PUNTUTJARPA ROCKSHELTER AND THE AUSTRALIAN DESERT CULTURE

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VOLUME 54 : PART 1
ANTHROPOLOGICAL PAPERS OF
THE AMERICAN MUSEUM OF NATURAL HISTORY
NEW YORK : 1977

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ANTHROPOLOGICAL PAPERS OF THE AMERICAN MUSEUM OF NATURAL HISTORY
Volume 54, part 1, pages 1-188, figures 1-94, tables 1-57

Issued September 27, 1977
Price. $12.20

ISSN 0065-9452

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ABSTRACT

Excavations at Puntutjarpa Rockshelter, in the Western Desert of Australia, reveal a continuous human occupation of this site from at least 10,000 years ago to the historic present. Analysis has stressed systematic comparisons of ethnographic Western Desert aborigine stone technology, camp sites, "native wells," and other archaeologically visible aspects of behavior with specific archaeological features and artifacts discovered in the excavations. Comparison also includes a preliminary assessment of paleoecological conditions based upon faunal remains and sediments deposited at the site.

Although some changes are evident in the stone toolkit, these are outweighed by evidence for cultural continuities pointing to a relatively stable adaptation to rigorous post-Pleistocene conditions in the Western Desert which has continued to the present (the ethnographic Ngatatjara aborigines and other Pitjantjatjara-speaking people of the Western Desert). This stability is viewed in relation to a risk-minimizing model, in which human behavior, both ethnographically and as reflected by evidence at Puntutjarpa, is most economically explained in terms of overcoming or reducing risks inherent in obtaining basic resources in a risky environment. This adaptive model is termed the Australian desert culture.

A specific discovery at Puntutjarpa of interest to Australian archaeologists is the documented occurrence of small, hafted stone scrapers (termed Micro-adzes) from the earliest dated levels there. These finds support the idea of an early appearance for the Australian "small tool tradition," at least with regard to this class of small tool. Backed blades and other types of small tools appeared later in the sequence, around 4000 years ago. Despite these changes in small tools, Large cores and Flake-scrapers appeared early in the sequence and continued in remarkably stable frequencies throughout. Seed-grinding activities are represented at Puntutjarpa from the earliest occupational levels to the historic period.

INTRODUCTION

The present monograph describes the excavations carried out at Puntutjarpa Rockshelter in 1969-1970 near the Warburton Ranges Mission in the Western Desert of Australia and discusses the relationship of these excavated remains to the traditional aborigine culture of that region as it was observed in 1966-1967 and 1969-1970. These were the first stratigraphic archaeological excavations to be carried out in the Western Desert, so conclusions drawn from the Puntutjarpa excavations can only be regarded as a first step toward understanding the prehistory of this region. More archaeological excavations and surveys are needed in arid Australia to test and perhaps modify these conclusions.

Aside from basic matters of establishing a stratigraphic sequence and cultural chronology for this region, the project has sought to understand the nature of prehistoric adaptation to this extraordinarily harsh environment. The cultural sequence at Puntutjarpa pertains only to the last 10,000 years, that is, to the post-Pleistocene period in the Australian desert. There may be earlier sites in the Western and Central Deserts of Australia—indeed, I am convinced that there are—that will one day afford a picture of how people first came to settle there and how they adjusted to the peculiar conditions of rainfall, topography, and resources. The Puntutjarpa sequence, however, describes an adaptation that was already established by 10,000 years ago and has persisted with remarkably little change up to the last 10 or so years. Thus the use of the term adaptation in this report connotes a state of being rather than a state of becoming, and it emphasizes the picture of how aborigines have coped with and solved the problems of living in the Western Desert throughout this 10,000-year period. The continuities in the archaeological sequence and the further continuities between the archaeological past and the ethnographic present stand as evidence of the ingenuity and resourcefulness of the desert aborigines, since these continuities really present a picture of uninterrupted success in coping with the problems of desert living.

As most people are aware, we are currently going through a period of rising ethnic consciousness in which minorities all over the world are searching for and emphasizing their traditional and cultural heritages. Such a development is well under way in Australia. Among the aborigines one can see two general kinds of responses; 1. those aborigines and part-aborigines—usually people who have lived in close contact with whites in cities or on the fringes of white settlements in the country districts—who feel a need to rediscover their traditions, and 2. other aborigines—a minority now but an increasingly vocal one—who have had a much shorter history of contact with whites and who feel the need to maintain traditions that are still strong in their respective societies. Aside from its more scholarly purposes, this report is intended to provide a resource for aborigines of both categories and for non-aborigines who have an interest in the well-being of these people. The findings in this report should encourage an informed appreciation of the nature and success of traditional aboriginal culture under difficult physical conditions. These findings should also prove useful to the Western Desert aborigines lest their lands are ever threatened with encroachments or seizure by whites. By demonstrating through archaeology that the traditional aboriginal culture of the Warburton region today represents the culmination of a continuous, 10,000-year sequence in which this same basic type of culture existed throughout that period, this report provides support, should it be needed, for future aboriginal land claims in the courts. While archaeology should not be regarded generally as an applied field, the practical implications that archaeological evidence may have for such matters as aboriginal land claims should not be overlooked. My hope is that this report will one day be of use to both the desert aborigines and to those non-aborigines who wish them well.

ACKNOWLEDGMENTS

In any project of this magnitude it is impossible to mention every individual who provided assistance. Many Australians and Americans helped in a variety of ways, and I can only say that the thanks I offer here does not really express my full appreciation.

