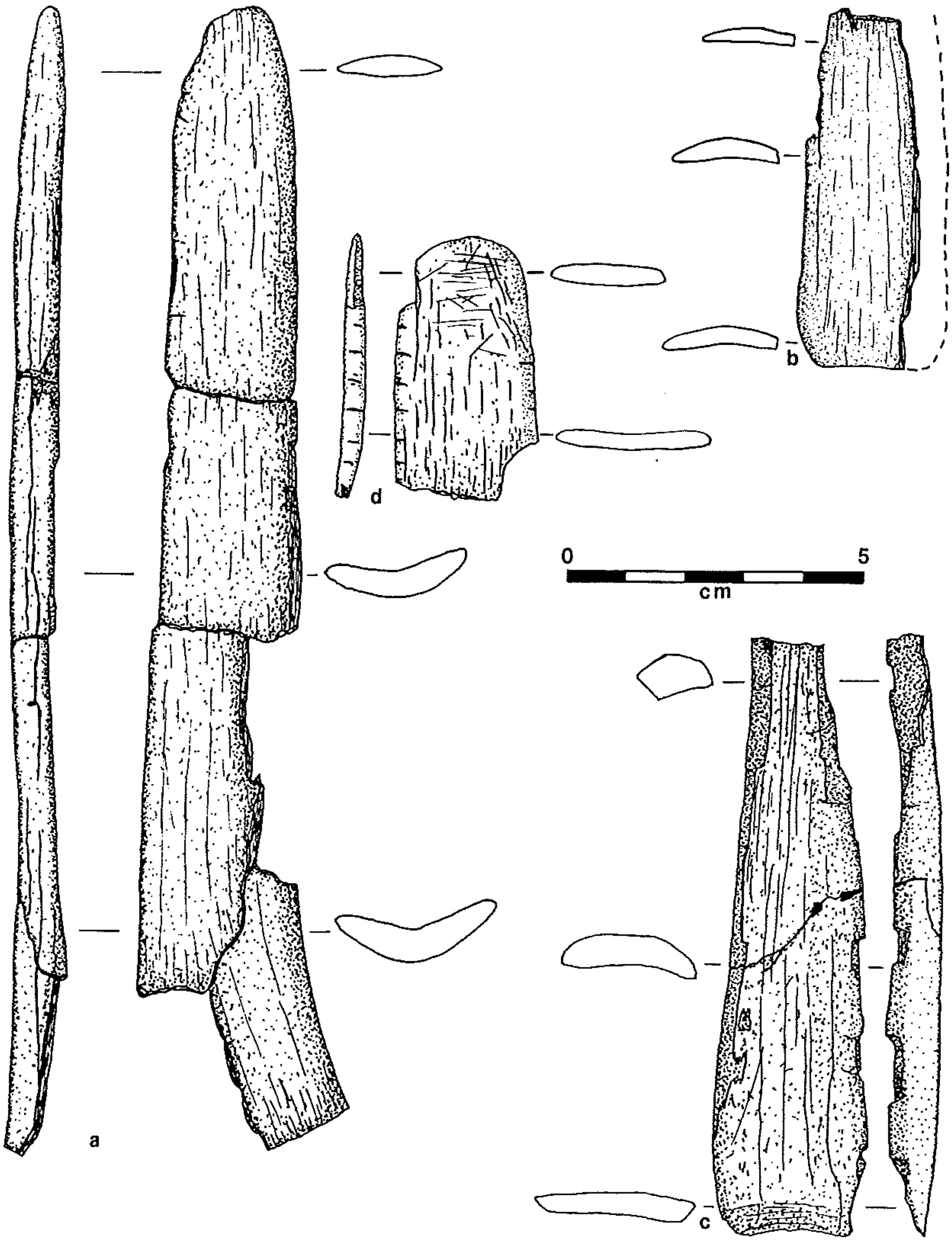

Fig. 15-8 (a-d) Antler scoops from the 11-USFL burned house structure in E4b.

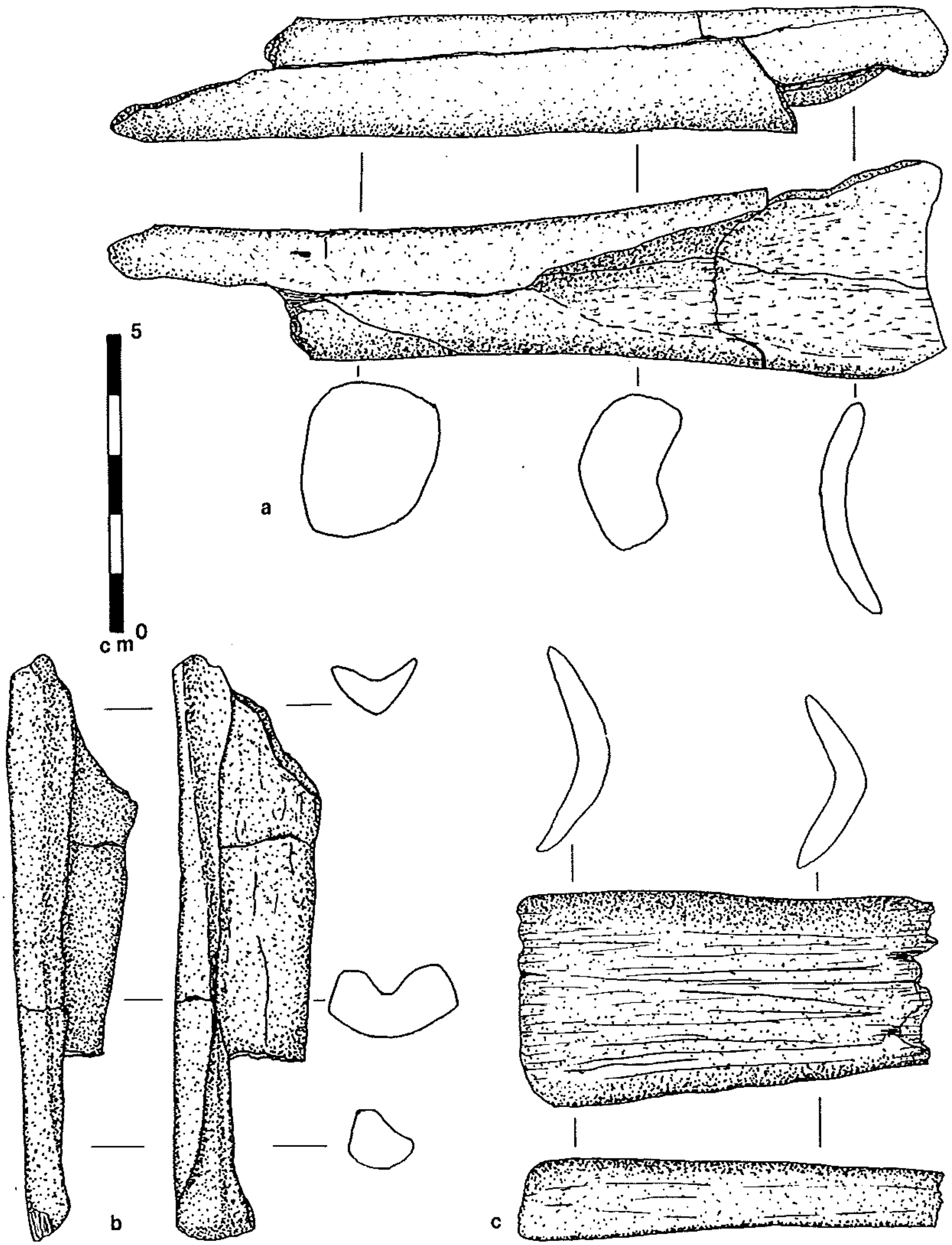

Fig. 15-9 (a&c) Antler scoops from the 11-USFL burned house structure in E4b. The tip of specimen (a) was found in B4b.

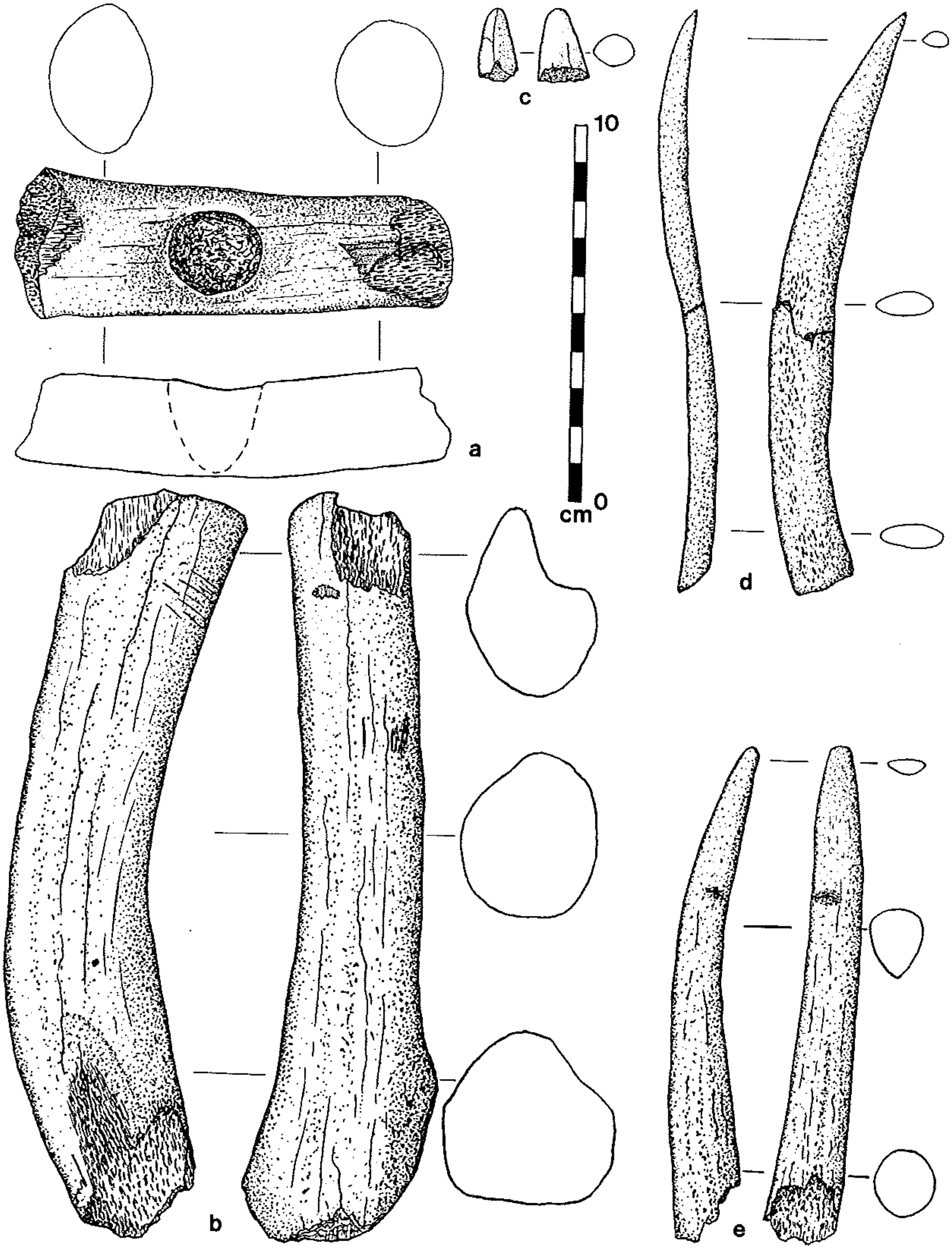

Fig. 15-10 (a) Antler shaft fragment with large perforation, possibly a handle, 13-LAL in B3; (b) broken antler flaking billet, 11-USFL in I6; (c) tip fragment of antler spatulate awl (?), 2-Coot in R8; (e) antler spatulate awl, 11-USFL/12-TSFL in E3-4.

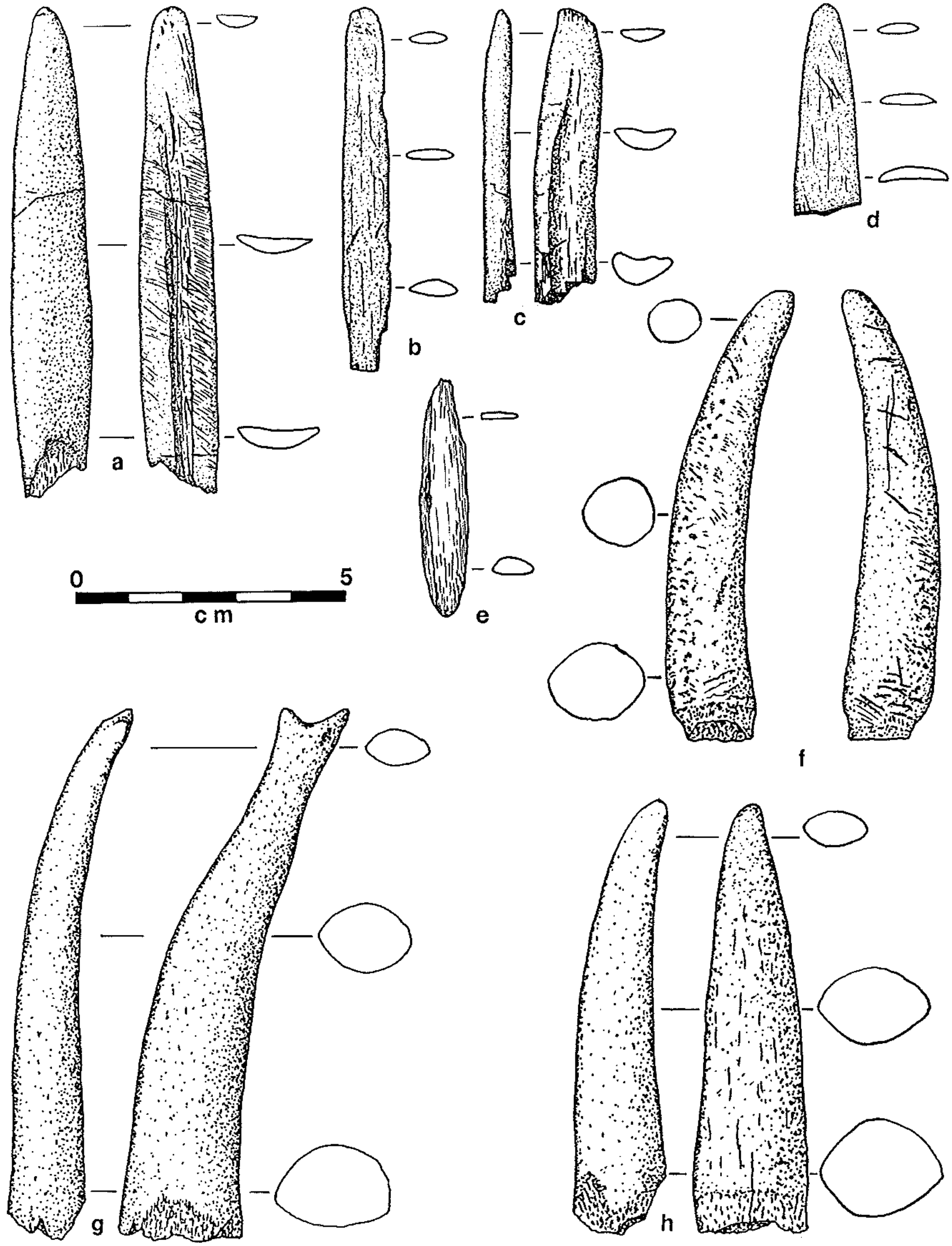

Fig. 15-11 (a) Bone spatulate awl, UAL in J1-2a; (bc) bone spatulate awl tip fragment from the 11-USFL burned house structure in E4b; (d) bone spatulate awl tip fragment, 11-USFL in X3b; (f) antler awl or pressure-flaker, 14-MAL in E1-2; (g) antler netting tool(?), 11-USFL in R2b; (h) antler netting tool (?) tip fragment, 8-LFL in G2c.

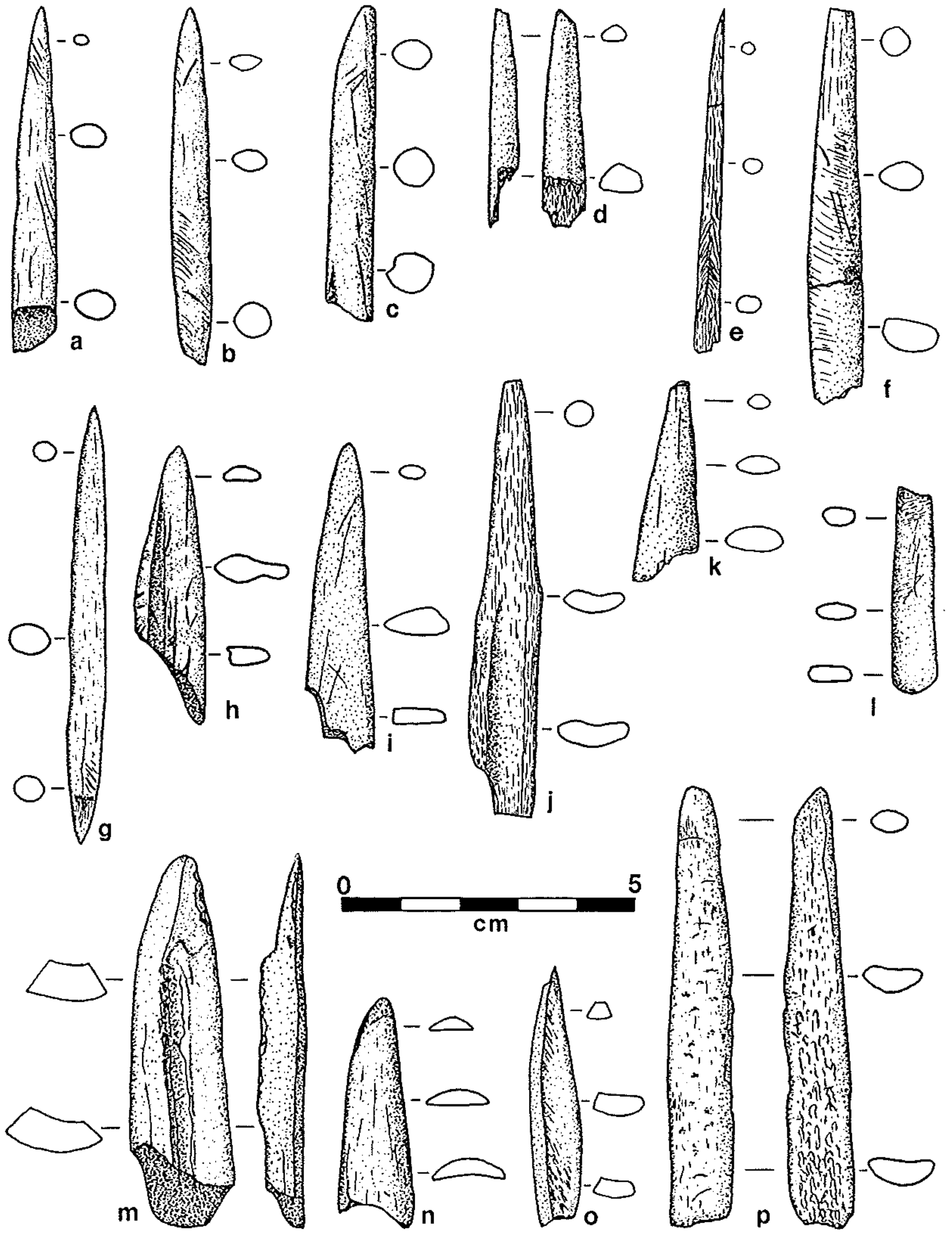

Fig. 15-12 (a-c) Bone point fragments, 6-S&B in G3; (de) bone point fragments, 8-LFL in A15; (f) 10-MSFL in A13; (g) double-edged bone point, 11-USFL in X3b; (h-p) bone awls (h) 4-Mix in S4b (i) 8-LFL in A15; (j-l) 9-LSFL (j) J5c (k) Y5b (l) X6; (m-p) 10-MSFL (m) E6 (n) E5 (o) E13 (p) E6.

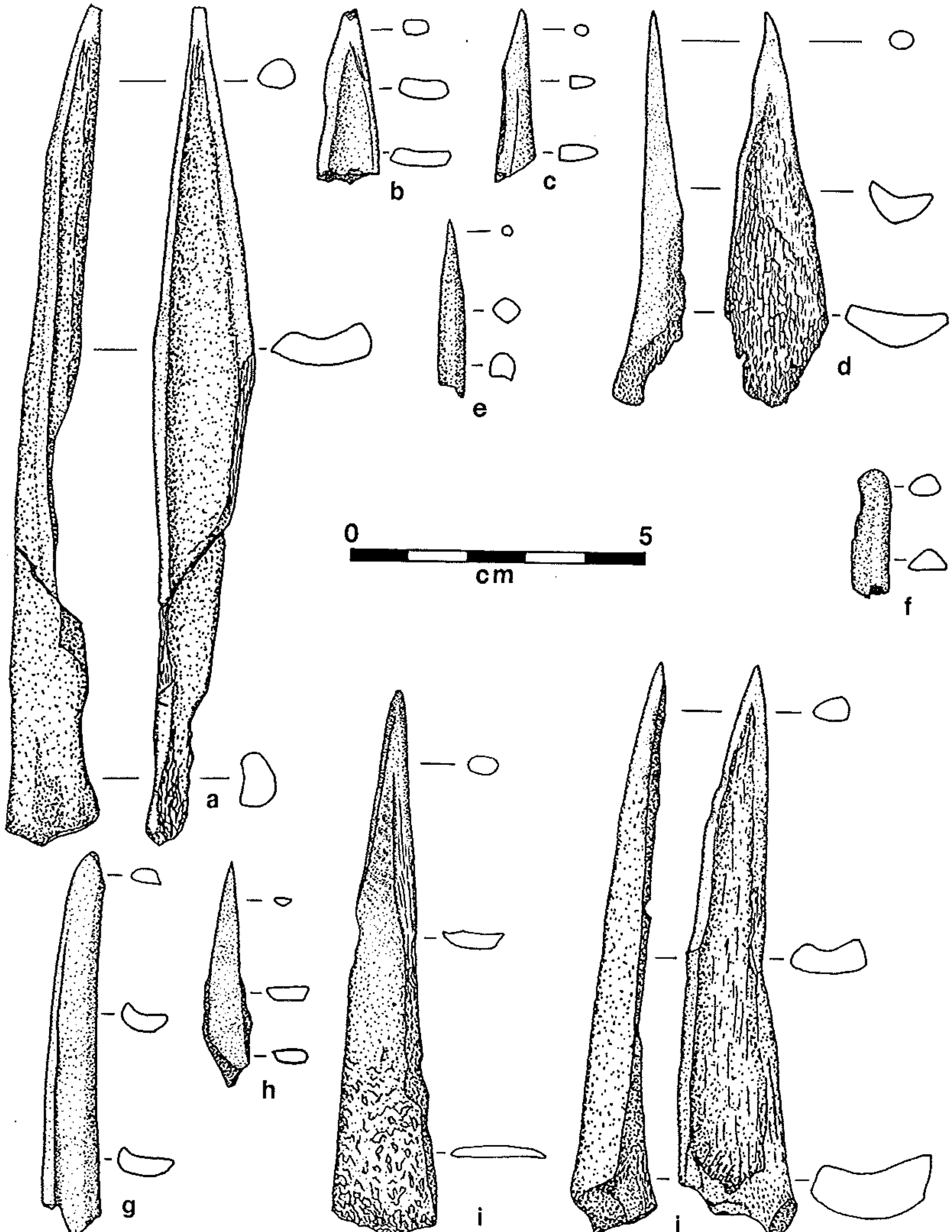

Fig. 15-13 Awls: (a) 10-MSFL in E6; (b-e) 11-USFL (bc) X3b (d) J4 (e) I6 (f) possible base fragment, 12-TSFL in E3; (g-i) 13-LAL (g) B3 (h) I3-4 (i) B3 (j) 11-USFL/TSFL in E3-4.

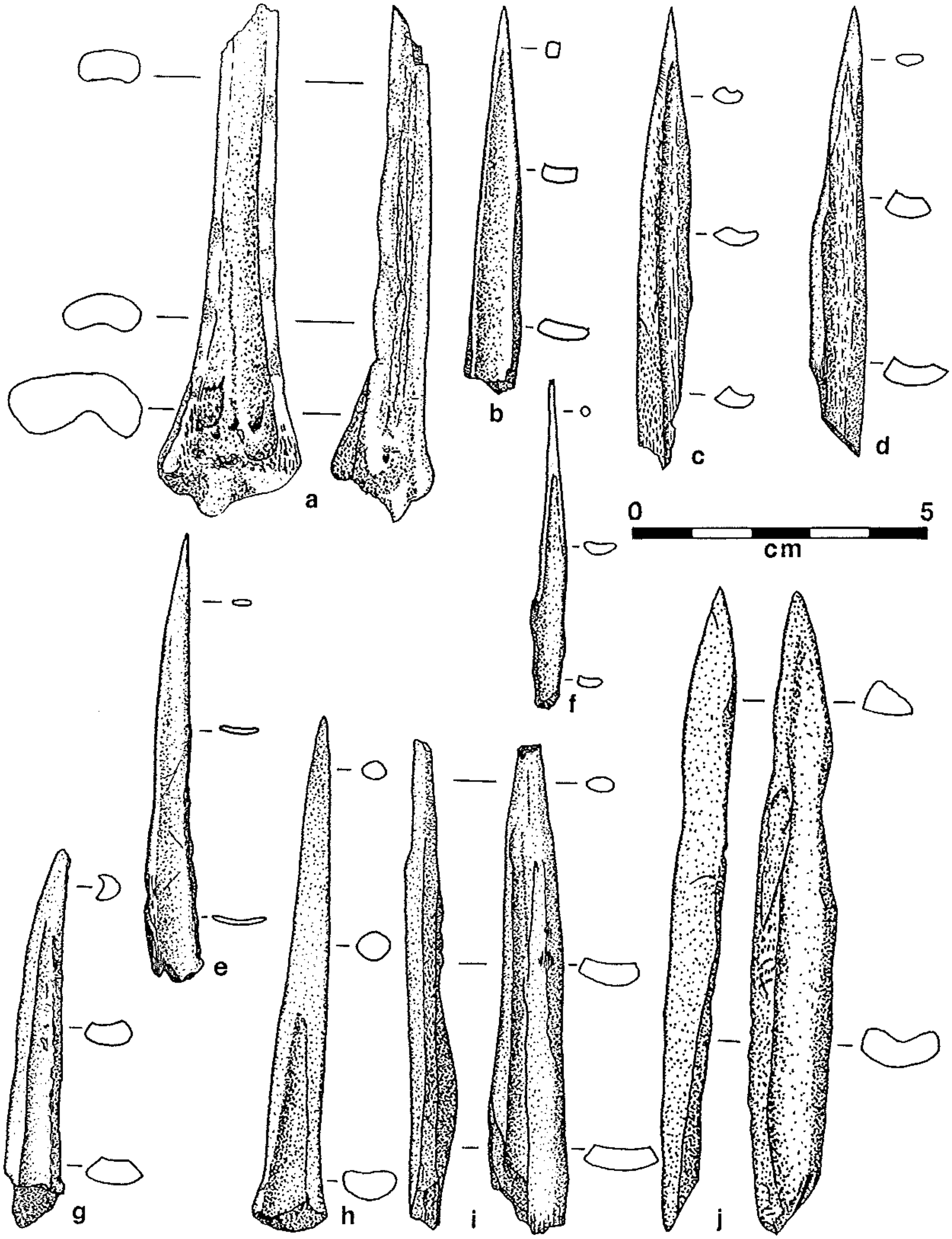

Fig. 15-14 Awls: (a-e) 14-MAL (a) B2 (b) E1-2 (c-e) B2; (f-j) 15-UAL (f) P1 (gh) J2a (i) X2 (j) P1.

Miscellaneous Awls

All recovered specimens are illustrated (Figs. 15-12 through 15-14). The earliest fragment (Fig. 15-12h) is unambiguous in its function--it has a high polish at the tip and along all prominent ridges, like all the later specimens. They are made on miscellaneous mammal bone splinters and were used mainly for perforating hides.

Bird Bone Points/Awls

These are sections of bird limb-bones cut obliquely to form a point which was then further ground. Most specimens show high polish at the tip suggesting use as awls rather than as arrow tips, although the latter possibility cannot be ruled out (Fig. 15-15).

Rammed Bird Bone

In the Arrowhead Loams, the first examples appear of slender bird limb-bones rammed into the cavities of others with somewhat larger diameters (Fig. 15-16). Fragments may have served as link shafts in part of an arrow armature, or possibly even as the mouthpiece/filter mechanism for a smoking pipe (see Chapter 17).

Ring-cut Bird Bone

These are not artifacts, but manufacturing byproducts of working bird bone. Cut marks are visible at one or both ends of the specimens--usually preserved because the break occurred accidentally away from the place intended (Fig. 15-16).

Notched and Incised Bone

Although most of these scarce specimens display little more than butchering marks or byproducts of bone tool manufacture, at least one (Fig. 15-16i) displays systematic deep notching, and two (Figs. 15-16jk) have patterned incisions. Whether or not these were strictly decorative or had some more complex meaning must remain beyond our understanding.

Round-sectioned Bone Points

These small well-finished point-fragments are illustrated in Fig. 15-12a-g. Apart from g (which is double-pointed and younger than the others), they are quite uniform end fragments without any trace of polish at the tip. It is tentatively suggested that they are projectile point heads rather than domestic utensils. Their most likely mode of incorporation in the site would have been as broken tips in animal carcasses brought back from the hunt. Although the appearance and disappearance of this point-type covaries neatly with that of Bison, the remains of that animal were all found at the south end of the site, away from Pits G and A which yielded these points. However, at least a dozen additional specimens were recovered by C. B. Howe from between NOUT probably from the 6-S&B and 9-LSFL.

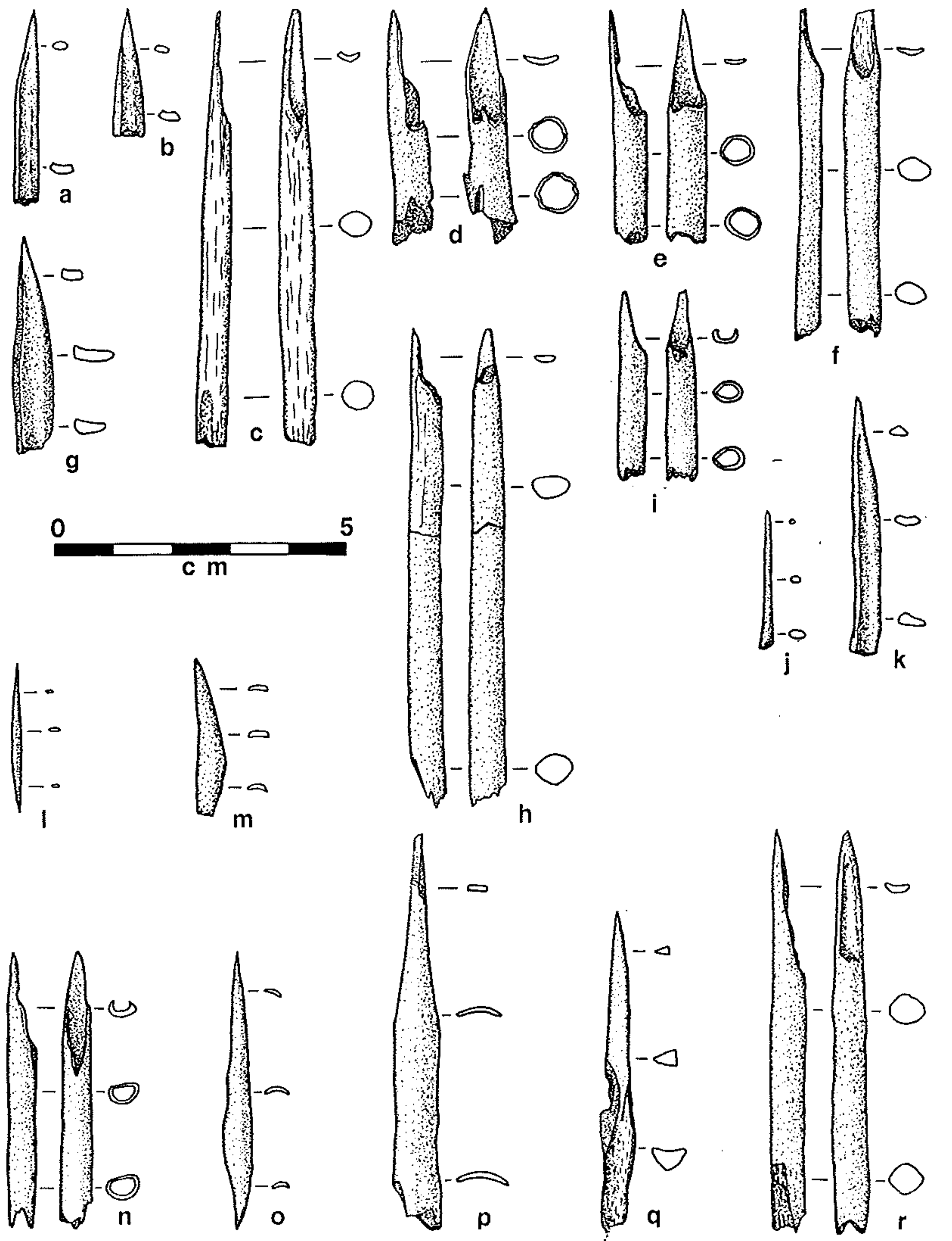

Fig. 15-15 Birdbone points/awls: (a) 8-LFL in A15; (b) 9-LSFL in P9 (c) 11-USFL in E4b; (d-g) 11-USFL (d) U1b (e) D3a (f) I6 (g) B4d (h-j) 11-USFL/12-TSFL in E3-4 (k) 12-TSFL in I5 (lm) AL? in O1a; (no) 13-MAL (n) B2 (o) J2b; (p-r) 15-UAL (p) J2a (q) P2 (r) X2.

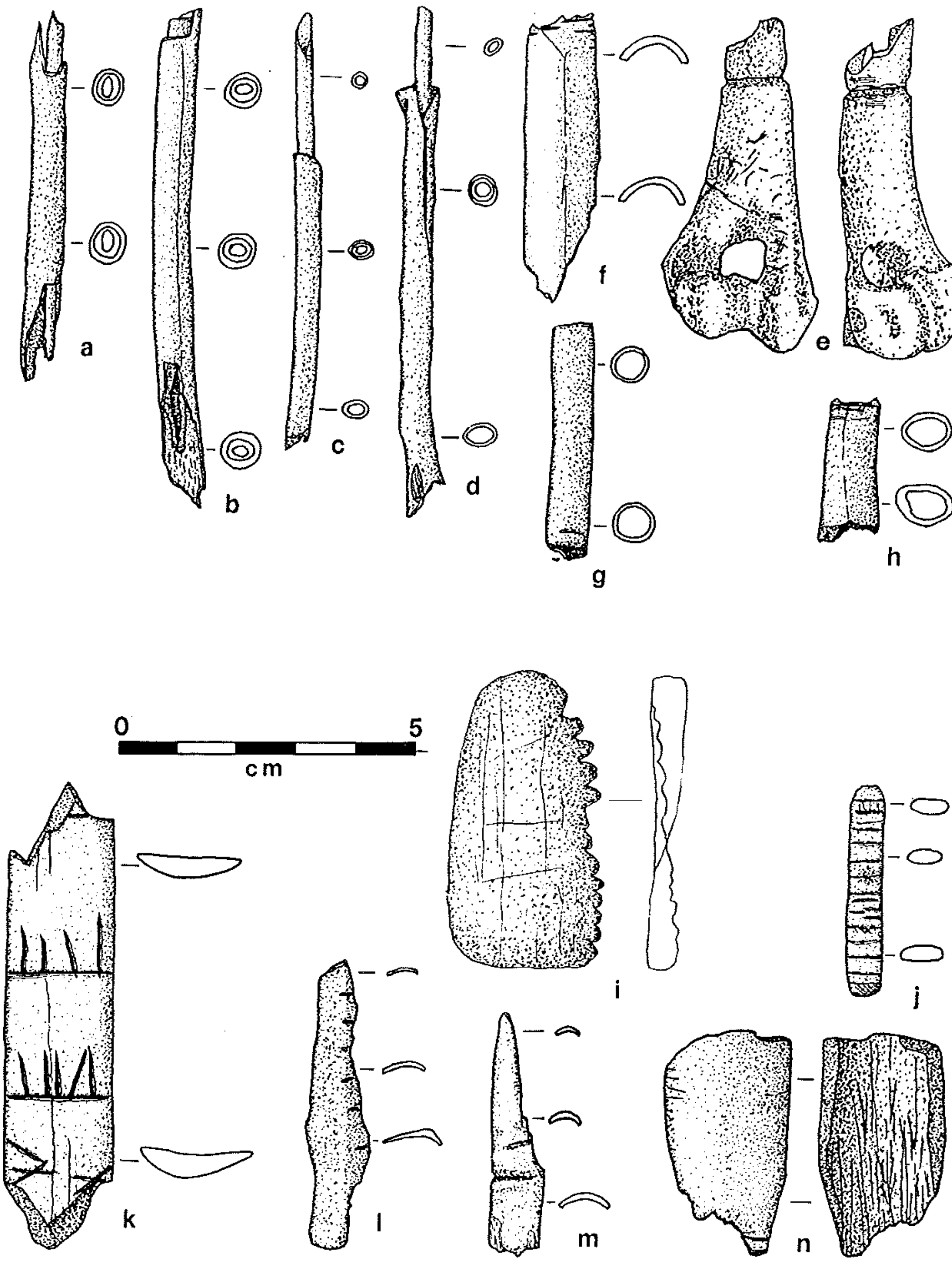

Fig. 15-16 (a-d) Rammed birdbone: (ab) 13-LAL in P3-4; (c) 15-UAL in V1b; (d) 15-UAL in P2; (e-h) ring-cut birdbone shaft fragments: (e) 11-USFL in X3a (f) 11-USFL in B4c (gh) 13-LAL in P3-4; (i-n) incised bone fragments; (i) between I and O, possibly 10-MSFL, C.B. Howe collection (j) 5-Scaup in P11b (k) 10-MSFL in B4e (l) 9-LSFL in S4a (m) 10-MSFL in posthole fill in floor of J5c (n) 13-LAL in Q3a.

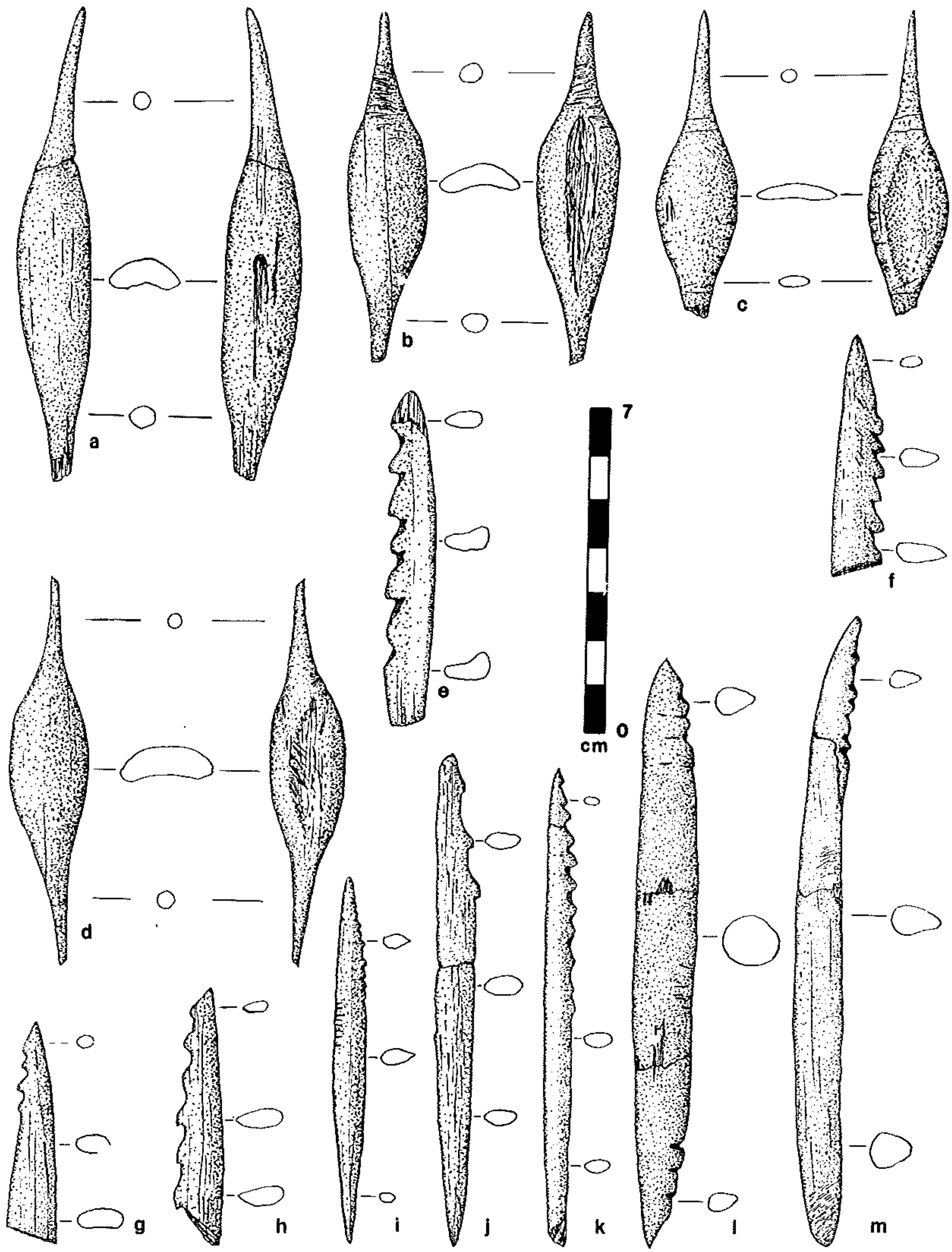

Fig. 15-17 (a-d) Double-pointed antler awls: (a-c) between T and U, probably 9-LSFL/10-MSFL; (d) with burial cremations near irrigation ditch west of K; (e-m) antler leister prongs: (ef) between T and U, possibly 5-Scaup; (g-i,k) between T and U, possibly 9-LSFL/10-MSFL; (j) between N and O, possibly 9-LSFL/10-MSFL; (lm) between T and U, possibly 5-Scaup. All specimens from C.B. Howe collection.