Many individuals voluntarily gave much of their time and resources to assist the project. Among the Australians are Ms. Sylvia Hallam (Department of Anthropology, University of Western Australia), Mr. Bruce J. Wright (Registrar, Western Australian Museum, Perth), Mr. and Mrs. Robert Lehman (Department of Education, Western Australia), and the Rev. D. L. McCaskill (Bunbury, Western Australia) who all worked as volunteer excavators during the Puntutjarpa excavations; Mr. Douglas Haynes and Mr. Robert Hewitt (both of the Western Mining Corporation) who extended us many courtesies of their field camp and helped acquaint us with the local geology of the Warburton area in 1967; Mr. David Kininmonth, Mr. Lloyd Fletcher, and Mr. Harry Lupton (Department of Native Welfare, Western Australia) who helped in innumerable ways to develop and improve our relations with the local aborigines; Mr. Robert Verburgt and Mr. Ron Robertson (both of the Commonwealth Weapons Research Establishment, Woomera, South Australia) who materially assisted us in our desert surveys; and, of course, the staff of the United Aborigines Mission at Warburton, who aided with their medical facilities and in their many courtesies and kindnesses during our stays at the Mission. Many Americans also helped, particularly Ms. Jane Gladson (First National City Bank, New York) who designed the computer code and did the systems analysis required for computer interpretation of the excavated data; Ms. Karen Essene (Social Science Research Institute, University of Hawaii) who supervised the computer analysis of the excavated data; Mrs. Freda Hellinger (Social Science and Linguistic Inst., University of Hawaii) who supervised the typing of the manuscript and tables; Mrs. Priscilla Ward, Department of Anthropology, the American Museum of Natural History, for her many editorial services; Mr. Nicholas Amorosi (Department of Anthropology, the American Museum of Natural History, New York) who prepared the drawings presented herein; Ms. Nancy Bronstein (Department of Anthropology, the American Museum of Natural History, New York during 1970-1971) who, in addition to the research described in her chapter in this report, performed many research duties including supervision of all measurements and classification of lithic artifacts excavated at Puntutjarpa and surface-collected from other sites in the Western Desert; and Ms. Naomi Miller and Mr. Jeffrey Quilter (Department of Anthropology, the American Museum of Natural History, New York) who worked on various aspects of the lithic analysis of material excavated from Puntutjarpa.

Several institutions helped us too. The Social Science Research Council (New York) funded the initial research carried out by my wife and me in the Western Desert during 1966-1967. The second season's fieldwork (1969-1970) was supported by a grant from the Frederick G. Voss Anthropology and Archaeology Fund (Department of Anthropology, the American Museum of Natural History, New York). The Voss Fund also paid for costs connected with the analysis of excavated materials (1970-1971). During both field seasons we were further assisted by a grant from the Australian Institute of Aboriginal Studies (Canberra) for the rental of a Land-Rover. The Western Mining Corporation (Perth), through the good offices of Mr. L. C. Brodie-Hall, permitted us to use their camp facilities near Warburton during the actual site excavations. The Western Australian Museum, through the interest and help of Ms. Sara Meagher, provided valuable assistance in the packing and shipping of specimens. The Social Science and Linguistic Institute, University of Hawaii provided the typing of the manuscript, and keypunching and programming services in the computer analysis of the excavated data. I am deeply grateful to these institutions for their cooperation and generosity.

I thank the many colleagues and other individuals who offered valuable advice concerning the conduct of the project and who, in some cases, took considerable time and effort to read and criticize portions of the manuscript. Among these are Mr. Harry Butler (Western Australian Museum), Dr. J. Peter White (Department of Anthropology, University of Sydney), Prof. Ronald M. Berndt and Dr. Catherine H. Berndt (Department of Anthropology, University of Western Australia), Prof. D. J. Mulvaney (Department of Prehistory, SGS, Australian National University), the late Mr. Hobart Van Deusen (Archbold Expeditions, the American Museum of Natural History), Prof. N. W. G. Macintosh (Department of Anatomy, University of Sydney), Dr. Ian Crawford (Western Australian Museum), Dr. W. D. L. Ride (Western Australian Museum), Mr. Frank Gare (Commissioner, Department of Native Welfare, Western Australia), Dr. Robert Tonkinson (Department of Anthropology, University of Oregon), Mr. Samuel Mollenhauer (United Aborigines Mission), Mr. Arthur Conacher (Department of Geography, University of Western Australia), Mr. and Mrs. Bruce Gouldthorpe (Department of Education, Western Australia), Mr. Neville Green (Department of Education, Western Australia), Dr. Norman B. Tindale and Dr. Charles P. Mountford (Department of Anthropology, The South Australian Museum). Of course the observations and conclusions presented in this report are entirely my responsibility, but I am grateful to these individuals for their well-informed advice on many matters pertaining to the project.

At the Warburton Ranges Mission and at Laverton, Western Australia, I also received much valuable advice and assistance from local aborigines. Foremost among these individuals are Mr. Andrew Lawson, Mr. Peter Frazer, Mr. Ivan Shepard, Mr. Paul Porter, Mr. Wally Porter, Mr. Mitapuyna Ward, Mr. Minmara Carnegie, Mr. Cyril Holland, Mr. Whittaker Cameron, and Mr. David Davies, although many others also helped and advised me. I am grateful for the hours these people spent patiently explaining their traditions to me and for their good-humored willingness to allow my wife and me to observe aspects of their daily life.

Finally, but above all, I thank my wife, Betsy, who participated in and contributed to every part of this research project. My thanks for her support go beyond what words can ordinarily express.[1]

[1] Richard A. Gould, Honolulu, April, 1974.

I: GEOGRAPHIC AND ENVIRONMENTAL SETTING

Although several geographers have discussed the nature of the Australian deserts and adjacent arid lands, a detailed description of the region between latitudes 20° and 28° and longitudes 122° to 132° has yet to be written. Mainly this is due to a shortage of useful observations of rainfall, relative humidity, and other vital statistics along with the fact that most of this vast interior region is useless, or at best marginal, for livestock and farming; hence there has been little economic incentive for making detailed observations on vegetation, soils, and other matters of ecological interest.