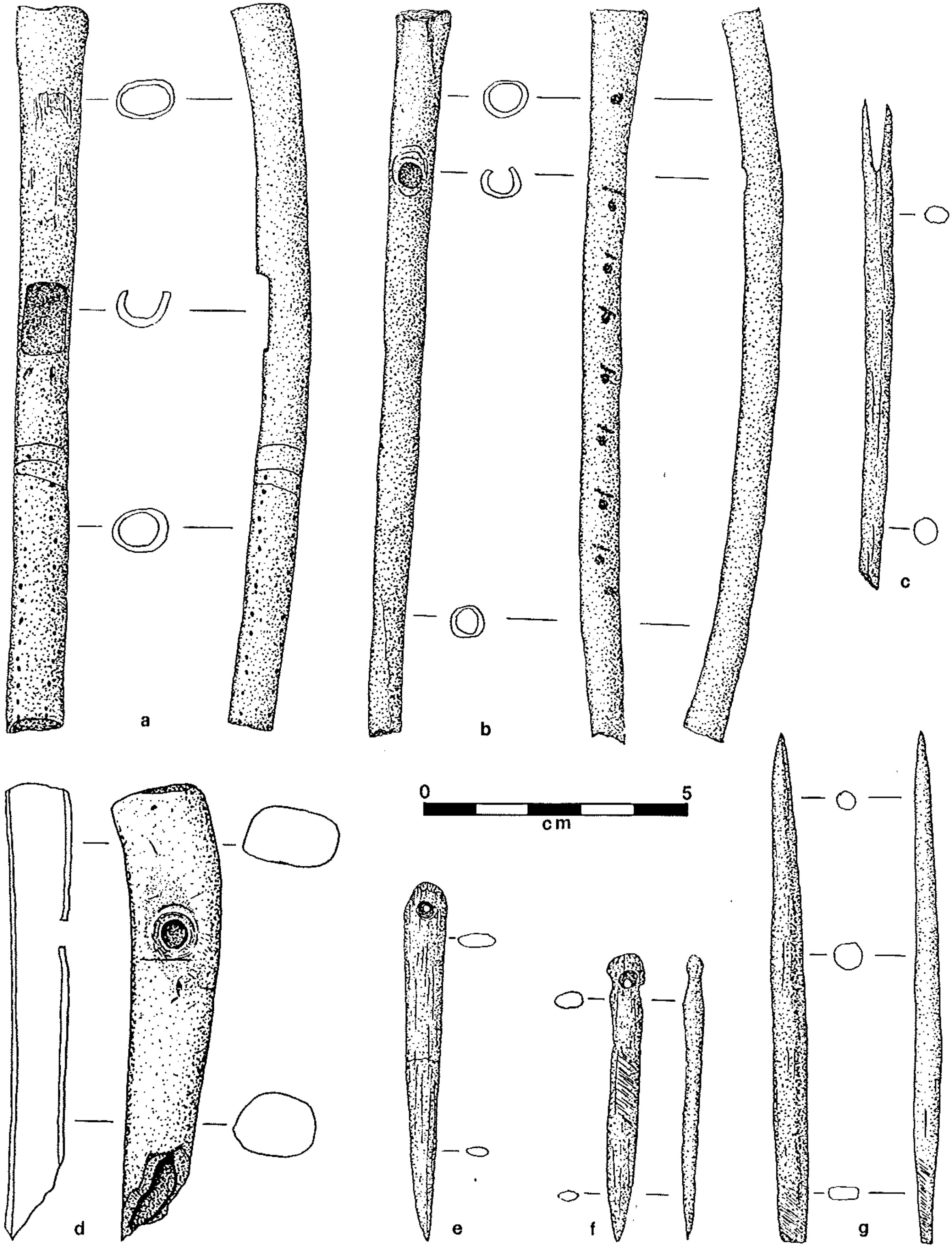

Fig. 15-18 (a) Birdcall (?), between E and J, 14-MAL or 15-UAL; (b) flute? between N and O, 14-MAL; (c) bone arrow nock? between N and O, possibly 5-Scaup; (d) birdcall (?) Pit Y in mixed surface tip, probably Arrowhead Loams; (ef) eyed needles, bone from cremation pits between E and I, 14-MAL; (g) bone point with bevelled base, between N and O, probably 14-Mal. All specimens from C.B. Howe collection, except (d).

Double-pointed Awls

Eight well-finished and heavily-used awls of antler have working tips at two opposite ends (Figs. 15-17a-d). None was recovered under controlled conditions. These are well polished over the entire surface through extensive handling. Howe (1979) has suggested use as blanket pins. Other possibilities include netting awls or toggles.

Leister Prongs

The specimens shown in Fig. 15-17 were also recovered under uncontrolled conditions, but some were reported to come from the 5-Scaup (C. B. Howe pers. comm.). Given the extreme rarity of specimens below the Loams sequence, the presence of such elaborately carved antler objects is surprising, but not necessarily impossible. Their uniform morphology strongly suggests that they formed the armatures of a leister head, with the barbs pointed inwards (Howe 1979;144).

Birdcalls

A single specimen of bird bone with a drilled hole in its flank is interpreted as a birdcall, as it can be made to emit ducklike noises, even in inexpert hands (Fig. 15-18d). More elaborately carved specimens--including a quite complex multiple-stop flute--were recovered from the C. B. Howe excavations (Fig. 15-18ab).

Forked Bone Shaft

A solid, notched shaft of bone was recovered by C. B. Howe, possibly also in the 5-Scaup. The notch is carved deeply and the opposite end is broken (Fig. 15-18c).

Eyed Needles

Two specimens recovered by C. B. Howe are illustrated in Fig. 15-18ef. Both are flat with tips and lateral ridges. The eyes are drilled.

Bevelled Bone Points

Several specimens were recovered from the later part of the Loams sequence. They are cylindrical sectioned and the butt is double-bevelled with clear grinding striae. An example is shown in Fig. 15-18g.

Conclusions

Sampling problems have obstructed any definite conclusions about the adaptational significance of the bone and antler work at Nightfire Island. On the face of it, this equipment was of no consequence to the earliest inhabitants of the site, but that picture may have to be modified if the context of Howe's finds in the 5-Scaup can be verified by further excavations. For the present, we may only tentatively conclude that the inhabitants responsible for other cultural debris in the 2-Coot through 5-Scaup were simply not producing or discarding tools in these materials. Their appearance in the 8-LFL may, therefore, reflect the shift in site role to a permanent village in which more household maintenance activities took place.

CHAPTER SIXTEEN

ORNAMENTS*

This category is defined as any object deliberately designed and/or decorated for personal adornment--usually by suspension. Most of these objects are pendants or beads, but there are a few specimens which do not fall readily into either of these classes.

Although relatively few pieces were recovered during the controlled excavations, a far greater variety came from C. B. Howe's trenches, and some of these specimens are included in this chapter in order to demonstrate the range of designs recovered from the site.

Bone Pendants

The earliest example of this category comes from the edge of the 2-Coot in X10 and there is no reason to doubt its context (Fig. 16-1a). The only other specimen recovered in situ came from the 13-LAL (Fig. 16-1c), but this could also be an arm-band fragment (see below). Several complete specimens were recovered by C. B. Howe, including an elaborately decorated and highly polished tool which he has suggested may be a sweat-scraper (Fig. 16-2c). The other perforated specimens are also highly polished (e.g. Fig. 16-1b), and resemble sweat-scrapers from ethnographic collections (Howe 1979). Several specimens of variable size were associated with human burials uncovered by C. B. Howe on the western rim of the site, and some examples are shown in Figs. 16-1h and 16-2abd. The lateral decorative motif on Fig. 16-2d resembles that on the 13-LAL fragment in Fig. 16-1c, suggesting a possible connection between this peripheral burial ground and the Arrowhead Loams.

The function of the double-perforated fragment shown in Fig. 16-1g is unknown. Like the ?sweat-scraper, this is highly polished and may have become so through prolonged contact with the wearer.

Stone Pendants

C. B. Howe (1979:279) has described six stone pendants, none of which came from the controlled excavations. One example shown in Fig. 16-1e is typical of the group. Two others are of serpentine and ?graphite and there are two other flat serpentine specimens about twice the size of the illustrated example. One other stone pendant is elongated and parallel-sided, of a white stone, not identified.

Pendants of Human Skull Fragments

Perforated, scratched, notched and heavily worn pendants of human cranial fragments were found with the grave goods of individuals buried to the west of K. None was recovered in the controlled excavations of the site. Three examples are shown in Fig. 16-3.

* by C. Garth Sampson, James A. Bennyhoff, and Richard E. Hughes.

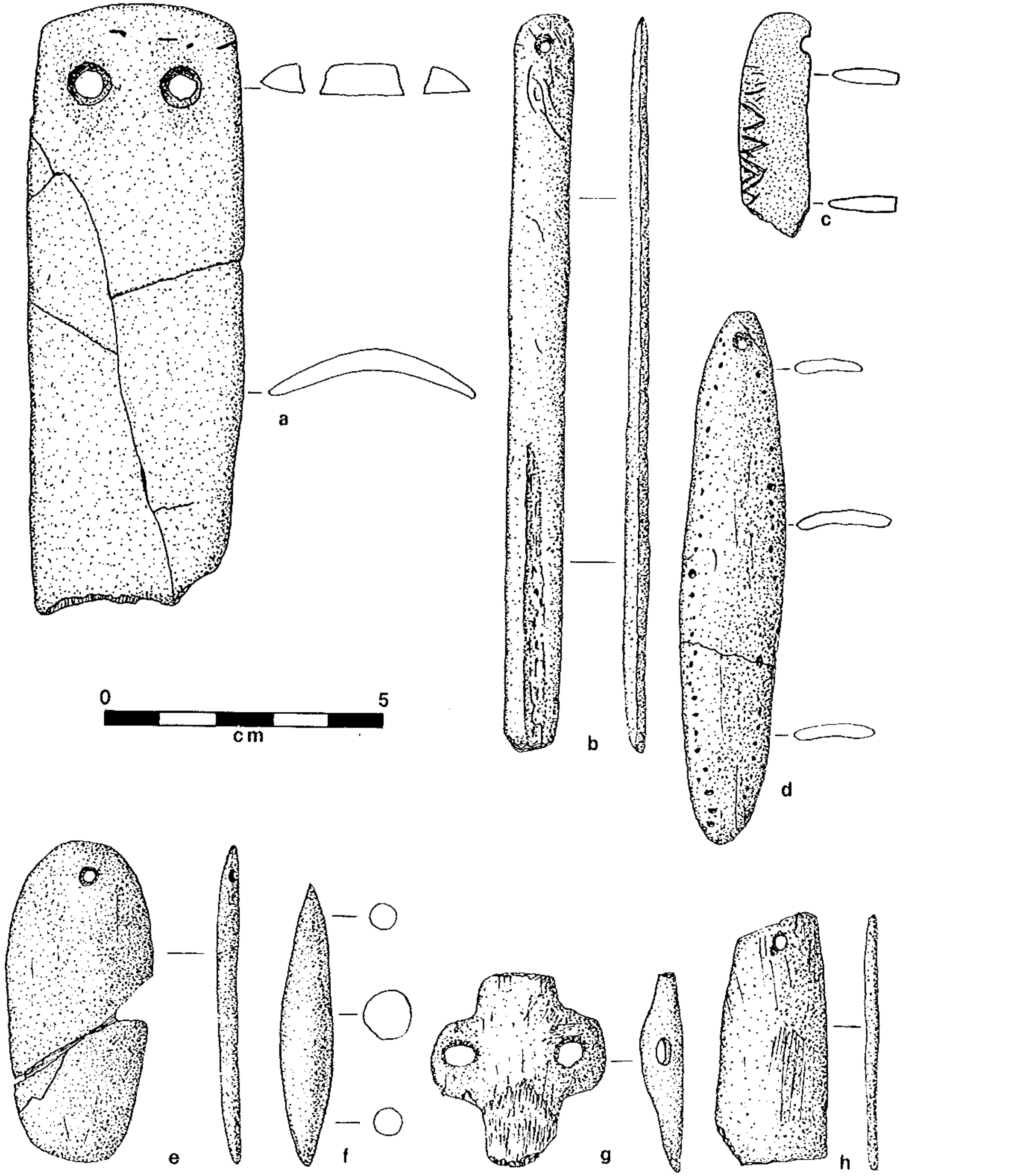

Fig. 16-1 (a) Double-perforated bone pendant, tip broken, 2-Coot in X10; (b) perforated bone sweatscraper(?), 14-MAL/15-UAL near EIJ, C.B. Howe collection; (c) decorated bone pendant fragment, 13-LAL in I3-4; (d) decorated sweat-scraper(?) probably 14-MAL in EI area, C.B. Howe collection; (e) one of two pendants of micaceous gneiss in IJ area, probably 14-MAL, C.B. Howe collection; (f) soapstone nose ornament, with cremation in 14-MAL, EIJ area, C.B. Howe collection; (g) double-perforated bone fragment from 10-MSFL/9-LSFL in MN area, C.B. Howe collection; (h) perforated end fragment of bone sweatscraper(?) with cremation burials west of K, C.B. Howe collection.

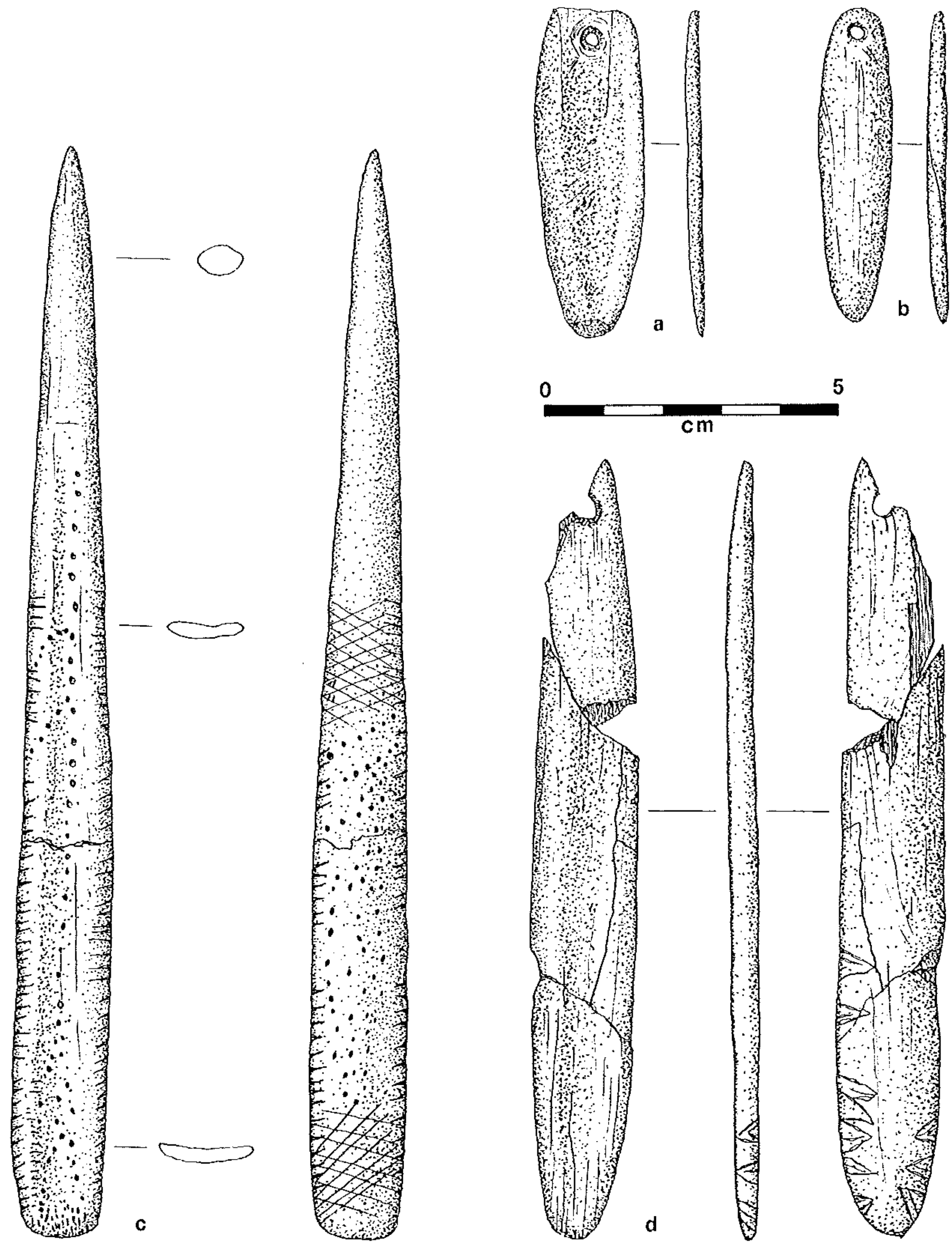

Fig. 16-2 (ab) Small perforated sweatscrapers(?) of bone, with cremations west of K, C.B. Howe collection (c) decorated bone sweatscraper(?) from 3-Grebe or 5-Scaup between T and U; (d) perforated and decorated bone sweatscraper(?) with cremations west of K, C.B.Howe collection.

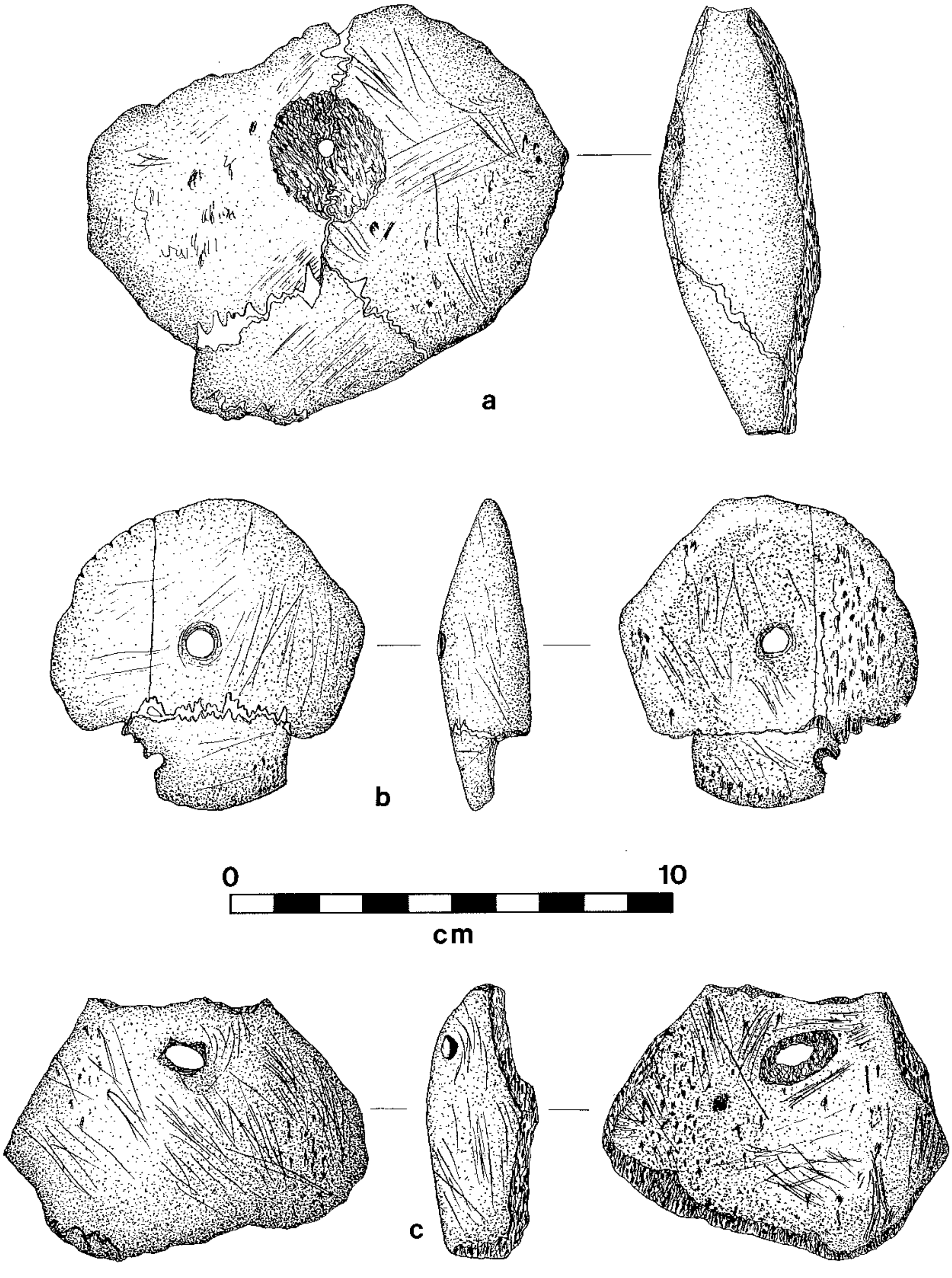

Fig. 16-3 Pendants of human skull fragments from the cremations near the irrigation ditch west of K, C.B. Howe collection.

Nose Ornaments

Several items identical in size and shape to nose ornaments worn by the historical Modoc were recovered by C. B. Howe, but none was recovered in the controlled excavation. A typical serpentine specimen is shown in Fig. 16-1f and Howe (1979) illustrates specimens in jade, crystal, obsidian and bone. He also suggests that some were made of whole dentalium shell. The stratigraphic context of all these specimens is uncertain, but they were concentrated in the middle part of the Loams sequence.

Arm Bands

Arm bands of carved elkhorn, typical of those in ethnographic collections, were recovered by C. B. Howe. One virtually complete specimen (Fig. 16-4a) came from between H and N, probably from the 14-MAL. A second elaborately decorated specimen was found with the burials west of K (Fig. 16-4b). It could be argued that the in situ fragment in Fig. 16-1c and classified as a bone pendant was in fact an arm-band fragment. As it came from the 13-LAL, this would suggest some antiquity for the historical Modoc ornament--apparently unique in the region.

Bone Beads

A single specimen made from a cut and polished length of bird bone was found in the 15-UAL at P2b. Again, Howe (1979) reports the recovery of dozens of such specimens, plus rare beads shaped from mammal bone shaft sections. Although numerous, they were never recovered as complete sets, but rather scattered among beads of other materials. This has prompted Howe to suggest that they may have been used in aprons like those described by Dixon (1907) among the Shasta to the south. Unfortunately, the stratigraphic provenience of this large collection is uncertain, but it apparently came from the Arrowhead Loams sequence.

Stone Beads

The C. B. Howe collection contains a perforated sandstone bead of uncertain stratigraphic provenience. A cache of 32 calcite crystals, notched and/or cross-grooved to facilitate binding (Howe 1979:220, 224) is also of uncertain provenience. No specimens were recovered from the controlled excavations.

Olivella Spire-lopped Beads

All but a few beads were recovered with human burials or from the grave infillings immediately above the burials. This suggests that most beads post-date the levels in which they were found. Virtually all the burials took place during the Arrowhead Loams accumulation (see Chapter 19), thus most of the beads in association must post-date 300AD. The distribution of bead groups is given in Table 16-1. Several other beads were thought by the excavators to be in situ, but Table 16-2 shows that most of these specimens were from pits that also yielded burials and the stray specimens are almost certainly derived from these. Those from Pits C, F, and L are the only exceptions, but the context of L4 is already in doubt as its C14 date has an unduly

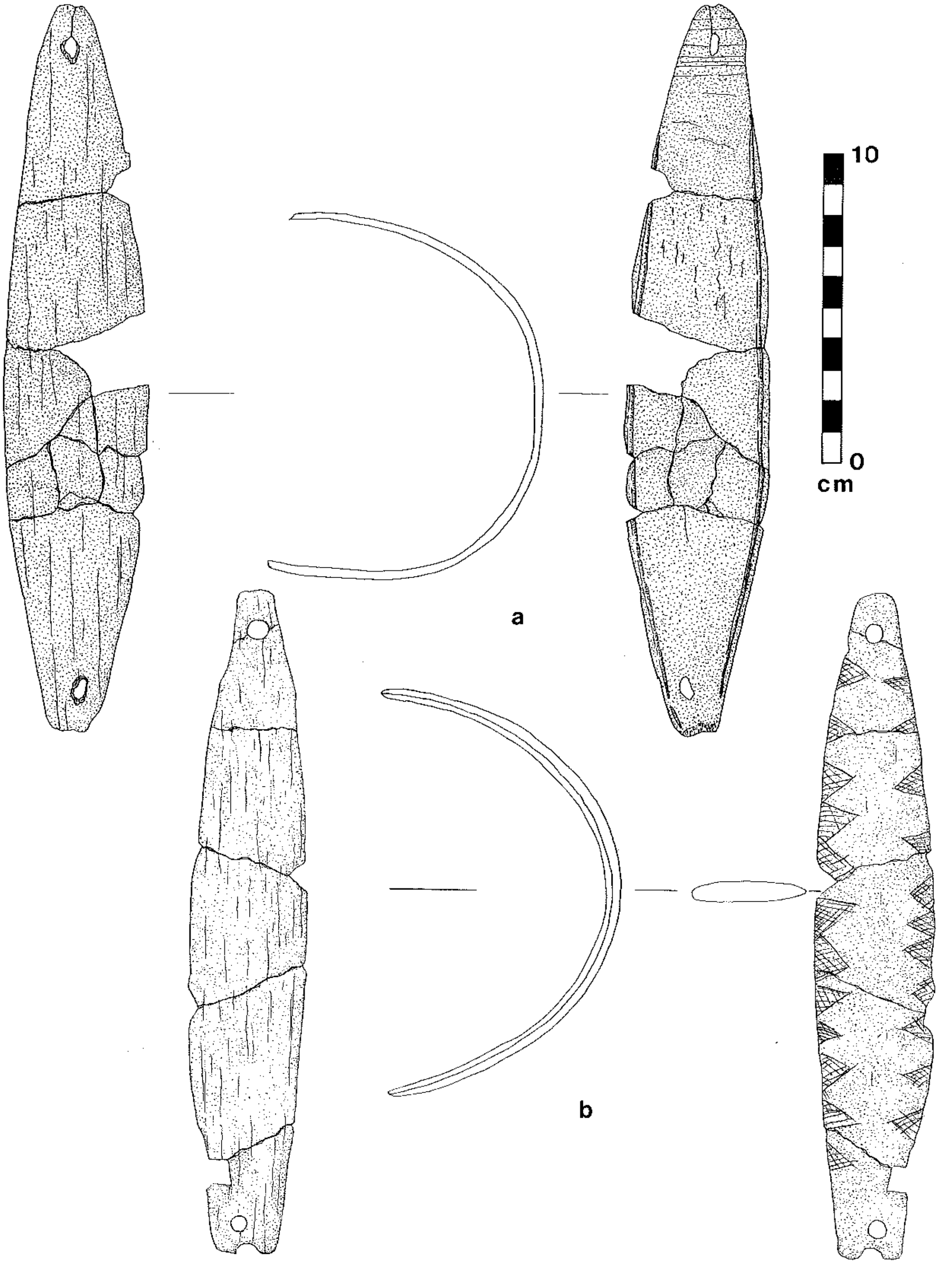

Fig. 16-4 Decorated armbands of curved elkhorn (a) 11-USFL or 14-MAL just east of N(b) associated with cremations west of K, C.B. Howe collection.

Table 16-1

Olivella Shell beads (total 591) from Burials (all intrusive from Arrowhead Loams)

Burial No.	Layer	Stratum	No. of Beads	Mode of Occurrence
R-I	R2b	11-USFL	28	necklace or attached to chest covering
R-II	R2b	11-USFL	15	possible knee-bangle?
			152	necklace?
R-I & II	R2b	11-USFL	23	in grave fill
R-III	R2b	11-USFL	22	necklace
R-IV	R2b	11-USFL	134	necklace or attached to chest covering
			4	in grave fill
R-IV & X	R2b	11-USFL	2	in grave fill
R-VII	R2a	12-TSFL	1	in grave fill
R-VII & VIII	R2a	12-TSFL	6	in grave fill
R-X	R2b	11-USFL	3	necklace
R-XI	R2a	12-TSFL	21	necklace?
I-I	I3b	13-LAL	32	in grave fill
I-II	I3b	13-LAL	1	in grave fill
I-III	I3b	13-LAL	1	in grave fill
I-IX	I3b	13-LAL	9	in grave fill
I-I-IV	I3b	13-LAL	51*	in fill above burials
E-III	E2	LAL/MAL	3*	in grave fill
A-I	A6	12-TSFL	83*	in fill around burial

* Included in analysed sample, less 1 broken bead in E-III and two in A-I

Table 16-2

Provenience of Olivella beads at Nightfire Island

Stratum	A	C	E	F	I	L	R	S	W	X
15-UAL	–	–	–	–	–	–	–	–	–	1
14-MAL	2	4	–	–	–	–	–	–	–	–
13-LAL	–	–	–	–	–	–	–	–	–	–
12-TSFL	–	–	–	–	–	–	2?	–	–	–
			3]					2]		
11-USFL	1	1	–	1	–	–	–	–	1	–
10-MSFL	–	–	–	–	–	–	–	–	–	–
9-LSFL	–	–	–	–	–	–	–	1	–	–
6-S&B	–	–	–	–	–	–	–	–	–	–
5-Scaup	–	–	–	–	–	–	–	–	–	–
4-Mix	–	–	–	–	–	–	–	–	–	–
3-Grebe	–	–	–	–	–	2	1	–	–	–
2-Coot	–	–	–	–	–	–	2	–	–	–

large sigma (Chapter 4). Both the C and F specimens come from the 11-USFL.

A total of 616 beads, including those from Table 16-2 plus the burial groups designated in Table 16-1 (see Figs. 16-5a, c), was analyzed in detail.

Although most were Olivella biplicata, at least four Olivella pycna were identified. Most beads were the Simple Spire-lopped (A1) class but there were also fifteen Oblique Spire-lopped (A2) beads, and one specimen was too fragmentary to classify. Class A1 beads were modified to the extent that the spire was broken or ground off perpendicular to the shell axis, while A2 beads had their spires ground down diagonal to the axis.

Bead size distribution by type and stratum is shown in Fig. 16-6. Bennyhoff and Hughes (1981a) suggest that Class A Spire-lopped beads be divided into three size categories on the basis of maximum diameter:

Spire-lopped (Class A)		Maximum diameter (mm)
Small	(A1a)	4.0 - 6.5
Medium	(A1b)	6.51 - 9.5
Large	(A1c)	9.51 - 14.0

These metric divisions do not fit well with the NFI collection (Fig. 16-6). A more appropriate size division for this group would be: Small (4.0 - 5.5mm), Medium (5.6 - 8.0), Large (8.1 - 14.0). The apparent differences in these two metric classification schemes highlight the problems involved in dating single beads by size alone, especially when immature specimens were being collected and used. In addition, the NFI beads probably were obtained through a Northern California exchange network whereas the metric divisions tabulated above pertain to beads obtained through a Central California network. Data are presently too incomplete to decide whether different size shells were being selected in these two networks. While most beads are of medium size in both measurement systems, the small and large categories differ significantly (n = 616):

Bead size	NFI	Central California
Small	9.9%	2.9%
Medium	58.3%	51.8%
Large	31.8%	19.3%

Unfortunately, the sizes of Simple Spire-lopped (A1) beads have not proved to be especially good time markers because of their extended period of use--from ca. 6000BC to ethnographic times. Unequivocal grave lot evidence or secure stratigraphic association available from sites in central California documents Early period and Phase 1--Late period emphasis on Small Spire-lopped beads (Type A1a). Large Spire-lopped (A1c) are more common during the Middle period and Proto-historic period, but Medium-sized Spire-lopped beads (A1b) can occur during all periods and, at present, have no precise temporal significance (Bennyhoff and Hughes 1981a). Isolated small, medium and large forms can occur in any period.

The midden distribution of Large Spire-lopped (A1c) beads at NFI agrees with data available from several sites on the western Great Basin. Large (A1c) beads dominate the assemblage in all strata. This early emphasis on type A1c is also reflected at Gatecliff Shelter,

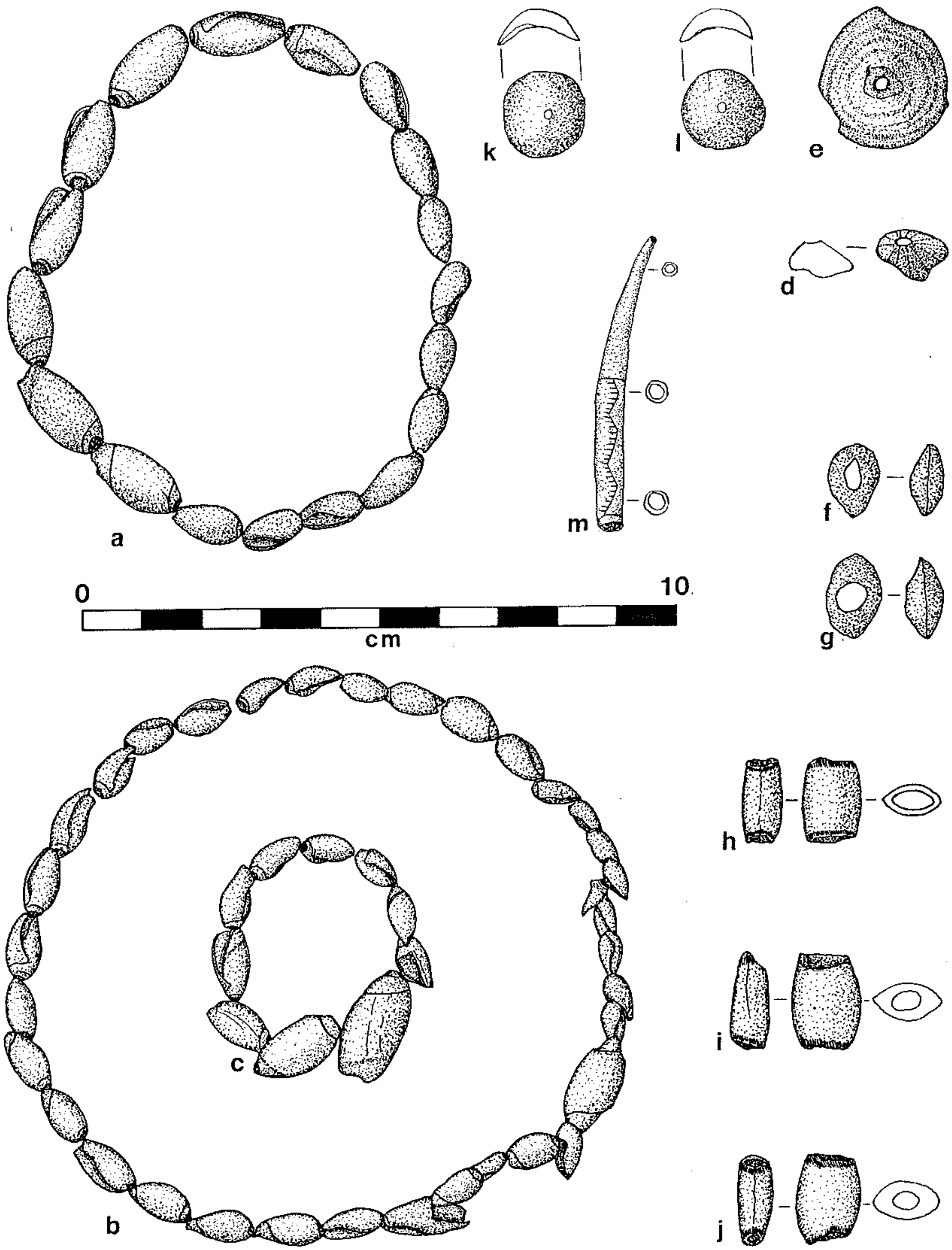

Fig. 16-5 Olivella spire lopped beads, not found in this arrangement, 12-TSFL in A6; (b) as in (A), in 14-MAL in I2-3; (c) 13-LAL in I3-4; (d) bead of Megatebennus, 14-MAL in E1-2; (e) bead of Acmaea, 15-UAL in J1-2a; (fg) chokeberry beads, carbonised, uncertain provenience, C.B. Howe collection; (h-j) pine nut beads, 13-LAL in Q3-4.

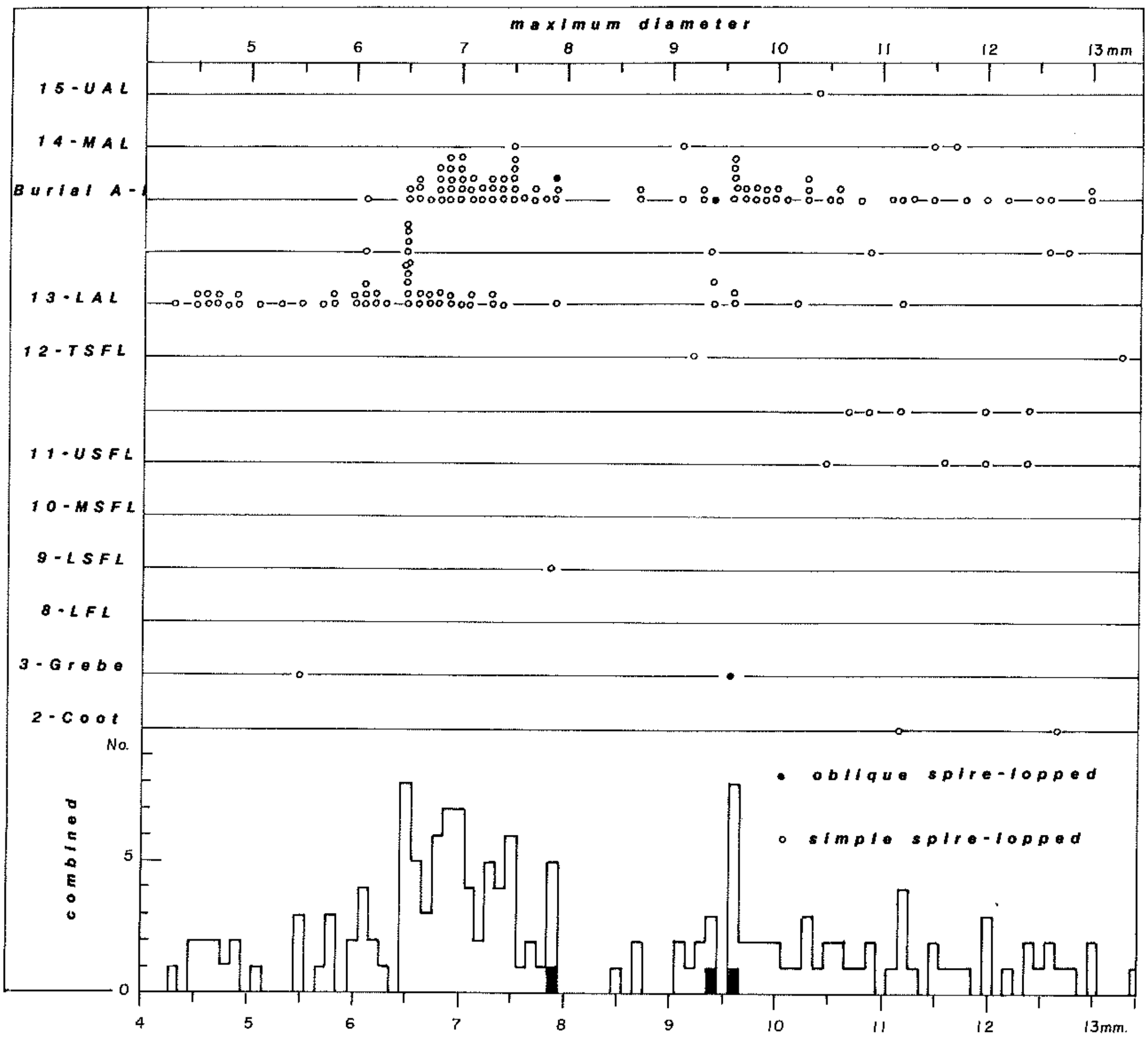

Fig. 16-6 Distribution of Olivella shell beads by stratum and diameter.

Horizon 6 (dated to ca. 1250BC-0BC) and at Leonard Rockshelter (Bennyhoff and Hughes 1981b).

Oblique Spire-lopped beads (A2) are emphasized in Early period grave lots in central California (Bennyhoff and Hughes 1981c) but this type, too, persisted into ethnographic times (Gifford 1947:10, type F5b). One of the two beads from the 3-Grebe (L4)--in an apparent disturbed context--is an A2 type. This would be chronologically consistent with the Early period emphasis suggested for the Great Basin and it is unfortunate that its associated C14 date is suspect. Perhaps this is the earliest specimen of its kind so far discovered. Occasional late use of type A2 is indicated at NFI by the occurrence of 14 type A2 with four burials. While type A2 represents only 2.4% of the 616 total spire-lopped beads, 4.9% of the 287 beads with four burials were type A2. Also these A2 specimens are, to our knowledge, the first archaeological occurrence of this type in northern California. Great Basin occurrences are limited, at present, to a small core area in Churchill and Washoe Counties, Nevada (Bennyhoff and Hughes 1981c).

Olivella Saddle Beads

Burial R-IX yielded 276 Saddle beads, clustered in the neck and left arm region. All specimens are clearly type F2 (Bennyhoff and Hughes 1981a) because bead width exceeds bead length (oriented with growth lines vertical). However, both the shape and the measurements indicate that these NFI specimens represent two new variants which will be designated F2c (Rectanguloid Saddle; 198 specimens) and F2d (Elliptical Saddle; 78 specimens). All but one F2c specimen have ground edges, in contrast to the frequent chipped edges of F2a and F2b.

Type F2c differs from type F2a (Full Saddle) and F2b (Round Saddle) in having a definite rectanguloid rather than oval shape, and there apparently has been no attempt to cut the bead on a diagonal across the growth lines as in types F2a and F2b (see Fig. 16-7a-f). The 165 measureable specimens reveal significant contrasts when compared to 87 F2a specimens from five central California grave lots, including a greater range for all measurements and the rare occurrence of shelved variants:

	F2c		F2a	
	range(mm)	$\overline{X}$(mm)	range(mm)	$\overline{X}$ (mm)
width:	6.6 - 13.5	10.0	8.0 - 13.6	10.1
length:	6.3 - 12.2	8.4	7.0 - 11.9	8.5
curvature:	1.4 - 5.0	2.8	2.3 - 4.7	3.3
perf. dia.:	1.2 - 2.4	1.6	1.2 - 1.9	1.4

	n	%	n	%
shelf edge	11	5.6 (Fig. 16-7, e)	0	0
shelved	10	5.0 (Fig. 16-7, f)	0	0

The NFI specimens represent the northernmost occurrence of type F2 saddles yet reported, but the shape and metrics suggest that the manufacturing center was different from that responsible for Central California Saddles. A single fragment of the wall section of an Olivella shell was found in the loose fill of the bulldozer cut. It probably represents a broken spire-lopped bead rather than evidence for local bead manufacture, although Haliotis ornaments were made locally.