LANDFORMS

On most maps the Western Desert is shown as made up of three separately named deserts: the Great Sandy Desert, the Gibson Desert, and the Great Victoria Desert, which occur from north to south, respectively. Taken together they occupy most of the interior of Western Australia along with large parts of adjacent South Australia and Northern Territory, covering an area about 250,000 square miles. The boundaries between these three named deserts are indistinct and cannot be defended on any but arbitrary grounds, so

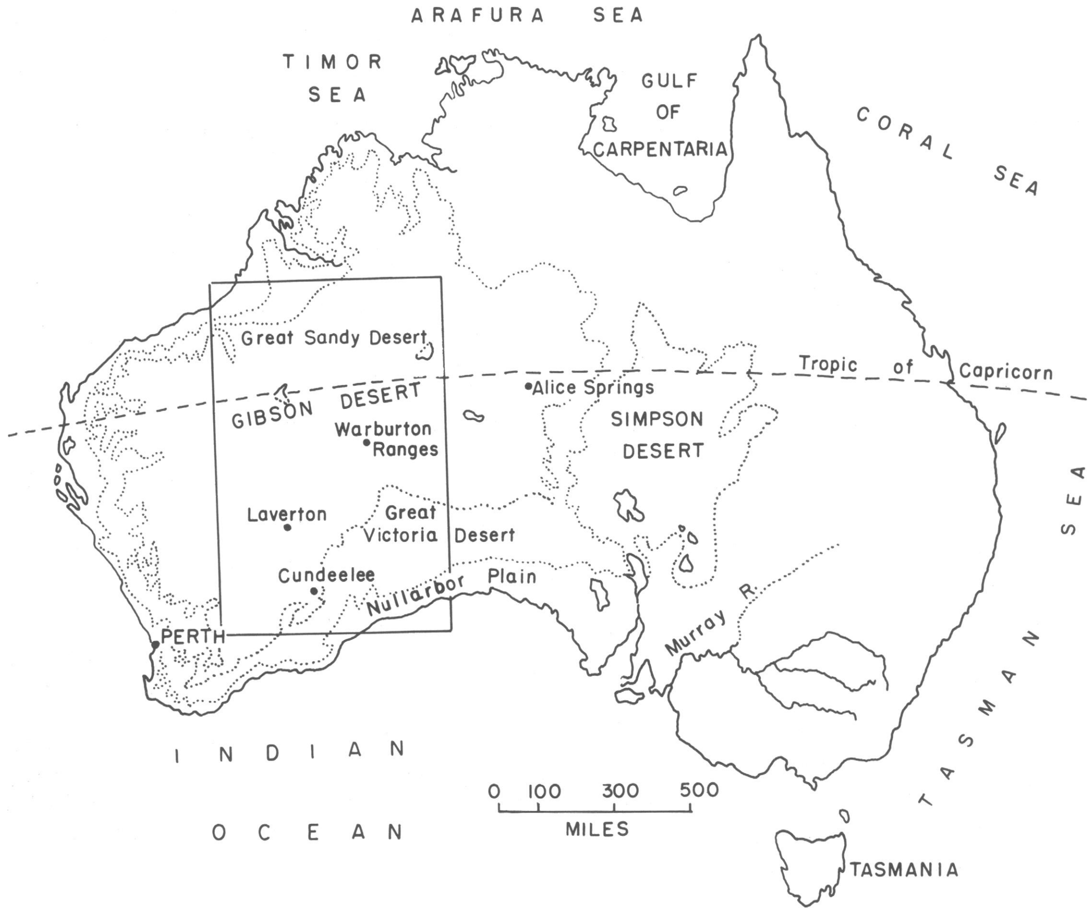


FIG. 1. Australia. Rectangle encloses Western Desert region.

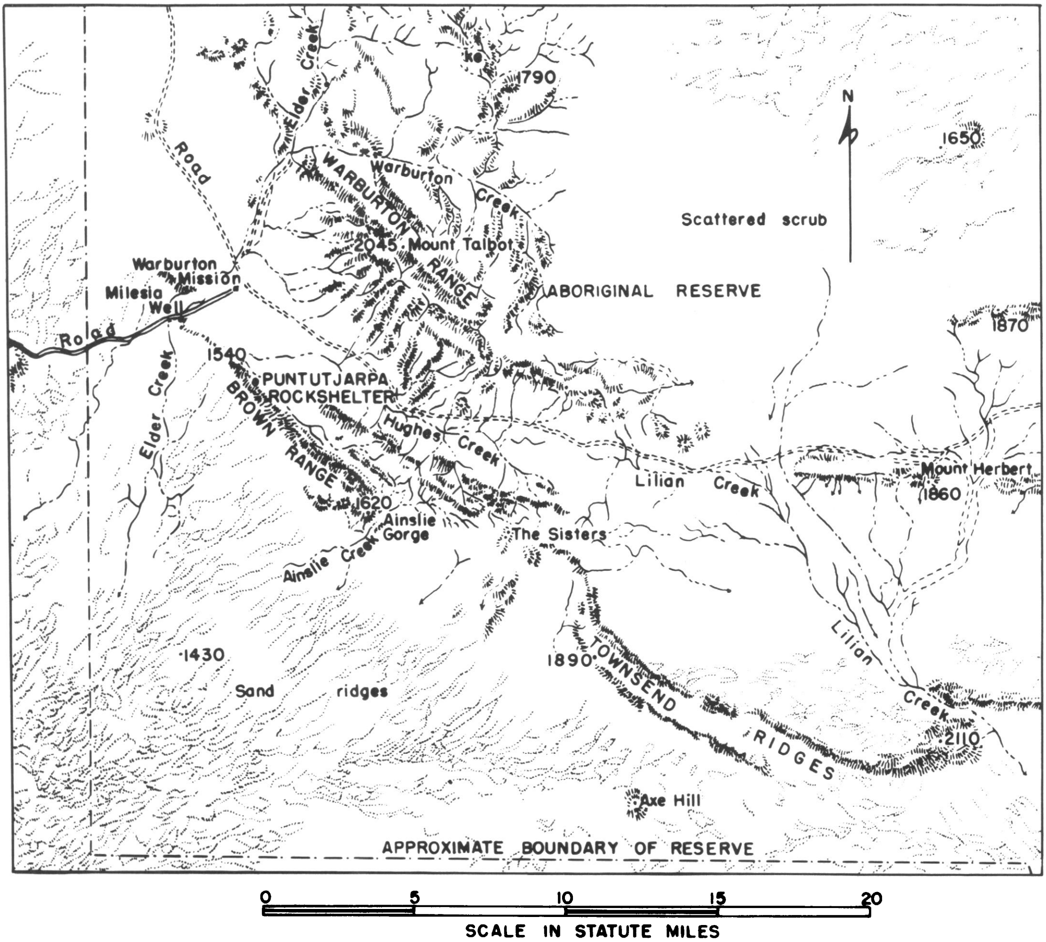


FIG. 2. Warburton Range area, showing Puntutjarpa Rockshelter, Warburton Mission, Brown Range, and other localities mentioned in text.