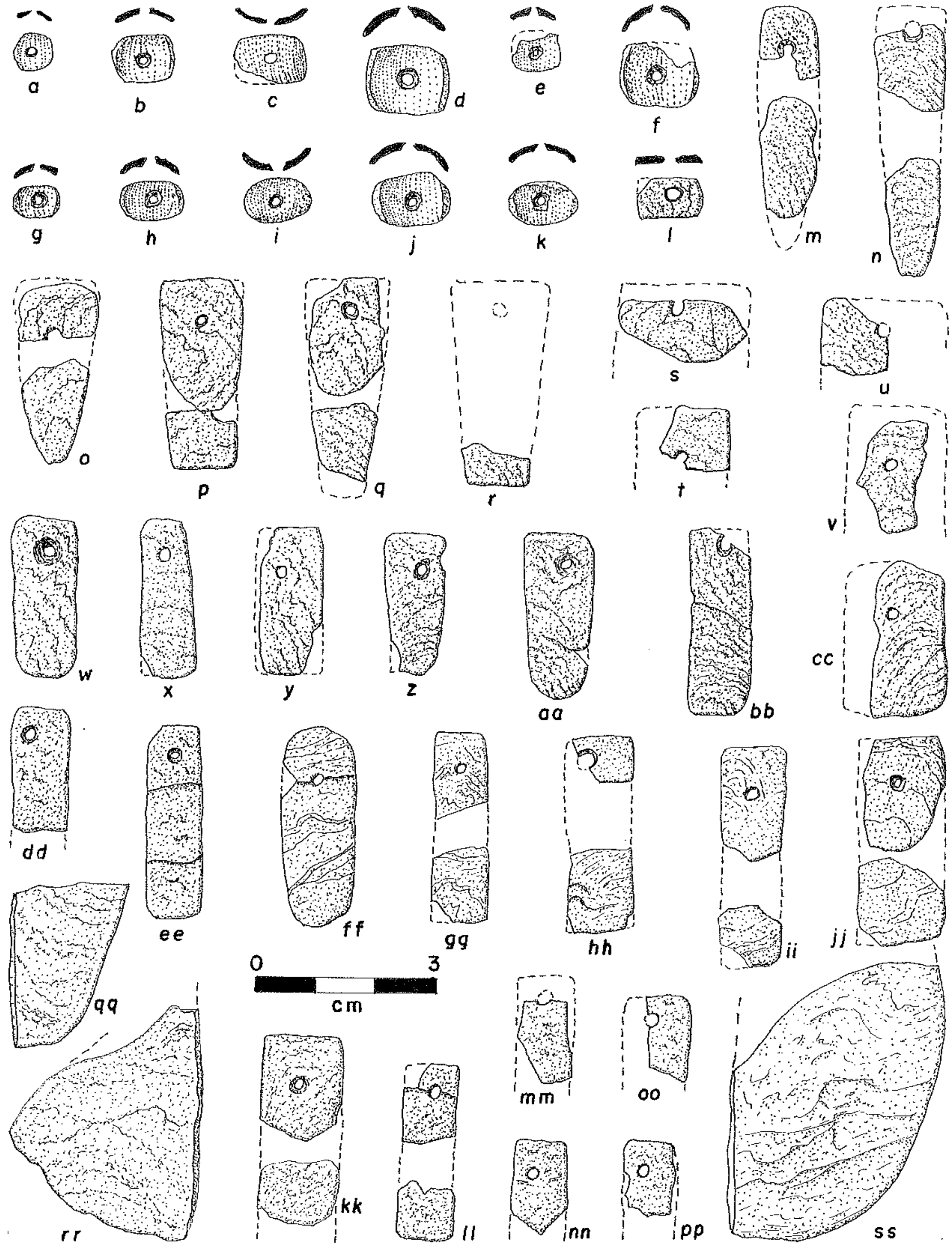

Fig. 16-7 (a-f) Olivella saddle beads Type F2c from Burial R-IX; (g-k) Type F2d from Burial R-IX; (l) Haliotis Type H1a bead from the loose fill of bulldozer cut; (m-pp) fragments of calcined Haliotis ornaments (?Haliotis rufescens) from the cremation fill of Burial E-X; (qq-ss) Haliotis ornament blanks.

The occurrence of only type F2a and F2b in grave lots (unmixed with Square Saddles, type F3) is diagnostic of the Intermediate Middle period in central California. A similar dating can be suggested for both F2c and F2d at NFI.

The elliptical saddles (type F2d) are distinguishable from other saddle variants by their elongate oval shape (Fig. 16-7g-k); their width/length ratio is tightly clustered between 1.20 and 1.51, whereas the ratio for other F2 variants extends down to 1.0. While most other metrics approach the range of F2c, the average bead is distinctly shorter. Only three of the 78 specimens retain a shelf-edge (Fig. 16-7k; none have a projecting shelf). The 75 measureable specimens provide the following metrics:

Width:	7.1 - 11.2mm, $\overline{X}$ = 9.4mm	
Length:	4.8 - 8.5mm, $\overline{X}$ = 7.0mm	
Curve:	1.5 - 3.4mm, $\overline{X}$ = 2.4mm	
Perf. dia.	1.2 - 2.3mm, $\overline{X}$ = 1.4mm	(mode = 1.8mm)

Haliotis Square Bead

A single type H1a bead (Fig. 16-7l) was found in the loose fill of the bulldozer cut. The epidermis had exfoliated, but all other abalone specimens at NFI represent *Haliotis rufescens*. The bead measured 11.0mm wide, 7.6mm long, and ca. 1.4mm thick; the central perforation was 3.0mm in diameter. While a single bead cannot be emphasized, this type is diagnostic of the Early period in central and southern California as well as the western Great Basin (Bennyhoff and Hughes 1981a). This is the northernmost occurrence reported for this bead type.

Haliotis Ornaments

Burial E-X, a cremation, yielded a minimum of 30 calcined abalone ornaments (Fig. 16-7m-pp). All appear to be *Haliotis rufescens* but the ground epidermis is too altered to permit certain species identification. Only 9 specimens are reasonably complete; the remainder are badly broken and suffered extreme exfoliation. An attempt has been made to match top and bottom fragments on the basis of shape, size, curvature and color, and it is felt that not more than 34 ornaments could be represented by the sample collection. Classification by shape is hindered by their broken condition, the simple forms represented, and the paucity of abalone ornaments from northern California. No decorative incising is present, and it is quite possible that a single elongate "type" is represented. Until complete specimens with double perforations are found in northern California, it will be assumed that all the NFI specimens had a single end perforation. The notable distance of the perforation from the top in 8 specimens (Fig. 16-7tvycc, ii-kk) would be unusual in central California and suggests a northern origin as does the lack of incision. The majority (ca. 23) suggest an oblong shape, though four (Fig. 16-7np-r) could be termed trapezoidal, two (Fig. 16-7mo) suggest a triangular shape and one (Fig. 16-7ff) could be considered oval. The epidermis on the back has been ground smooth on all specimens; 11 of 30 suggest that the epidermis had been removed completely. While these simple shapes occur from the Early period onward, the probable

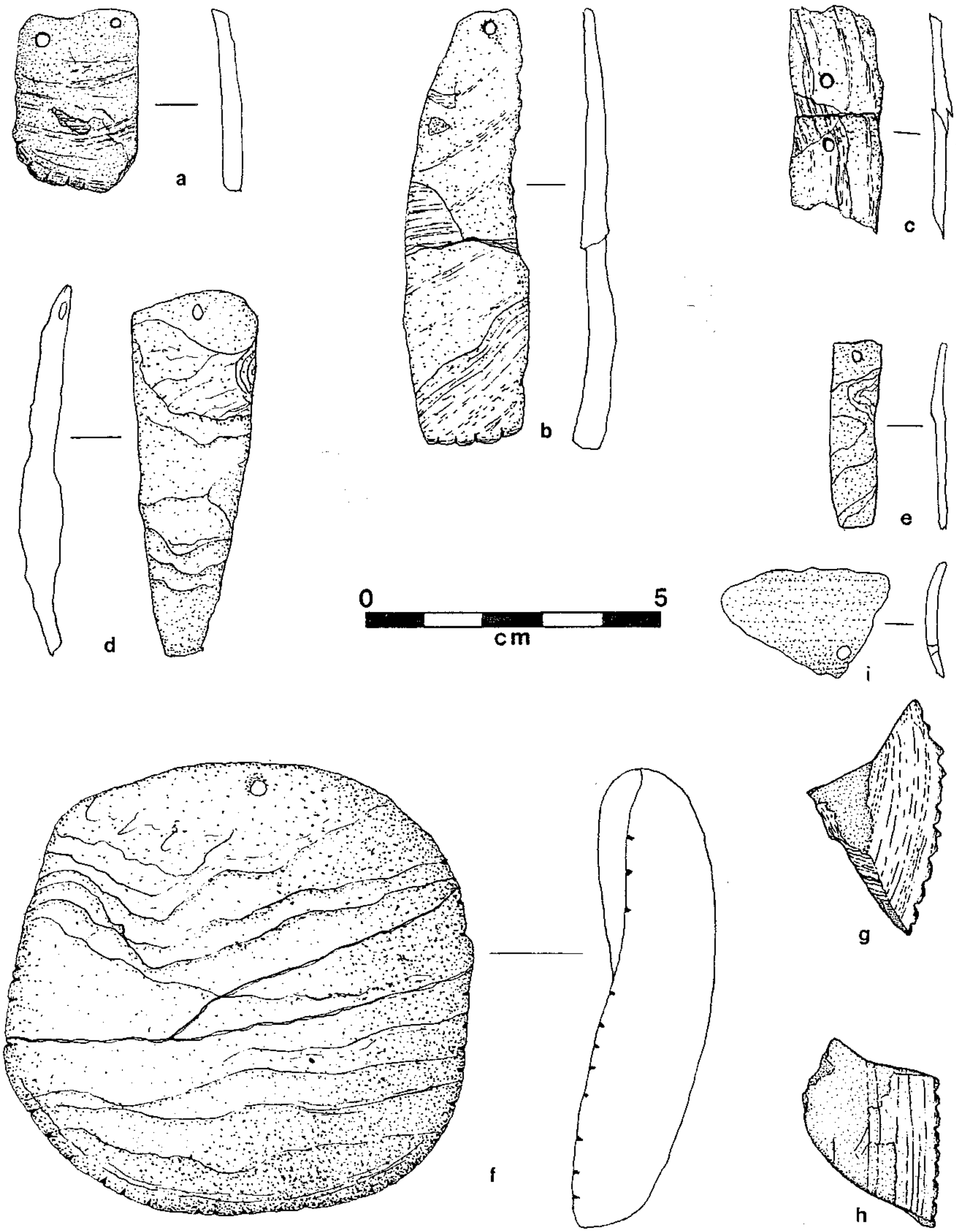

Fig. 16-8 (a-f) Haliotis pendants in the C.B. Howe collection. (a-c) on pit house floor intersected by bulldozer cut in the IJ area; (d-f) with cremations in the 14-MAL in the EJI area; (gh) notched clam fragments, probably from 6-S&B or 3-Grebe in R, but disturbed by intrusive burials; (i) abalone fragment on wrist of burial S-I.

emphasis on red abalone and the oblong form emphasis suggest that Burial E-X should date to the Late period and post-dates the saddle beads found with Burial R-IX. Burial S-I had a triangular abalone ornament attached to the wrist (Fig. 16-8i).

Haliotis Ornament Blanks

Burial S-I was accompanied by 5 *Haliotis rufescens* ornament blanks (Fig. 16-7qq-ss). The epidermis had been ground smooth on all specimens, but the pink color remained visible. The roughly triangulate pieces retained roughly sawed edges with minimal grinding, and no purposeful shaping or attempted perforation is evident. All had at least one broken edge, but they ranged in size from 28 x 19.4 x 2.0mm to over 47.6 x 34.5 x 2.0mm. At least occasional local manufacture of abalone ornaments in the interior of northern California can therefore be proposed. A small, unmodified fragment (12.4 x 11.3 x 1.0mm) of *Margaritifera margaritifera* shell was in the same grave but probably represents food refuse in fortuitous association.

Figure 16-8 shows some examples of abalone pendants rescued by Howe with the cremation in the 14-MAL in the E, I, J area. Several additional specimens are illustrated by Howe (1979:216-217, 220-221) and the same area yielded about half of an abalone shell with a series of notches along one edge.

Other Shell Beads

Shell beads of other marine species may not have reached the site before the 13-LAL at around 300AD. Again, most of these come from the burials. Two notched-edge clam fragments which may be from pendants (Fig. 16-8gh) come from the lower layers of Pit R--probably derived from the intrusive burials which date from the Arrowhead Loams. These specimens almost certainly post-date 300AD, therefore. The only beads not found with burials were the perforated specimen of *Acmaea* sp. (limpet) in the 15-UAL at J-1-2a (Fig. 16-5e) and another of *Megatebennus bimaculatus* (keyhole limpet) in the 14-MAL of E1-2 (Fig. 16-5d).

The C. B. Howe collection contains beads of the following marine molluscs: *Haliotis* sp., *Dentalium pretiosum* (tusk), ?*Tresus* sp., ?*Tellina* sp., *Spisula* sp. (clams), *Mytilus* sp., and *Botula* sp., (mussels, *Acmaea* sp., *Megatebennus bimaculatus*, and *Glycimeris subobsoleta* (glycimeris). Although none of these is from a secure provenience, it is reasonably certain that most of them come from cremation pits dating to some part of the Arrowhead Loams. The same applies to the dense concentration of 200 beads of a local freshwater mussel found by Howe (1979:209-219).

Nutshell Beads

Three pine nut beads were recovered from the 13-LAL (Fig. 16-6h-j). The ends were charred and the kernel removed so that the shell could be strung. Rare carbonized chokeberry beads (Fig. 16-5fg) were found by Howe in the upper part of the Loams sequence, together with several pine nut specimens.

Conclusions

The extreme paucity of stone drills at NFI (Chapter 14) hints strongly that the very abundant marine shell ornaments were not made here. Although whole shells were imported from the coast (e.g. the half abalone from the Howe excavations), and five abalone ornament blanks occurred wiith Burial S-1, there are no other grounds for believing that marine shell ornaments were made locally. It is assumed that most of these specimens reached the area as ready-made exchange items.

Although the exchange sphere of the NFI inhabitants may have come into contact with the Pacific coast in earlier times (two Olivella beads in the 3-Grebe), the first reliable date for such contact comes in the 11-USFL around 600BC. By the time of the 13-LAL (300AD), the position of the NFI occupants in the wider exchange network may have become more central. During the Arrowhead Loams accumulation, this group probably served as important dispersal agents for such items. Certainly, their position near the opening of the Klamath River Gorge would have given them a strategic advantage for controlling the flow of exchange items between the coast and the lake country east of the Lower Klamath basin. Goods entering Modoc territory from the coast were more likely to pass this way than along any other route, given the physical barriers and recorded political animosities of neighboring tribes. Steatite objects will have followed a similar route, the nearest steatite outcrop being at Happy Camp (Fig. 11-1) where the Klamath River cuts through the Siskiyou Mountains.

The site itself need not be construed as a dispersal center, however. Olivella beads (Type A1) have been documented at other sites in the lower Klamath Basin, among them Petroglyph Point Cave #1 (Heizer 1942:Fig. 66b, top) Sis-223, Sis-239 (Squier and Grosscup 1954) and Sis-259 and Sis-303 (J. Johnson, pers. comm.). Twenty specimens were recovered from emergency excavations at nearby Sis-258, though "thousands" of this type were reportedly obtained there by local residents (J. Johnson 1966:15). This must mean that NFI was just one of the sites periodically occupied by the group who had taken control of the exchange network for this region.

Several questions arise from the timing of these events: does the switch in site roles from semi-permanent winter village to summer fishing village have anything to do with the inhabitant's concern with the exchange network? Also, is it chance that these events coincide with the advent of bow-and-arrow technology? Further, what is the connection between the rise of this network, and the evidence for increased inter-group violence (outlined in Chapter 19)? Discussion of these problems will be delayed until the closing chapters.

CHAPTER SEVENTEEN

PIPES

Smoking pipes made of drilled and ground stone were recovered from 11 pits in the northeast and southern areas of the site. The earliest fragment came from the top of the 6-S&B. The 10-MSFL yielded the largest number of pieces, and several complete specimens came from the Arrowhead Loams (Table 17-1).

A large but selected sample of pipes was recovered from C. B. Howe's excavations in the NOUT area, from the EBJ area, from the spoil of the bulldozer cuts, and from the burial group exposed in the irrigation ditch west of K (see Chapter 1). This collection contains several complete pipes, unfortunately without adequate stratigraphic documentation, but nevertheless providing valuable supplementary data.

Typology

Three major categories can be recognized. Composite Pipes with stone bowls into which bird bone mouthpieces are attached; Straight Pipes in which smoke is drawn in a straight line from one end to the other, without separate mouthpiece attachments; and Angle Pipes carved in one piece, but with a pronounced elbow in both the body and the internal smoke-canal. Each of these major categories can be further subdivided. Composite Pipes include: Composite-inserted stem in which the bird bone mouthpiece is inserted into a narrow canal at the thick base of the elongated stone bowl (Fig. 17-1a or Fig. 17-5b); Composite-flanged also an inserted-stem design, but carved with a flange around the exterior of the bowl, probably to distribute heat and to facilitate holding the hot bowl (Fig. 17-4d, Fig. 17-6a); Composite-inserted bowl in which a short, usually thin-walled bowl is inserted into the flared end of a bird or mammal bone and bound in place with cord or sinew (Fig. 17-6e).

Straight Pipes include: Straight-constricted in which the smoke-canal narrows, usually near the bowl-end, to hold a carved stone plug--either drilled or laterally notched--in the constriction (Fig. 17-5acd); Straight-open in which the smoke-canal is unconstricted. The outer diameter is uniform along the whole length of the pipe, and the canal diameter is roughly uniform, or tapers from bowl to mouthpiece-end. Both ends are slightly bevelled (Fig. 17-7b); Straight-tapered in which the exterior of the pipe is wider at the bowl than at the mouthpiece end, the walls are relatively thinner at the bowl end, and the interior canal has no constriction; but also tapers towards the mouthpiece (Figs. 17-3d, 17-4a).

Angle-pipes include: Angle-flanged, relatively small pipes with a carved ridge running parallel to the long-axis of the mouthpiece section. The ridge is notched and probably served to distribute heat and facilitate holding; Angle-plain, both canal and exterior make a distinct elbow about halfway along the length of the pipe. The mouthpiece section tapers towards the end in both canal and exterior while the bowl end is of uniform diameter. No complete specimens are available but an elbow fragment is seen in Fig. 17-2d. See Howe (1979:131) for more complete examples.

The stratigraphic distribution of these types may now be discussed. Although no pipe fragments were found below the 6-S&B in the controlled excavations, several specimens were found in that context by C. B. Howe, and some of these still have traces of the yellow-mottled sediment of the 5-Scaup mucks adhering in scoriae voids. Four of these are shown in Fig. 17-7acf. All of them,

Table 17-1

Distribution of stone pipes and pipe fragments

Stratum	A	B	E	G	I	J	P	Q	T	V	Y
15-UAL	-	-	-	-	-	-	-	-	-	1	-
14-MAL	-	-	4	-	-	-	-	1	-	-	-
13-LAL	-	-	-	-	-	-	-	1	-	-	-
12-TSFL	-	-	-	-	-	-	-	-	-	-	-
11-USFL	-	-	-	-	-	-	-	-	1	-	-
10-MSFL	1	1	1	-	3	1	-	-	-	-	1
9-LSFL	-	-	-	-	-	-	1	3	-	-	-
8-LFL	-	-	-	1	2	-	-	-	-	-	1
6 S&B	-	-	-	-	1	-	-	-	-	-	-

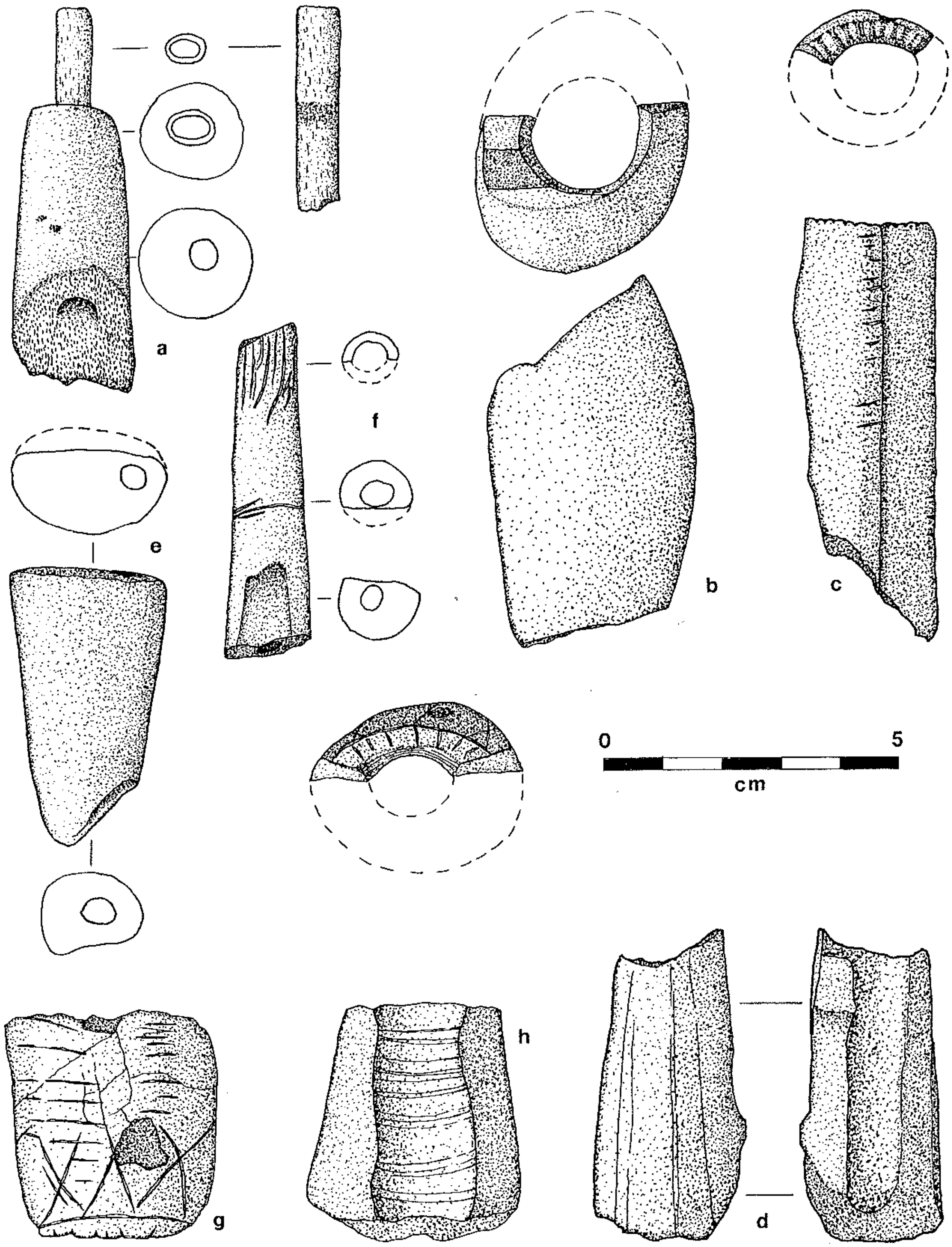

Fig. 17-1 Pipe fragments: (a) sandstone stem fragment with birdbone mouthpiece inserted, from 6-S&B in I8, probably derived from overlying surface; (b) bowl fragment with part of rim, 9-LSFL in P9; (c) sandstone shaft fragment with notched rim, 8-LFL or base of 10-MSFL in I7c or surface of I8; (d) sandstone stem fragment, as in (c); (e) basalt stem fragment, 10-MSFL in I7b; (f) incised sandstone stem fragment, 10-MSFL in J5b; (gh) incised basalt fragments, 10-MSFL in I7a.

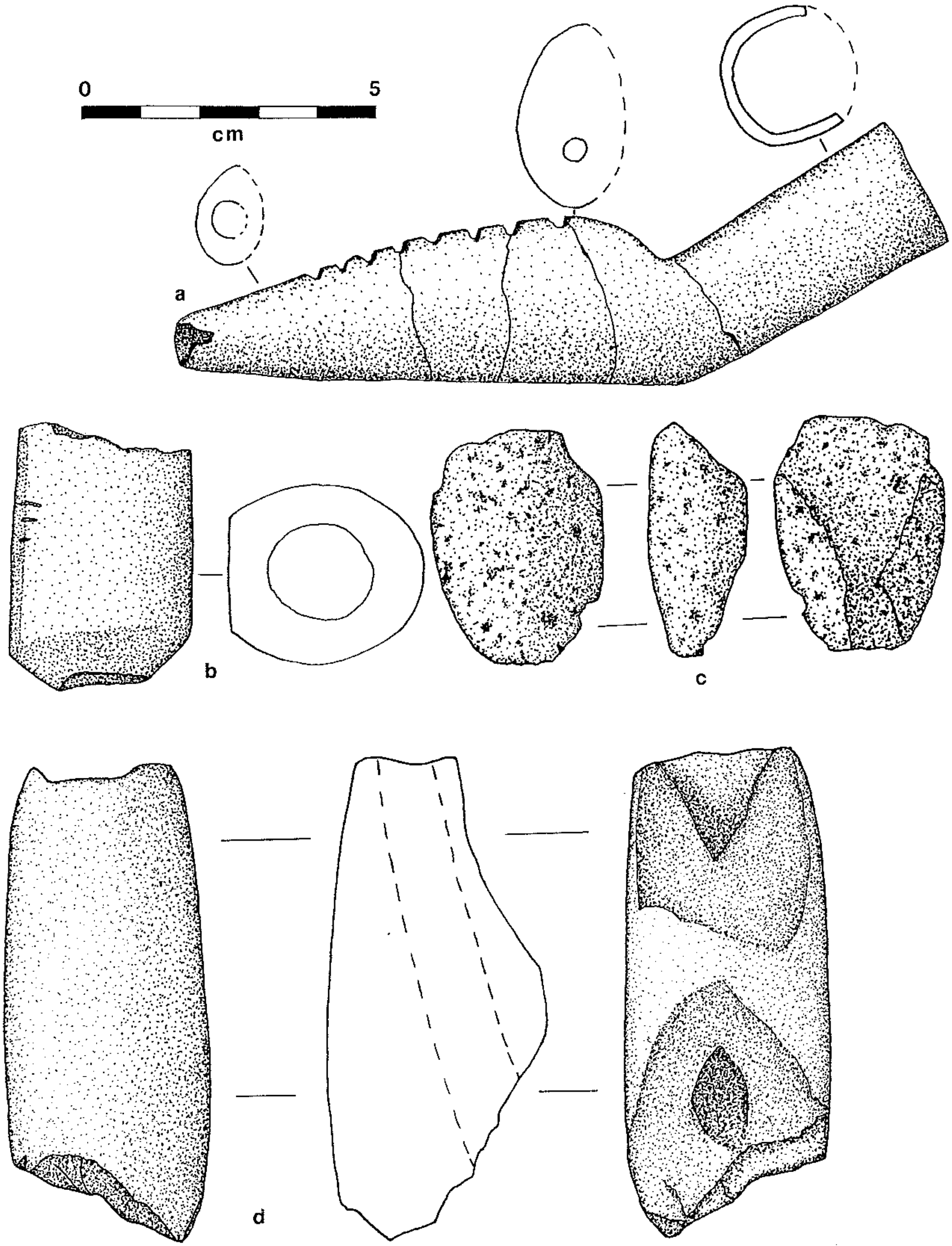

Fig. 17-2 (a) Angle-pipe, sandstone, with the 11-USFL burned house structure in E4b; (b) sandstone rim with flattened side, 10-MSFL in A13; (c) bowl fragment of scorioaceous lava, 10-MSFL in Q4; (d) sandstone stem fragment with curved canal, 10-MSFL in T3.

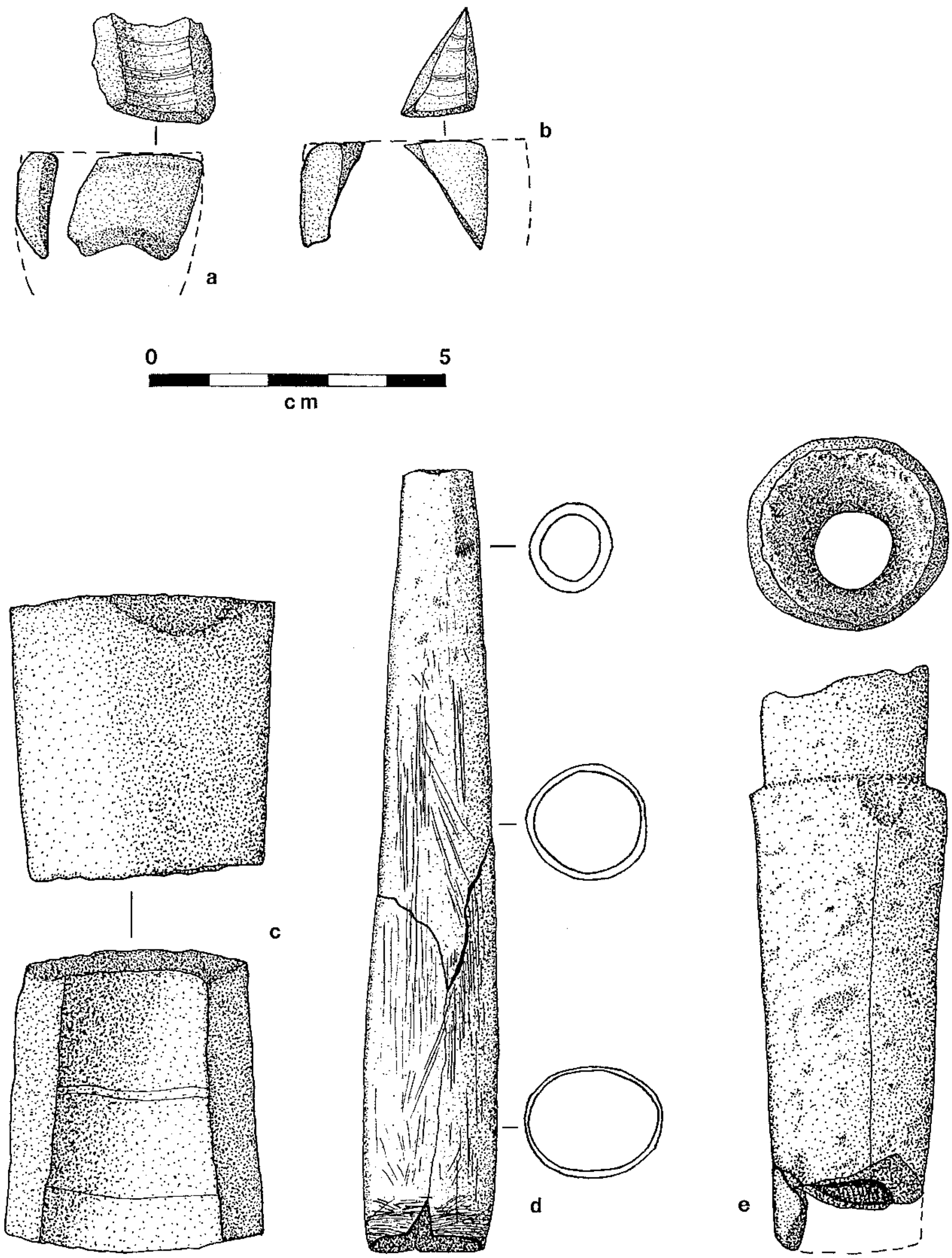

Fig. 17-3 (ab) Sandstone pipe bowl fragments, 10-MSFL in Q6-7; (c) basalt stem fragment, 10-MSFL at Y4; (d) whole steatite pipe from 14-MAL in Q2-3; (3) sandstone stem and rim from 11-USFL in X3b.

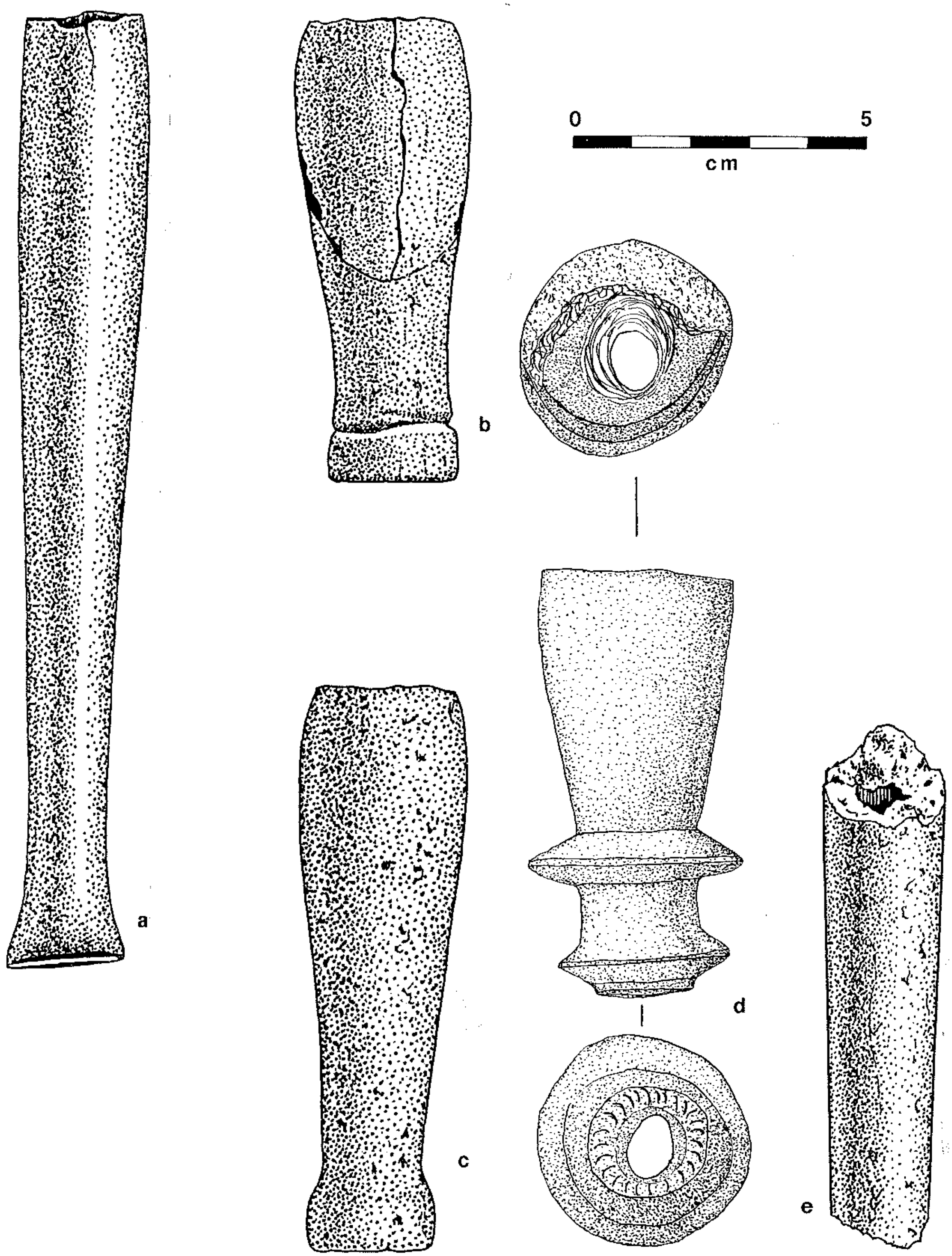

Fig. 17-4 (a) Steatite pipe in cremation pit fill of Burial E-X, 14-MAL in E1-2; (b) sandstone pipe in fill of Burial E-IX in the 14-MAL; (c) red sandstone pipe, as in (b); (d) flanged pipe carved from blackened ?kaolinite, 14-MAL in BEJ area, C.B. Howe collection; (e) sandstone stem fragment at base of cremation pit, with (a).

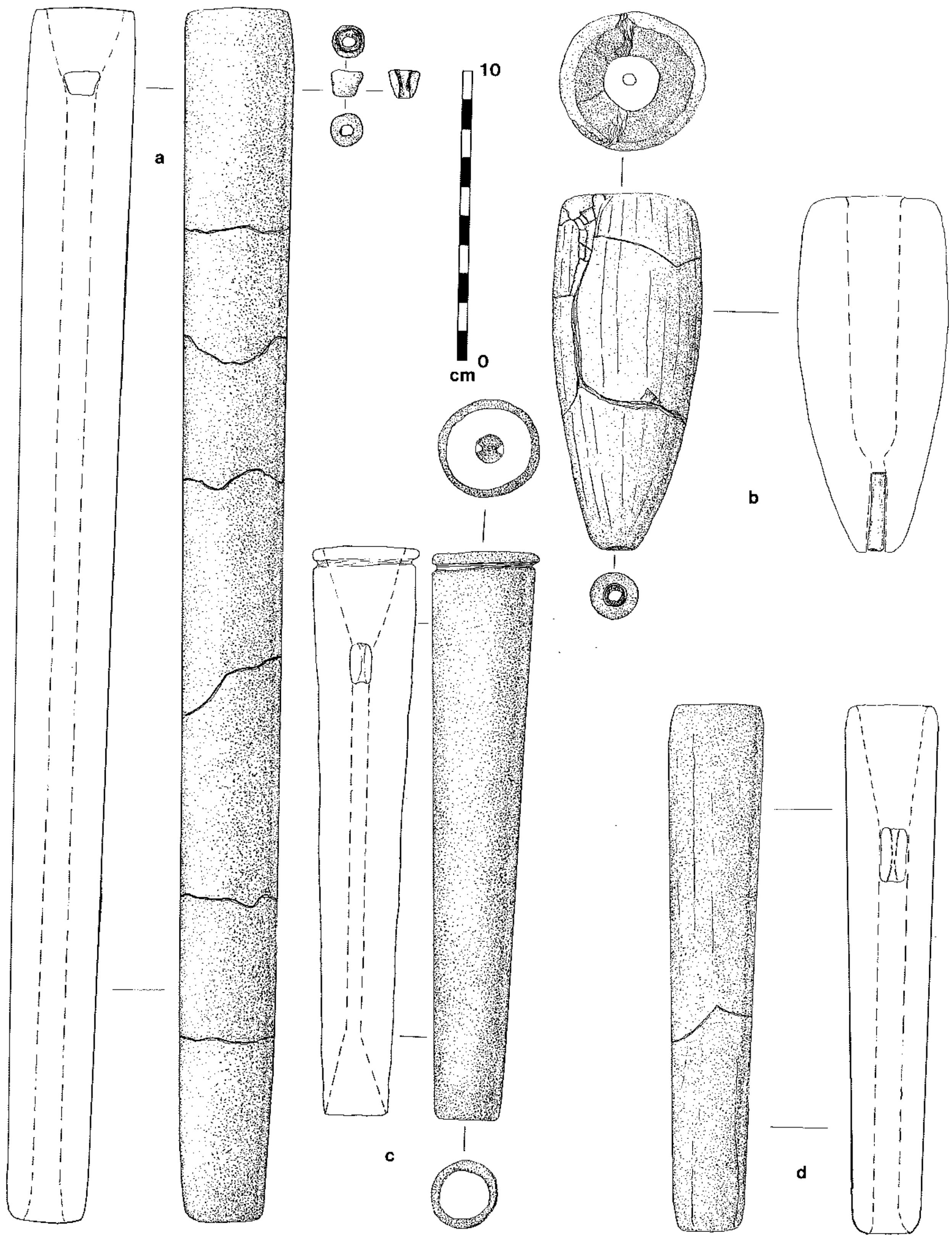

Fig. 17-5 (a) Straight pipe, dark brown sandstone, with conical drilled sandstone plug, probably 14-MAL, C.B. Howe collection; (b) light green ?clay pipe bowl with birdbone mouthpiece fragments inserted in the canal, associated with the cremations west of K; (c) straight pipe, gray-brown sandstone, with cylindrical, double-notched plug, probably 14-MAL, C.B. Howe collection; (d) straight pipe, dark brown steatite, with double-notched plug, probably 14-MAL but deeper than (a) and (c), C.B. Howe collection.

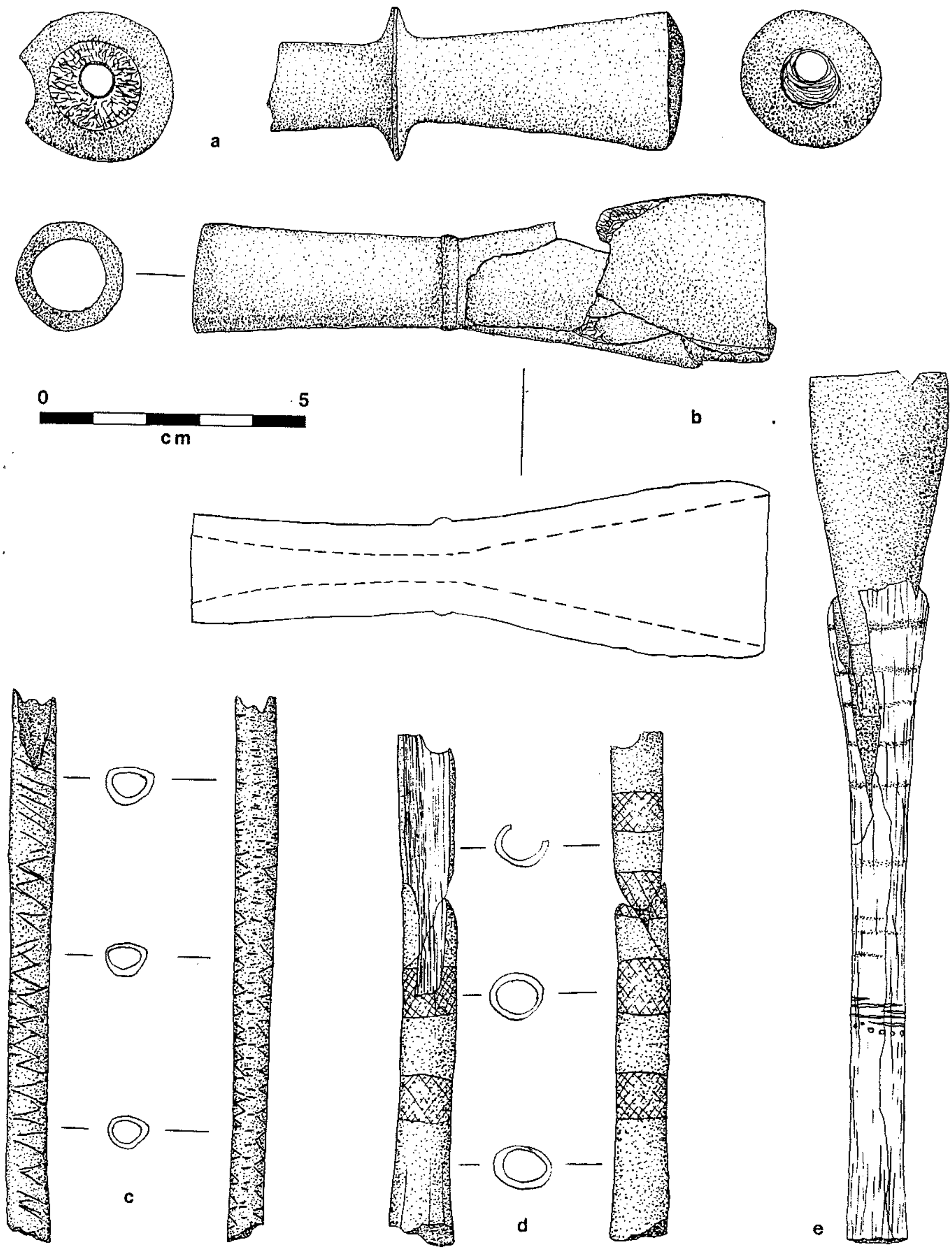

Fig. 17-6 (a) Flanged pipe, buff ?kaolinite, 14-MAL in EI area, C.B. Howe collection; (b) flanged pipe, dark red fine-grained lava, 14-MAL/15-UAL in EBJ area, C.B. Howe collection; (cd) decorated birdbone mouthpieces for pipes, 14-MAL in EJ area, C.B. Howe collection; (e) complete steatite pipe bowl inserted into bone mouthpiece with dark staining from bindings, 14-MAL/15-UAL in IJ area, C.B. Howe collection.

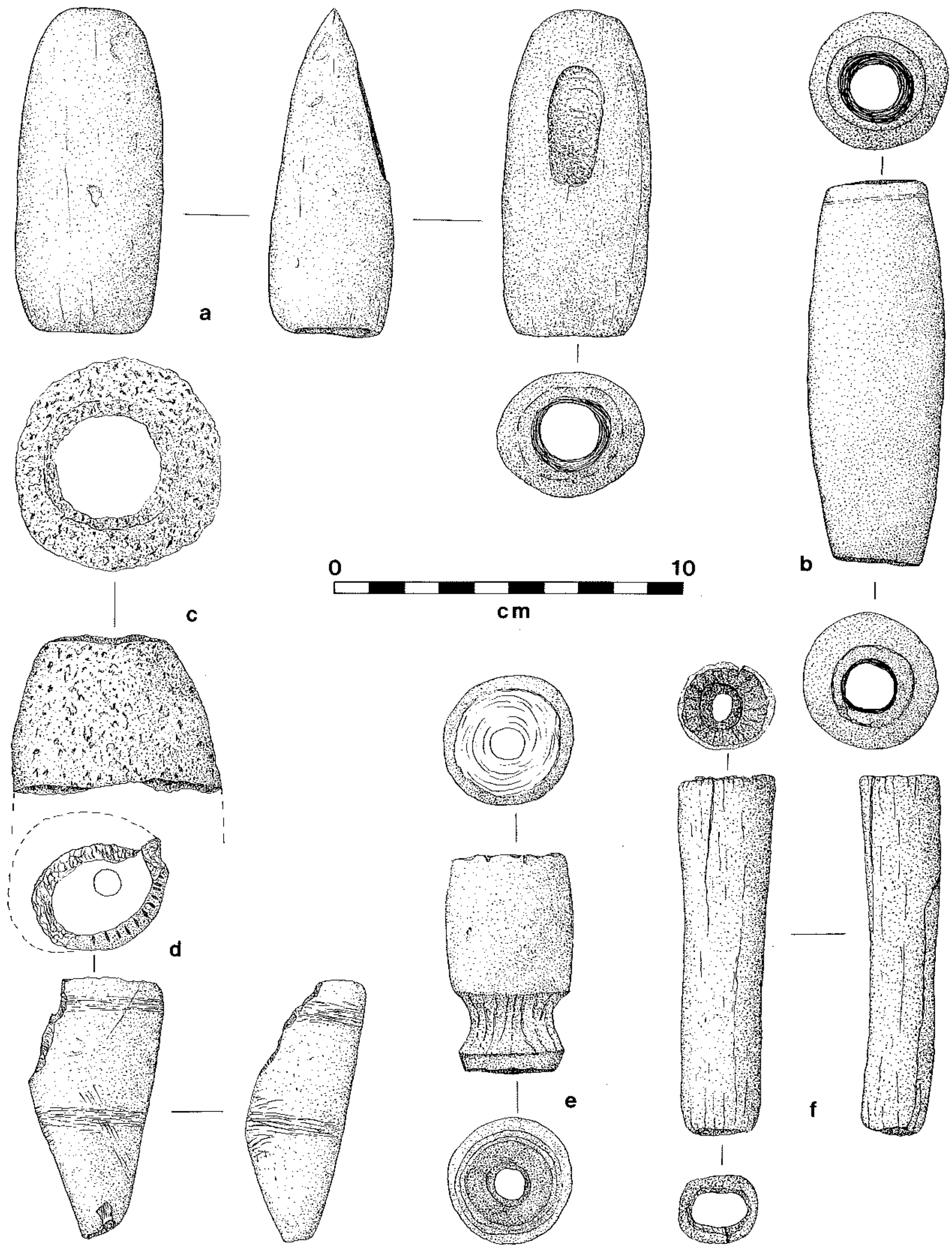

Fig. 17-7 (a) Pipe end fragment bevelled to the shape of a wedge, presumably recycled as a hide-working tool, light red sandstone or cinder, purported to come from the 3-Grebe between D and H; (b) red cinder pipe, possibly from the 5-Scaup north of I; (c) scoriaceous lava end fragment, supposedly from the 3-Grebe southwest of O; (d) pipe bowl with offset canal, white ?kaolinite, in 9-LSFL/ 10-MSFL west of U; (e) fine basalt pipe bowl, probably 10-MSFL between D and H; (f) highly polished antler pipe with charred interior, purported to come the 3-Grebe or 5-Scaup between O and T. All specimens from C.B. Howe collection.

including the antler specimen, can be placed in the Straight-open subtype, and they are made of red volcanic cinder or of scoriaceous lava. Illustrations of additional specimens may be seen in Howe 1968:239 and 1979:133. A composite-inserted stem specimen is also claimed from these strata (Howe 1968:240) but the documentation is not quite as firm for this specimen. Although not recovered under ideal conditions, there are sufficient grounds for accepting that they came from the 5-Scaup or from the 6-S&B at the very latest. They are made of local rock types, they are of the most elementary design, and there are no fragments from the overlying strata which could be fitted into this subtype. Subject to verification by future research, it is tentatively proposed that these are the first pipes to appear at the site (Table 17-1).

The next clear grouping is in the Small-flake Loams, but many of these pieces are too fragmentary to be typed. The least ambiguous pieces suggest that the following subtypes were used: Composite-inserted stem (Figs. 17-1a, 17-2c, and Howe 1979:136, 139); Composite-flanged (Fig. 17-3e); Angle-flanged (Fig. 17-2a and Howe 1979:131); and Angle-plain (Fig. 17-2d). Some pieces, e.g. Fig. 17-3c, may belong to the Straight-constricted type, but are too small for certain diagnosis. Basalt came into limited use for pipe-making, and a buff-colored fine sandstone was preferred to the local soft volcanic rocks. The source of this material is unknown.

In the Arrowhead Loams, particularly in the 14-MAL, Composite-inserted bowl, Straight-constricted and Straight-tapered forms were introduced and steatite came into use for pipe-making for the first time. More complete specimens were recovered since they were included with burial goods during this period.

Commentary on the Pipes

There is little direct evidence to allow the reconstruction of pipe manufacturing techniques, and no experimental replication has been attempted. The bowl interior of the specimen in Fig. 17-7e shows clear rotary scarring which is not perfectly symmetrical. This suggests a scraping action rather than the use of a manual drill. Although such action would suffice for widening the ends of the smoke-canal, the canal itself must have been completed by drilling. However, flaked obsidian drills are absent from the site, except for a few irregular and lightly-worn specimens found in the Howe excavations. Drilling may have been accomplished with wooden or reed drills used with a drilling grit of sharp-edge minerals obtained by breaking down basalt chunks (Howe 1979), but no direct evidence of this has been obtained. Another possibility is that pipes were not manufactured here, but were acquired ready-made by trade. However, there are rare hints that in the 10-MSFL pipe-making actually took place here. Fig. 17-1e may illustrate a specimen which was incorrectly drilled, and the C. B. Howe collection includes another in which the drill-holes from opposite sides have failed to meet. Howe (1979) suggests that some specimens resembling those classed in this work as small mortars (Fig. 10-8) could in fact be unfinished pipe bowls. None of the other available specimens from the 10-MSFL show clear signs of breakage during manufacture. In the Arrowhead Loams, signs of on-site manufacture are definitely absent. Although the sample is small, and not always sufficiently documented, there are enough grounds for concluding that pipes were at first made here from local rock types and that this industry was supplemented during the Small-flake Loams by exotic rock types and by some ready-made pipes from elsewhere. By the time of the Arrowhead Loams, this industry had been supplanted by a thriving traffic in sophisticated pipes acquired through trade from elsewhere. The possible sources of these pipes and of their exotic rock types remain to be investigated as part of a larger research project on the regional pipe-trade.

The substance probably smoked most frequently was Nicotiana attenuata (Coyote tobacco) which Howe (1979) reports growing on Sheepy Island and near several historic Modoc camp-sites. Howe also points out that there is a strong possibility that it was deliberately planted by the Modoc, but this would require an elaborate botanical field survey to verify. At least one specimen in the Howe collection contains a carbonized cake and an unburned wad or "dottle" in the base of a Composite-inserted stem bowl (Howe 1968:239). If similar specimens can be recovered, identification of the plant-fibre may prove possible.

The limited sample available suggests that pipes were occasionally decorated, but without great care or attention (e.g. Fig. 17-1g). Howe (1979:135) illustrates several additional decorated fragments in which the prevailing motifs are hastily executed chevrons, parallel notches, or rings around the pipe circumference. One specimen has its outer surface pitted, with disc shell beads inserted into a row of larger pits. The presence of similar motifs on two bird-bone fragments in the Howe collection suggests that these may have served as mouthpieces (Fig. 17-6cd), but they show no charring or staining of the interior. The significance of the motifs, if any, is unknown. They may designate ownership by a person or group, but none of the pipes found in burials or with cremations was so decorated. The ethnographic record indicates that Modoc/Klamath smoking was communal, with the pipe in use by several smokers, but the record is silent on pipe ownership (Gatschet 1890).

The later historic Klamath and Modoc were seen by Spier (1930) in 1925-26 to be using a Composite-inserted stem type of both stone and clay with a wooden mouthpiece of elder from which the pith had been removed. He also reported that stone angle-pipes were in common use. Only one clay specimen was recovered from a peripheral burial (Fig. 17-5b) without adequate documentation. It seems likely, however, that the ues of clay in pipe-making may have preceded European contact, at least at Nightfire Island.

CHAPTER EIGHTEEN

HOUSE FLOORS AND RELATED FEATURES

Following the completion of the 6-S&B platform at Nightfire Island at about 2,900BC (see Chapter 5), a small group of closely-spaced dwellings with gray and/or white clay floors was established at the north end of the site. Outlines of the earliest of these (7-GraCl) cannot be seen because the excavation pits which located them are too small in area.

However, a decision was taken, after all 24 pits had been excavated, to devote a short time to stripping a floor with abundant charred timber which had been encountered in Pit E. This done, it was seen that a second, earlier house floor underlay the first, and this too was stripped under extreme pressure of time. The surviving records of the two structures reflect the usual shortcomings associated with such rapid operations. They nevertheless give us the only complete view of two types of Nightfire Island dwellings. A prominent feature of both structures was the incorporation of a clay lining to the floor. Without this special feature, many other dwelling surfaces would not have been visible during excavations. It became apparent, therefore, that several of these clay floors had been penetrated by pits elsewhere in the site.

These will be described, together with the two complete stripped floors in chronological order, by stratum.

The 7-Gray Clay

The four northern Pits ABDE intersected what appear to be the earliest fragments of clay pit house floors laid down on the 6-S&B basalt block surface (see Chapters 3 and 5).

House floor A16 is seen in section (Fig. 2-6) as a line of dark gray clay, thicker in the east face, thinning abruptly in the southwest, and missing from the northwest where the underlying gravelly 5-Scaup muck is exposed. Although the edges of A16 were not plotted before removal, they can be roughly reconstructed (Fig. 18-1a). Mud cracks were observed in the clay surface, which apparently yielded no artifacts. The very few obsidian and basalt flakes found at this level were bagged together with specimens from the underlying 5-Scaup and artifact associations are uncertain.

House floor B8 is another gray clay line in all but the west section of Pit B (Fig. 2-7). It was laid down directly on the 6-S&B surface, part of which was exposed on the west edge of the floor (Fig. 18-1b). The sections show that the hard-packed floor surface was irregular and varied in thickness. It was overlain by fragments of a later white clay floor (B7) in the southeast and southwest corners of the pit, and by organic muck in the northeast (B6). The floor may not have been cleared as a separate surface and the field records are ambiguous. Evidently, three post-holes originated from this surface--one of which was captured in the north section, and two of which were profiled (Fig. 18-1c). It is possible, but by no means certain, that the mortar pictured in Fig. 10-4f was set into this floor, but records of its true elevation conflict. Artifacts possibly from the surface of this floor were three unstemmed points (Fig. 13-5fg and 13-6a), a pestle (Fig. 10-11c) and 12 flakes with various edge damage. Two of the post-hole fills also contained one retouched flake each.

House floor D4c was unfortunately not drawn in section (Fig. 2-9) but was recognized during the excavation and bagging operation. Its

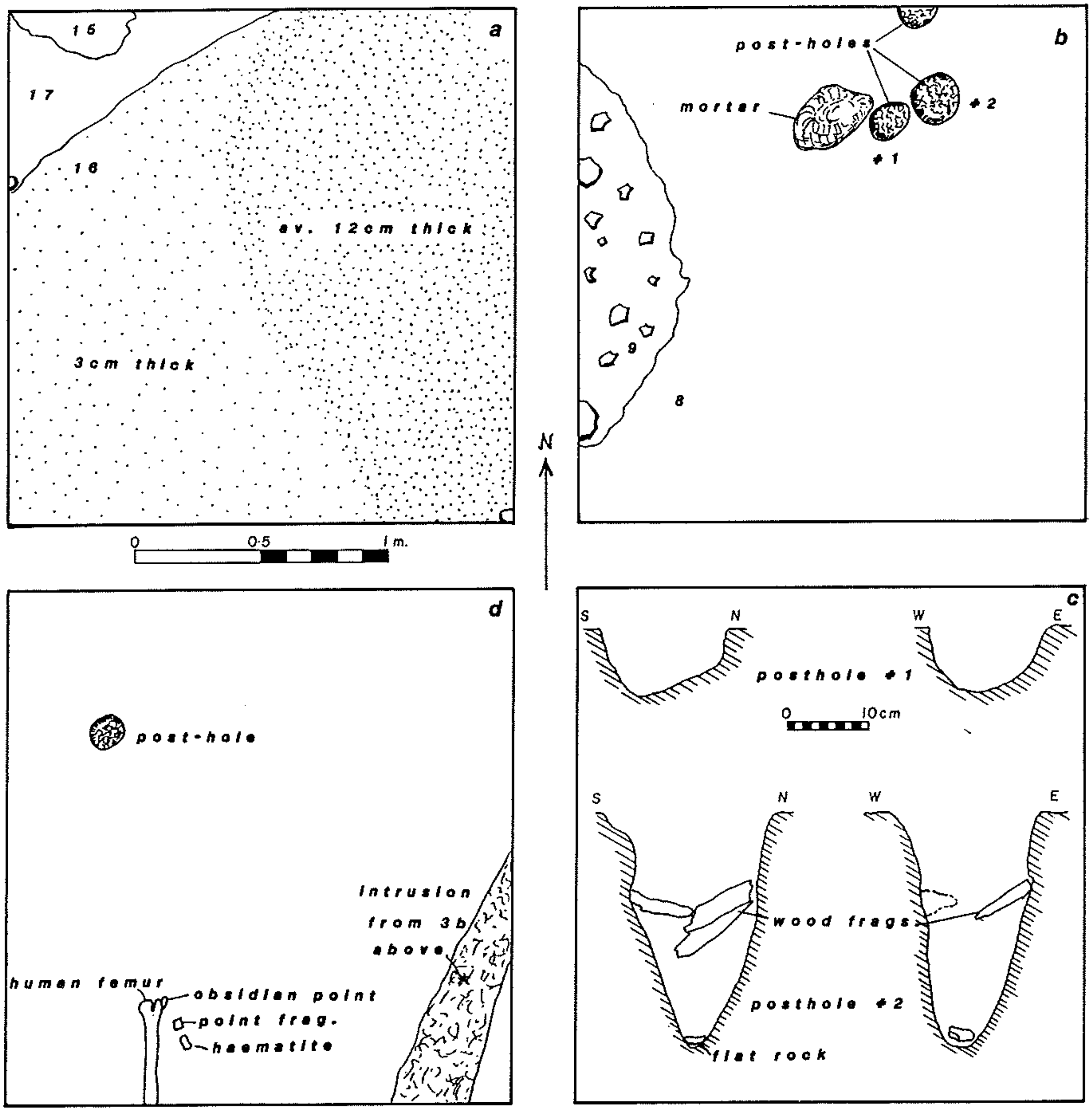

Fig. 18-1 (a) Reconstructed plan of the clay floor outline of A16 in the 7-GraCl; (b) reconstructed plan of the clay floor outline in B8 in the 7-GraCl; (c) profiles of the post holes in the clay floor of B8 in the 7-GraCl; (d) plan of the floor surface exposed in D4c in the 7-GraCl, with objects recorded in place.

horizontal extent cannot be recorded, therefore. It overlay the 6-S&B of D5, through which a single small post-hole penetrated to the lake bed. When transposed on to north and west sections of Pit D, the post-hole appears to originate in the 6-S&B, but its elevation records conflict and it probably originated on the floor. In the southwest corner of this floor fragment was a human femur lying with the proximal head covering a Side-Notched Type A point (Fig. 13-24f), a mid-section of a large Unstemmed point or knife, and a small lump of haematite (Fig. 18-1d).

House floor E10 was recorded only in the east face of pit E (Fig. 2-10) which lacks section records for the other three faces--consequently the extent of this gray clay floor within the pit is unknown. It was laid down on the surface of the 6-S&B in E11. It was not cleared as a separate surface and its contents, if any, were mixed with the overlying fill of E9 in a single spit.

Although it is reasonably certain that B8 and D4c were indeed pit house floors, this interpretation of A16 and E10 is based more on inference than on direct evidence. Their stratigraphic position, and the fact that they are both overlain by convincing floor framgents supports the interpretation, but the mud-cracks and enigmatic thinning in A16 can be viewed either as natural deposition or as flood-damage of the floors.

The 8-Large Flake Loams

A group of clay floors was intersected by Pits ABCEFJH. Their distribution overlaps with the preceding 7-GraCl, with a compacted surface extending around the northwest edge of the site (Pits C and F). This group also provides the first completely excavated floor (E8). The records for each pit follow.

A white silty clay floor occurred in A14 at the top of the 8-LFL sequence. The floor surface was scraped down, but no objects were plotted in place. The clay was missing from a patch in the east face where the underlying fill of the A16 pit house showed through. The surface of the A14 floor yielded two-mid-sections of bone awls, one of which is shown in Fig. 15-12f. Embedded in or just below the white clay itself was an Elko Side-Notched Point (Fig. 13-22h), a Northern Side-Notched Point (Fig. 13-17g), an obsidian projectile tip, an obsidian core, 11 retouched flakes and a bipointed stone of gray basalt.

In Pit B, fragments of another white clay floor intersected layer 6. These lay directly on the 7-GraCl floor of B8. There were two fragments--the thick, more extensive area was in the the southwest of the pit, and a thin lens was captured in the southeast corner. They apparently interfingered with a thin layer of black organic clay in the northwest. All three fragments were covered by the dark humic fill of B5. The B6 floor was scraped clean and yielded an Elko Eared and an Elko Corner-notched point, the mid-section of another obsidian projectile point and 10 retouched flakes, none of which was plotted in place.

C5a is actually a thick layer of brown organic clay. Its upper surface was seen to be compacted, and a single post-hole originating from the surface was sectioned in the north face of Pit C (Fig. 2-8). The surface was in turn covered by the laminated hard-brown clays of C4b. As it was not recognized during excavations, the surface was dug through without cleaning and its contents, if any, were bagged together with material above and below it.

The floor in E8 was the first to be completely stripped. The southern rim of the circular pit house was intersected in the north face of Pit E, which was dismantled before drawing. Excavations were extended northwards to uncover the entire floor, with a pause to draw

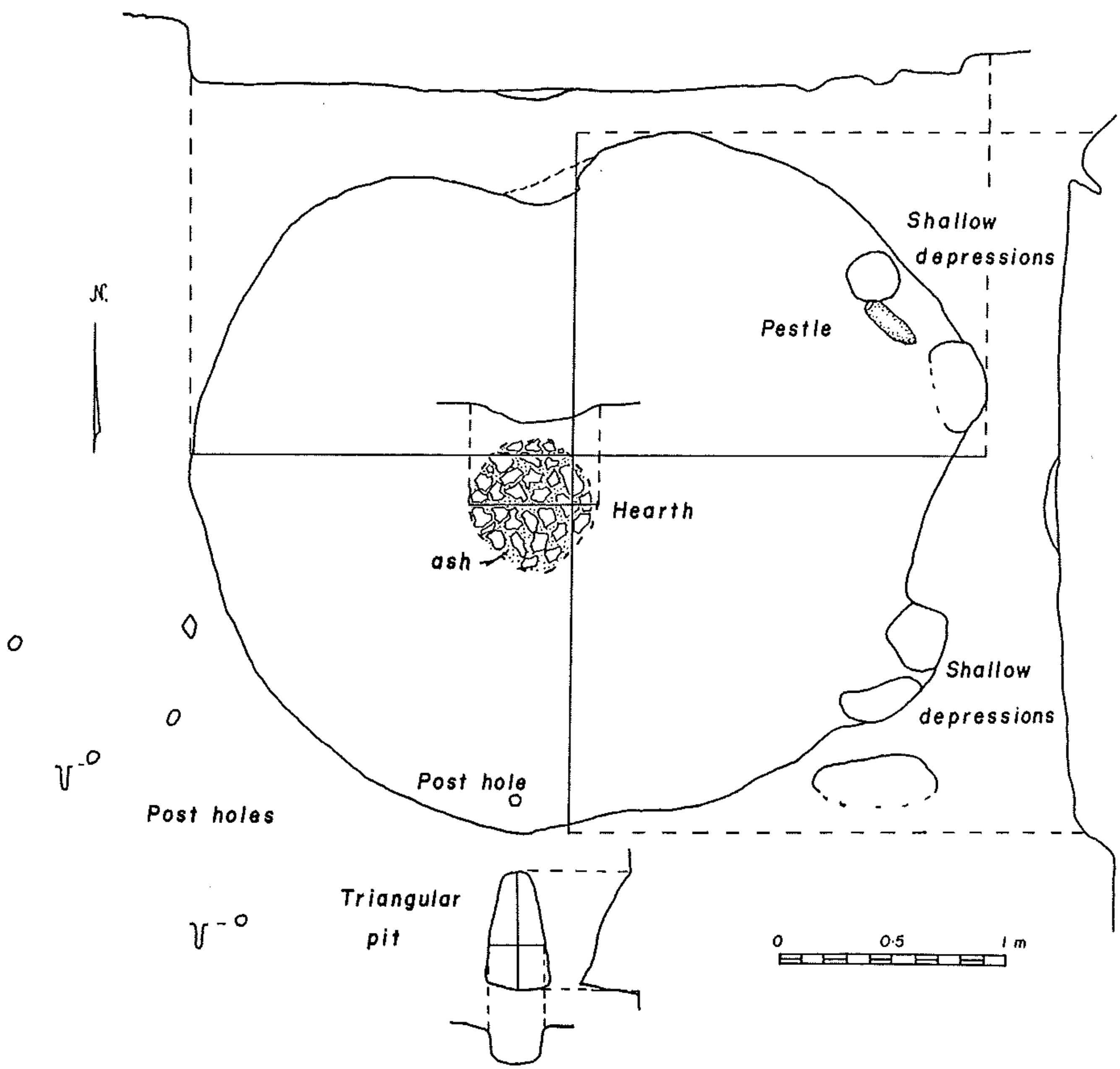

Fig. 18-2 Plan of the pit house in E8.

Above this was A9--another fragmentary, uneven, white clay floor of variable thickness. Although cleared as a separate unit, the artifacts on its surface were not plotted. They included two obsidian projectile point tips, a chert core, six retouched flakes and an antler wedge.

Also in the top of the 10-MSFL was a possible compacted surface between D4a and the underlying D3b.

The correlation of E5 with this group remains doubtful. It may be aruged with equal force that the surface is merely an extension of the gray clay rim of the E8 pit house (end 9-LFL) or that it was laid down to build the timber structure overlying it in 4b(11-USFL).

Although Q4 was suspected by the excavators to be a living surface, there is little to support this other than a higher density of cultural debris in the sediment immediately overlying it, plus a concentration of rocks and a dense mat of rootlets. There was no clay floor, nor was the Q4 surface compressed. Among the debris was the pipe bowl shown in Fig. 17-2c, the small mortar in Fig. 10-8c, and an Elko Corner-notched Point. There were also three projectile tip fragments, three cores and several pieces of wood among the various flakes, fragments, and faunal remains. Given the streambank setting of this deposit, it is equally likely to be a lag concentration rather than a deposit caused by human activities.

The thin white clay exposed in the north and west sections of T3b was almost certainly a house floor, but its surface was not cleared and plotted, nor was the clay itself excavated as a separate unit, its contents having been mixed with the overlying fill of T3a. An extension of this surface may occur on N3 where the brown clays have been compressed, but this too was not treated as a separate unit.

The 11-Upper Small Flake Loams

Lying directly on the gray/white clay of E5 was a group of burned timbers and associated artifacts in E4b (Fig. 18-8). This was first intersected in the west face and the northwest corner of Pit E. These faces were removed without being recorded so that the timbers could be completely exposed. Consequently the wood was not recorded in place within any of the vertical faces of this excavation (see Fig. 2-10). Once exposed, the timbers were seen to form a dense cluster overlapping the southwest rim of the earlier E8 pit house. Evidently the pit house, the triangular pit and the post-holes in its rim had filled completely with brown loam (E6) before the burned timbers were laid down. None of these fills contained timber or charcoal. A carbon-14 sample taken from a burned log in the E4b group yielded a date of 367BC (Chapter 4), confirming its correlation with the 11-USFL.

The distribution of timbers is shown, superimposed on the plot of the southern part of the E8 pit house in Fig. 18-9. The group was composed entirely of fragmented poles which had collapsed outward from an original upright and/or leaning configuration which is now difficult to reconstruct. A few fragments may have been badly charred and warped planks. Among the few structural details to remain were two forked supports; two thicker poles (ca. 12cm diameter) which overlay a thinner (ca. 7cm diameter) pole at right angles to it; and a scatter of burned basalt chunks, some of which rested on top of the timbers.

Among the many artifacts found in the fill between the poles, only some were plotted in place before removal. These were the pestle fragments (Fig. 10-14a), the whole pestle (Fig. 10-4b), an obsidian core, an obsidian knife fragment (Fig. 14-4f), and a thick narrow unstemmed point (Fig. 13-12g). However, many other items were

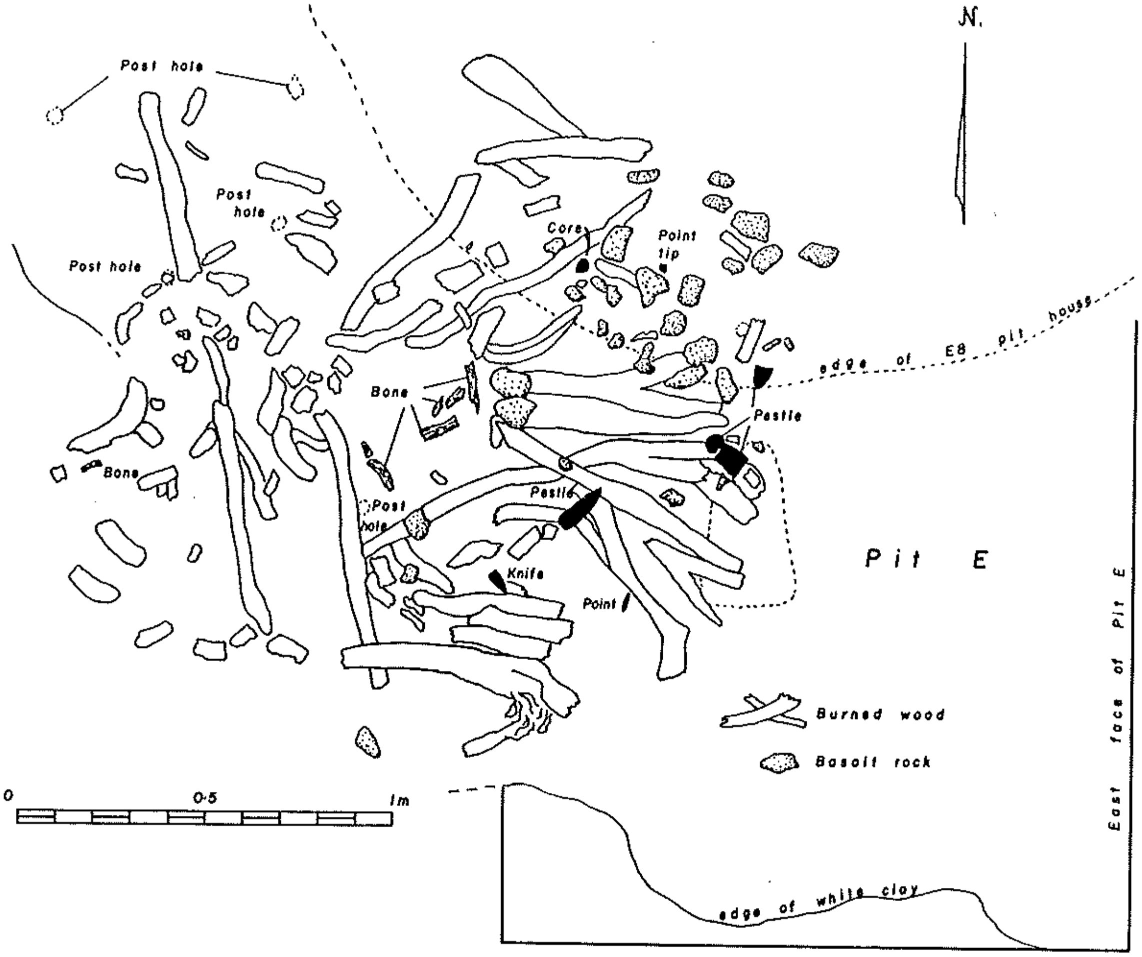

Fig. 18-9 Plan of the E4b burned house structure, with associated artifacts.

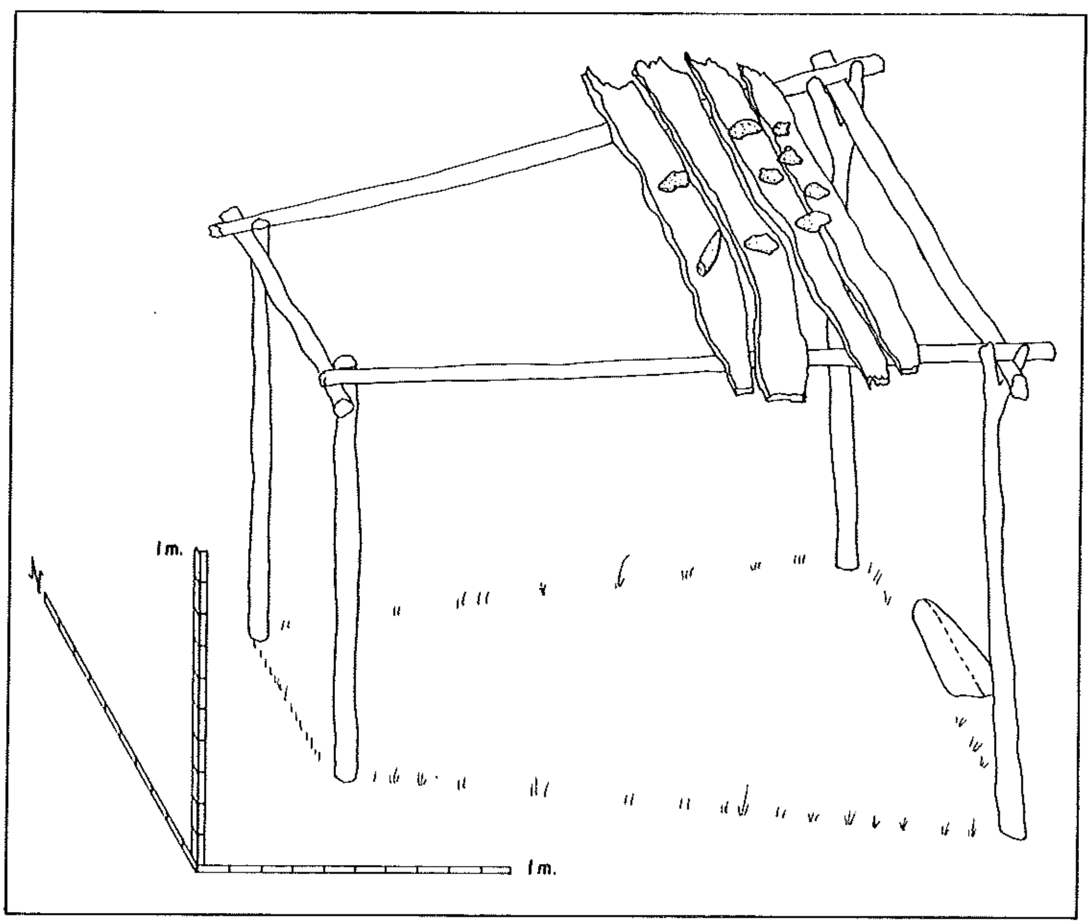

Fig. 18-10 Tentative reconstruction of the burned house structure in E4b.

recovered from the same fill: a Type 3 bowl (Fig. 10-6a); a pestle tip fragment (Fig. 10-14c); antler wedges (Fig. 15-2ab); bone and antler scoops (Fig. 15-7; 15-8abcd; 15-9abd); bone spatulate awls (Fig. 15-11bc); bird bone points (Fig. 15-15defg); a pipe (Fig. 17-2a); an Elko Corner-notched point; a side-notched point (Fig. 13-18k); and an obsidian projectile point tip. Several pieces of mammal bone have been plotted in place, but many more were recovered from the fill between the poles. These included a cervical vertebra and an M^1 of a mountain sheep, an otter phalange, a pronghorn mandible, and another mandible of <u>Canis</u> sp.

A minimal reconstruction is offered in Fig. 18-9.

Although no other clay floors were encountered in the 11-USFL, there are three possible compacted surfaces. One is at the top of E4a and is visible along most of the large central section shown in Fig. 2-10. In the general haste to clear the deposits down to the E4b and E8 structures, this later feature was not cleared or plotted. Both its position above the other structures, and its recorded dimensions hint that this was another dwelling floor.

The second compacted surface was on F2a, but it was missed during excavation and was neither cleared nor plotted as a separate unit. It was first noticed when the small pit profile originating in this surface became visible in the east face of Pit F (Fig. 2-11).

The third was evidently on the surface of C5a, into which at least one narrow pit had been dug--sectioned by the north face (Fig. 2-8). There was also a small depression sectioned in the east face, and others may have been missed during excavations, as these did not emerge until the sections were exposed. Like the other surfaces, these were not cleared and plotted as separate units.

<u>The 13-Lower Arrowhead Loams</u>

The only floor encountered in the Arrowhead Loams was the gray clay level of P4. This was dug through and mixed with overlying and underlying materials so that its surface contents cannot now be identified. Although the field records hint at a possible deliberate arrangement of rocks at the south end of the pit (Fig. 2-21), their significance cannot be assessed.

<u>Historical Analogs for E8</u>

The completely uncovered pit house base in E8 is the only floor remnant for which a Modoc analog can be found. The superstructure of E8 could have resembled the domed-shape hut said by Ray's (1963) informants to be a typical summer dwelling. However, it was also said to be the earliest house-type of the several different designs built by the Modoc in the late 19th century, and it was used more extensively as a summer <u>and winter</u> dwelling in former times. The frame was built up from pairs of bent willows set in a 3-4m diameter circle and tied in parallel arches with willow-bark cordage. Maximum height of the dome was about 2m. A square smoke hole was built in at the apex, as was a small rectangular doorway in the wall at ground level. The doorway could face any direction but west, which was the direction of the land of the dead. An east-facing doorway was preferred. Two or three layers of reed mats were laid over the willow frame and stretched taught. A single mat was hung over the doorway. The structure could be used as a summer home or a year-round home for old people who could no longer manage the ladders of the winter earth lodges. A fire would be maintained in it only if it was inhabited in winter, and earth was laid up around the base. However, the floor was not dug out in the manner seen in E8.

The interior layout of E8 has a good analog in the Modoc mat-hut used for winter. This was built over a shallow pit of comparable depth to E8. The entrance was a small mat-covered doorway at the east end where the edge of the pit was ramped or trampled down. The outer wall was sometimes set back from the edge of the pit, and a central circular fire pit filled with rocks (for ventilation of the fire) was maintained constantly. The areas on either side of the doorway were used for storage. However, the superstructure of the Modoc mat-hut differed from E8; it had a more elongated rectangular shape and there were four main house posts set in post holes in a rectangular configuration around the central fireplace. These were definitely absent from E8 which incorporated features of both house types. Given that it is 4000 years older than its ethnohistoric analogs, it is not unreasonable to view it as an ancestral form of later types. The continuity of this adaptation is impressive, to say the least. Although we are unable to detertmine that the house floors in the 7-Gray Clay were also of the E8 design, the assumption is not an unreasonable one.

One aspect of the Nightfire Island house floors is missing from the documenation on Modoc house types; the use of clay as a flooring material. This raises doubts about the orignial interpretation of these gray and/or white clays as man-laid deposits (see Chapter 5). The excavators' records assert that the pit for E8 was dug into a thick white clay which was piled up around the edges of the pit (E7). However, the pit floor itself was not penetrated by the excavators and their initial interpretation remains unproven. The argument that E7 is white clay thrown up around the edge of the pit during the excavation is also unproven because too few vertical sections through this complex were recorded.

It may be argued with equal force that the pit was dug into the normal organic loam fill and then deliberately lined with clay brought to the site from exposed lake bed clays elsewhere. A clay lining would act as a sealant to keep the house interior dry in a normally damp matrix. Clay linings may have been a technique especially suited to lakeshore settlements such as this one. The apparent disappearance of house floors from the later levels of the Arrowhead Loams may simply reflect the abandonment of this technique as the general level of the Nightfire Island platform became raised high enough above the marshy surround that the surface fill was relatively dry. Without clay linings, shallow pit house floors would not be as clearly defined.

Ultimately, any doubts must be resolved by further work at the north end of the site to uncover more examples with improved stratigraphic controls.

Historical Analogs for E4b

The tentative reconstruction of E4b shown in Fig. 18-9 is somewhat analagous to the superstructure of the Modoc earth-covered sudatory or sweat lodge, as described by Ray's (1963) informants. However, the comparison is weakened on several counts: the dimensions of E4b suggest a structure about half the size suggested by Ray's (1963:161-62) account; the clay floor of E4b was level, whereas the sweat lodge usually had a floor dipping towards the back; there is no trace of a pit rim in E4b, whereas the sweat lodge was usually built over a shallow pit of trapezoidal plan with the widest end at the front (door) side. Another difficulty with this comparison is that the Modoc heated rocks on a fire outside the door, and these were rolled down the slope to the back of the lodge where they were sprinkled with water. The position of the rocks in the E4b reconstruction places the rocks near the doorway, and at least some of them appear to have been on top of the structure rather than within it. Furthermore, the long list of domestic utensils found among these timbers does not equate with the leisurely activities recorded as taking place within the Modoc sweat lodges.

In spite of these various objections, the analog should not be dismissed too promptly. Although the various utensils came from around the timbers, none was recorded from beneath a fallen pole, and the association is by no means perfect. Also, the excavators' records insist that the post holes and the triangular pit beneath the timbers must be associated with the E8 pit house. This could be disputed--Spier (1930:206) saw a hollow for heated rocks on the right side of the doorway to a small Klamath sweat lodge, as he entered. If the triangular pit ascribed to E8 was in fact part of the E4b structure, its position would fit quite well with Spier's observation (Fig. 18-8). As the pit contained neither rocks nor charcoal, the argument cannot be advanced any further[1]. Eyewitness accounts of Klamath and Modoc dwellings (Fremont 1846; Meacham 1875; Ogden 1961) are of no help in evaluating this interpretation.

Finally, we are bound by general accounts of sudatory design which do not account fo the range of design variability which was actually permitted by the historic Modoc. Cressman's (1977) excavations of various Klamath pit houses have shown that so-called 'rules' for pit house design implied in the ethnographic accounts were often ignored by the builders themselves. Given these uncertainties, together with the 2000 year gap between E4b and the ethnohistoric record, nothing more can be made of the comparison.

Obviously, the recovery of more and better records of pit house structures and their associations is one of the most compelling arguments for further excavation of the site.

<u>ENDNOTES: CHAPTER EIGHTEEN</u>

1. Howe (1979:171) argues for a sudatory function for E4b on the presence of sweat-scrapers among the timbers. The "several fragments" he mentions may have been from the scoops in Fig. 15-7 to 15-9. None comparable to the highly polished specimens which Howe recovered from the western crematory (Fig. 16-2) was found at E4b.

CHAPTER NINETEEN

THE BURIALS

Human skeletal remains of 45 individuals were recovered during the controlled excavations at Nightfire Island. Although the scarcity of visible grave pit outlines has made it difficult to ascribe burials to specific strata, it is reasonably certain that two cemeteries came into use at the site no earlier than the base of the 13-LAL[1]. One burial ground on the southwest edge of the village (Pits KRSW) was used at sometime between the 13-LAL and the 14-MAL to dispose of partly cremated corpses, some of which show signs of violent deaths. The second burial ground at the north end of the site (Pits ABDEI) may have served first as a casual burial area where partly cremated bodies were interred in the fill of the now silted-up pit house of layer 5 (Chapter 18). The olivella shell beads which normally accompanied the burials in both cemeteries were replaced in 14-MAL times in the northern cemetery by more exotic shell beads, decorated bonework, pipes and ornaments of bone and exotic stones. More effective cremation was also introduced in 14-MAL times, after which the skeleton was often totally ashed. Ash-filled cremation pits were concentrated in the 14-MAL and 13-LAL about the area of Pits EIJ, but these were disrupted by bulldozer cuttings (Chapter 2), and only some of the quite abundant grave goods from this crematory were rescued without field records. Another such crematory came into use probably in 15-UAL times to the west of the village where the cremation pits were dug directly into the surface of the exposed diatomite of the lake bed. These later crematories have good analogs in the ethnohistorical records of Modoc cremation procedures, and these records will be summarized first, so that the burial patterns to be described in later sections can be more readily understood.