here they will be treated together as a unit within which local features will be described.

This entire area belongs to a Great Plateau or shield composed of a basement complex of pre-Cambrian rocks (Mabbutt, 1970, pp. 2-7; Keast, 1959, pp. 15-17), which covers most of Western Australia. This vast plateau averages between around 1000 and 2000 feet of altitude above sea level. The topography over this area, however, is far from uniform. By far the largest percentage of the total area is taken up with sandhills often alternating with claypans and interdunal corridors or extensive plains of red sand. In most places the sandhills run parallel to each other, in an east-west or northeast-southwest direction, with interdunal corridors ranging from a few hundred feet to many miles in width. These dunes are stabilized by a thin covering of spinifex (*Triodia* sp.) vegetation along with occasional trees and shrubs. There are few places in the Western Desert where one finds dunes or sandplains utterly devoid of vegetational cover.

In a recent study, one geographer has classified most of the area covered in this paper as "sand desert," characterized by longitudinal ridge type dunes that are closely but not precisely related to the direction of the prevailing winds (Mabutt, 1969, pp. 28-30, and fig. 3). Mabutt (1969, p. 17) noted that: "Wind action naturally becomes more important during drought and whenever the ground cover has been disturbed by fire or by man and his grazing animals. In the dunefields beyond the ambit of the desert river systems, wind action has of course been paramount; the surface materials are wind-transported and the whole relief wind moulded." Despite their apparent stability, these dunes can, on occasions such as those described above, become unstable and move. Little is known about the past geological history of such movements in the Western Desert, but evidence in the form of fossil dune cores seen in the Cooper River floodplain in Queensland and the character of ancient dunes in the West Kimberleys suggests that the prevailing trend of the major Australian dune systems is ancient and reflects past periods of aridity more severe and widespread than is the case at present (Mabutt, 1969, p. 17; 1971, pp. 74-75). Twidale (1968, pp. 230-231) concurred with this view and cited additional evidence to support it.

There are also large areas covered by broad, undulating knolls of gravel (called ṛiṛa by the aborigines) and relatively flat areas of gravel or weathered rock that have been termed shield deserts by at least one geographer (Mabutt, 1965, p. 107; 1969, pp. 25-26). This kind of formation is particularly common along the southwest edge of the Western Desert, but smaller areas can be observed at many points where they interrupt tracts of sandhills and sandplains. Often these areas are eroded into low cliffs (sometimes containing shallow caves) called "breakaways." Finally, there are isolated but prominent mountain ranges. The two largest are the Warburton-Musgrave Ranges system and the Rawlinson-

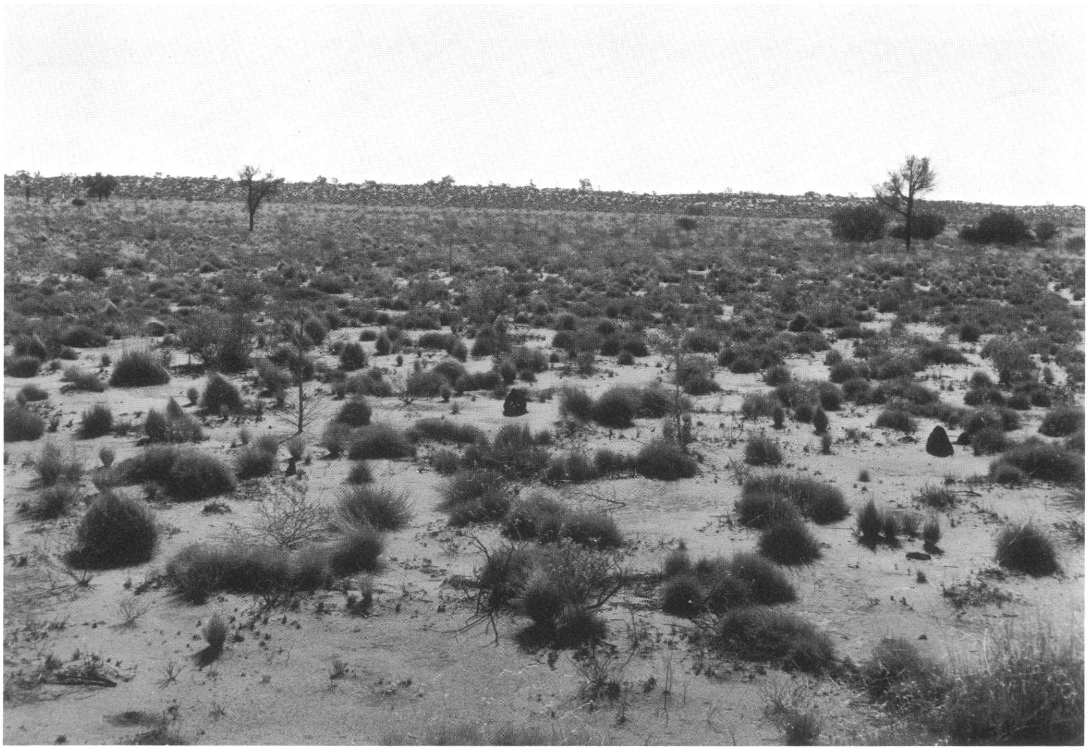


FIG. 3. Sandhill country with spinifex vegetation, to the north of the Warburton Range and Puntutjarpa Rockshelter.