Modoc Cremation Procedures

We are fortunate that Ray's (1963) informants were able to give an unusually full account of these procedures. Cremation was the sole method of disposal used by the Modoc--a cultural trait shared with the Klamath, but with no other surrounding tribes who all practiced burial exclusively. Among the Modoc, the only uncremated burials were secret ones: infanticides and aborted fetuses. The only adults who may have been buried uncremated were social outcasts, but it is not clear whether or not this category included slaves. Otherwise, burial was unacceptable: even those killed in battle and those who died while travelling were brought home for cremation. The body was always burned as soon after death as possible, but invariably in daylight and usually at the crematory used by the paternal relatives. If the corpse had to be carried a long way to this place, it might be partly cremated so that only the bones need be transported over land (canoe transport being taboo). Crematories were usually on rocky promontories near the village, but only if enough fuel was available. If firewood was scarce, a place on soft ground was chosen where a shallow trench could be dug first and the pyre of available fuel (such as sagebrush) was stacked over this. Any bones not totally ashed by the time the fire had died down were shovelled into the trench and covered with ash and stones. Under normal circumstances the body was burned in new clothing, sometimes decorated with beadwork, and bead necklaces were strung around the neck. The body was wrapped in tanned buckskin or reed/grass matting and was carried in a second buckskin which was folded over the corpse once it had been place on the pyre. The head always pointed westwards--the direction of the land of the dead. All old clothing and all other personal belongings were placed next to the pyre. Sometimes a slave was killed at the crematory with an arrow to the heart or a club blow on the head, and his body was placed on the same pyre with that of his master. Last-minute trading

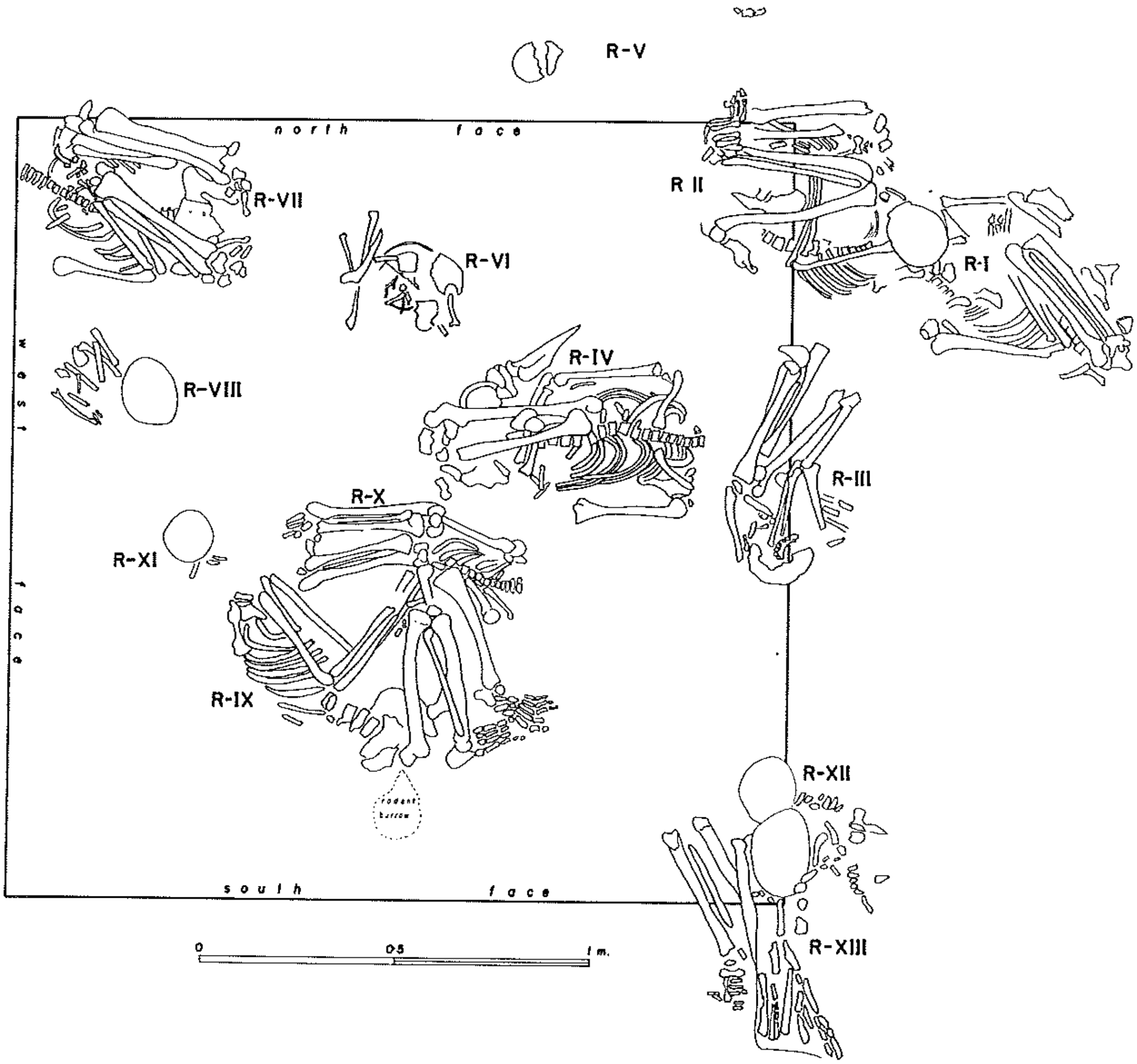

Fig. 19-1 Plan of disposition of the thirteen skeletons in layer 2 of Pit R.

All the excavated skeletons (and the two mentioned above) were situated in the dark brown loam of layer 2, which has been ascribed to the 11-USFL (2b) and 12-TSFL (2a) on the basis of its stratigraphic position, sediment description, elevation and artifact content (Chapter 3). Layer 1 is a turf horizon formed by the weathering of the top of 2a during the period of the Arrowhead Loams accumulation elsewhere.

The pit faces fail to verify from which level the skeletons were interred into layer 2, but associated artifacts indicate that they were all interred during the Arrowhead Loams accumulation. Grave infillings around every skeleton were identical in color and texture to the undisturbed matrix of dark brown loams. The fill around Burials R-I and II, R-III, and IV and R-IX and X was slightly darker than the layer 2 matrix and small fragments of calcrete, derived from the underlying hardpan crust of layer 3, were seen in these fills. The south face of Pit R in Fig. 2-23 shows that the top of layer 3 was slightly penetrated by grave bases under R-XII and XIII and by the unexcavated burial in the west end of the face. The only grave pit which may have fully penetrated the hardpan was R-V (see north face in Fig. 2-23). There were no clear grave pit outlines for any of the other skeletons. The darker fills are assumed to be traces of charcoal and organic staining.

Inspection of the salient features of each skeleton (Table 19-1) reveals three subgroups. Subgroup (a) comprises seven (possibly eight) adults: (R-I to IV, possibly R-V, R-VII and R-IX and X) with olivella and other shell necklaces or garment decorations. All had obsidian projectile points in the surrounding fill which were so close to the skeleton and in such orientations as to leave little doubt that they were embedded in the flesh at the time of burial. At least four of these bodies were decapitated.

Subgroup (b) comprises three child burials (R-VI, R-VIII, and R-XI) all in small graves dug shallower than Group (a). One had a few olivella beads, but they were otherwise without goods.

Subgroup (c) comprised the adults R-XII and R-XIII without shell decorations, but accompanied by numerous exotic stones. Each subgroup wil be discussed in turn.

Subgroup (a) in Pit R

Burial R-I (Figs. 19-2 and 19-3) lay about 50cm below the modern surface. The skeleton is poorly preserved: some foot and hand bones are missing, and ribs and vertebrae are fragmentary. Nine small fragments of cranium are all that survived of the head. The skull may have been destroyed when a pit for R-II was dug through it. As the R-I skeleton settled, slight rotation of the flexed legs separated the left tibia and fibula from the limb bones and parted the left arm from the shoulder girdle. The field sketches show a pointed stone object lodged between two of the upper ribs, but this is not labelled and it cannot be identified in the artifact collection. There were three obsidian flakes with edge-damage and a few other flake fragments (obsidian and chert) in close association with the skeleton, but their positions were not plotted. There were 28 olivella shell beads in the fill around the thoracic area, but it is uncertain whether they belonged to this burial or to the overlapping R-II. Bone and shell fragments and a few animal teeth were also found close to R-I, but were not plotted except for the herbivore mandible below the pelvis. The Small Foliate Point (Fig. 19-4a) in the pelvic region was outside the darker grave fill and could belong in layer R2b (USFL).

As suggested, R-II may have been in a separate (later) grave from R-I. If so, the grave must have been slightly too small to receive the body in a prone position, and the head was propped against the pit

Table 19-1

The Burial Group in Pit R

Burial No.	Layer	Stratum	Status	Posture	Lying on	Neck or Head to	Amputation	Projectiles in place (?)	Olivella beads	Other Associated Artifacts
R-I	R2b	11-USFL	adult	flexed	left side	NW	-	upper left ribs	front thorax(?)	-
R-II	R2b	11-USFL	adult	flexed	right side	SE	-	lower left ribs, pelvis	knees(?) necklace	3 scrapers 1 projectile
R-III	R2b	11-USFL	adult	flexed	left side	S	-	rib cage, left shoulder	necklace	-
R-IV	R2b	11-USFL	adult	flexed	back	E	decapitated	upper right ribs, spine	front thorax	bone polisher
R-V	R2b	11-USFL	adult	?	?	SW	?	?	?	-
R-VI	R2a	12-TSFL	infant	?	-	-	-	-	-	-
R-VII	R2a	12-TSFL	adult	flexed	back	NW	decapitated	left elbow or pelvis	-	2 projectiles (in fill?)
R-VIII	R2a	12-TSFL	child	?	-	-	-	-	-	1 square shell bead
R-IX	R2b	11-USFL	adult	flexed	left side	NW	decapitated	right hip	-	266 square shell beads - thorax
R-X	R2b	11-USFL	adult	flexed	back	E	decapitated	lumbar spine, neck	necklace	-
R-XI	R2a	12-TSFL	infant?	?	-	-	-	-	necklace	-
R-XII	R2a(?)	12-TSFL(?)	adult	flexed	right side	NW	-	-	-	quartz crystal-left temporal
R-XIII	R2a(?)	12-TSFL(?)	adult	bundle(?)	-	-	-	-	-	1 projectile, 1 retouched flake, 1 core, 1 blade fragment, 1 whetstone, 34 agate pebbles, 1 quartz crystal, novaculite slab, 1 bone point.

wall in such a way that subsequent settling has rotated the skull anticlockwise and into its upright position. Preservation is somewhat better than in R-I, but the settling rotation normal to such flexed burials separated the left tibia and fibula from the femur so that patellae and epipheses became scattered. There were no obvious signs of rodent disturbance.

The individual must have been wearing a necklace, as there was a diffuse ring of 152 olivella beads in the fill around the front of the cranium, and it is possible that the beads recovered with R-I in fact belong with this same necklace. Another cluster of 23 olivella beads was found scattered around the knee area of R-II, but it cannot be determined whether these were part of the necklace or were perhaps knee-bangles. Also in the knee area and between the two bead concentrations, there was a bifacially retouched flake fragment of obsidian (Fig. 19-4e) above the left femur proximal, a retouched chert flake in the fill roughly between the knees, and a broken Elko Corner-Notched Point (Fig. 19-4d) in the fill just 3cm above the first flake. Either they were thrown into the grave at the time of burial, or were originally in a small pouch with the bead necklace. It is unlikely that these objects inflicted flesh wounds in the knee area. It is probable, however, that the fine-grained basalt Rose Spring Corner-Notched Point (Fig. 19-4b) close to the left ribs and the obsidian specimen (Fig. 19-4c) close to the pelvis were embedded in the body. The Elko Corner-Notched Point base fragment (Fig. 19-4h) inside the pelvic girdle could possibly have been embedded, but the tip was never found. It is unlikely that the bifacially retouched obsidian piece (Fig. 19-4f) close to and just above the left heel was embedded and this would also apply to a chert core, the position of which was never plotted. The infilling above R-I and R-II yielded one more retouched obsidian flake, 15 olivella beads, a few obsidian flake fragments and some fragmentary bone and shell. A broken Gunther Point (Fig. 19-4g) also came from the fill.

The foot bones of R-III (Figs. 19-5 and 19-6) are represented by fragmentary scraps only. They were probably destroyed by the digging of a pit for R-II. The preservation of R-III is extremely poor, and most vertebrae and the sacrum are fragmented. Nearly all of the pelvis and ribs have disintegrated, as have the hand bones. The skull was extensively damaged during an overnight visit by a cow to the excavations. Altogether, 22 olivella beads were found in a close concentration around the neck region--probably a tight, single-strand necklace. There was a ?Rose Spring Point fragment (Fig. 19-4i) close to the head of the left humerus, and another Gunther Point (Fig. 19-4k) recorded as coming from the rib cage. There were also a few obsidian and chert flake fragments near the skeleton, but their positions were not plotted. The antler wedge tip, antler fragment and herbivore tooth all came from above the skeleton in backfill not directly associated with it.

Missing from R-IV are the left forearm and hand, and all of the left leg and foot except for the fibula distal. It is likely that they were removed while the pit for R-X was being dug. However, it cannot be argued that the head of R-IV was removed by the digging of a grave for R-III, because the condition of the R-III skeleton suggests that it could be older than R-IV. It is far more likely that R-IV was decapitated before burial. However, there are 135 Olivella beads near the cervical vertebrae and scattered over the front of the rib cage. If this was a necklace, the question then arises--how was this held in place on a headless corpse? Perhaps the beads were attached to the front of a skin garment. A Gunther Point (Fig. 19-4l) was found close to the vertebral column, but this was not plotted. The tip fragment of another (Fig. 19-4j) was lodged between the upper right ribs. A bone polisher made from an ungulate tibia was found close to the right ilium, suggesting possible suspension by thong or bag at the hip. The bevelled surface of this specimen exhibits a high sheen (Fig. 19-7)

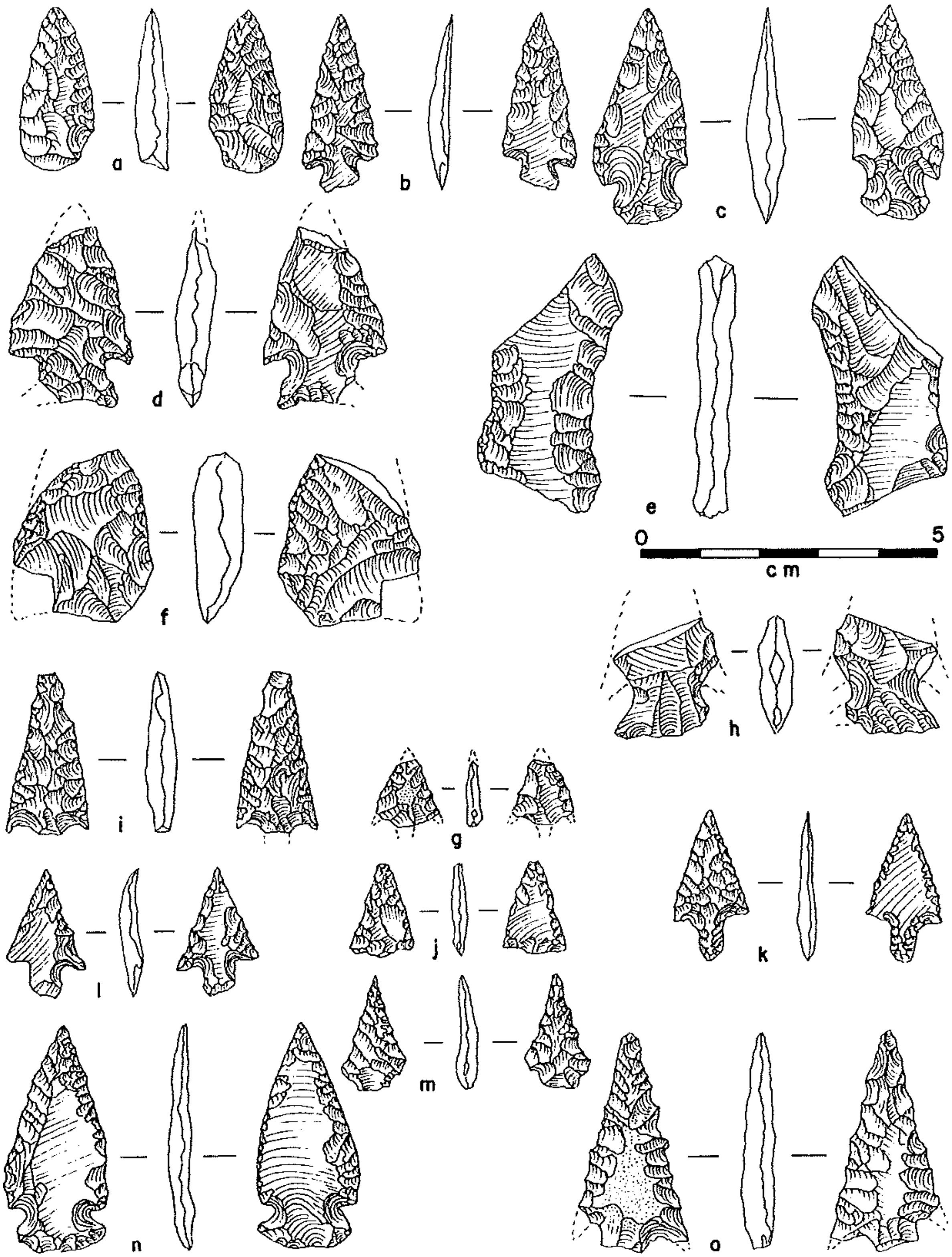

Fig. 19-4 (a-h) Artifacts associated with Burials R-I&II: (a) Small foliate point with R-I; (bc) Rose Spring Corner-Notched Points with R-II; (d) small Elko Corner-Notched Point with R-II; (ef) bifacially trimmed flake fragments with R-II; (g) Gunther Barbed Point in fill of R-I&II; (h) small Elko Corner-Notched fragment with R-II; (i) ?Rose Spring Corner-Notched Point with R-III; (j) Gunther Barbed Point with R-IV; (k) Gunther Barbed Point with R-III; (l) Gunther Barbed Point with R-IV; (m) Gunther Barbed Point with R-VII; (n) Elko Side-Notched - Round-based variety, in fill of R-VII&VIII: (o) ?Elko fragment in fill of R-VII&VIII.

Table 19-2

Burials in Pits R and S, listed by sex

Males	Age	Lying on	Head (or neck) to	Decapitated?	Points in place	Beads in place	Other Associations
R-I	17-20	left side	NW	no?	upper left ribs	front thorax?	
R-IV	35-40	back	E	yes	upper right ribs, spine	front thorax	bone polisher
R-VII	25-30	back	NW	yes	left elbow or pelvis?	present?	
R-IX	25-30	left side	NW	yes	right hip	front thorax	
R-XII	25-30	right side	NW	no			quartz crystal
S-I		back	NW	no	left shoulder		shell on wrist
Females							
R-II	25-30	right side	SE	no	lower left ribs, pelvis	necklace	
R-III	35-45	left side	S	no	rib cage, left shoulder	necklace	
R-X	12-15	back	E	yes	lumbar spine, neck	necklace	

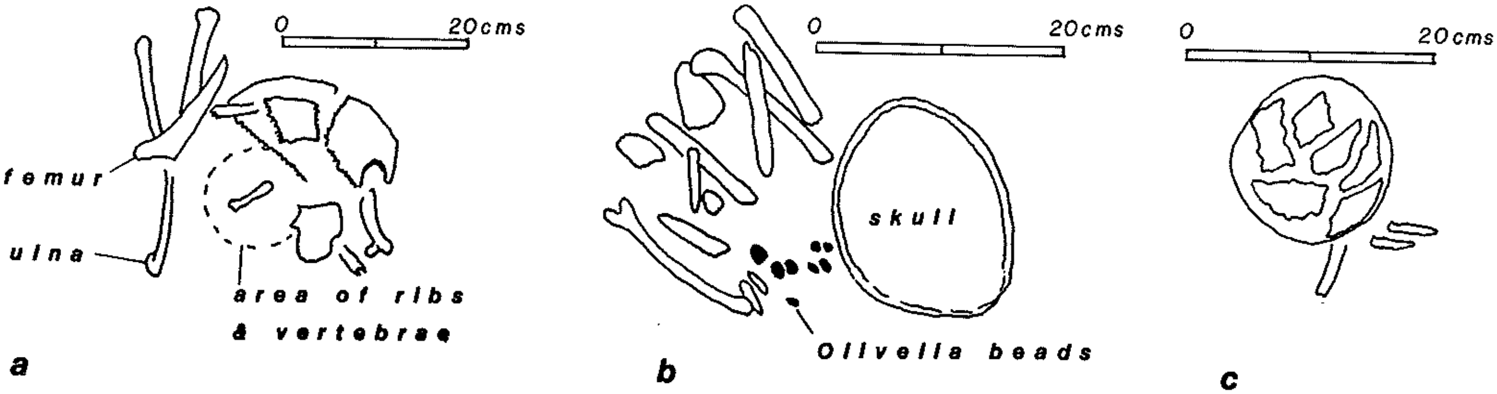

Fig. 19-12 Plans of the child burials (a) R-VI; (b) R-VIII; (c) R-XI.

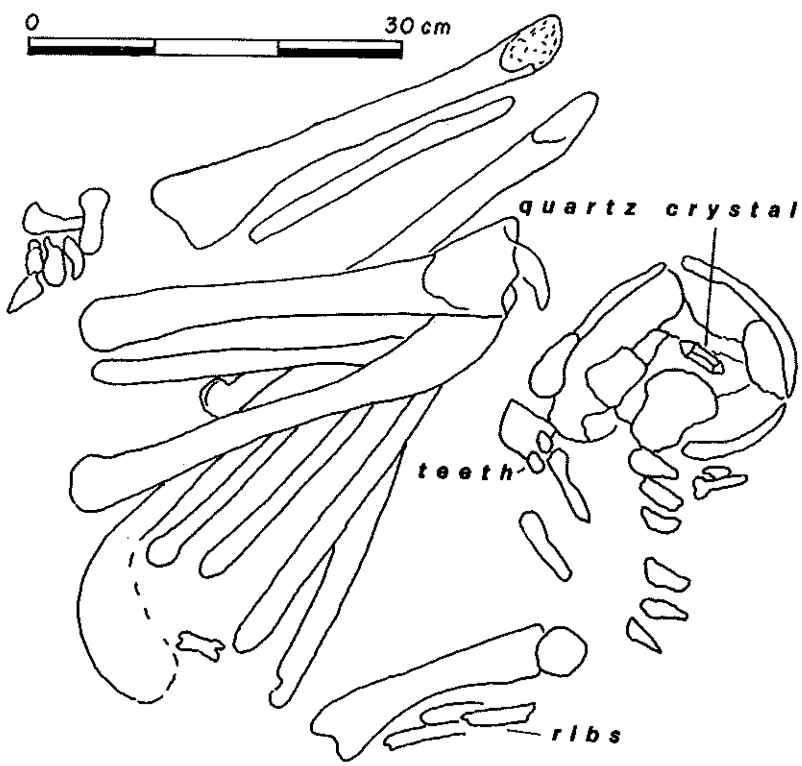

Fig. 19-13 Plan of R-XII and associations.

animal bone splinters in the surrounding fill (not plotted) there were no other clear associations.

Burial R-XIII was placed on top of R-XII and offset slightly to the southeast of it. Although there were a few centimeters of sediment between the skeletons, this is not sufficient to suggest a separate and later interment--the two individuals must surely have settled into the trench from the same funeral pyre. Given the pairing pattern in Subgoup (a) we would expect R-XIII to be the female of this pair. Although the overall size of the skeleton and the lack of robusticity in the fragmentary skull both hint at such a diagnosis, absolute proof is unobtainable. The pelvic area has been totally destroyed and no key elements could be found. Indeed, all the bones are so fragmentary that little could be learned about this individual at all, although most of the post-cranial skeleton is represented to varying degrees.

The associated grave goods with R-XIII are of more interest. At the southeast end of the fragmentary bone scatter was a tight concentration of artifacts and semi-precious stones which may have formed the contents of a pouch (Fig. 19-15). It included seven obsidian projectile points (Fig. 19-16a-g), the mid-section of a ?small blade, or possibly a preform blank (Fig. 19-16h), a small whetstone of quartzitic sandstone, a retouched flake of obsidian, and an obsidian core. Bonework included a concave-oblique-bevelled O-sectioned bone point (Fig. 19-16i) and a perforated bone fragment. Mixed in with the artifacts were 34 water-polished agates of various colors and hues, as well as a quartz crystal and a thin slab of unworked novaculite.

In the fill immediately surrounding the bones of R-XII and R-XIII was an obsidian projectile point, the tip fragments of two others, a chert core, nine retouched flakes, two basalt mortar fragments, and several flakes and animal bone fragments. None of these was plotted in place and they may be assumed to come from the grave fill.

The grave goods may reflect the contents of a pouch belonging to a shaman. Although ethnohistorical analogs for such an interpretation are rather scattered, the accumulated evidence is nevertheless helpful. Dixon (1904:23ff) states that Shasta shamans used a small needle-like object about 3 inches long to "pull out pain"--a description which could fit the bone point in Fig. 19-16i. Barrett (1910:253) mentions that among both the Modoc and Klamath, projectile points were collected from abandoned sites to be used as "charms in medicine and gambling", and Spier (1930:114) describes the use of arrowheads tied at intervals to a string in one of the Klamath shaman's routine swallowing tricks. Modoc shamans also "swallowed"[2] loose arrowheads to divert the members of a slave-raiding party while they waited out the night before a dawn attack (Ray 1963:140).

Ethnohistorical analogs for the agate pebbles are not known. Among the numerous possibilities are: gaming pieces, gambling counters or objects representing individual spirits. Howe (1979:195) points out that the nearest known source for these is in the Siskiyou Mountains, within the territory of the Shasta. The sea coast of southern Oregon is a second possible source.

The origins of the quartz crystals are unknown. Furthermore, analogs for the placing of the quartz crystal on the head of R-XII are not forthcoming. Although the headgear of the Modoc shaman varied with his different duties, these normally included fur or feather caps. Nothing in the literature precludes the sewing of a quartz crystal into the shaman's headgear, however. This would imply, of course, that both individuals in the pair were shamans.

In summary, burials R-XII and R-XIII show important differences from the pairs in Subgroup (a). There were no embedded projectiles, and no trace of the normally ubiquitous olivella beads. Unfortunately, the sacral deformities normal to adult males in both

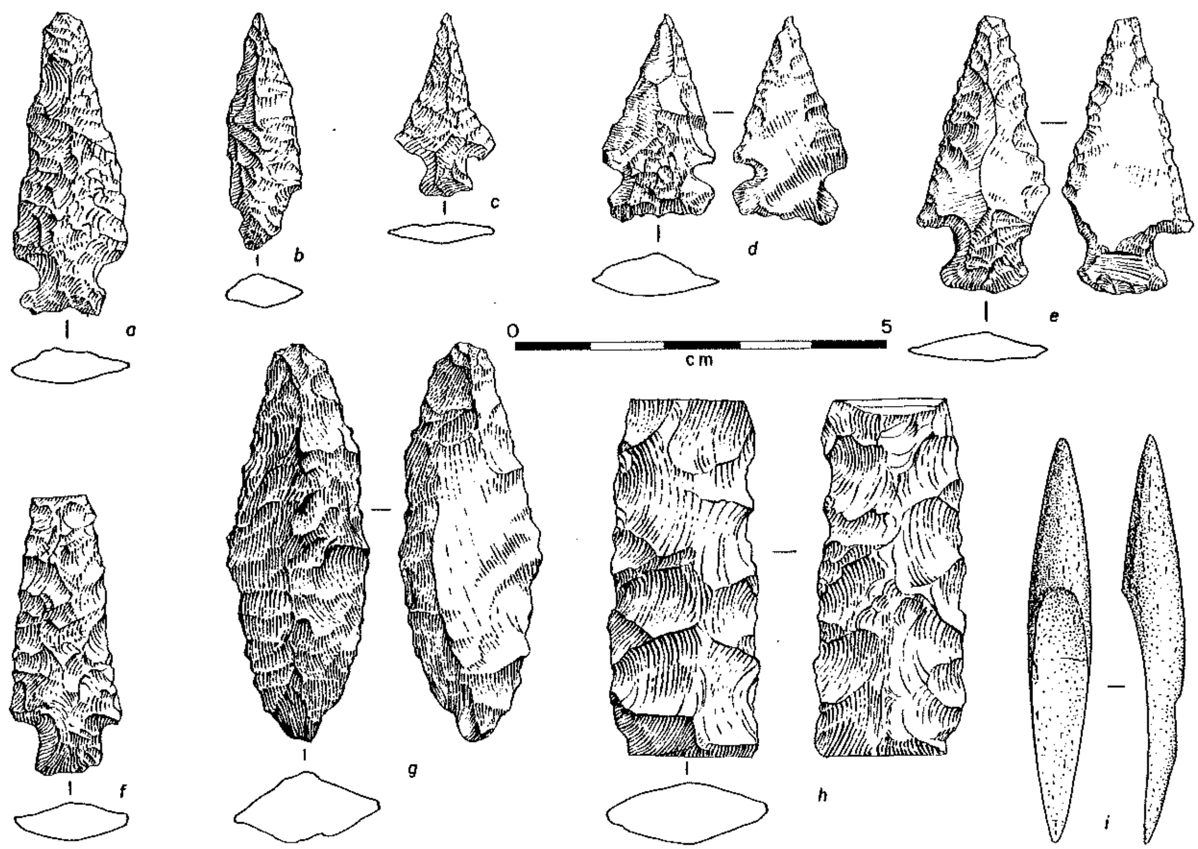

Fig. 19-16 Artifacts associated with R-XIII. Positions shown in Fig. 19-15.

cemeteries (see Chapter 20) cannot be determined in this skeleton because the sacrum has disintegrated. Finally, the grave goods are unique and invite the inference that either R-XIII or both were shamans. Another remote possibility is that R-XII was the shaman and R-XIII was a bone-bundle which was part of his paraphernalia placed on the pyre together with his other equipment. The cause of death is unknown, but a violent end need not be ruled out--Dixon (1904:25) points out that among the Shasta, a shaman who repeatedly failed to cure his patients could himself be murdered by the villagers.

Burial S-I (Fig. 19-17)

The skeleton of an adult male with the same sacral deformity seen in the subgroup (a) males was intersected by the east face of Pit S. This burial must be close to the edge of the eastern margin of the entire cemetery, therefore. The east face of Pit S. has captured the grave outline in profile (Fig. 2-24). The plan form of the trench was not plotted, however, nor were its horizontal dimensions recorded. The captured profile intersected the skeleton at the ankles, and therefore sectioned the edge of the grave only. The gray ash filling contrasted with the brown loam of layer 2 and cut through the tan-sand/clay lens in layer 3. The boundary of the ash with the undisturbed gray loam of layer 3 was visible as a textural change. The stratigraphic position of S-I poses identical problems to those of the Pit R. group: there are no Arrowhead Loams overlying the top of the grave, and the organic staining of layer 1 obscures the pit profile so that it cannot be determined whether it was dug from the existing surface (Arrowhead Loams) or from just below it (12-TSFL).

The bottom of the trench had filled with ash before the partly cremated body settled on its right side with the head to the northwest. After the fire had died down, the corpse was turned on its back and the legs were fully flexed, causing extensive disarticulation. Two objects were in close association: a fragment of perforated abalone (Fig. 16-8i) lay directly on the wrist; and a ?Rose Spring Side-Notched Point (Fig. 19-7j) was close to the left shoulder. In the fill around the skeleton was the tip fragment of a pestle and several clamshell bead fragments. Two olivella beads came from the same general level as the burial in Pit S, but their positions were not plotted.

Burial S-I has much in common with the adults in subgroup (a) in Pit R, but there are a few important differences: more ash has survived in the trench, thus forming a sharper contrast between the fill and the matrix; there is no sign of a second individual--this was probably not a paired burial; the head was not removed; olivella beads were not used in great numbers. The skeleton is no more charred than the other adults so that a larger, more efficient fire cannot be inferred from the apparent increase in ash. It may be that this grave is later in age than the others so that its ashy profile has not yet leached out completely. It is also possible, however, that S-I represents a transition to a more thorough cremation procedure which will be shown to occur in the later levels of the northern cemetery.

Burial W-I

The cranium of a young child was intersected in the south face of Pit W, part of which was dismantled before drawing, so that the remainder could be recovered (Fig. 2-28). The skull cap lay in the lower part of layer 4 (9-LSFL). The profile of a shallow trench can be inferred from the south face, but its real depth cannot now be verified. The original surface from which the burial was interred is unknown. The individual bones of the skull were separated and lay in a flat circular configuration, but no other bones were recovered. Although the undisturbed matrix in the same excavated spit as the

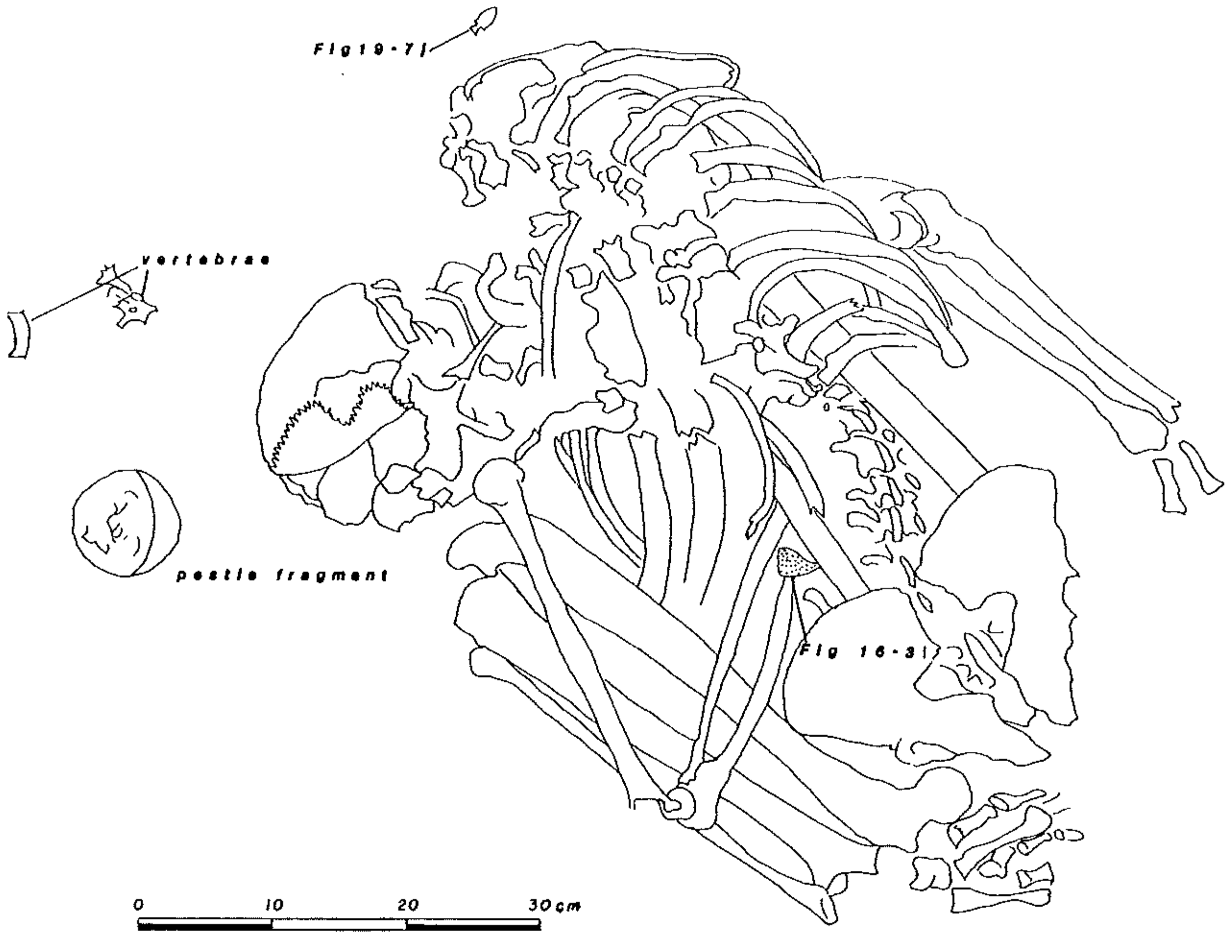

Fig. 19-17 Plan of Burial S-I.

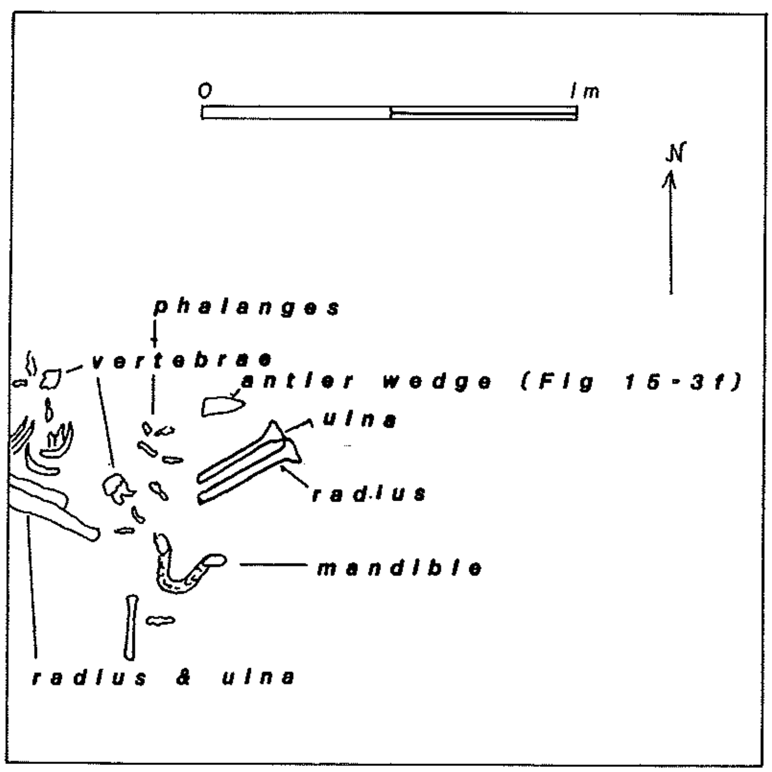

Fig. 19-18 Plan of Burial X-I.

skull was rich in artifacts and animal bone, no obviously associated grave goods were found. Burial W-I is of little interest except that it demonstrates the southerly extension of the Southwestern cemetery.

Burial X-1

Scattered remains of a single adult skeleton were encountered in the southwest corner of Pit X in layer 2 and 3a at the base of the 15-UAL. Although plotted in place (Fig. 19-18), the bones were not mapped in relation to the charcoal-lined pit underlying them. The profile of the shallow cremation trench was captured in the south and west faces (Fig. 2-29). Apart from one severly burned and cracked antler hide-working tool cum wedge (see Fig. 15-3f), no other associated artifacts were identified or plotted. Only the mandible, the two forearms and hand bones, some larger vertebrae, and a few ribs were recovered, and the lower part of the skeleton was left in situ. The recovered elements were not included in the skeletal analysis described in Chapter 20. Although not completely recorded, X-I is important because it indicates that the Southwestern cemetery area may have come back into use in 15-UAL times as a sporadically used crematory, after centuries of disuse. The burial correlates, therefore, with the Northern and Western Crematories to be described later, rather than with the Southwestern Burials.

Burial K-I

The west face of Pit K intersected parts of an adult skeleton (Fig. 19-19). Because it was decided not to remove the rest of the burial, its trench profile was captured in the west and south faces (Fig. 2-16). The trench was dug from layer 2 (11-USFL) into the top of the hard-pan of layer 3. The bones included most of the pelvis, parts of the sacrum, two ulnae, and two clusters of phalanges. Although the field notes record this as a flexed burial, this is not apparent from the plotted configuration. The rest of the skeleton was left in situ and the recovered bones were unaccountably omitted from the skeletal analysis (Chapter 20). No grave goods were recorded. Burial K-I is the stratigraphic equivalent of the Pit R burials. Although incompletely recorded, it shows the western extent of the Southwestern cemetery. It is interesting to note that two pits were dug either from layer 1 (12-TSFL) or from the surface (Arrowhead Loams). Their profiles were captured in the east and south profiles (Fig. 2-28). Neither of these yielded human remains, but the shallower of these in the east face was labelled "cremation pit"? in the field records. Like X-I, these may be further indications that the area came back into use as a crematory, albeit a less important one than those to be described later in this chapter.

Significance of the Southwestern Burials

Cremation procedures--albeit rather inefficient ones--were introduced to Nightfire Island probably in the 13-LAL, perhaps around 300AD. Although it can be shown that these procedures were directly ancestral to the Modoc cremations practiced in the late 19th century, the ethnohistorical records cannot be used effectively to explain all aspects of the southwestern burial group. Most urgently needed is an adequate explanation of the circumstances surrounding the violent deaths suggested by subgroup (a) and S-I. Next: why were they killed and buried in male-female pairs? Also, why were the males (and sometimes the females) beheaded?

It is suggested that these macabre additions to the normal Modoc ceremony can be better understood within the framework of another well-documented Modoc institution--seasonal slave-raids. During the

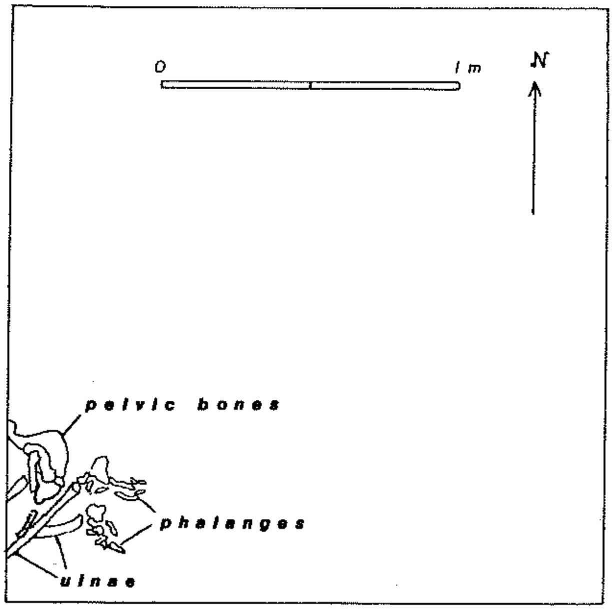

Fig. 19-19 Plan of Burial K-I.

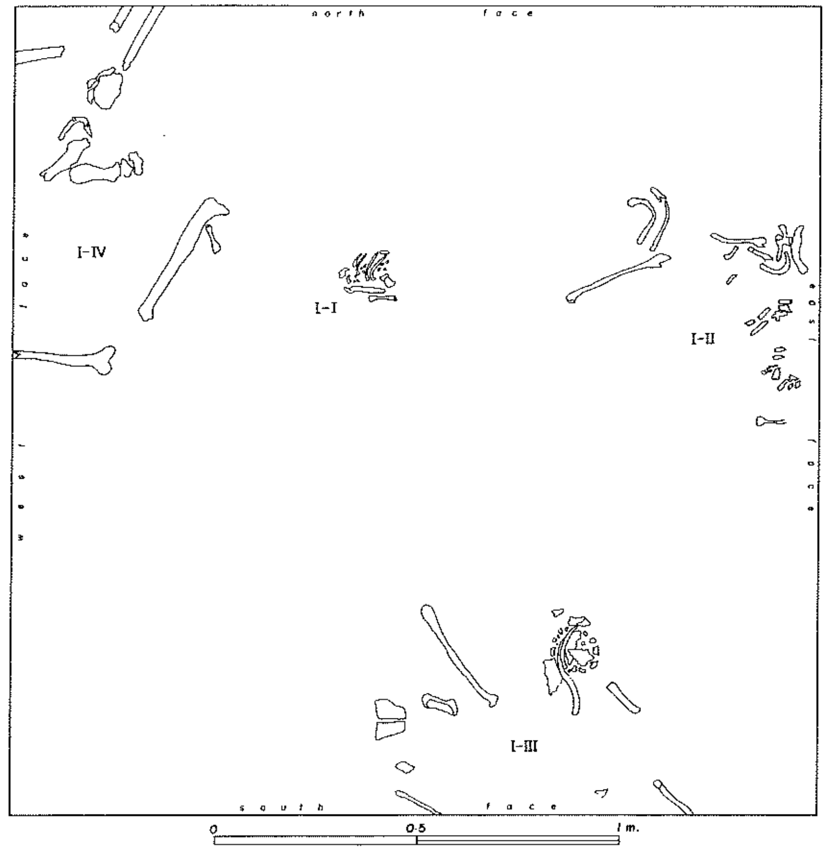

Fig. 19-20 Disposition of the four individuals in I3b.

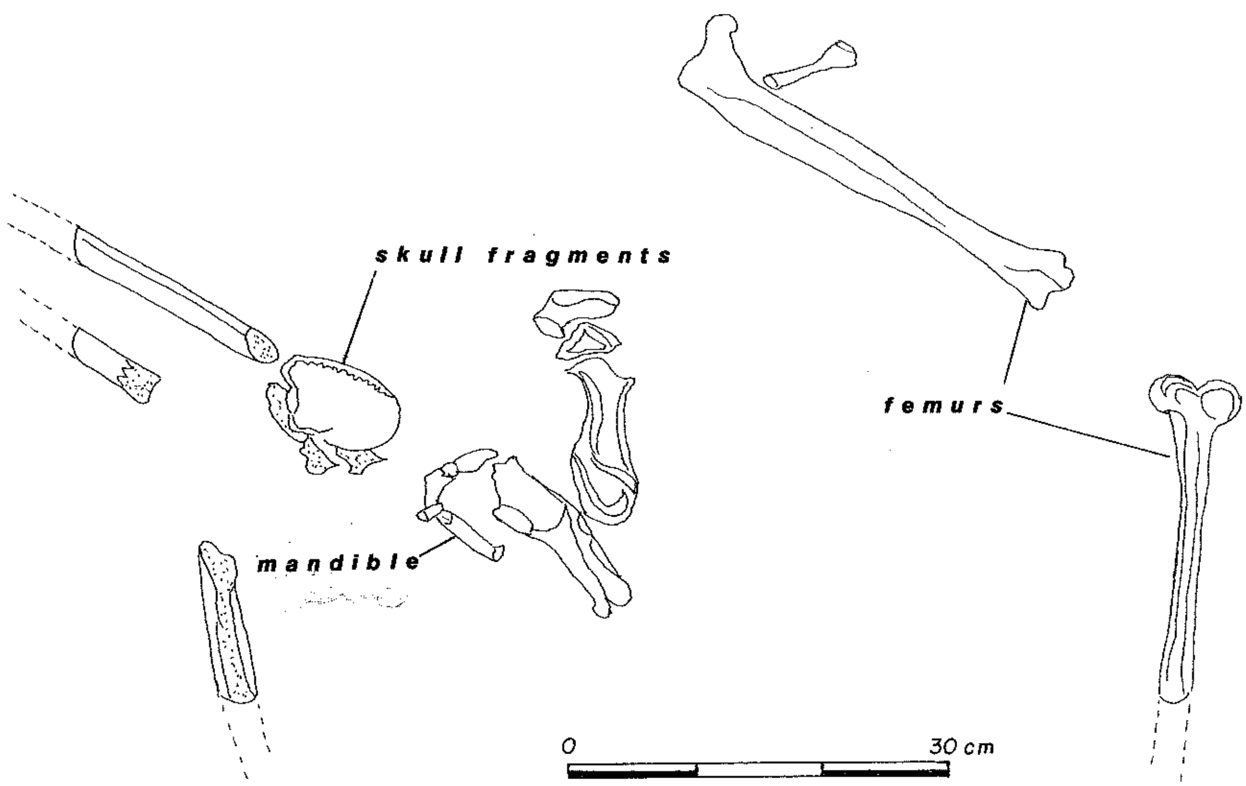

Fig. 19-21 Plan of Burial I-IV.

19th century, the Modoc mounted periodic raids on the Pit River tribes and less frequently on the Shasta. Slaves thus obtained were traded to the Klamath who acted as middle-men, bartering them further north to the Columbia River. Raiding parties could be 10 to 100 men led by a provisional organizer who fought for himself and was not a battle commander in the literal sense. The shaman also fought for himself, having seen to the appropriate pre-battle rituals. Battles, particularly with the Shasta who tended to fight back, were bloody affairs with heavy losses on both sides. The Modoc traditionally retreated only after massive loss of life, leaving their dead in the field. If victorious, they would cremate their dead, sometimes returning with their bones to their own village for burial. Enemy corpses were scalped, but no other mutilations were condoned. The Klamath, however, took hands, feet, or even whole heads from the bravest male victims (Spier 1930:33).

The Modoc were seldom if ever raided by the Klamath or by the Pit River tribes, but they were raided by the Shasta. Although the raiding methods and tactics of the Shasta are relatively poorly known (Dixon 1904), they probably resembled those of the Modoc. If this is acceptable, then a suitable analog becomes available for the anomalous features of the Southwestern burial group: entire families could have been surprised and killed in a series of raids, giving rise to the male-female pairs, both riddled with arrowheads. They would have been buried by their kinsmen who returned to the village after the raiders had retired. Although the Shasta took scalps--as did the Modoc-it is quite possible that male heads (and some hands and feet) were taken by the raiders had they been ancestral Klamath. In 1826-7, P. S. Ogden observed fresh human skulls on stakes in a Klamath village (Ogden 1961), but it is unclear whether these were trophies or ancestral relics. No such record for the Modoc can be found.

The Northern Burials

This cemetery, without areas of especially high density, occurred between Pit I in the south and pit B in the north. Its western limit was Pit A and D, but its eastern limits did not reach Pit J. On stratigraphic grounds, it correlates with the Northern cemetery (burials in USFL/TSFL) and remained in use for a longer period into the LAL/MAL accumulation.

The Burials in Pit I

Pit I intersected four burials all situated in the top layer 3b which has been ascribed to the 13-LAL. These include one infant burial (I-I) and the disarticulated mixed remains of six adults in I-II, I-III, and I-IV. Fig. 19-20 shows that the walls of Pit I were not dismantled when these were encountered, so that only parts of I-II, I-III and I-IV were recovered, the remainder being left in situ. Although the field records state that no grave pit-outlines were visible for any of these burials, the south and east faces of Pit I show a quite obvious pit outline for I-II and I-III (see Fig. 2-14). The black humic fill of layer 3 penetrates through the lighter clay of layer 4 and into the darker clays of layer 5. This shallow (30cm deep) pit infilling reveals whitish ash lenses in the south face. The pit outline seen in the northeast corner, penetrating from layer 1 into layers 2-3, contained no human bones.

Burial I-I was that of an infant which was probably flexed and settled on the left side with the forearms and hands over the forehead and the head roughly to the east. Altogether, 32 olivella beads were concentrated in the fill around the ribs. There were no other associations.

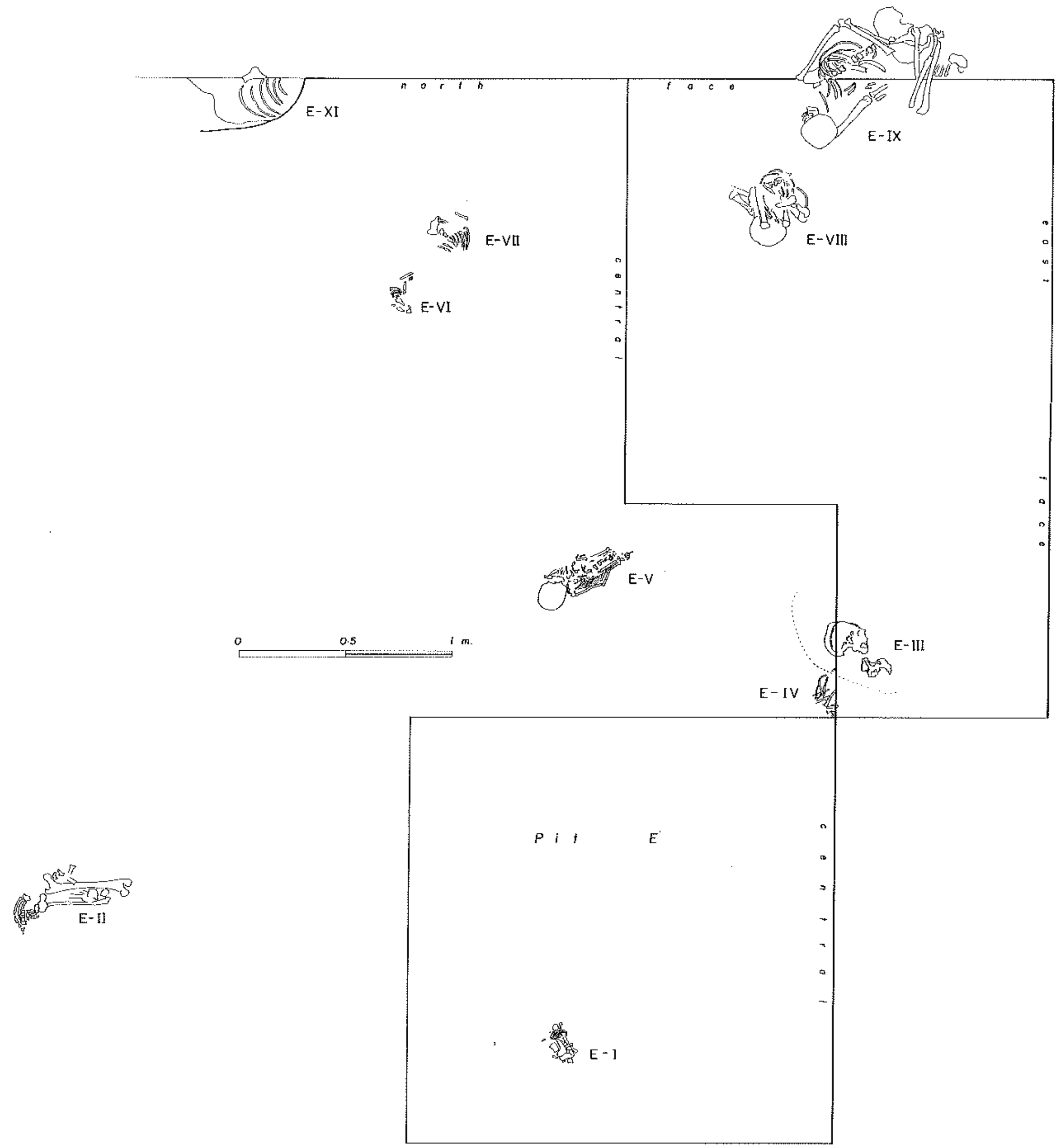

Fig. 19-22 Disposition of the burials around Pit E.

Burial I-II was a totally disarranged scatter of bones from a single adult. A few olivella beads were close to the two complete ribs and a fragment of incised animal bone came from the surrounding fill as well as a few obsidian or chert flake and bone splinters.

Burial I-III was an incomplete scatter very similar in character to I-II. There were olivella beads no more than 1cm above the general level of the bones and a few obsidian flakes in the fill. There was a fragmentary humerus belonging to a second individual in this scatter.

Burial I-IV was in a friable matrix with more sand and some carbon. However, no pit outline was visible (Fig. 19-21). There were nine olivella beads in the fill immediately between and above the bones, and several obsidian or chert flakes and animal bone fragments were found nearby. There was a large rodent burrow exposed immediately below the level of the bones and sectioned by the west face (Fig. 2-14). The bones are the mixed remains of an adult, an adolescent and a young child.

In summary, the Pit I subgroup may be stratigraphically later than the Southwestern Cemetery. The use of olivella beads persisted into this period, but there are no signs of closely associated arrowheads. However, the trench containing three adults (I-II and I-III) indicates that group cremations may have persisted. Also, the increase in charcoal and ash in the fill--yielding clear pit outlines--suggests that more effort was made to build a larger, more effective pyre.

<u>The Burials around Pit E</u>

Eleven burials were encountered during the uncovering of the pit house floors at Pit E (see Chapter 18). Their disposition in relation to the recorded sections is given in Fig. 19-22, and their vertical positions are projected on to the stratigraphic sections in Fig. 19-23. The salient features of each burial are summarized in Table 19-3.

Burial E-I was a partially articulated infant skeleton with the skull crushed and shattered. Although no grave pit outline could be seen, it must have been placed in a small shallow hole scraped out of the surface of the deep fill in the layer 5 pit house. Thus it could have been buried during either 12-TSFL or 13-LAL times.

Burial E-II was probably interred in the same manner and broadly in the same period as E-I. Again, no grave pit outline was visible. This articulated left limb was presumably separated from the body during the business of fitting the semi-cremated remains into the receiving trench. It is located close to the outer limits of the Pit E extension cutting, and we must assume that the rest of the skeleton was left <u>in situ</u>. The separated leg was presumably buried in another trench on its own.

Burial E-III was interred presumably from layer 1 (removed by bulldozer). The grave outline was partly captured in profile in the central section and the plan of its outline was only partly mapped. The broken skull and sacrum of an adult was mixed with a few bones and fragments from a young child. Two olivella beads were found in the surrounding fill, most of which had already been stripped by the bulldozer before excavation. The E-III cremation was clearly more thorough than the earlier two just described.

Burial E-IV suggests an equally efficient cremation. Although a separate operation from E-III, the partly stripped ash fill contained small fragments of at least four individuals mixed together.

Table 19-3

The Northern Burials

Burial No.	Layer	Stratum	Status	Posture	Orientation	Associated artifacts
E-I	4a?	11-USFL	infant	flexed on left side	NW-SE	none
E-II	4a	11-USFL	left leg and foot of adult	flexed	E-W	none
E-III	2	13-LAL/14-MAL	1 child, 1 adult	-	-	2 olivella beads
E-IV	2	13-LAL/14-MAL	1 child, 1 adolescent, 2 adults	-	-	none
E-V	2	12-TSFL	child	flexed, on back	head to SW	none
E-VI	4b?	11-USFL	infant	-	-	none
E-VII	4b	11-USFL	infant	-	-	none?
E-VIII	2	13-LAL/14-MAL	adolescent	flexed, upright	facing S	2 retouched flakes, 1 antler wedge in fill
E-IX	1	14-MAL	adult	semi-flexed on right side and back	head to WSW	2 stone pipes, 20 abalone beads, 1 obsidian projectile pt., 1 retouched flake, 2 worked bone fragments
I-I	3b	13-LAL	infant	flexed on left side	head to E	32 olivella beads in fill
I-II	3b	13-LAL	adult	-	-	few olivella beads near ribs
I-III	3b	13-LAL	2 adults	-	-	olivella beads above bones
I-IV	3b	13-LAL	1 adult, 1 adolescent 1 infant	-	-	9 olivella beads in fill
B-I	4c	11-USFL	infant	flexed on back	head to E	none
D-I	1b	13-LAL	adult	fully flexed on right side	head to NW	chert flake near jaw
A-I	6	12-TSFL	infant	-	-	83 olivella beads at same level
A-II	5	13-LAL	adult	flexed on left side	head to SE	none

Burial E-V was probably interred from a level in the 13-LAL or 14-MAL. In contrast to E-III, the cremation was fairly inadequate and the child's skeleton was fully articulated (Fig. 19-24).

Burial E-VI was another infant burial into the lower part of the infilling of the layer 5 pit house. Although still partly articulated, the postcranial skeleton was so dispersed that the original posture and orientation could not be determined. The skull was disintegrated to small fragments. No grave outline was visible so that the level from which it was buried cannot now be determined.

Burial E-VII was found immediately north of E-VI and about 10cm lower in the same fill. It was evidently another semi-articulated infant with the cranium crushed and fragmentary. Other than a sketch plan of its position and an elevation reading, there are no other records of this individual.

Burial E-VIII was almost certainly buried from somewhere in layer 1. Although the fill around the skeleton was black, no pit oultine was recorded. The position of this burial is unique among the Nightfire Island burials in that the body was placed in an upright sitting position. The skull was detached and placed so that it appears to be resting on the hands, which were thrust between the knees at the time of burial (Fig. 19-25 and 19-26).

Burial E-IX yielded the clearest pit profile of the entire group (Fig. 19-23). Although not plotted, the horizontal outline was reported as roughly circular. It was evidently dug from a level within layer 1 and about 20cm below the modern surface. The body was placed so that the partly flexed legs and pelvis were turned on the left side, with the upper trunk turned so that the back lay flat on the grave floor. The head was upright, bent in this position probably because it was propped up against the pit wall. The head and cervical vertebrae were separated from the shoulders and the zygomatic arch appears to have been cut through before death. Grave goods were clearly associated with the burial (Fig. 19-27). A red sandstone pipe (Fig. 17-4c) was lodged under the mandible. A second pipe broken into seven pieces but still in place, was recovered from alongside the right humerus (Fig. 17-4b). Immediately over the broken pipe lay two flat lengths of burned wood and numerous carbonized chunks, suggesting the charred remains of a board laid alongside the right shoulder and extending out to the area of the bent knees. Also under this board, traces of basketry were seen lying flush with the edge of the skull. Wedged between the knees and the overlying board was a second trace of matting--overlain with a fragmentary bundle of cordage. An obsidian point was found in the fill immediately west of the left tibia proximal, and beneath the board. Another chert projectile point was plotted in the fill between the right humerus and the ribcage and may have been embedded in the body[3]. A cluster of animal bones was plotted 5cm below the back of the skull, but these too cannot now be isolated in the collections from the rest of the bone from the fill. The retouched flake probably came from the fill to the east of the right tibia, and its association with the burial is uncertain. The positions of the two worked bone fragments were not plotted.

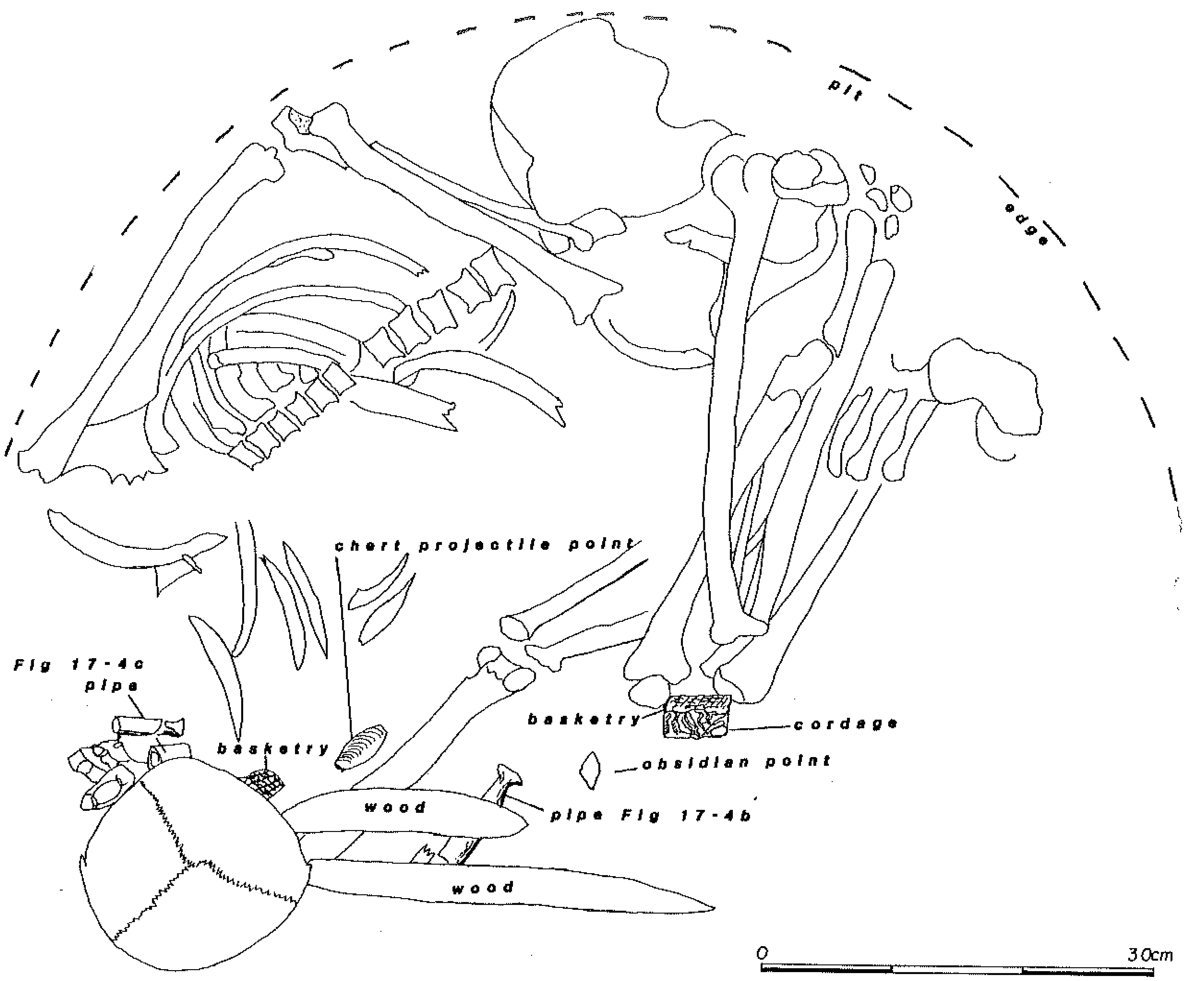

Fig. 19-27 Plan of Burial E-IX.

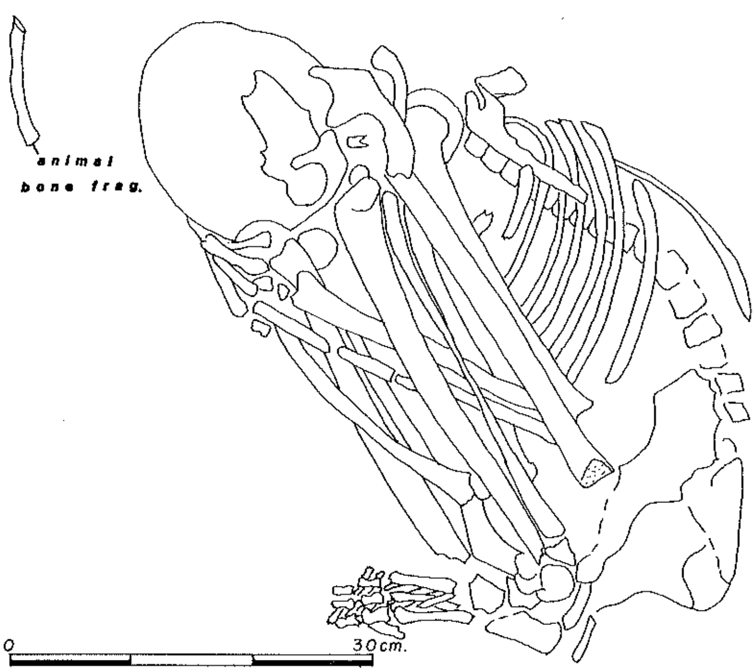

Fig. 19-28 Plan of Burial D-I.

was presumably buried in a shallow depression from layer 5 or above, and it must date to no earlier than the 13-LAL. The skeleton was seriously disturbed and broken up during first shovel contact so that few diagnostic bones were recovered and their positions were not plotted. The 83 olivella beads recovered from layer 6 almost certainly came from this burial, but the records are vague.

Burial A-II is that of a flexed adult intersected by the south face of Pit A. The face was partially dismantled in order to uncover the remainder of the skeleton before the profile was drawn (Fig. 2-6). Consequently, the grave outline--if it was visible--has not survived. The interment took place either from somewhere in layer 4, or possibly above this. It follows that the earliest possible period for this cremation would be the end of the 13-LAL. The body settled on the left side with the trunk rotated so that the right arm was pinned under the back (Fig. 19-29), and the left arm was tightly flexed under the chin. The head was towards the southeast. Although the bone preservation is good, rodent disturbances have separated the left femur and damaged the pelvis. The skull, originally intact and in place, was dislodged and fragmented at first shovel contact. Although a retouched flake came from the fill near the skeleton, it was not plotted and its association is therefore in doubt.

Significance of the Northern Burials

The character of this cemetery clearly differs from the Southwestern Burials: male-female pairs could not be determined; only the 'slave' (E-IX) showed signs of a possibly violent death; cremation was more complete in several cases; less thoroughly cremated (i.e. complete and articulated) individuals varied in posture and orientation; there were almost as many infants and children (10) as adults and adolescents (14); only the 'slave' was accompanied by grave goods.

Several of these differences are time-related. If we consider only those Northern burials which are strictly correlated with the Southwestern cemetery--i.e. recovered from the 11-USFL and 12-TSFL--it emerges that there are seven infants and young children, plus the solitary adult leg. Also, there are no olivella beads associated with these, except for the ambiguous occurrence in A-I. The contrast with the stratigraphically coeval Southwestern cemetery is still more pronounced, therefore. It is possible that the infilling of the level 5 pit house (Chapter 18) came into use first as a casual burial area for disposing of very young children. We may also have an analog here for the Modoc custom of secret burial for infanticides. Unfortuantely, the staining of many of the infant remains is too ambiguous to allow definite statements about which individuals were cremated, and which may have been buried without the normal ceremonies.

Turning next to the stratigraphically later burials in the 14-MAL, it becomes apparent that more efficient pyre building was being practiced so that adults (now more numerous than children) were being reduced to fragments more often. Olivella beads were still used in the ceremony (Pit I and E-III), but orientation of the body was far form systematic.

Finally, it emerges that the 'slave' in E-IX was the latest of the whole group. The anomalous associations were therefore time-related and link this individual more clearly with the ensuing crematory discussed below.

In summary, the Northern burials reflect both continuity and change in the cremation procedures first seen in the Southwestern cemetery. The olivella beads continued to be used as an intrinsic part of the ceremony during the 13-LAL accumulation, but pyre construction was becoming more efficient with time, so that decreasing amounts of the adult skeleton tended to survive.

The Northern Crematory

This subdivision is admittedly artificial. It represents a later stage in the development of the Northern cemetery which can be clearly demarcated in the archaeological record. During the 14-MAL accumulation, the cremation procedure was perfected to the point where whole adult skeletons could be reduced to small undiagnostic fragments of charred bone embedded in ash within the cremation trench. This event coincided with a marked increase in the number and variety of possessions and personal ornaments which could survive the cremation process. Unfortunately, the controlled excavations intersected a very small sample of these cremation pits--not all of which yielded grave goods.

Burial E-X is a cremation pit dug exactly into the upper fill of the 'slave' E-IX but not quite down to the level of the top of the E-IX skull (Figs. 19-23 and 19-30). No plan was drawn of the contents of this pit and the human bone was so charred and fragmented that it has no diagnostic value. In the carbonized fill was the sandstone pipe stem fragment shown in Fig. 17-4e, together with the whole steatite pipe in Fig. 17-4a. There were also 30 abalone beads, all of which are shown in Fig. 16-7. The fill also contained a Gunther Barbed Point (Fig. 19-7k) and a retouched flake.

Burial E-XI was a second cremation exposed by the bulldozer cut (Fig. 19-23). Although partly mapped in place and captured in the north section, no burial record was made out for this shallow pit. The only remaining diagnostic bones were the longer limb bones, ankle bones and sacrum of an adult. The field sketches indicate that the bones were lying on top of a thick bed of charcoal and charred bone fragments. There were no associated artifacts.

Although it is tempting to suppose that E-X was a higher-status individual (grave goods and complete cremation) than E-IX (no goods and incomplete cremation), some doubts may be raised by evidence from other exposed pits. If the trench seen in the northeast corner of Pit I (Fig. 2-24) belongs to this group, as may the pit in the southwest corner of Pit G (Fig. 2-20), then it must be inferred that complete cremation could be bestowed on individuals without grave goods. The case for status differences remains ambiguous, therefore.

Furthermore, these four occurrences were but a small sample of a much larger field of cremation pits in the 14-MAL which were distributed over the area between pits BEIJ. A dozen or more were uncovered by the same bulldozer cut which stripped the top of Burial E-XI. Mr. C. B. Howe (pers. comm.) was able to recover some of the associated grave goods from these, but there are no records of exact provenience. Among the very abundant grave goods were eyed bone needles (Fig. 15-18e, f), decorated sweat-scrapers (Fig. 16-1d), pendants (Fig. 16-1c), soapstone nose ornaments (Fig. 16-1f) *Haliotis* pendants (Fig. 16-3d, f), and pipes (Figs. 17-4j, 17-5c, 17-5d, 17-6a-e).

Also from one of these came a cache of agate pebbles, quartz crystals, natural obsidian splinters, and weathered projectile points--none of which are the Gunther Barbed type (Howe 1979:194). There are obvious parallels with the earlier cache found with R-XIII, tentatively suggested to be the contents of a shaman's pouch. This second cache would indicate continuity in shamanistic equipment into the MAL/LAL period.

The Western Crematory

A second area of cremation pits about 150m west of Pit K was intersected by a narrow irrigation ditch and subsequently opened up by Howe (1979:191-2). This burial ground was entirely off the site and could not be tied into its stratigraphic sequence. The numerous shallow pits were dug into the gray diatomite of the lake bed surface and it follows that this must have been dry land at the time. Again, no detailed records of the pits were made, but there were apparently over a dozen--each filled with ash, charcoal, and carbonized human bone. In several cases, the bone was sufficiently intact to determine that individual pits contained the remains of two or three individuals. The fill in some pits was mixed with abundant red haematite powder. Not encountered in the fills of earlier burials, this seems to be yet another innovation in the development of the Modoc cremation procedures. Although probably the most recent of all the burial grounds, ethnographic analogs for this are not forthcoming. In fact, Ray's informant specifically mentioned that during the preparation of the corpse, the face was <u>not</u> painted and that nothing was put in the hair (Ray 1963:114). One informant told a story of a shaman's cremation which might, however, provide a clue--"It was the most unusual fire ever seen, the flames were of many colors and very high" (p. 70). It is remotely possible that this effect may have been caused during oxidation of limonite powder to haematite in the blaze--either by accident or by design. The case is weakened by the fact that the shaman in question was an expatriate Modoc who died in Oklahoma, and it is not clear whether the informant was giving an eyewitness or a second-hand account.

Grave goods in the Western Crematory were very abundant, including items such as the awl shown in Fig. 15-17f, the bone pendants in Fig. 16-1h, and 16-2abd, the human skull pendants in Fig. 16-4abc, the decorated elkhorn armband in Fig. 16-5b and the pipe in Fig. 17-5b. It is reasonable to assume that this second off-site cremation group was somewhat later than the group exposed in the BEIJ, area (MAL/LAL period). As the sedimentary evidence suggests periodic inundations by the lake in MAL times, it is improbable that the cemetery would have come into use until the next dry spike or possibly after the site was abandoned.

Conclusions

Burials took place outside the village until the end of the 11-USFL. At some point between about 300-500AD, two burial grounds came into use--one on the southwest edge of the village was used for the victims of a series of raids and a second in and around the fill of an abandoned pit house for the disposal of infants. Even at this early stage, the basic ceremonial outlines of the historical Modoc cremation procedure are clearly visible--the trench covered by a brushwood pyre, and the addition of beads before and during the cremation. After the advent of the bow-and-arrow to this site, the raid-victim cemetery passed out of use, and more efficient pyres were introduced at the northern graveyard. At some point in the MAL, perhaps between 500-700AD, log-burning pyres were introduced, leading to near total cremation. This innovation coincides with a proliferation of grave goods but also with the abandonment of olivella beads. The site may have continued as a burial ground after the village was abandoned.

From the beginning, many of the characteristic features of Modoc society may be perceived in place: the shaman, the victims of raiding parties, skull trophies from victorious raids elsewhere, rules for the disposal of slaves, and rules for the disposal of infants. At least these elements of Modoc social organization can be traced back into the prehistoric past for some two thousand years.

ENDNOTES: CHAPTER 19

1. The earliest recorded human remains are from the 7-GraCl: an adult femur from the pit house floor fragment in D4c (Chapter 18).

2. Not literally. Slight-of-hand tricks were part of the shaman's normal repertoire. The arrowheads "reappeared" after appropriate incantations. Although the projectiles in Fig. 19-16 were all concentrated in the abdominal region of R-XIII, this is an amusing coincidence and need not be taken to mean that they had been swallowed and failed to reappear--leading to accidental death!

3. These cannot be located in the collections, and consequently have not been illustrated or identified.

CHAPTER TWENTY

THE HUMAN SKELETAL REMAINS

Analysis of the skeletal material was conducted by Dr. K. A. Bennett in 1969. The measurements, indices, and criteria used in his analysis reflected the state of the art at that time. Although a few procedures have been refined or replaced since then, a review of these refinements suggests that none of them, if applied to the Nightfire Island assemblage, would drastically alter the results to be described in this chapter. Care has been taken to quote the sources of methodologies used, wherever this seems appropriate. Measurements were taken with standard hinge and sliding calipers, an osteometric board and a Mollison Craniophore.

Because nearly all skeletons were cremated to some degree, preservation varied considerably, with some represented by only a few fragments and others by the nearly complete skeleton (see Chapter 19 for details). In general, however, preservation was poor and the sample numbers were quite low.

Age Determination

The criteria used to determine the age-at-death of individuals are shown together with the results in Table 20-1. Wherever possible, the symphyseal components of McKern and Stewart 1957) were determined (10 individuals); long-bone length was used for young children, following Johnston (1963), for nine individuals. In other cases of extreme fragmentation, tooth eruption sequences or dental attrition have been used (six individuals). Fusion of long-bone epiphyses was used to age two individuals, and overall size was used for rough evaluation of burials recorded, but too fragmentary to be recovered.

Similar to most early Native North American skeletal populations, a high infant mortality rate at Nightfire Island is indicated--nearly one third of the entire population died before two years of age. This undoubtedly represents a minimal proportion because infant bones tend to deteriorate rapidly and to be cremated more thoroughly. Perhaps a more accurate picture of the infant mortality rate is to be gained when the earliest, inefficiently cremated sample from the USFL/TSFL is considered: nine out of nineteen individuals--almost half the sample--are infants and young children.

Although three individuals passed middle age (40+), there is an anomalous peak in the 25-30 year range. As at least three of these five individuals may have met violent ends, the peak may be connected with the generally violent conditions attendant upon raiding warfare.

Sex Determinations

Determinations are listed in Table 20-2, together with the criteria used for each adult. Morphology of the pubic symphysis following Phenice (1969) could be used for only five males. In most other cases, the width of the greater sciatic notch and the sub-pubic angle could be used. Two individuals without pelves were evaluated on cranial morphology alone.

Only 14 adults (10 males and four females) could be aged and sexed (Table 20-3). It is again apparent that the spike at 26-30 years in age distribution is dominated by males--a further hint that this may be related to raiding warfare which was strictly a male activity. No doubt the probability of death for males of warrior age was higher

Table 20-1

Age Determinations

Burial No.	Age at death Years	Symphyseal Components * I - II - III	Bases of determinations Other Observations
R-I	17-20	2 - 1 - 0	Epiphyseal maturation of pubic symphysis
R-II	25-30	4 - 3 - 4	Epiphyseal maturation of pubic symphysis
R-III	35-45		Entirely on dental attrition (no innominates available)
R-IV	35-40	5 - 5 - 4	Epiphyseal maturation of pubic symphysis
R-V	unknown		No records
R-VI	greater than 1		Length of long bones (Johnston 1963)
R-VII	25-30	3 - 3 - 4	Epiphyseal maturation of pubic symphysis
R-VIII	1 1/2-3 1/2		Eruption of deciduous dentition: length of right femur
R-IX	25-30	4 - 2 - 3	Epiphyseal maturation of pubic symphysis
R-X	12-15		Epiphyseal maturation of pubic symphysis
R-XI	infant		Overall size - no records
R-XII	25-30	3 - 2 - 4	Epiphyseal maturation of pubic symphysis
R-XIII	adult		Overall size
S-I	20-25	2 - 2 - 0	Epiphyseal maturation of pubic symphysis
I-I	newborn-1/2 yr.		Femur length
I-II	adult		Total fusion of epiphysis with diaphysis; eruption of all permanent dentition
I-III	adult		Overall size
I-IVa	1 1/2-2		Eruption of deciduous dentition in the mandible
I-IVb	adult		Only on comparative fusion of tibial epiphysis with diaphysis

Table 20-1 (Continued)

Burial No.	Age at death Years	Symphyseal Components * I - II - III	Bases of determinations Other Observations
I-IVc	12-17		Non-fusion of proximal epiphysis of right tibia and scapular spine
E-I	newborn-1/2 yr.		femur and humerus lengths
E-II	adult		both proximal and distal epiphyses fused to shafts of all long bones
E-IIIa	40+		Dental attrition
E-IIIb	1 1/2-2 1/2		Lengths of both humeri
E-IV	30+		Dental attrition
E-V	1 1/2-2 1/2		Lengths of femur, humerus and ulna
E-VI	newborn-1/2 yr.		Lengths of femur, humerus and ulna
E-VII	infant		Overall size - no records
E-VIII	12-15	0 - 0 - 0	Eruption of permanent dentition; epiphyseal maturation of pubic symphysis
E-IX	20-25	3 - 2 - 1	Epiphyseal maturation of pubic symphysis
E-X	unknown		Cremation
E-XI	25-30	4 - 3- 3	Epiphyseal maturation of pubic symphysis
B-I	newborn-1/2 yr.		Length of femur and humerus
D-I	40+		Dental attrition
A-I	newborn-1/2 yr.		Lengths of femur and tibia
A-II	40+		Dental attrition

*After McKern and Stewart, 1957

Table 20-2

Sex Determinations

Burial No.	Sex	Basis of Determination
R-I	male	narrow sub-pubic angle; narrow greater sciatic notch
R-II	female	presence of pre-auricular sulcus; sub-pubic angle, cranial morphology
R-III	female	cranial-morphology-rounded orbits, small mastoids: vertical ascending ramus; very gracile long bones
R-IV	male	pubic symphysis morphology (Phenice 1969)
R-V	unknown	no records
R-VI	unknown	infant
R-VII	male	narrow sub-pubic angle; pubic symphysis morphology
R-VIII	unknown	young child
R-IX	male	narrow sub-pubic angle; pubic symphysis morphology
R-X	female	sub-pubic angle; angle of greater sciatic notch
R-XI	unknown	infant
R-XII	male	pubic symphysis morphology; angle of greater sciatic notch
R-XIII	unknown	too fragmentary
S-I	male	sub-pubic angle; angle of greater sciatic notch
I-I	unknown	infant
I-II	unknown	incomplete
I-III	female	fragment of a wide greater sciatic notch
I-IVa	unknown	incomplete
I-IVb	female	presence of well-developed pre-auricular sulcus; wide angle of greater sciatic notch
I-IVc	unknown	incomplete
E-I	unknown	infant
E-II	unknown	leg only
E-IIIa	male?	cranial robusticity
E-IIIb	unknown	infant
E-IV	unknown	incomplete
E-V	unknown	infant
E-VI	unknown	infant
E-VII	unknown	infant
E-VIII	male	sub-pubic angle; angle of greater sciatic notch
E-IX	male	narrow sub-pubic angle; angle of greater sicatic notch
E-X	unknown	cremation
E-XI	male	pubic symphysis morphology; sub-pubic angle; angle of greater sciatic notch
B-I	unknown	infant
D-I	female	angle of greater sciatic notch
A-I	unknown	infant
A-II	unknown	too fragmentary

Table 20-3

Age and Sex Distribution

Age Range	Male	Female	Unknown Sex	n
0-2	-	-	10	10
3-5	-	-	-	0
6-12	-	-	-	0
13-15	1	1	1	3
16-19	1	0	0	1
20-25	2	0	0	2
26-30	4	1	0	5
31-35	0	0	0	0
36-40	1	1	0	2
over 40	1	1	1	3
	10	4	12	26
Adult	0	2	4	6
Totals	10	6	16	32

than for females. Unfortunately, the sample for the older ranges are too small to reveal whether or not more females were surviving past middle age.

Determinations of Stature

Table 20-4 gives stature estimations derived from prediction equations based on the long bone measurements (Genoves 1967) of eleven measureable adults. Although the sample is really too small to be amenable to statistical treatment, the equations were computed for visual intrapopulation comparison alone, and not to indicate actual stature. Two trends warrant our attention. First, the difference in the male stature estimates are almost negligible, so that the male segment of the population appears quite homogenous. Secondly, the individual from burial E-IX (thought to be a non-Modoc slave, based on the manner of his burial) is at the taller end of the range for males. Although the estimates for females are few in number, they are generally shorter than the males--a quite normal trend.

Metric Dimensions

Again, metric dimensions were taken in the full knowledge that the samples would be too small for statistical manipulation, but this was deemed worthwhile merely to allow visual intrapopulation comparisons. Cranial and post-cranial dimensions for the adult males are shown in Table 20-5, and for adult females in Table 20-6. Examination of these reveals that, once again, there is remarkably little variance among the males--as was the case with the stature estimations. Also, differences between E-IX and the other males become more obvious in Table 20-5. If this individual was indeed a non-Modoc slave, then the case is further supported by these data. Except for E-IX, the male segment of this population appears quite homogenous and it is quite probable that the villagers (perhaps 12-15, with an upper limit of about 20 living at the site at any one time) were inbred.

Discontinuous Traits

Because so many skulls were missing and others were fragmentary, there is scanty evidence for discontinuous traits. Obviously, frequencies of occurrence cannot therefore be calculated. Nevertheless, a few general observations may be made: this population probably had high frequencies of shovel-shaped incisors and H-shaped pteria; there were probably moderate frequencies of tympanic plate dehiscences; and low frequencies of wormian bones, mylohyoid bridges, metopic sutures, ear extoses, parietal notch bones, pharyngeal fossae, and "K"-shaped pteria. Numbers are given in Table 20-7.