Petermann Ranges system, both of which run from east to west with summits ranging from 2000 to 4000 feet, but there are also numerous smaller formations. These mountains are conspicuous landmarks in an area of otherwise monotonous relief, but they are neither high nor extensive enough to lead to any significant local increase in rainfall; hence they lack permanent streams.

CLIMATE AND WATER SUPPLIES

For an area with an almost continuous covering of one sort or another of vegetation, the Western Desert possesses extremely small amounts of surface water. This aridity is a function of several factors, both climatic and physical. There are still too few scientific observations from this region for it to be possible to determine the relative importance of these different factors, but taken together they more than account for the present desert conditions.

West of Alice Springs and, indeed, throughout the Great Plateau, there is no coordinated system of drainage. The only year-round or seasonally flowing rivers run relatively short distances from the margins of the plateau to the sea. There are many short creekbeds in the Western Desert, but these rarely contain water except after torrential rains, which flow quickly through them into depressions between sandhills or into salt lakes. Sometimes, however, water can be obtained by digging in the bottom of these creekbeds. Owing to the local presence of subsurface moisture, these creekbeds are often lined with large eucalyptus trees, the most prominent being the ghost gum (*E. papuana*).

Freshwater springs are rare (though a few do occur), so, ultimately, all life in the desert depends on the relationship between rainfall and evaporation. As Gardner (1944, p. xxx) has succinctly stated: "Three climatic zones may be recognized [in Western Australia]: a northern area of summer rainfall of a monsoonal character, with a cool dry season; a south-western area of winter rainfall with a period of summer drought, and a vast central area of low and unreliable rainfall of no marked periodicity, depending entirely upon extensions of the climatic systems which dominate the northern and southern areas." The "vast central area" referred to by Gardner is, of course, the Western Desert. The maps in figure 4 show average rainfall for the months of January and July for Western Australia. They indicate that the Western Desert lies in the worst possible place in terms of overall rainfall. Annual mean rainfall in the Western Desert is under 10 inches nearly everywhere, although exact figures are lacking in most places.

Two other climatic factors are also of importance when considering the water supplies available in the Western Desert; evaporation and variability from year to year and place to place. Mean temperatures in January run between 85° and 90°F. with frequent daytime maximums over 120°F. In July the means range between about 50° and 65°F. with nighttime lows sometimes at or below freezing. This means the hottest season coincides with the period when the heaviest rains are likely to fall (i.e., January-February). Throughout most of the Western Desert evaporation from a free water surface exceeds 100 inches per year (Keast, 1959, p. 21), meaning that evaporation exceeds rainfall in most places by a factor of 10 to 1. Variability is perhaps best expressed as an annual mean percentage from the annual mean rainfall. As the map in figure 5 shows, the Western Desert lies entirely within the area bounded by the line indicating a variability of 30 percent or more. This is a departure of from 10 to 20 percent above the calculated world mean variability for rainfall (Leeper, 1970, p. 17). In practical terms these figures indicate a region of rainfall which is both scanty and unpredictable from year to year and place to place. It is also a region of disorganized drainage and constant high evaporation.

The Western Desert region is entirely lacking in permanent rivers and freshwater lakes, and springs are rare. Thus both men and animals must depend entirely upon localized natural catchments of rainwater. These natural catchments consist of:

1. Localized subsurface water tables or areas of underground flow. These generally fill after floods and dry out slowly. Men and animals often dig to obtain water in such places, creating small waterholes (so-called native wells) which are sometimes among the most reliable sources of water in the desert.

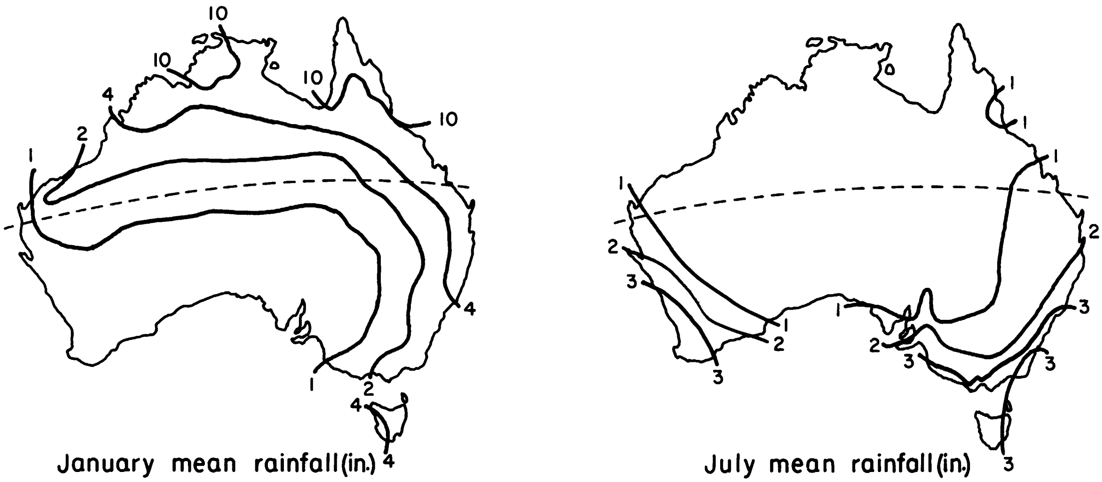


FIG. 4. Average rainfall for Australia during January and July (after Leeper, 1970).

2. Water stored in the channels of creekbeds, particularly in narrow or shaded places where evaporation is reduced. Generally speaking, these are of little importance in open country, but in narrow, rocky gorges in places like the Rawlinson and Petermann Ranges large pools of fresh water may persist for long periods of time.

3. Claypans and a few freshwater lakes and pools. These are generally shallow and short-lived because of rapid evaporation, but they are important sources of water after heavy rains.