Vertebral Sacral Deformities

These have been discussed by Bennett (1972) and will be briefly summarized here. Of the ten individuals with vertebral columns complete enough to be observed, only E-IX was without some form of vertebral and/or sacral deformation. Each of the nine individuals had 25 instead of the usual 24 presacral vertebrae. In all but one of these it was the sixth lumbar that was partly or completely sacrilized and was in varying stages of fusion to the first sacral vertebra. In the ninth individual, the extra vertebra was a thirteenth thoracic. Sacrilization of L6 was already advanced in the two young adolescents R-X and E-VIII, but it was impossible to tell how much earlier this might have begun in the growth of individuals. In the two youngest

Table 20-4

Estimations of Stature in Males and Females in cms.
(after Genoves 1967)

Burial No.	Bones Used: Humerus	Femur	Tibia	Radius	Ulna
Males					
R-I	162	160	161	163	163
R-IV	162	161	161	164	165
R-IX	162	156	159	163	163
R-VII	163	159	161	163	163
R-XII	-	-	-	-	166
S-I	163	165	165	164	165
E-IX	165	165	164	163	165
Mean	163	161	162	163	164
Standard deviation:	1.16	3.52	2.22	0.50	1.25
Females					
R-II	-	151	-	154	-
R-X	140	147	148	-	-
I-IVb	-	-	151	-	-
D-I	157	153	157	161	164

Table 20-5

Cranial and Post-cranial Metric Dimensions in Males

Measurement	Burial Numbers									
	R-I	R-IX	R-IV	R-VII	R-XII	E-IIIa	S-I	E-VIII*	E-IX	E-XI
Cranial length	---	---	---	---	180	182	176	172	189	---
Cranial breadth	---	---	---	---	141	---	142	136	145	---
Basion-bregma height	---	---	---	---	---	137	136	131	148	---
Endobasion-nasion	---	---	---	---	---	104	103	97	106	---
Endobasion-alveolar point	---	---	---	---	---	106	103	93	103	---
Endobasion-gnathion	---	---	---	---	---	---	113	93	113	---
Min. frontal dia.	---	---	---	---	102	---	97	93	97	---
Max. bizygomatic dia.	---	---	---	---	---	---	145	127	144	---
Nasion-alveolar point	---	---	---	---	---	73	69	67	69	---
Nasion-gnathion	---	---	---	---	---	---	121	109	122	---
Ext. alveolar length	---	---	---	---	---	57	52	51	54	---
Ext. alveolar breadth	---	---	---	---	---	63	63	63	64	---
Nasal height	---	---	---	---	---	54	50	46	49	---
Nasal breadth	---	---	---	---	---	27	24	23	24	---

Table 20-5 (Continued)

Measurement	Burial Numbers									
	R-I	R-IX	R-IV	R-VII	R-XII	E-IIIa	S-I	E-VIII	E-IX	E-XI
Orbital height	---	---	---	---	---	36	36	33	33	---
Orbital breadth	---	---	---	---	---	41	39	38	37	---
Biorbital breadth	---	---	---	---	---	---	99	93	96	---
Interorbital breadth	---	---	---	---	---	25	23	24	---	---
Min. nasal breadth	---	---	---	---	---	7	10	10	8	---
Auricular height	---	---	---	---	---	---	124	112	125	---
Symphyseal height	---	---	---	---	35	---	33	30	36	---
Bigonial diameter	---	---	---	---	108	---	110	94	104	---
Bicondylar length	---	---	---	---	---	---	129	112	128	---
Height of ascending ramus	---	---	---	---	---	---	62	51	72	---
Width of ascending ramus	---	---	---	---	33	---	31	27	37	---
Condylo-symphyseal length	---	---	---	---	---	---	102	92	102	---
Cranial index	---	---	---	---	78.3	---	80.7	79.1	76.7	---
Cranial module	---	---	---	---	---	---	151.3	146.3	160.7	---
Mean height index	---	---	---	---	---	---	85.5	85.1	88.6	---
Length-height index	---	---	---	---	---	75.3	77.3	76.2	78.3	---

Table 20-5 (Continued)

Measurement	Burial Numbers									
	R-I	R-IX	R-IV	R-VII	R-XII	E-IIIa	S-I	E-VIII	E-IX	E-XI
Breadth-height index	---	---	---	---	---	---	95.8	96.3	102.1	---
Upper facial index	---	---	---	---	---	---	47.6	52.8	47.9	---
Total facial index	---	---	---	---	---	---	83.4	85.8	84.7	---
Nasal index	---	---	---	---	---	50.0	48.0	50.0	49.0	---
Orbital index	---	---	---	---	---	87.8	92.3	86.8	89.2	---
Maxillo-alveolar index	---	---	---	---	---	110.5	121.2	123.5	118.5	---
Left humerus:										
Max. length	314	309	313	314	---	---	318	256	323	---
Max. middle dia.	23	21	24	24	---	---	23	17	23	---
Min. middle dia.	17	16	16	18	---	---	16	14	17	---
Circum. of mid-shaft	65	61	67	69	---	---	65	50	67	---
Max. head dia.	45	42	44	46	---	---	46	36	47	---
Right humerus:										
Max. length	314	313	---	316	---	---	318	264	326	---
Max. middle dia.	24	21	24	24	---	---	24	17	25	---

Table 20-5 (Continued)

Measurement	R-I	R-IX	R-IV	R-VII	R-XII	E-IIIa	S-I	E-VIII	E-IX	E-XI
					Burial Numbers					
Min. middle dia.	18	16	18	17	---	---	17	13	17	---
Circum. of mid-shaft	68	61	71	68	---	---	68	51	71	---
Max. head dia.	45	46	---	46	---	---	47	37	48	---
L. clavicle, max. length	153	---	149	---	---	---	---	---	154	---
R. clavicle, max. length	---	---	147	---	---	---	153	---	---	---
Left femur:										
Max. length	---	408	---	417	---	---	446	---	452	---
Bicondylar length	---	404	---	413	---	---	441	---	448	---
Mid. dia., a.-p.	27	25	---	31	32	---	28	20	28	---
Mid. dia., lateral	26	27	---	27	30	---	26	19	25	---
Circum. of mid-shaft	83	83	---	90	95	---	84	60	83	---
Sub.-troch. dia., a.-p.	26	24	---	24	29	---	26	25	28	---
Sub.-troch. dia., lateral	32	32	---	35	36	---	32	25	34	---
Max. head dia.	43	43	---	44	45	---	46	40	47	---
Right femur:										
Max. length	424	406	429	422	---	---	450	372	445	---

Table 20-5 (Continued)

Measurement	Burial Numbers									
	R-I	R-IX	R-IV	R-VII	R-XII	E-IIIa	S-I	E-VIII	E-IX	E-XI
Bicondylar length	421	403	424	419	---	---	443	368	443	---
Mid. dia., a.-p.	27	25	28	30	31	---	28	20	27	---
Mid. dia., lateral	25	26	26	27	29	---	26	19	26	---
Circum. of mid-shaft	81	80	87	87	93	---	83	60	81	---
Sub.-troch. dia., a.-p.	25	23	27	25	---	---	30	19	27	25
Sub.-troch. dia., lateral	35	32	34	35	---	---	30	25	35	33
Max. head dia.	44	42	44	44	---	---	46	41	48	---
Left tibia:										
Max. length	---	---	---	354	---	---	373	---	369	---
Nut. for. dia., a.-p.	33	35	---	39	---	---	38	25	36	---
Nut. for. dia., lateral	23	24	---	24	---	---	23	19	24	---
Circum. of mid-shaft	82	86	---	83	---	---	86	60	83	83
Mid. dia., a.-p.	31	31	---	33	---	---	33	21	31	32
Mid. dia., lateral	21	22	---	19	---	---	20	16	21	20
Right tibia:										
Max. length	356	346	353	351	---	---	374	---	367	---

Table 20-5 (Continued)

Measurement	Burial Numbers									
	R-I	R-IX	R-IV	R-VII	R-XII	E-IIIa	S-I	E-VIII	E-IX	E-XI
Nut. for. dia., a.-p.	32	35	38	36	40	---	38	24	36	---
Nut. for. dia., lateral	25	24	23	23	26	---	23	18	27	---
Circum. of mid-shaft	84	83	85	83	95	---	87	62	83	---
Mid. dia., a.-p.	29	31	33	31	35	---	34	23	30	---
Mid. dia., lateral	23	22	19	19	24	---	21	17	22	---
Left radius, max. length	---	---	---	243	---	---	249	---	242	---
Left radius, phys. length	---	---	---	228	---	---	233	---	228	---
Right radius, max. length	241	241	245	243	---	---	246	---	242	---
Right radius, phys. length	228	229	230	230	---	---	230	---	226	---
Left ulna, max. length	---	255	---	261	---	---	271	---	257	---
Right ulna, max. length	258	263	269	261	273	---	270	---	261	---
Left fibula, max. length	---	---	---	337	---	---	349	---	350	---
Right fibula, max. length	337	321	---	---	---	---	351	---	349	---
L. humero-femoral index	---	75.7	---	75.3	---	---	71.3	---	71.5	---
R. humero-femoral index	74.1	77.1	---	74.9	---	---	70.7	68.8	73.3	---
L. humerus, middle index	75.0	76.2	66.7	75.0	---	---	69.6	76.5	73.9	---

Table 20-5 (Continued)

Measurement	Burial Numbers									
	R-I	R-IX	R-IV	R-VII	R-XII	E-IIIa	S-I	E-VIII	E-IX	E-XI
R. humerus, middle index	73.9	76.2	75.0	70.8	---	---	70.8	82.4	68.0	---
L. claviculo-humeral index	48.7	---	47.6	---	---	---	---	---	47.7	---
R. claviculo-humeral index	---	---	---	---	---	---	48.1	---	---	---
Left femur:										
Platymeric index	72.2	75.0	---	68.6	80.6	---	81.3	72.0	82.4	---
Pilastric index	103.8	108.0	---	114.8	106.6	---	107.7	105.3	112.0	---
Middle index	96.3	92.6	---	87.9	93.8	---	92.9	95.0	89.3	---
Right femur:										
Platymeric index	71.4	71.9	79.4	71.4	---	---	100.0	76.0	77.1	75.8
Pilastric index	108.0	104.0	107.7	111.1	106.9	---	107.7	105.3	103.8	---
Middle index	92.6	96.2	92.9	90.0	93.5	---	92.9	95.0	96.3	---
Left tibio-femoral index	---	---	---	84.9	---	---	83.6	---	81.6	---
Left tibia:										
Platycnemic index	69.7	68.6	---	61.5	---	---	60.5	76.0	66.7	---
Middle index	67.7	71.0	---	57.6	---	---	60.6	76.2	67.7	62.5
Right tibio-femoral index	84.0	85.2	82.3	83.2	---	---	83.1	---	82.3	---

Table 20-5 (Continued)

Measurement	Burial Numbers									
	R-I	R-IX	R-IV	R-VII	R-XII	E-IIIa	S-I	E-VIII	E-IX	E-XI
Right tibia:										
Platycnemic index	78.1	68.6	60.5	63.9	65.0	---	60.5	75.0	75.0	---
Middle index	79.3	71.0	57.6	61.3	68.6	---	61.8	73.9	73.3	---
Left humero-radial index	---	---	---	77.4	---	---	78.3	---	74.9	---
Right humero-radial index	76.8	77.0	---	76.9	---	---	77.4	---	74.2	---

* Burial E-VIII is only 12-15 year of age, and the metric dimensions are not comparable to the other adult males.

Table 20-6

Cranial and Post-cranial Metric Dimensions in Females

Measurement	Burial Numbers					
	R-II	R-X*	R-III	I-III	I-IVb	D-I
Cranial length	170	---	166	---	---	172
Cranial breadth	133	---	128	---	---	137
Basion-bregma height	---	---	---	---	---	126
Endobasion-nasion	---	---	---	---	---	102
Endobasion-alveolar point	---	---	---	---	---	---
Endobasion-gnathion	---	---	---	---	---	---
Min. frontal dia.	92	---	84	---	---	97
Max. bizygomatic dia.	---	---	---	---	---	136
Nasion-alveolar point	---	---	---	---	---	---
Nasion-gnathion	---	---	---	---	---	---
Ext. alveolar length	53	---	---	---	---	---
Ext. alveolar breadth	63	---	---	---	---	---
Nasal height	49	---	---	---	---	---
Nasal breadth	23	---	---	---	---	---
Orbital height	---	---	---	---	---	36
Orbital breadth	---	---	---	---	---	42
Biorbital breadth	---	---	---	---	---	96
Interorbital breadth	---	---	---	---	---	21
Min. nasal breadth	---	---	---	---	---	7
Auricular height	---	---	---	---	---	---
Symphyseal height	---	---	32	---	---	---
Bigonial diameter	---	---	92	---	---	99
Bicondylar length	---	---	---	---	---	117
Height of ascending ramus	---	---	---	---	---	58
Width of ascending ramus	---	---	---	---	---	31
Condylo-symphyseal length	---	---	---	---	---	96
Cranial index	78.2	---	77.1	---	---	79.7
Cranial module	---	---	---	---	---	145.0
Mean height index	---	---	---	---	---	81.6
Length-height index	---	---	---	---	---	73.3

Table 20-6 (Continued)

Measurement	Burial Numbers					
	R-II	R-X	R-III	I-III	I-IVb	D-I
Breadth-height index	---	---	---	---	---	92.0
Upper facial index	---	---	---	---	---	---
Total facial index	---	---	---	---	---	---
Nasal index	46.9	---	---	---	---	---
Orbital index	---	---	---	---	---	85.7
Maxillo-alveolar index	118.9	---	---	---	---	---
Left humerus:						
Max. length	---	259	---	---	---	299
Max. middle dia.	20	18	19	---	---	18
Min. middle dia.	15	12	14	---	---	13
Circum. of mid-shaft	56	49	56	---	---	52
Max. head dia.	---	35	---	---	---	39
Right humerus:						
Max. length	---	257	---	---	---	---
Max. middle dia.	---	18	19	---	---	19
Min. middle dia.	---	12	15	---	---	13
Circum. of mid-shaft	---	49	57	---	---	53
Max. head dia.	---	36	---	42	---	---
L. clavicle, max. length	---	---	---	---	---	---
R. clavicle, max. length	---	---	---	---	---	139
Left femur:						
Max. length	400	386	---	---	---	---
Bicondylar length	397	384	---	---	---	---
Mid. dia., a.-p.	25	20	23	---	---	23
Mid. dia., lateral	25	19	25	---	---	23
Circum. of mid-shaft	76	62	74	---	---	72
Sub.-troch. dia., a.-p.	22	19	21	---	---	21
Sub.-troch. dia., lateral	29	25	27	---	---	28
Max. head dia.	41	37	---	---	---	---
Right femur:						
Max. length	---	379	---	---	---	407
Bicondylar length	---	377	---	---	---	405

Table 20-6 (Continued)

Measurement	Burial Numbers					
	R-II	R-X	R-III	I-III	I-IVb	D-I
Mid. dia., a.-p.	24	21	23	---	---	24
Mid. dia., lateral	24	19	24	---	---	22
Circum. of mid-shaft	75	62	73	---	---	73
Sub.-troch. dia., a.-p.	23	20	21	---	---	21
Sub.-troch. dia., lateral	27	28	27	---	---	27
Max. head dia.	41	37	40	---	---	40
Left tibia:						
Max. length	---	317	---	---	327	---
Nut. for. dia., a.-p.	28	25	29	---	30	28
Nut. for. dia., lateral	22	18	16	---	19	19
Circum. of mid-shaft	67	61	67	---	66	65
Mid. dia., a.-p.	25	23	28	---	25	24
Mid. dia., lateral	13	16	17	---	17	17
Right tibia:						
Max. length	---	317	---	---	---	349
Nut. for. dia., a.-p.	---	25	30	---	---	28
Nut. for. dia., lateral	---	19	19	---	---	19
Circum. of mid-shaft	---	62	69	---	---	65
Mid. dia., a.-p.	---	23	28	---	---	24
Mid. dia., lateral	---	17	18	---	---	17
Left radius, max. length	---	---	---	---	---	239
Left radius, phys. length	---	---	---	---	---	229
Right radius, max. length	221	---	---	---	---	241
Right radius, phys. length	208	---	---	---	---	230
Left ulna, max. length	237	---	---	281	---	262
Right ulna, max. length	237	---	---	---	---	262
Left fibula, max. length	---	---	---	---	---	---
Right fibula, max. length	---	277	---	---	---	---
L. humero-femoral index	---	66.6	---	---	---	---
R. humero-femoral index	---	68.3	---	---	---	---
L. humerus, middle index	70.0	66.7	73.7	---	---	72.2
R. humerus, middle index	---	66.7	78.9	---	---	68.4
L. claviculo-humeral index	---	---	---	---	---	---

Table 20-6 (Continued)

Measurement	Burial Numbers					
	R-II	R-X	R-III	I-III	I-IVb	D-I
R. claviculo-humeral index	---	---	---	---	---	---
Left femur:						
Platymeric index	75.9	76.0	77.8	---	---	75.0
Pilastric index	100.0	105.3	92.0	---	---	100.0
Middle index	100.0	95.0	108.7	---	---	100.0
Right femur:						
Platymeric index	85.2	71.4	77.8	---	---	77.8
Pilastric index	100.0	110.5	95.8	---	---	109.1
Middle index	100.0	90.5	104.3	---	---	91.7
Left tibio-femoral index	---	82.1	---	---	---	---
Left tibia:						
Platycnemic index	78.6	72.0	55.2	---	63.3	67.9
Middle index	52.0	69.6	60.7	---	68.0	70.8
Right tibio-femoral index	---	83.6	---	---	---	85.7
Right tibia:						
Platycnemic index	---	76.0	63.3	---	---	67.9
Middle index	---	73.9	64.3	---	---	70.8
Left humero-radial index	---	79.0	---	---	---	79.9
Right humero-radial index	---	82.6	---	---	---	---

* Burial R-X is only 12-15 years of age, and the metric dimensions are not comparable to the other adult females.

Table 20-7

Numbers of Individuals With and Without Various Discontinuous Traits

Trait	No. With	No. Without
Lambdoidal Wormian Bones	1	8
"K" Shaped Pteria	0	5
"H" Shaped Pteria	5	0
Dehiscences of the Tympanic Plate	4	2
Mylo-Hyoid Bridges	0	4
Metopic Sutures	0	8
Auditory Exostoses	0	7
Pharyngeal Fossae	0	6
Shovel-Shaped Incisors	5	0
Parietal Notch Bones	1	5

cases, sacrilization of L6 was advanced and fusion had begun between the lateral extremities of both transverse processes and the corresponding surfaces of both alae and sacrum. In the adult sacra, the fusion of the L6 and S1 centra and articular facets varied from total to none. However, the dorsal plate between these two never fused so that an opening of variable size was always present. The timing of these various fusions was not age-dependent.

Of the eight individuals with the L6 intact, five showed a defect of the neural arch in which the two halves failed to unite properly in the midline--giving rise to a mild form of spina bifida occulta. These were R-II, R-IV, R-VII, S-I, and E-IIIb. The condition varied from a simple separation of the halves to a deep cleft between halves which were twisted to one side. One individual had the defect repeated in S2 and another exhibited it in S3.

In two individuals, the dorsal openings in the sacral canal were large enough so that the occurrence of small meningoceles was a possibility, but the total absence of associated defects in other parts of the post-cranial skeleton rules out most of the well-known conditions linked with spina bifida occulta such as the Arnold-Chiari Syndrome, for example.

Also, the length of the sacral haitus varied widely, with some which were abnormally large. One extended to the caudal border of S2 and another to the lower border of S1.

In addition, six of the nine individuals with lumbo-sacral fusion had unusually large and deep fossae lateral to the first and second sacral tuberosities. Thus, the short posterior sacroiliac ligament must have had an abnormally broad and strong attachment. This is the superior part of the dorsal sacroiliac ligament which forms one of the major bonds between the sacrum and the ilium.

Bennett (1972) has argued cogently that these are congenital malformations. Although their frequencies vary between populations and between age-groups within single populations, the frequency of these disorders is never as high as that suggested by the small Nightfire Island population. It is very likely that the cause of this unusually high frequency was increased homozygosis over a series of generations through high levels of inbreeding.

Other Pathologies

Miscellaneous pathologies were limited mostly to the dentition, with the observed conditions below followed in parentheses by the number of individuals representing each case: antemortem tooth loss (4); dental calculus (6); cementum hyperplasia (1); crowded anterior dentition--two were limited to the central and lateral incisors (3); alveolar abscesses (6); miscellaneous caries (4); and general undiagnosed periodontal disease, usually indicated by varying degrees of alveolar resorption (5). Other pathologies included five adults (Table 20-8) with osteoarthritic lipping of the centra of the cervical vertebrae. Burials R-XII and I-III showed evidence of osteoarthritis in the elbow and wrist joints. Undiagnosed inflammatory changes in bone were observed in only a single case (E-XI) in which a general periostitis (with a considerably thickened and spongy cortex) was apparent in the distal part of the right tibial shaft. Finally, one adult female (R-II) displayed an advanced osteoporotic condition in both

Table 20-8

Miscellaneous Pathologies

Burial No.	Sex	Age	Pathology
R-II	F	23-30	severe arthritic lipping on distal facet of right radius; orbital osteoporosis in both orbits; periodontal disease
R-III	F	35-45	slight arthritic lipping in cervical vertebrae; severe alveolar resorption-periodontal disease
R-X	F?	12-15	right ribs (6 & 7?) have long spicula extending superiorly 50mm forward of the vertebral ends
R-XII	M	25-30	arthritic lipping in cervical vertebrae and both elbow joints; periodontal disease
I-I	U	adult	severe arthritic lipping of the cervical vertebrae; moderate lipping on the thoracic vertebrae
I-III	F	adult	severe arthritic lipping in both elbow and wrist joints
E-VIII	M	12-15	abcess on tip of left PM_2 root adjacent to left mental foramen
E-XI	M	25-30	considerable swelling of distal part of right tibia only--osteomylitis?
D-I	F	40+	slight arthritic lipping in cervical vertebrae; periodontal disease--extensive antemortem tooth loss
A-II	U	40+	arthritic facets on cervical vertebrae; considerable alveolar resorption--periodontal disease

Table 20-9

Dental Attrition (after Brothwell 1965)

Burial No.	Age & Sex		Attrition Value
R-II	25-30	F	5+
R-III	35-45	F	5++
R-XII	25-30	M	5 to 5+
S-I	20-25	M	4+
E-III	40+	M	5++ to 6
E-IV	adult		5+
E-VII	12-15	M	2+ to 3
E-IX	20-25	M	3+
D-I	40+	F	5++
A-II	40+		6 to 6+

orbits. Similar to the periostitis, however, the underlying cause could have been due to a host of different factors, and the present evidence is much too limited to suggest specific diseases.

Individual adults who were conspicuously free of miscellaneous pathologies were E-IX and S-I.

Possible Antemortem Trauma

The cervical vertebrae of R-VII--C6, C7 and especially C1--have parallel and criss-cross cut marks which may indicate in vivo hacking. The head is missing from the skeleton.

There are also cut marks across C5-7 of the cervical vertebrae of R-X. Not only is this skeleton headless, but these cervicals are directly associated with the two halves of a broken obsidian projectile point which was most probably the cause of the mark.

Finally, E-IX has a possible trauma to the left zygomatic arch. It was apparently cut through posterior to the zygomaxillary suture, presumably by a massive blow from a sharp instrument.

Dental Attrition

The dentition of only 10 individuals was sufficiently complete to allow an evaluation of the attrition rate. These are shown in Table 20-9 with the attrition gradient proposed by Brothwell (1965:69). It is obvious that attrition among young adults was quite advanced--presumably a reflection of the amount of grinding and pounding grit in the food derived from processing plant foods by mortar and pestle (Chapter 10). Again, E-IX stands out from the others in having somewhat less advanced tooth-wear for his age group (cf. S-I). Although this individual cannot be compared with a large sample of his peers, it is apparent that he does not fit with the overall attrition rate for the others, and it is likely that he was raised on a diet with a lower frequency of pounded plant-foods than the others.

Conclusions

The skeletal data are too few to permit statistical manipulations, but they are quite revealing nevertheless. The Nightfire Island villagers were evidently inbreeding over a number of generations, giving rise to an overwhelming frequency of vertebral-sacral deformities among adults, and a remarkable lack of variance in the stature and general skeletal proportions of the males. The female sample, although much fewer in number, suggests somewhat wider variability.

As might be expected, the infant mortality rate was extremely high, and the higher frequency of deaths among young adult males of warrior age is entirely in keeping with the signs of violence and warfare indicated by various traumas and other archaeological implications (Chapter 19).

The high rate of dental attrition in this group is also to be expected since they pounded various plant-foods in mortars carved from scoriaceous lava which certainly contributed an exceptionally high grit content to the diet.

Only the young adult male E-IX stands out from the population: a taller, more robust individual without the sacral deformities, remarkably free of other pathologies, and raised on a diet with less grit than the others. The accumulated evidence strongly suggests that he was of non-Modoc origins. The fact that he received a severe cheek wound before death hints that he may have been a slave or a fellow warrior from a neighboring tribe.

CHAPTER TWENTY-ONE

INSIDE NIGHTFIRE ISLAND: ITS ROLE IN LAKESHORE ADAPTATION

This chapter summarizes the changing fortunes of the inhabitants of Nightfire Island as reflected in their cultural and other remains, and it examines the extent to which changes in those remains were influenced by the ecological and dietary fluctuations outlined in Chapter 9.

The site first came into use within a few centuries of 5,000BC--sufficiently long after the Mt. Mazama eruption that any scars formed on the adjacent vegetation and animal life had long since healed over during the intervening millennium. Whether the lake was lowered by partial drainage due to faulting attendant upon this eruption, or by the extremely arid climatic episode suggested for this same period (ca. 6,000BC) by some researchers, remains an open question. How much time elapsed between the lowering of the lake, the full recovery of the landscape, and the first occupation of the 2-Coot is also an open question, but it was certainly less than a millennium, because derived Mazama ash occurred in the underlying 1-Basal.

Human affairs in the surrounding countryside during that crucial millennium between the Mt. Mazama explosion and the occupation of the 2-Coot will be examined in the following chapter. In the centuries prior to 5,000BC, the resources of the Lower Klamath marshland were no doubt being explored, and the central question of this work is whether that exploration was being carried out by expert marsh-dwellers or by beginners. Nightfire Island was probably one of several such small spots chosen for temporary habitation. Apart from its strategically central location, it also offered a periodically dry footing next to moving and, therefore, potable water that failed to ice over in winter. The configuration of the original platform is not clear from the surviving contours of the 1-Basal and 2-Coot, but it may have been a streambank levee ridge of a reed-and-tussock island. Evidently, it was considered important enough to make periodic, albeit half-hearted, attempts to stabilize the surface with small loads of basalt rubble. That surface has been considerably rearranged--either the recovered samples from the 1-Basal and 2-Coot are from downstream edges of a denser scatter not reached by the excavations, or minor oscillations in lake level destroyed any intrasite patterning. No central hearth for this pioneer occupation was recovered for the same reason, or because it was missed due to the sampling strategy used in planning the excavations.

The platform was used as a waterfowling station--presumably one of many sites on the subsistence round of the group whose territory incorporated the shoreline and the banks of Sheepy Creek. This site could have accommodated only single households or small hunting parties whose visits were no doubt short-lived and not necessarily always at the same time of the year. Obsidian source data would suggest that their range took them more frequently to the north around Spodue Mountain and Sycan Marsh than to the east end of the Lower Klamath Basin (Fig. 21-1). Unfortunately, there are not enough sourced specimens from the 2-Coot to develop a clear picture for this stratum alone, and we must be content with a generalized statement of obsidian sources for the period when the site was used mainly as a waterfowling station. The relatively smaller quantities of local obsidians from the Medicine Lake Highlands during this period suggests a less intensive use (and perhaps knowledge) of the surrounding terrain compared to later periods when the site was more regularly used for longer spells.

During the earliest occupations of the site, the main business at hand was the procurement of coots. These are relatively easy to catch, requiring very little skill, experience or equipment. Although this is particularly so in winter (ice, clubs) the case for the 2-Coot as a winter waterfowling station is not otherwise supported. They were also bringing parts of mammal kills to the platform, and the meat-weights represented by the meagre sample of fauna formed a more substantial part of the diet than the element-counts suggest. This very wide range of fauna indicates the presence of a fully matured mid-Holocene hunter-trapper-forager adaptation in which the domestic dog was already an intrinsic part. The central question is whether they were concentrating on coot procurement here because these were the most available waterfowl or because they had not yet learned to catch anything else.

Their surviving equipment provides no ready-made answers to this question. The nicely-finished mortar in the 1-Basal and the pestle in the 2-Coot bespeak a prior tradition of plantfood pounding, but this technology could have been developed in either a marshland adaptation or in a dry-land hunter-forager adaptation focussed on locally available plants such as the ipos. The paucity of grinding equipment (two manos in the 1-Basal) suggests less concern with seed-gathering here, and the complete absence of shaped weight stones suggests no special interest.

Obsidian was brought here usually in relatively large blocks or more rarely in the form of giant roughouts. Also, scavenged obsidian was brought in, thus starting a long chain of havoc in the OH dates here and later in the sequence. Chert and basalt from closer sources were fetched from time to time, but were clearly thought to be inferior materials. As expected at a temporary hunter's camp, the full spectrum of toolmaking activities was not necessarily represented. What little flaking took place here was almost all aimed at producing extra spear and dart points. Unfinished unifacial and percussion-flaked bifacial preforms were common, and the debitage indicates that finely finished points were seldom completed here. Instead, large crudely made and inexpertly notched points are common, suggesting a certain haste and carelessness about form. Another recurrent feature is the reshaping and resharpening of heads into stubby points (typed as cf. Martis). All this suggests work in progress while on the move. Knappers would have been preoccupied with tasks other than the careful finishing of dart points. Perhaps most of the knapping here was guided by the need to keep equipment in working order and enough spares on hand for the tasks which lay ahead. And yet the odd well-finished piece did find its way into the garbage-strewn mud around the platform: an occasional Elko-like form, Parman-like pieces (mostly broken stems), and Northern Side-Notched points. The breakage rate was high, and many were probably rejected from spear shafts to be replaced by others in the spares bag.

Most of this work reflects a concern with hunting on dry land and has little or no bearing on the procurement activities on the platform itself. Although bifacial thinning flakes were relatively large, they were not in great demand. No doubt some tule and cattail processing took place here, but the relatively light damage-rate to flake edge suggests that this may not have been the main function of the platform. The presence of well-made scrapers in these lower levels hints at more frequent concerns with hide-working than with matting and rope-making.

The 3-Grebe marks the continuation of the same modest platform maintenance activities, culminating in the more permanent spit-like base in squares R-M with its *in situ* hearth. Also significant is the change from coots to grebe as the predomiant waterfowl taken here. Probably more elusive, certainly (to us) fouler-tasting, the grebe yields rather more meat per bird, but it is difficult to imagine why visitors to the station would have wilfully altered their normal tactics to obtain this bird in preference to coot. As their relative availability today is so insignificant at all times of year, we cannot seek some seasonal shift in the subsistence round as an appropriate answer. It seems more likely that the increase in grebe in their waterfowl bag between 4,800-4,450BC was simply something that happened to the bird population and was not the result of some newly acquired skill or item of equipment. Certainly none is apparent in their material remains.

The increase in flaking activity during this period (a doubling of the amount of debitage per point) may hint at longer visits, perhaps coupled with a more permanent platform. The rate at which debitage edges were being used also doubled, indicating an increase in cutting and shredding activities, probably connected with reed processing. The range and frequency of projectile point types remained the same, however. There were also no changes in the pounding and grinding equipment. These people were doubtless the descendants of the original occupants, now able to take advantage of a more stable living surface to spend longer periods here, carrying out a wider range of maintenance activities. Although this signals a subtle change in the scheduling of the subsistence round, there are no very obvious changes in the range of animal parts being brought to the site. The bird/mammal ratio remained unchanged, and what changes there are among the mammal species are best explained in terms of a trend towards warm-dry conditions rather than any shift in procurement strategies and/or equipment. Although the increase in the frequency of dog bones may have something to do with more prolonged stays at the site, this is far from demonstrable.

The period of the <u>4-Mix</u> (ca. 4,450-3,750BC) witnessed a warm-dry trend that influenced the composition of the adjacent forest cover, the mammalian fauna, and the lake level. A modest retreat in the shoreline away from the site may have led to its abandonment for a few centuries. Under these conditions, there was little reason to continue building up the surface, and little seems to have been done to further the growth of the platform except that the apron of 4-Mix around its edge became far more densely packed with refuse than was the case in the previous strata. Activities at the platform remained "Business as Usual", with no changes on the bird/mammal ratio. The shifts in mammal frequencies are best seen in terms of the impact of the warm-dry episode, and changes in bird frequencies (more dabblers) in terms of a lowering lake level. Bison appear for the first time, and it is tempting to assume that herds migrated westwards at this time in reponse to the prevailing climatic trend. The first appearance of grizzly may also be connected to this climatic deterioration, but neither case is certain.

The effect of these changes on the equipment of the visiting hunters was minimal. Plantfood pounding equipment is absent, but the first grinding slabs appear. There were no changes in the ratio of projectiles to debitage, and the rate of debitage edge damage remained the same. Also, the range of point types remains unchanged, although depleted only because the sample is so small. These were most likely the direct inheritors of the 3-Grebe subsistence round who, when faced with a gradually changing catchment, probably used the platform less and less until it was finally abandoned altogether. At this point, our view of the catchment and of human affairs within it is blacked out.

The window reopens some centuries later with the advent of the <u>5-Scaup</u> (3,500-3,000BC). Warm-moist conditions prevailed, the lake level had risen again to the point where the site was embedded in marshland, and it was once again in use as a waterfowling station. The platform surface itself has eluded the excavators, but the densely packed apron of refuse in muck has survived. Activities here had changed somewhat from former times: the catching of scaup dominated all else, although hunting and trapping sorties still took place. The preference for scaup over coots during this spell defies interpretation--either changes in lakeshore microniches, in migratory flyways, in the season of the occupation, or in procurement tactics might do to explain the changes, but none is to be preferred over the others in our present state of ignorance.

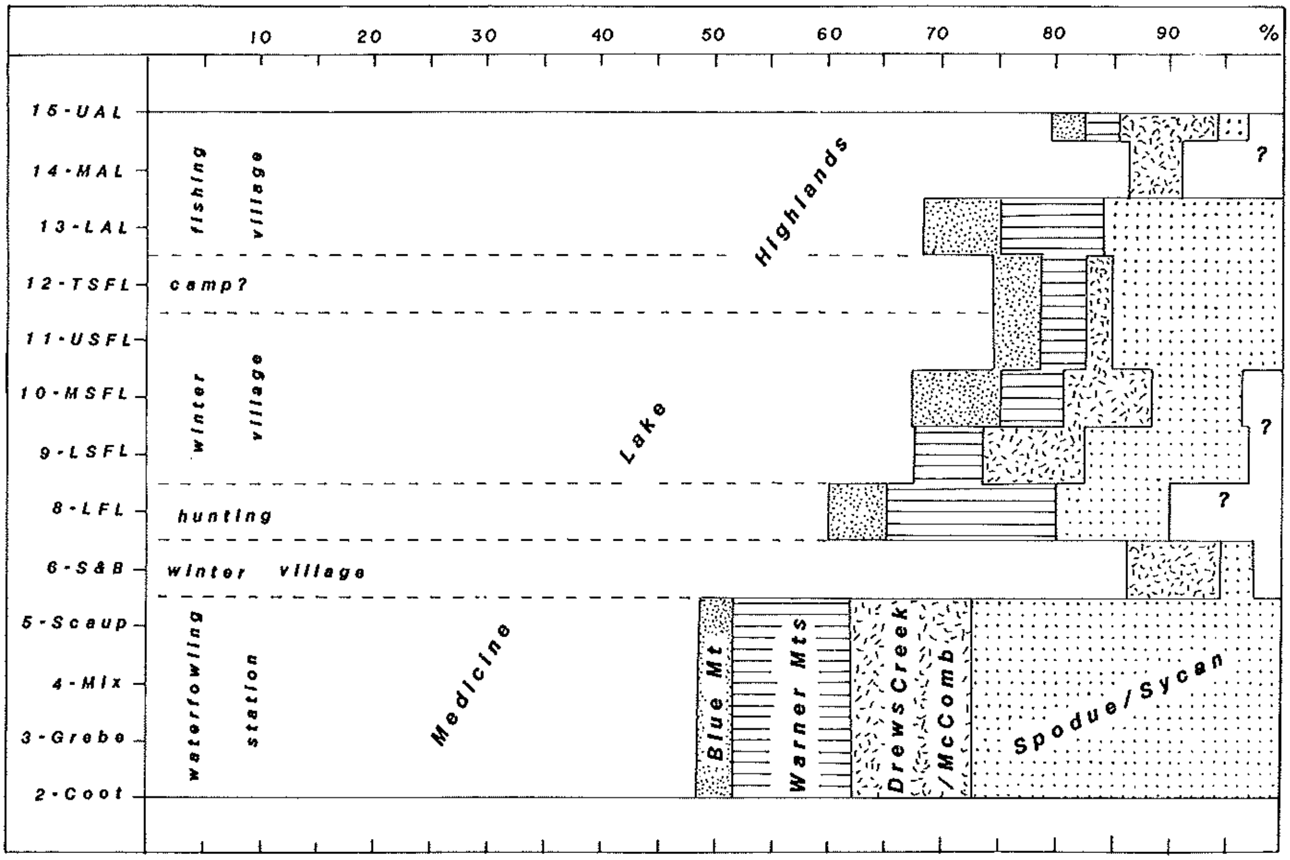

Fig. 21-1 Obsidian source groups by stratum, based on percentages in Table 11-6. Values for 2-Coot through 5-Scaup are averaged on the combined sample total. The 11-USFL and 12-TSFL samples are similarly combined.

With the marshland once again near the site, plantfood processing was reintroduced (mortars, pestles) and there are more diverse items of grinding equipment. Also, the bipointed stone makes its first appearance. This was introduced in a refined form along with several new projectile point types--Humboldts, various side-notched forms, small corner-notched types, a large stemmed point, and a thick slender form without stem or notches. The unifaces, crude notched points, and resharpened Martis-like points of yore were no longer seen, but the basic flaking debitage changed not at all--indicating that most of these new types were brought here ready-made. The kinds of knapping conducted at the site remained much as before, and the thinning flakes continued to be snapped and used in much the same ways. The introduction of so many new and diverse dart points must surely reflect major changes in typology during the preceding centuries while the site was abandoned. What social and territorial upheavals may have taken place during this episode are obscured from view, but there remains the distinct possibility that the platform was now being occupied by hunting parties with a different cultural background from those who first built it.

At some time between 3,000-2,850BC the decision was taken to lay down the 6-S&B platform and to convert the site to a semi-permanent village. Following this, it probably became the node of the inhabitants' subsistence round, whereas before it had always been peripheral. The decision could have been precipitated by a slight lowering of the lake level (losses in marshland species in the fauna) but the other factors influencing the decision are elusive. Most of the minor changes in the fauna can be explained in terms of the site's new role.

The same applies to changes in the artifacts. As we might expect at a semi-permanent village, there is an increase in pounding and grinding equipment for processing stored foods. Also, as we might expect, projectile points were being more carefully finished on the site, particularly those with side-notches. Obsidian was being conserved by starting many points from slightly smaller flake blanks, leading to the early appearance of some of the diminutive Great Basin "types". The only completely new tool to appear, however, was the robust bone point, possibly linked with bison hunting (a modest peak in bison elements occurs here). The first pipe fragment also became incorporated in the fill at this time--no doubt another consequence of the switch to semi-permanent occupation.

Following this change in site roles, there is also a marked emphasis on the use of local obsidians (Fig. 21-1), suggesting a more intensive use of the surrounding terrain. It is also interesting to note that obsidians from eastern sources are not present in the studied sample, but without further research it is useless to speculate why an easterly curtailment of the traditional subsistence round should lead to a decision to convert this waterfowling camp into a village.

During the ensuing couple of centuries, the village with its clay-lined pit houses (7-GraCl and 8-LFL) piled up deposits at an unprecendented rate so that before 2,500BC the top of the earlier 3-Grebe spit had been completely submerged in fill and structural melt. However, while this accumulation proceeded, the shoreline and its marshland waterfowl resources were already retreating from the site which by this time may have been located in meadowland. For a while the villagers persisted here, depending increasingly on hunting, and there is a strong possibility that the site was finally abandoned.

Obsidian sources in the 8-LFL were again diversified, with eastern flows once more accessible, and it is tempting to suppose that this reflects a more wide-ranging subsistence round with increased hunting expeditions to compensate for the lack of lakeshore resources.

The stone artifacts show few changes of any sort, even in small technological details, from the 6-S&B assemblage. Foliate forms continued to decline and side-notched shapes still dominated the repertoire. The only new forms to appear were rare single-shouldered points and the Surprise Valley Split-Stem, but these must reflect expanding contacts beyond the site and have no bearing on the residents' response to declining marshland resources. Another question is the impact of the purported lake-level drop on the local plantfood supply. Although there are pestles aplenty, stone mortars are absent. If plantfood patches dwindled as the marshes receded, could it be that collecting expeditions went farther afield than before and wooden mortars proved easier to transport? There is no way of telling. However, mortars were removed from the E8 pit house, leaving telltale impressions on the clay floor, and this at least indicates that mortars were moved around.

For the rest of the equipment, the appearance of antler wedges, awls, bone points, and more pipe fragments in these strata were simply a consequence of increased sedentism at the site already evident fom the presence of modest, semi-subterranean house structures.

Abandonment, it if took place at all, must have been abrupt and probably short-lived--perhaps during the cool-dry spike in the bristlecone record around 2,500BC. It was promptly reoccupied in the 9-LSFL when the lake level rose again, but the exact date of this event has not been established. At some time between 2,450-1,950BC, resettlement took place around the south and east rim by intermittent tipping of more rubble and domestic garbage. This episode witnessed three, not necessarily connected, shifts in adaptive strategies. First, plantfood exploitation was intensified, leading to an abundance of mortar, pestle, and grindstone fragments in the tip. Second, fowling activities were reestablished, with coots once again quite commonly taken in place of scaups. There are also signs that duck and geese trapping techniques may have developed--spheroid and bipointed stones may represent net weights or bolas stones, either of which could be connected with this sort of fowling. Thirdly, fish began to be casually exploited in a small way. Together, these three changes reflect an important step towards maximizing the resources of the immediate surroundings, thus allowing the community to persist. The question remains whether or not any of these developments could have been responsible for the sudden concern with conserving obsidian, now highly visible in the reduction sequence of the 9-LSFL. One possible explanation lies in the need for large quantities of twine needed for fishing nets, lines, and set nets used for ducks and geese. All of this had to be manufactured from shredded tule and cattail which was best produced with obsidian edges. The impact of this new requirement had an obvious effect on the whole production system for sharp-edged obsidian: core-splitting, shatter cones, extra fragmentation, and general reduction in the size of cores, bipolar crushed pieces, and surviving whole flakes.