4. Rockholes formed by pitting of granite or other rock surfaces. These are often important sources of water because they are well shaded and sometimes situated so as to receive large amounts of runoff after rains. In the literature these are sometimes referred to as "gnammas" (Twidale, 1968, p. 116).

SOILS AND VEGETATION

Western Desert soils occur in a variety of types, none of which has been mapped in any detail. Desert sand hills are widespread, consisting mainly of red sand dunes alternating with claypans. There are also areas of "gibber"–flat pavements of loose stone covering old soils. Gibber plains generally have sparse vegetation, but on the whole this type of formation is less common in the Western Desert than in the deserts on the eastern side of the continent. Also prominent are desert sand-plain soils which are ". . . a product of a past climatic regime which produced a more or less flat terrain and gave drainage conditions leading to the formation of lateritic gravel . . . The soils are highly infertile and natural vegetation of spinifex and shrub conforms with this feature and the arid climate" (Taylor, 1949, pp. 38-39). Finally, there are desert loams that vary in salinity and the amounts of lime and small stones present. These are probably the most fertile of all the desert soils.

With regard to vegetation, Gardner includes the Western Desert within what he has termed the Eremean Province (1944, p. lvi). Wood and Williams (1949, p. 77) have emphasized, along with Gardner, the general lack of detailed vegetational mapping and the scarcity of systematic botanical collections referring to the desert as ". . . a complicated mosaic of plant communities belonging to different structural forms depending on rapidly changing microhabitats." Both scholars noted the dominance of different species of spinifex (*Triodia*) throughout the sand-hill and sand-plain areas along with other shrubs like *Newcastleia*, *Crotalaria cunninghamii*, *Duboisia hopewoodii*, *Grevillea eriostachya*, *Hakea rhombalis*, and others. In places on the sand-plains and around most of the mountain ranges one encounters tracts of mulga (*Acacia aneura*, along with other species of *Acacia*) which may vary from a few hundred feet across to many miles. The areas immediately surrounding the Rawlinson-Petermann and Warburton-Musgrave mountain systems are particularly well endowed with this type of vegetation, which some plant ecologists regard as comparable with the thornscrub vegetation observed in other arid zones of the world (Riley and Young, 1966, pp. 66-67). Vast, monotonous tracts of mulga scrub also dominate the western desert fringe, occurring prominently in areas around towns like Laverton, Leonora, and Wiluna, and in areas to the east and north of Curtin Springs, on the eastern fringe in Northern Territory. These fringe areas presently represent the farthest limit of livestock into the desert. These sheep and cattle stations are irrigated wholly or in part by wells with wind-driven pumps, to supplement the uncertain rainfall.

The "microhabitats" referred to by Wood are evidenced by local clusterings of trees of various forms. These include the so-called desert oak (*Casuarina decaiseneana*) in sandhill country, mallee gums (*Eucalyptus concinna* and other species of *Eucalyptus*), often occurring in limestone or caliche areas, the ghostgum (*E. papuana*), and other large eucalypts in rocky terrain or along the margins of creekbeds; stands of native pine (*Callitris* sp.) in and along rocky gorges; and isolated groves of blackboy trees (*Xanthorrea thorntonii*) in certain widely separated sandplain areas.

The presence of these concentrations of distinctive tree-forms offers evidence of localized differences in moisture, soil acidity, shade, and other factors. Even in areas of the desert with the most uniform climate, vegetation, and topography there are variations in the flora that ensure a variety of basic food and material resources for the aborigines.

FAUNA

In comparison with other parts of the world, Australia lacks species of what can truly be called "big game." This is especially so in the Western Desert. The largest indigenous game animals found in this region are the red kangaroo (*Megaleia rufa*), the euro or hill kangaroo (*Macropus robustus*), and the emu (*Dromaius novaehollandiae*). All three species are seen occasionally in the sandhill country but tend to be concentrated in areas of mulga scrub, especially in the vicinity of mountain ranges. They generally become plentiful in an area after a couple of seasons of heavy rains. In the mulga scrub along the desert fringes these animals are more numerous than anywhere in the desert and are seen more often running together in groups. Although individuals of all three species can grow more than 100 lbs. in other parts of Australia, it is unusual in the desert to find them weighing over about 80 lbs.

Among the smaller marsupials, the most common are rock wallabies (*Petrogale penicillata*), the nail-tailed wallaby (*Onychogalea lunatus*), the rabbit-eared bandicoot (*Macrotis lagotis*), the fat-tailed marsupial rat (*Antechinus macdonnellensis*), the fat-tailed marsupial mouse (*Sminthopsis hirtipes*), and the jerboa marsupial mouse (*Antechinomys spenceri*), all of which are hunted and eaten by the aborigines. Other small marsupials are known to have been important to the aborigines but have become increasingly rare since the introduction of European fauna. These include the so-called native cat (*Dasyurus geoffroyi*), the long-nosed bandicoot (*Perameles eremiana*), the brush-tailed possum (*Trichosurus*

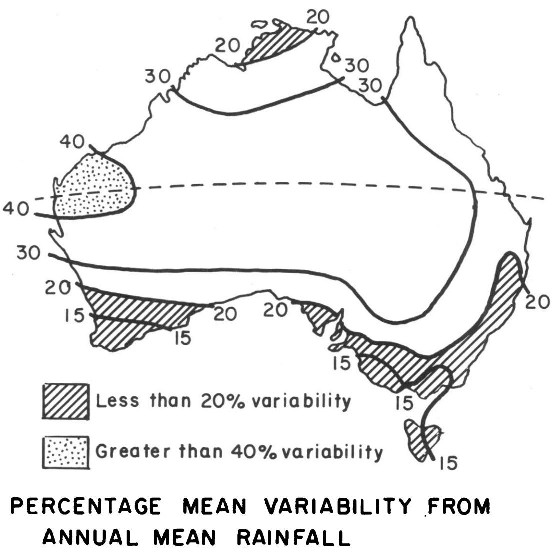


FIG. 5. Percentage mean variability from annual mean rainfall (after Leeper, 1970).

vulpecula), and the brush-tailed rat kangaroo (*Caloprymnus campestris*).

Today several of the European-introduced species have become important food resources for the desert aborigines. This is particularly true of the rabbit, but to a lesser degree of mice and feral cats as well. Cattle, sheep, goats, and camels are sometimes seen running wild, and these are occasionally caught and eaten. The introduction of myxomatosis either did not reach or has had little long-term effect on the rabbit population in the desert, which appears to increase whenever there have been fairly heavy rains.

As a source of protein for the desert aborigines, lizards are of greater importance than mammals. At least three varieties of goanna (*Varanus varius*, *V. giganteus*, and *V. gouldii*) are hunted in the sandhill and sandplain country along with the common blue-tongue (*Tiliqua scincoides*) and other, smaller edible lizards. The aborigines also eat smaller birds, such as a variety of pigeons and doves, cockatoos, budgerigars (*Melopsittacus undulatus*), and the highly prized "bush turkey" or bustard (*Ardeotis australis*). Bats and edible snakes (particularly the carpet-snake, *Morelia spilotes*) are also captured whenever possible.

LOCAL GEOGRAPHY OF THE WARBURTON RANGES AREA

In general terms, the Warburton Ranges area, where the site of Puntutjarpa Rockshelter is situated, represents a kind of "oasis" within a much larger area of open, spinifex covered terrain. This idea is not to be interpreted too literally, however, as the water resources of the Warburton Ranges region were generally poor and unreliable (Sofoulis, 1962a, p. 14). Rather, this area, meaning mainly the Warburton Ranges proper along with the broad plain lying between the Warburton and Brown ranges, and certain hilly areas to the east, contained dense stands of mulga vegetation and was relatively well endowed with game (especially macropods) in comparison with the surrounding areas of sandhills and ṛiṛa. Today the area within about a 10-mile radius of the Warburton Ranges Mission is badly denuded of cover, mainly as a result of overgrazing by livestock at various times in the Mission's history as well as by overexploitation by large numbers of aborigines concentrated at the Mission. But descriptions offered by aborigines and missionaries who lived in or visited this area before 1934, when the Mission was founded, point out that this area literally teemed with game after a season or two of heavy rains, and they indicate that the mulga vegetation was so thick in most places that paths had to be cut in the bush to allow camels to pass through.

The Warburton Ranges rise to a maximum elevation, at Mt. Talbot, of 2045 feet above sea level, although it should be remembered that the surrounding country generally lies at an elevation of over 1000 feet. Thus the visible rise of the Warburton Ranges from base to summit is not impressive. The Warburton Ranges, the Brown Range, and the Townshend Range to the east all run generally east to west. They all have broad summits, with long, gradual slopes descending to the south and steep escarpments descending to the north. The Brown Range, which lies approximately 6 miles south of the Warburtons, represents the westernmost exposure of a long formation of hard quartzite ridges that extend eastward and includes the Townshend Range, Ranford Hill, and the Hocking Range, a distance of about 50 miles. The most prominent of these formations occurs in the Townshend Range at Lilian Creek, where the ridge reaches an elevation of 2110 feet. The Brown Range, in which Puntutjarpa Rockshelter is situated, is a low and relatively unimpressive escarpment that reaches a maximum elevation of 1620 feet near Ainslie Gorge. Nevertheless, the Brown Range at nearly every point commands an excellent view to the north and northeast, across the flat, mulga-covered plain, to the Warburtons. There are several breakaway formations of the conglomerate to the east of the Brown Range, including a prominent formation known as The Sisters.

Water resources of the Warburton Ranges area consist mainly of scattered and small "gnamma" holes and a few "native wells." Examples of the former have been seen at several localities, most notably at Ainslie Gorge (Yuturi) and in an area immediately to the north of Mt. Talbot

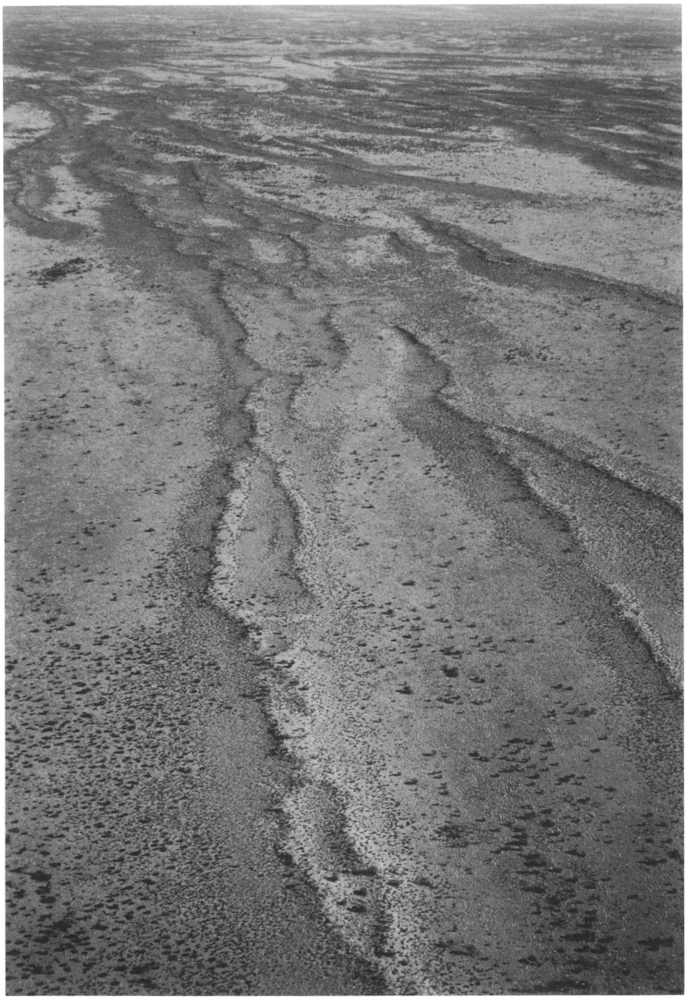


FIG. 6. Air view of sandhill terrain about 90 miles north of Warburton Ranges Mission, from altitude of 1000 feet above ground.