Significantly, there is absolutely no evidence that the villagers were being denied access to local obsidian sources. Indeed, there seems to have been a slight increase in the use of Medicine Lake Highlands obsidians, rather than the reverse (Fig. 21-1), a pattern which was to persist up until the 13-LAL.

It would also be interesting to know if this pressure on the obsidian supply might have influenced dart point production in any way. Certainly, there were rising frequencies of smaller side-notched forms (Desert-like and Rose Spring) as well as the smaller unstemmed leafshaped forms. Probably the advent of the two "new" types (Elko South Fork and Type B) with side notches emerged due to this general pressure to conserve obsidian, but the rising fequencies of Elko Corner-notched and Eared types is not easily explained in this way. These probably reflect wider trends in stylistic change taking place at the regional level.

Although it is remotely possible that this period was marked by socio-polical difficulties in obtaining enough obsidian (e.g. ownership of the nearest outcrop changed to a neighboring tribe), there is no indication that the villagers were going to alternative sources.

In the closing centuries of the 9-LSFL, there are signs that meadowland was again making gains over marshland, and this trend continued unabated into the <u>10-MSFL</u> (1,900-1,300BC) culminating in a prolonged abandonment of the site. Before this, however, the catchment went through a massive expansion of shallow marshland, and bison disappeared from the scene--perhaps as a response to deteriorating grazing. None of these events had any visible effect on the material equipment of the villagers, who continued to operate here much as they had done before, except for the necessary increase in netting and trapping activities attendant upon an increase in the numbers of ducks and geese in the diet. This drying trend no doubt continued apace until the lake shore resources had become so remote from the site that it became untenable and was abandoned for several centuries. Yet there is no trace in the archaeological record that the site switched roles during the deteriorating circumstances of the upper 10-MSFL--it seems to have been used as a village site to the bitter end.

The abandonment lasted several centuries and it overlapped with the cool-dry episode of the bristlecone record between 1,200-700BC (Chapter 9). Presumably Lower Klamath Lake was reduced to a couple of shallow ponds at best during this period.

Reoccupation took place around 600BC and the <u>11-USFL</u> began to accumulate after the lake level had been restored to something approaching its former configuration around the site. The only part of the surrounding catchment failing to recover was the meadowland which was presumably replaced by sage flats.

After so long a gap in the record, it would be reasonable to expect some changes in the kinds of equipment being abandoned at the site. Perhaps the most significant change from the days of the 10-MSFL was in architecture: Clay lined pit house floors were not constructed. Instead, lighter surface structures were thrown up on the platform, leaving little trace there other than a few compacted surfaces and a couple of pits and depressions, unless of course they were burned in place and rapidly covered like the example in the E4b. A notable increase in the number of antler wedges in the 11-USFL hints at a need for more side-planking for these houses than was previously incorporated in the rooves of pit houses. Certainly the switch to less substantial structures raises the question of whether the site was re-established as a semi-permanent village or as some more specialized extraction camp. Although the architectural changes make this a compelling argument, the dietary evidence summarized in Chapter 9 provides only one clue in its support: a definite increase in fish remains over the 10-MSFL. Yet the density of fish is not as great as in the overlying strata which belong more clearly to a Spring/Fall fishing village. This intermediate status for the 11-USFL defies interpretation. One model suitable for future testing would be that the entire mobility pattern of the Lower Klamath basin's inhabitants had altered to a more fluid, mobile system (obviously without winter lakeshore villages) during the preceding arid episode of 1,200-700BC, and that this revised pattern was not immediately abandoned after the lake level rose again.

Other changes in portable equipment are difficult to interpret. Bipointed stones disappear, and there are no pipes. The ratio of points:debitage doubles, suggesting that far more points were being made off the site and were brought ready-made--a pattern which starts in the 11-USFL and is seen to persist through the rest of the site's history. There is a resurgence in large foliate points, which in turn suggests the use of more large obsidian blanks, yet there is also a marked increase in the use of chert. Although none of these features would contradict the case for a circulating rather than a radiating mobility pattern, none of them provide strong support either. Indeed, typological changes over the intervening abandonment episode were minimal--increases in Elko Round-based Side-notched forms over other side-notched points, and slight gains in Rose Spring contracting stems--certainly suggesting that those returning to the site were of the same broad cultural tradition as those who had abandoned it centuries before.

With the onset of the <u>12-TSFL</u> there can be little doubt that the site was now being used as a small, temporary procurement station--probably a summer fishing village visited by no more than a couple of households at any one time. The decrease in habitation area, the absence of compacted living surfaces, and the rise in the densities of fish bone all point to this conclusion. The reasons underlying the two separate concentrations of deposit are elusive, however. Although an abandonment suggested for 100BC-50AD may be the right answer, this remains far from certain. Both the absence of adequate dates and the disruptions to this stratum brought about by burial grounds initiated in the overlying 13-LAL have contributed to these uncertainties. Although there is nothing in the rather small faunal sample and in the grinding/pounding equipment to suggest changes in the rest of the diet, the lithics suggest some sort of break with the typological tradition of the 5-Scaup through 11-USFL cultural framework. It seems that flaking activities again resemble those of times when the pre-village platform was little more than an infrequently used way-station. Large preforms were again left at the site, and the changes in flake shapes suggest that these were being produced on the spot. Also, there was a drop-off in skilled workmanship such as the sharp-edged parallel-sided notches and the serially pressure-flaked finish. Also, the large side-notched forms virtually disappear at this stage. Perhaps the absence of any master flintknappers among the now rare practitioners would explain the curious reversals in flaking technology. It is regrettable that the artifact sample is so small, coming as it does just before the bow-and-arrow. It would be good to know whether the skills of dart-point manufacture were going into general decline as the bow-and-arrow was being introduced.

That introduction in the <u>13-LAL</u>, around 300AD, does not seem to have caused any immediate upset in the subsistence system, nor were all the old traditional dart-point patterns abandoned at once. There were no changes in the bird:mammal element ratio, and no changes in the composition of the mammal bag which cannot be better explained in terms of microniche changes in the catchment. Although the bow-and-arrow may have been used occasionally for fishing, the sudden appearance of Gunther Barbed points does not correlate well with the steady increase in fishing remains which began back in the 11-USFL. Of fish hooks there is no trace, so we must assume that nets and funnel traps were usually employed, as in the ethnohistorical record. There is certinly nothing in the avifunal composition to suggest that the bow-and-arrow was used to increase the numbers of ducks and geese in the bird bag.

Instead, the most suggestive corelation with the advent of the bow-and-arrow is the inclusion of the site within the range of the olivella bead exchange network. These and other marine shell items suggest that trade contacts with the coast became firmly established at this time. It may not be mere happenstance that this event coincided with the burial grounds in the 13-LAL with their copious hints of raiding and reprisal-seeking counter-raids. It is not unreasonable to suppose that the site became the repeated target of war-parties from rival groups in the adjacent territories. Whether or not this warfare was connected with some struggle to control the network is beyond the scope of this enquiry, and we are left speculating whether the use of the bow-and-arrow in such raids made them more lethally effective, and whether the weapon itself might have acted as a stimulant to such raiding.

These gruesome events may also provide the answer to the as yet unaddressed question of why the site changed roles in the 12-TSFL. If, as is possible, raiding began in the 12-TSFL (some burials may have occurred then--the stratigraphy is unclear) the village may have become untenable as it was too visible a target, easily approached at night by water. Raiding in the 13-LAL and thereafter would have taken the form of surprise attacks on isolated households, a pattern still fashionable in ethnohistoric times.

The last clay lined pit house floor was laid down in the 13-LAL after which this design was not used here again. Although shallow pit house profiles may not be visible in the Arrowhead Loams, this does not preclude their presence in later times--as the many inverted and mixed dates would suggest. Temporary structures without pit bases continued to be erected, using the traditional log-splitting techniques (antler wedges) and reed matting (spatulate awls, increases in edge-damaged flakes). Plantfoods continued as a staple, giving rise to abundant mortars, pestles, and grinding equipment in the refuse.

By about 400AD, there was a minor shift in Gunther Barbed point design that allows us to recognize the 14-MAL stratum. At this time, we see a slight reduction in the overall size of the camp, but no significant changes in activities. Obsidian arrowheads of a stable design were being produced in large numbers during the 14-MAL, leaving a distinct trace in the dimensions of the debitage. A few dart point forms lingered on, but the Humboldt and Elko designs were finally abandoned.

Why exactly there are so few distant obsidians represented in the 14-MAL remains enigmatic (Fig. 21-1). Perhaps, as Hughes suggests (Chapter 11), this is symptomatic of the society settling down into well-defined and smaller territories following the violent turmoil of 13-LAL times. That there is no Glass Mountain obsidian in the 14-MAL suggests to me that the occupants were denied access to this new and prolific flow by rival groups to the South, and not, as Hughes would have it, that the site was abandoned before the Glass Mountain flow was formed. Given the ethnohistoric record of Modoc/Achomawi tensions in this intertribal no-man's-land, it is not too farfetched to presume that such tensions went back in time to the 14-MAL.

After 1300AD, the very numerous fishbone dumps in the 15-UAL suggest that this had again become a fishing camp from which harvesting, hunting and fowling were periodically conducted. Arrowheads now prevailed over all other point forms, and the few older shapes still present could all have served as arrow tips, except perhaps for the few hardy unstemmed specimens.

Although slowly diminishing in importance and size, and not energetically maintained against periodic flooding, the terminal Nightfire Island nevertheless partook in the burgeoning exchange system which now involved not only marine shell but also exotic stone objects, dance knives, fancy arrowheads, ready-made bowls and platters, pipes, and possibly furs and slaves as well. Under these circumstances, it is not too surprising that more distant obsidian sources appear once more at the site.

Exactly why it was finally abandoned is far from clear, but there is no reason to suppose that ecological factors turned against it. The fact that its inhabitants disappeared at a time when the exchange system was at its most vigorous may hint at an eclipse by some neighboring group which was better centered to control the network of supply and demand of exotic goods.

The Rival Models

At the conclusion of Chapter 9, it appeared that the balance of ecological data tipped slightly in favor of the Learner Model in which resident hunter-trapper-foragers penetrated the marshes, first exploiting the easily caught diving waterfowl and the abundant plantfoods, then establishing themselves there to gradually acquire the know-how to add increasing amounts of dabbling waterfowl and, eventually, fish to their dietary intake. This provisional choice can now be reviewed in the light of what we have learned from the material equipment of the people involved.

The extreme paucity of objects readily seen to be fowling- or fishing-gear inhibits the comparison. Thus, we are left uncertain whether the rise in ducks and geese in the waterfowl bag after the 10-MSFL is the result of changes in availability or changes in procurement skills. The same ambiguity surrounds our understanding of the later increase in the amounts of fish bone in the 11-USFL. The key to the whole problem is nets--did they become larger, finer-meshed, stronger, and more complex in design through time (the Learner Model)? Or were the earliest nets already competent enough from the start and merely used to catch whatever was available (the Know-it-all Model)? Without preservation of the nets themselves, we are left with only a few possible weightstones and netting awls and these are no help at all in choosing the right model.

The very obvious proliferation of equipment of all sorts as time passed can also be explained in terms other than those of the Learner Model. First, the change in site role from waterfowling station to semi-permanent village in the 6-S&B introduced the first proliferation of new gear at the site. Next, the entanglement of the site within the regional exchange network brought a still wider range of items on to the platform. Neither of these events can be seen as material reflections of a gradual enhancement of marsh-adapted skills.

Perhaps the most interesting complication arises fom the break in projectile point designs following the prolonged abandonment after the 4-Mix. The abrupt appearance of classic Great Basin designs does not coincide with any change in site role, yet it was the makers of these points who eventually set about converting the site into a village. If the people responsible for the 5-Scaup accumulation were "outsiders" they certianly knew what they were about when they reoccupied the platform. Thus it seems that the Learner Model may have some validity for the early part of the site's history up to the 4-Mix, and the Know-it-all Model could well apply to the 5-Scaup and thereafter. Certainly the reoccupation of the 11-USFL following prolonged abandonment signals that the Know-it-all Model applies here, as it does again for the purported 15-UAL reoccupation. In both cases, the material equipment shows unequivocally that the site was reinvested by people of the same cultural tradition as the previous occupants. There is therefore no cause to invoke repeated waves of "outsiders" following later abandoments, and the linguistic evidence quoted in Chapter 1 as well as the skeletal deformities described in Chapter 20 would both support this position.

ENDNOTES: CHAPTER TWENTY-ONE

1. Finer stratigraphic subdivisions of the 10-MSFL might reveal a role-change, but this was masked by later calcification.

CHAPTER TWENTY-TWO

THE NIGHTFIRE ISLAND LAKESHORE ADAPTATION IN THE BROADER CONTEXT OF DESERT WEST PREHISTORY*

The most striking aspect of Nightfire Island's long archaeological history is the chronic shifting back and forth between different settlement and economic regimes that is revealed by cultural and natural remains from the site. These shifts coincide to a great extent with the fluctuations in lake level and correspondingly in the immediate biotic setting of the site. The correlations established in Chapters 9 and 21 between abandonments and changes within the site, the temperature/moisture fluctuations indicated by the White Mountains bristlecone pine curve, and other evidence, indicate that changing Holocene climates by affecting local biota influenced the lives of many generations of Nightfire Islanders.

It has been averred that this sort of chronic environmental fluctuation, induced by climatic change, was one of the givens of aboriginal life in the Desert West (Aikens 1978a, 1982). At the same time, however, it has been claimed that, despite such changes, the repertoire of patterns for living within the area was remarkably stable because the varied geography of the western environment fostered the persistence (in various suitable locations) of diverse knowledge and behavior patterns. Knowledge being cumulative and readily transferable, the learning gained over a broad territory and thousands of years of experience was seen as a common heritage within the ken of all the native peoples of the Desert West: perhaps not continuously present in all localities, but available for use.

The data from Nightfire Island allow this general model--the Know-it-all Model, in the characterization of Chapter 21--to be put to a specific test. The Know-it-all Model suggests that the Nightfire Islanders, when first they occupied the site about 4,000bc[1], were heirs to several thousand years' accumulation of knowledge pertaining to life in Great Basin lake-marsh settings. The Great Basin, on the western edge of which Lower Klamath Lake and Nightfire Island exist, has after all been characterized as a land of lakes. Fresh-water meres, some of them vast, dominated the area during glacial times, and many lakes and marshes exist there today.

There are, however, clues in the early Nightfire Island record to suggest that its first occupants were Learners, who didn't already Know It All about the exploitation of lake-marsh resources. The fact that they heavily exploited the coot, a foul-tasting but easily captured bird, is one indicator. The lack of any tools specifically adapted to lake-marsh exploitation is another. A broader perspective on lakeside cultures in the Great Basin will provide a context within which the implications of Nightfire Island for understanding the history of lake-marsh adaptation in the Desert West may be assessed.

* by C. Melvin Aikens

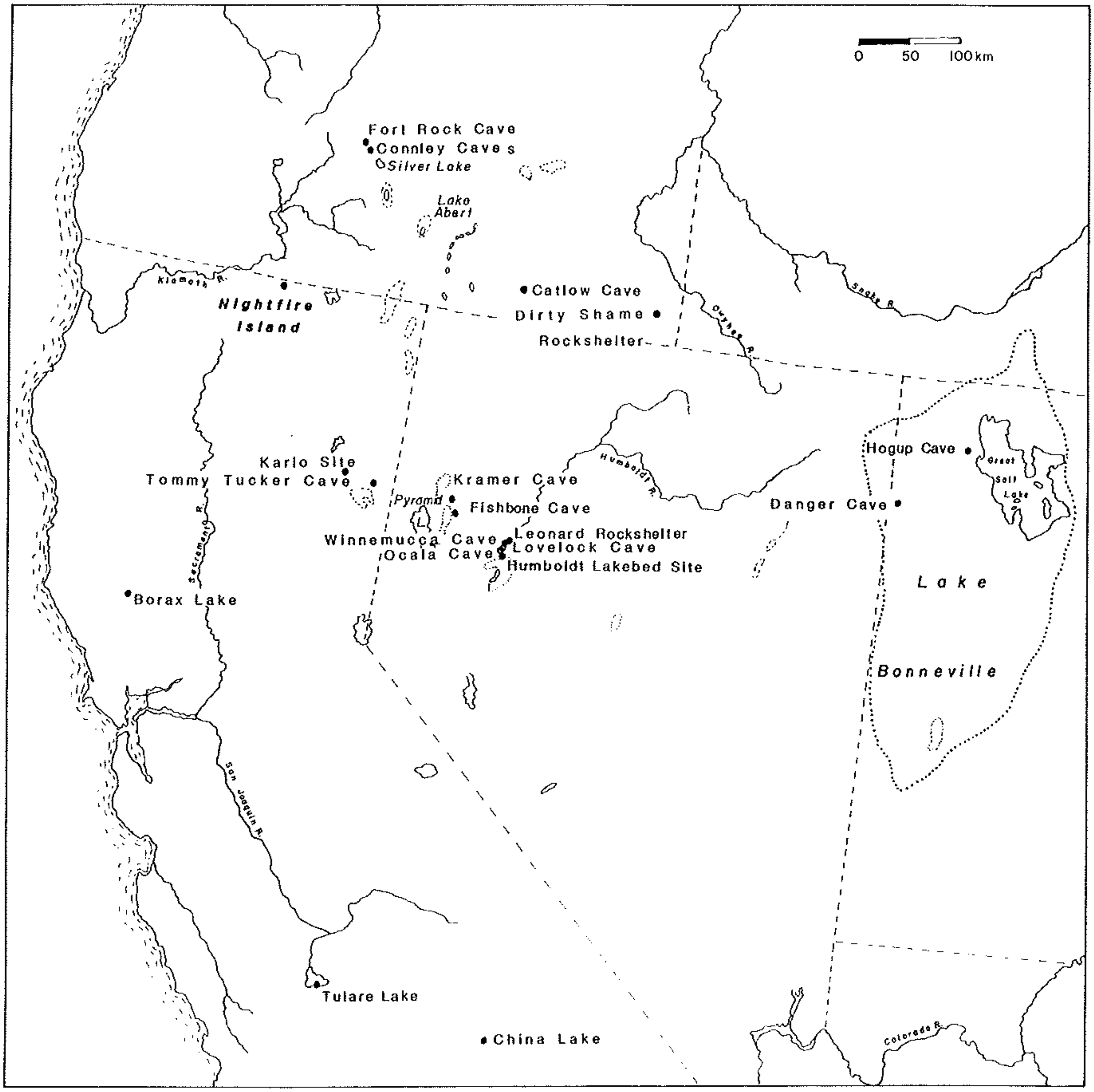

Fig. 22-1 Archaeological sites mentioned in Chapter 22.

Early Postglacial Occupations

The first widespread and clear evidence of human occupation along open lake shores in the Far West is afforded by Clovis Fluted projectile points found on the strand-lines of ancient Pleistocene lakes. Numbers of such points have been reported at China Lake, Tulare Lake, and Borax Lake in California (Davis 1975; Meighan and Haynes 1970; Riddell and Olsen 1969), and a considerable number of isolated surface finds, many from lakeshore settings, are known from Nevada, Utah, and Oregon (Aikens 1983). None of these artifacts has yet been C14 dated, but the C14 chronology established for the Clovis complex in the southwestern United States makes it reasonable to place them between 9,000 and 9,500bc (Haynes 1969). This time range follows closely upon a period of drastic declines in lake levels from high terminal Pleistocene stands to much lower early Holocene stands. At the Dietz site in east-central Oregon, a Clovis occupation occurs on the lowest strandline of the northern Alkali Lake basin (Fagan 1984).

Lakeshore caves were also first occupied at the time of the Pleistocene-Holocene transition. A C14 date of about 11,200bc from charcoal just above lake gravels appears to date the earliest artifacts from Fort Rock Cave, in south-central Oregon. The cave lies on an ancient strandline of Pluvial Fort Rock Lake; a C14 assay on shells form an old beach line near the same elevation some miles from the cave, though perhaps equivocal because of problems inherent in the C-14 dating of shell, gave comparable age of about 11,000bc. Thus, it appears that Fort Rock Cave was first occupied when lake waters stood at the level of the beach in front of it. The Connley Caves, several miles away in the Silver Lake Basin at an elevation a few tens of feet above modern Paulina Marsh, were occupied by about 9,200bc (Bedwell 1973: Table 19).

At Danger Cave in northwestern Utah, the first dated traces of human occupation were several small firehearths which lay on a clean sand deposited as the waters of a late, low stand of Pleistocene Lake Bonneville receded from the cave. Charcoal from one of these fireplaces was C14 dated to 8,300bc (Jennings 1957: Table 11). Hogup Cave, some 60 miles to the northeast was first occupied between about 6,800 and 6,400bc (Aikens 1970: Table 2). Fishbone Cave, Nevada, has a C14 date of 7,900bc for the earliest cultural level, and at Leonard Rockshelter, which overlooks the present-day Humboldt Lakebed near Lovelock, Nevada, a C14 date establishes human use of the site as early as 6,700bc (Heizer 1951).

Clearly, the earliest Desert Archaic cave sites known in the Great Basin were associated with lakeshore environments. But the artifact assemblages from these occupations are conspicuously lacking in specialized tools that may be specifically identified with an adaptation to lake-marsh resources. The state of affairs at Hogup Cave is illustrative. Fish hooks, fish spears, line or net sinkers, are absent; so are fish remains, though this could reflect a lack of adequate recovery techniques rather than an actual absence of fish bones (Greenspan 1982). The water birds attested by thousands of bones were perhaps caught by hand, or (less likely) shot using atlatl darts tipped with the same large stone points as those used for land hunting. Pickleweed seeds from the saline playa edge were collected, winnowed, and ground using a basketry and milling stone technology which did not differ from that used away from the lake shores. Netting found at the site could have been used in fishing or fowling, but was just as likely used in the capturing of jackrabbits, whose bones were found in the thousands. The use of bulrushes for making matting is first seen at this time; this is the one technologically visible aspect of lacustrine adaptation that may have developed very early in the history of lake-marsh exploitation.

At Hogup Cave, the exploitation of a marshland avifuana and of pickleweed from the playa edge continued down to about 1,200bc. Land hunting and gathering also remained important. Interestingly, the cultural and natural remains of the period before 1,200bc showed a great diversity of species exploited and tool types used at the site. This seems to imply a fairly sophisticated use of the area's resources, but specialized tools that could be specifically identified with lake-marsh adaptation never did appear.

After about 1,200bc, the lake-marsh habitat near Hogup Cave was no more. A core taken from a spring below the site showed lake sediments overlying earlier peaty marsh deposits, implying that rising water had drowned and destroyed the marshland (Aikens 1976:544; Mehringer 1977:121). The cave layers dated subsequent to this time showed a virtually complete absence of avifaunal remains, and a great reduction in pickleweed chaff. Terrestrial hunting and gathering dominated thereafter, right down to the end of the sequence in late prehistoric times.

From Catlow Cave in eastern Oregon a comparably well-marked transition is known between early levels in which a marshland avifauna was abundantly attested, and later levels in which it was almost completely missing (Cressman et al. 1940, 1942). This site, excavated in the late 1930's, was never directly dated. But projectile points from its deposits, of types C14 dated at Dirty Shame Rockshelter to the east and the Connley Caves to the west, suggest that Catlow Cave was probably occupied from about 6,000bc to late prehistoric times (Bedwell 1973: Aikens, Cole, and Stuckenrath 1977; Aikens 1982). The transition from a predominantly lacustrine avifauna to a predominantly terrestrial mammalian fauna apparently took place prior to the introduction of bow-and-arrow technology at about 1,000bc; the date cannot be more precisely fixed. As at Hogup, the artifact assemblage from Catlow Cave reflects a generalized kit suitable for exploitation of both terrestrial and lacustrine resources, and tool types specifically adapted to lake-marsh hunting and gathering were not identified.

Another example of an early lake-side occupation is afforded by the Connley Ccaves of south-central Oregon. This series of small caves, at the base of a bluff overlooking a present-day marshland, was occupied as early as 9,200bc. In early levels preceding the Mt. Mazama volcanic ash horizon of about 5,000bc, marshland birds dominated the faunal assemblage. After that time, marshland species dropped off almost completely, and occupation of the site was apparently very slight until it began to pick up again about 1,000bc. Developments after that period are regrettably unknown because the upper levels of the cave deposits had been destroyed by artifact collectors, truncating the archaeological record. Again, artifacts technologically specialized for use in lake-marsh environments were not discovered (Bedwell 1973; Grayson 1979).

These examples all attest an early postglacial period during which Great Basin sites near lakeshores or marshes were used as bases for the exploitation of wetlands flora and fauna. In all cases these early lake-shore occupations were subsequently terminated, due either to late-postglacial drowning of the marshlands, as at Hogup Cave, or more generally, to mid-postglacial desiccation. This early period of lake-marsh hunting and gathering came to an end without ever having developed a material culture specifically adapted to the resource base that was exploited; the lacustrine economic emphasis is recognized purely on the basis of site setting and biotic evidence.

How is this fact to be interpreted? It seems unlikely that the absence of thoroughgoing lake-marsh specializations during this period simply reflects people's failure to fully learn the nuances of the habitat they were exploiting. After all, several thousand years of time and experience were undeniably involved. Rather, the absence of technological specialization suggests that lake-marsh resources, though clearly important, did not loom large enough in the lives of these early people to warrant an intense year-around focus on them. The tool kit used at lakeshore sites was one just as applicable to hunting and gathering in terrestrial habitats. In a time soon after the initial colonization of the West, when population densities must have been much lower than they later became, people may have been able to support themselves on only the best of the food resources the country could provide, by ranging more freely and harvesting less intensively than was possible during later periods.

Later Holocene Lake-Marsh Adaptations

The Lovelock Culture, dated in western Nevada and eastern California between about 2,700bc and 550ad--according to Hattori (1982:21-22) it may have persisted down to 1350ad--was technologically adapted to lake-marsh exploitation in a way that early postglacial lakeside cultures were not. Lovelock Cave, near the town of Lovelock, Nevada (Loud and Harrington 1929; Napton 1969; Heizer and Napton 1970), is the richest and most informative single site. The culture is also well-attested at Winnemucca Cave (Heizer and Krieger 1956), Tommy Tucker Cave (Riddell 1956), the Karlo Site (Riddell 1960), the Pyramid Lake area (D. Tuohy, pers. comm.), and Kramer Cave (Hattori 1982).

The distribution of Lovelock Culture sites is essentially coterminous with the western Lahontan Basin. Walker Lake, Washoe Lake, Carson Lake, the Humboldt-Carson Sink, Pyramid Lake, Winnemucca Lake, and Honey Lake have existed there at least intermittently throughout postglacial times as relicts of Pluvial Lake Lahontan. Hattori's (1982:32-51) recent review of postglacial lake history in this region indicates that generally deep waters existed between about 33,000 and 9,000bc, after which lake levels fell during the interval between 7,000 and 2,000bc to elevations lower than the lakes maintain today. Some bodies of water probably dried completely. Even Pyramid Lake, normally fed by the Sierran Lake Tahoe via the Truckee River, shrank greatly when Lake Tahoe itself dropped so low that for a time it ceased to overflow into the Truckee. From 3,000bc to the present there has been a general trend, though with short-term reversals and desiccations, toward refilling of the Lahontan Basin lakes. The most recent desiccations occurred during an interval between about 850 and 1250ad, and after about 1550ad. This last drying trend was subsequently reversed, in the Winnemucca Lake Basin at least, by a short-lived modern lake stand that lasted from the 1860's until 1939. Then the lake again dried, this time due to the upstream diversion of irrigation waters from its feeder river.

The Early Lovelock Phase began at Lovelock Cave about 2700bc, a time roughly coincident with the rebirth of substantial bodies of water in the Lahontan Basin. Occupation intensified during the later part of the phase, 1,450 to 950bc. Occupation continued through Transitional Lovelock (1,950bc-50ad) and Late Lovelock (50-550ad) phases, with human use of the cave essentially coming to an end about 550ad, when rockfall blocked its entrance (Heizer and Napton 1970:40, 41). Lovelock Wickerware basketry from Falcon Hill, C14 dated to about 1350ad shows that at least one diagnostic of the Late Lovelock Phase may have endured there some hundreds of years longer (Hattori 1982). Though the ending date for Lovelock culture is not well-established, there is a suggestive rough correspondence between the closing of the Lovelock period and the interval of increased aridity noted for the Lohantan Basin between about 850 and 1250ad.

The relevance of these climatic correlates of the Lovelock period to an understanding of the culture is made obvious by the impressive dietary evidence for lake-marsh exploitation by the Lovelock folk. Plant and animal remains identified from a large sample of human coprolites of the Transitional and Late phases at Lovelock cave overwhelmingly attest the resources of a lake-marsh habitat: tui chub, cui-ui sucker, Tahoe sucker, Lahnotan speckled dace, molluscs, duck, mudhen (coot), bulrush, cattail, tule, saltgrass, Great Basin wildrye, and Seuda, all were present as meal remains in the coprolites.

The very abundance of evidence for a diet founded on lake-marsh resources led Napton (1969) to term the Lovelock Culture pattern, as seen at Lovelock Cave, a lacustrine specialization. This economic pattern placed significantly greater stress on lake-marsh resources than did those attested at earlier lakeshore sites. This is shown by the appearance at last of fish remains and of specialized artifact types that are specifically related to lake-marsh exploitation: duck decoys and fishhooks. There have been recovered from Lovelock Cave, Humboldt Cave, and Ocala Cave a considerable number of remarkably life-like duck decoys made of tule bundles bound together in the shape of a waterbird, and even in some cases covered by duck skins flayed with the feathers in place. Such artifacts are still made by the ethnographic Washo and Northern Paiute, who traditionally used them in the hunting of marsh birds. Simple composite fish hooks, made by binding a bone splinter to a wooden shank, were also recovered from Lovelock Cave. Again, comparable specimens are known ethnographically (Heizer and Krieger 1956; Wheat 1967).

Netting fragments found at Lovelock Cave, Tommy Tucker Cave, and other places have been interpreted as the remains of gill nets for fishing, or bird nets for the mass harvesting of low-flying coots. These birds could be driven into them and caught because of their habit of skimming extremely low over the water rather than climbing aloft when startled into the air (Napton 1969). Netting was used by the ethnographic Northern Paiute for these purposes, though the known archaeological specimens cannot reliably be distinguished from nets presumably used in taking jack rabbits. Such nets have an antiquity in the Great Basin exceeding the age of the Lovelock Culture by several thousand years at least.

A further indication that the Lovelock Culture may represent a year-round lakeshore adaptation, or at least a much longer season of residence in lacustrine zones than was characteristic of early postglacial lakeside occupations, is the fact that relatively substantial semisubterranean houses become known from the western Lahontan Basin during the Lovelock period. From a site near the town of Lovelock, from the very extensive, essentially unreported Humboldt Lakebed Site below Lovelock Cave, and from the vicinity of Honey Lake, are known pit houses which date to the time of the Lovelock culture (Cowan and Clewlow 1968; Heizer and Napton 1970; Riddell 1956). As Napton (1969) suggests, intensive utilization of the rich and varied resources of the lake-marsh setting may have supported a sedentary residential pattern during this time.

Another conspicuous lakeshore adaptation has recently come to light at Abert Lake, in south-central Oregon (Pettigrew 1980). Archaeological surveys have revealed dozens of sites around the lakeshore, of which at least 20 exhibit depressions interpreted as partially-infilled house pits. The shells of freshwater snails and clams, and fish bones, suggest a lacustrine economy, though the faunal evidence so far recovered is extremely limited. Projectile point styles sugge t that the sites were occupied between about 2,500bc and 1500ad, and four C14 dates on archaeological features demonstrate human activity there between at least 1,500bc and 1200ad. The time range is quite closely congruent with that of the Lovelock Culture, though artifactual evidence is still too scant to show whether or not this ancient Chewaucanian Culture--as it has been called--is closely related to the Lovelock manifestation to the south.

The cultural pattern at Nightfire Island itself, summarized in the preceding chapter, need be reviewed only briefly here. The site was first occupied shortly after 4,000bc, primarily as a temporary short-term fowling station for the taking of coots, although a wide range of other species was also hunted there. The occupation of the earliest period was a typical fully matured mid-Holocene hunter-trapper-forager adaptation, the recovered assemblage being comparable to those known at the same period for non-lacustrine settings. This use continued until about 2,950bc, when a brief hiatus occurred in the occupation of the site.

In levels which document a reoccupation of Nightfire Island between about 2,750 and 2,350bc, the site is seen once again as a fowling station. A series of new projectile point types suggests that a new ethnic group may have taken up residence in the area, though additional support could be wished for such an interpretation. By shortly after 2,350bc, the site had become a semipermanent village, with partially subterranean pit houses, an increase in pounding and grinding equipment, and other evidence of increasingly sedentary occupation. Waterfowling remained a major emphasis. The period 1,950-1,600bc saw a further intensification of plant food exploitation, as attested by an abundance of mortar, pestle, and grinding stone fragments, and the first exploitation of fishing, as indicated by bone remains. Fishing became increasingly important in the following centuries, and along with fowling and plant gathering remained central to the food economy of the site right down to the end of its occupation in late prehistoric times. During the first few centuries AD the role of the site shifted to that of a small, temporary settlement, evidently a Spring/Fall fishing village; despite its apparently diminished local importance, however, after about 270ad it became increasingly involved in an extensive and busy interaction oriented toward northwest California and the Pacific coast. After this date, exotic Olivella shell beads, large obsidian dance knives, and ground stone bowls, platters, and pipes were brought to the site. This pattern continued until Nightfire Island was again abandoned in late prehistoric times. Its inhabitants, now identifiable as the ethnographic Modoc, remained in the area, but apparently did not occupy Nightfire Island during the time of White contact and trade, for no Euro-american objects of significance have been found there.

Finally, mention must be made of Kawumkan Springs Midden, a long-occupied site on the Sprague River in Klamath territory to the north of Nightfire Island (Cressman 1956). This site, never C14 dated, was originally estimated to predate 7,000bc; subsequently, obsidian hydration analysis has offered a temporal range for the occupation of about 3,000bc-1000ad (Aikens and Minor 1978). Though not strictly in a lake-marsh setting, the site does occupy a watery environment adjacent to a perennial river, a very large spring-fed pool, and a wet meadow. Fish bones were numerous throughout the midden, and in the upper two levels bone fish gorges and harpoon parts were found. Birds and large mammals were also represented throughout, but as at Nightfire Island, fish came increasingly to dominate the later levels. Kawumkan Springs and Nightfire Island, together, seem to document somewhat parallel patterns of development in Klamath and Modoc territory, though there are, of course, differences in local setting and details of the archaeological record.

Origins of the Later Holocene Lake-Marsh Adaptations in the Western Great Basin

As the foregoing shows, the later lake-marsh cultures known from the western Great Basin are clearly set off from earlier postglacial manifestations. In the case of the Lovelock Culture, fish hooks and duck decoys exemplify specific technological adaptations to the environmental setting. The establishment of pit house villages along lakeshores, characteristic of the Lovelock, Chewaucanian, and

Nightfire Island cultures, further shows that these later Holocene lake-marsh adaptations were at times sufficiently stable to warrant investment in the expensive construction of relatively substantial long-term dwellings. Significantly larger populations than existed in early postglacial times are also implied.

The appearance of these later Holocene lake-marsh adaptations followed quite closely a climatic recovery from a mid-Holocene interval of decreased effective moisture that had sharply reduced postglacial lake levels in the western Lahontan Basin for perhaps two or three millennia. The new lake-marsh adaptations all seem to have begun forming quite soon after 3,000bc, as lake systems were reborn in the region. The pre-3,000bc histories of Lower Klamath Lake, where Nightfire Island is located, and of Abert Lake, center of the Chewaucanian occupation, are not yet fully documented and dated. But sedimentary and peat deposits, water salinity, Mt. Mazama tephra, and other evidence make it quite clear that they too were reborn after having been dry or radically reduced for a considerable interval of mid-Holocene time (Antevs 1948:176-78).

Were these new lake-marsh cultures the work of Learners, or Know-it-alls? In addressing this question, the strongly Californian cast of many elements of Lovelock material culture compels a brief excursion into archaeological and ethnographic comparisons, and into historical linguistics. Spire-lopped <u>Olivella</u> shell beads, abalone shell beads and <u>Amphissa</u> shell beads, known from several Lovelock Culture sites, are of Californian types and unquestionably imports form the Pacific coast. Other specimens of Californian type, though perhaps of local Lovelock manufacture, are ground and polished charmstones, slate rods, and bone spatulas. All of these elements appear in Central California as early as the Windmiller Culture, ca. 4400bc, and persist thereafter down to late prehistoric times (Beardsley 1954; Ragir 1972). Coiled basketry trays found in the Lovelock culture have counterparts in ethnographic California, and stuffed duck and goose decoys analogous to those of the Lovelock Culture were used historically by the San Franciso Bay Costanoans and the River Patwin of Central California. Composite fish hooks made with a bone barb and a wooden shank, like those of the Lovelock Culture, are also known from the ethnographic Hupa of northwestern California and the Klamath of southwestern Oregon (Heizer and Krieger 1956; Napton 1969). Whether these perishable items known from ethnographic California have a time depth comparable to the archaeological specimens of the Lovelock Culture is unfortunately not determined. The open California sites that have provided the currently available record for Windmiller and later times do not afford good conditions for the preservation of organic remains. It seems, however, a good possibility.

With the above facts in view, Hattori (1982) has recently suggested that linguistic and cultural relatives of the ethnographically known Penutian-speaking Central Californians may have occupied the western Great Basin during Lovelock Culture times. Historically, Northern Paiutes belonging to the Numic branch of Utaztekan held that region, but their tenure there is believed to have been relatively brief, probably less than 1000 years or so (Lamb 1958; Goss 1977, with references; Aikens and Witherspoon 1984). The linguistic map of western North America shows a more or less solid block of Penutian speakers extending westward along the Columbia River of Oregon-Washington to the Pacific Coast, thence southward between the Sierra-Cascades and coast as far as south-central California. Scattered groups of Hokan-speaking people, apparently separated by the Penutian incursion, occupy both coastal and montane environments around the peripheries of the Penutian distribution.

Linguistic geography thus suggests that plausible predecessors of recent Northern Paiute occupants of the old Lovelock Culture territory, and of the Chewaucanian territory further north, might be either Penutian or Hokan-speaking peoples. Immediately west of the ancient Lovelock Culture heartland is the territory of the ethnographic Washo, a Hokan-speaking group which historically roved between Lake Tahoe in the Sierra and the westernmost Great Basin desert ranges. To the north and west were the Maidu, a Penutian-speaking group which similarly occupied the Sierra and its eastern foothills. Other Hokan speakers, including the Achumawi-Atsugewi, lived farther north, and beyond them, in southern Oregon, were the Penutian-speaking Klamath-Modoc. Again, these were people of the mountain-desert transition zone. In all cases, they are peoples with ancient Californian connections. Further, linguistic divergences within Penutian and Hokan indicate that the modern languages derive from pre-existing speech communities that began to split apart around 5000 years ago (Kroeber 1955; Swadesh 1954). This is strikingly close to the time of inception of the Lovelock and other western Great Basin lake-marsh cultures, and dovetails with the archaeological and ethnographic evidence suggesting that they have Californian ties.

To return at length to the question of whether the later Holocene lake-marsh cultures of the western Great Basin were the work of Learners or Know-it-alls. A case can be made that these cultures were neither the work of Great Basin Know-it-alls transferring ancient knowledge preserved elsewhere within their territory to the rejuvenated western Great Basin lakes and marshes--as implied in the introduction to this chapter--nor the work of local Learners rebuilding lost knowledge of lake-marsh exploitation after a milennium interval of relative aridity in their homeland--as suggested by the Learner Model presented in Chapter 21. It seems, instead, more in keeping with the available evidence to attribute the origins of these cultures to relatively numerous and expansive Californians already adapted to fishing and fowling in suitable habitats of the cool, wet Sierra-Cascades. They were relatives and communicants of equally ancient residents of California's great Central Valley, with its vast marshlands incomparably rich in fish and fowl and other waterside resources. In this scenario, people of the cooler and moister montane regions, Know-it-alls from the edges of the Great Basin, were preadapted to take advantage of the freshening marshlands of the Lovelock territory and the Klamath Basin farther north. They had merely to expand at opportunity eastward down the slopes of the Sierra-Cascades as moisture conditions improved in the lowlands. In doing so, they crowded back into their desert hinterland the Great Basin peoples who had preceded them and were themselves just then beginning to exploit the new marshlands in the ancient manner of the desert hunter-trapper-foragers that they were.

Congruent with this model is the evidence of relatively limited lake-marsh exploitation during the Early Lovelock period in the western Lahontan Basin, followed by much more intensive occupation, with increasing evidence of Californian connections, during the Transitional and Late Lovelock phases. At Nightfire Island, the evidence is comparable: an initial period of occupation where old-style (Great Basin-like) land hunting and gathering was at least as important as lake-marsh exploitation, followed by a later period exhibiting much more intensive concentration on wetlands resources, and the construction of substantial and apparently quite permanent dwelling places. Whether the Chewaucanian culture of Abert Lake had a comparable history remains a hypothesis to be tested when further research is carried out in that important area; the model here advocated implies that it did.

By historic times, much of the territory here mentioned was again in the hands of Great Basin desert people. A Northern Paiute folktale describes their extermination, at Lovelock Cave, of a people who had occupied the country before the Paiutes (Hopkins 1883) came; an account from the Surprise Valley Paiute of the Oregon-California borderland similarily tells that the Klamath once occupied current Paiute territory as far east as Steens Mountain in southeastern Oregon, but that the Paiutes got the better of them and drove them out (Kelly 1932). The Chewaucanian abandonment of Abert Lake may well have occurred at this time. In terms of the model proposed here, this

Paiute takeover would have been fostered by the gradual pullback of wetlands-adapted Penutian and perhaps Hokan-speaking people into their montane homelands as drying climate after the 9th Century AD reduced the productivity of their interim western Great Basin habitat. Ultimately, they were obliged to rejoin their ancient kin in adjacent higher, moister regions in order to maintain their established life way. The Paiute would have readily claimed the abandoned country because to them, a desert-adapted people, it was still a comparatively well-watered and choice land even when its earlier occupants could no longer sustain themselves there in the manner to which they had been accustomed (Aikens and Witherspoon 1985).

Nightfire Island, of course, was not involved in this final scene of ethnic and linguistic replacement. Situated in a somewhat higher and better watered area, it remained within the territory of the Penutian-speaking Klamath-Modoc right down to historic times, though the site itself was apparently abandoned shortly before the time of White contact.

ENDNOTES: CHAPTER TWENTY-TWO

1. Uncalibrated radiocarbon years, designated ad/bc rather than calibrated Calendar years (AD/BC) are used in this chapter to allow comparisons with other sites.

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