(Tjangimurutjungku). These gnammas are of special interest because they are small and narrow tubelike holes that have been provided with capstones or stone plugs by the aborigines to reduce evaporation (fig. 8). These are all small and hold only a few gallons of fresh water. Of greater importance were two substantial "native wells"; one at the west end of the Brown Range, about 2½ miles from Puntutjarpa, and the other at the junction of Johnson and Elder creeks, at the west end of the Warburton Ranges. This first waterhole, called Milesia Well on most maps (including the Talbot section, Series R 502, Royal Australian Survey Corps, 1962) was the original site of the Warburton Ranges Mission and continued in use until the Mission put in deep bores a few miles to the north. This site had previously been visited by aborigines, as shown by the presence

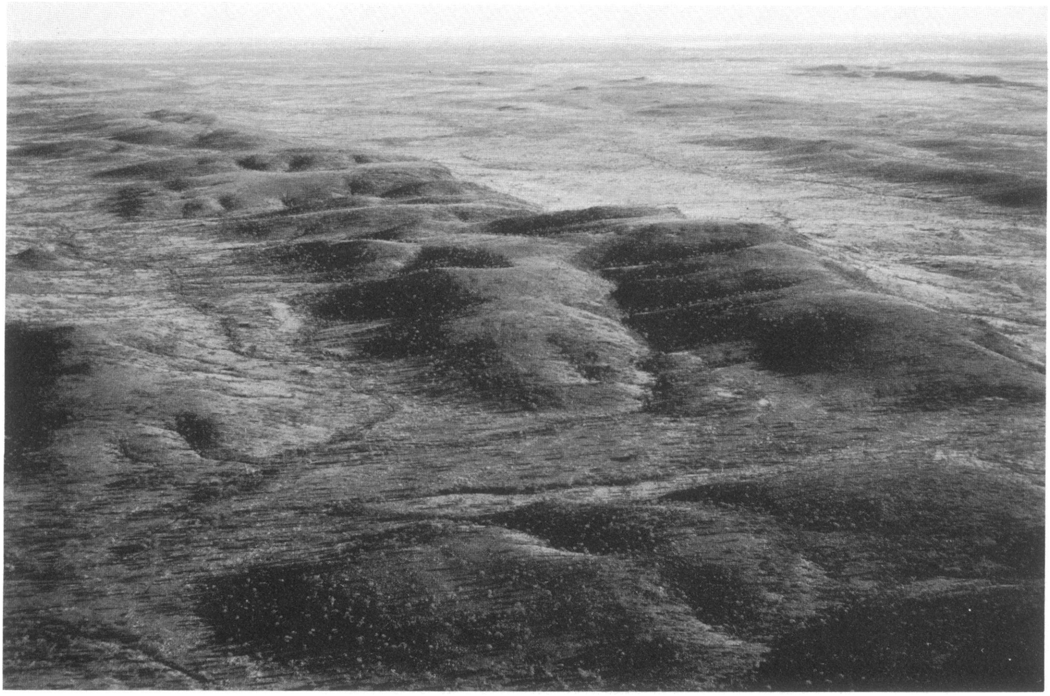


FIG. 7. Air view of Warburton Range, facing northwest, from altitude of 2000 feet above ground.

of scattered stone artifacts and flakes, but the original extent and nature of this aborigine site has been obscured by the disturbance of the ground surface during the period of Mission settlement there. The other waterhole, called Warupuyu, was the scene of some important ethnographic filming and observation of aborigines by E. O. Stocker and Norman B. Tindale in 1935 (Tindale, 1936, pp. 481-485) and it continues to be visited sporadically by aborigines. Not counting mechanical wells, this is presently the most reliable water-source in the Warburton area. The water here is heavily mineralized but is drinkable on most occasions. In addition to gnammas and these two native wells, there are other, less dependable native wells in the area along with a few small claypans and creekbed depressions that hold water after rains but are less reliable in periods of prolonged drought. When compared with other mountainous areas in the Western Desert, the Warburton region is poorly endowed with dependable water sources, although relatively it is better than the surrounding sandhill and ṛiṛa country. Sofoulis (1962, p. 14) has accurately summarized the situation regarding natural water supplies in the Warburton Ranges region by stating that: "Natural gnamma and rock hole sources are unreliable and consequently native movements are restricted to post pluvial periods."

Sofoulis (1962b) has also summarized the geology of the Warburton Ranges area, and all references made in this study to rock types and locations in the Warburton area are based on this nomenclature. Figure 9 below is a schematic north to south cross section of the Warburton area showing in general terms the locations of the principal rock formations. This diagram is based on the descriptions in Sofoulis as well as on advice furnished in 1967 by Douglas Haynes, a geologist, who was at that time employed at Warburton by the Western Mining Corporation.

Of special interest are the Townshend Quartzites, which form the low escarpment in which the Puntutjarpa Rockshelter site is situated, and the Warburton Porphyry formation, which provided an important source of raw material for aborigine tool making. The Townshend Quartzites are hard, buff-colored rocks with thin laminations and a tendency to break off in blocks. The steep, north-facing slopes of the Brown and Townshend Ranges contain many small rockshelters and overhangs formed by shallow undercutting in places where blocks have fallen away, and Puntutjarpa is one such shelter. In November, 1969, the author, along with Sara Hartley and Robert Lieber, made a ground survey along the entire Brown Range, and further surveys along the entire length of the Townshend Range and Ranford Hill formations were carried out in 1970 along with brief visits to the Hocking Range. Numerous rockshelters were observed, although relatively few contained any fill. Later test excavations showed at least two of these (aside from Puntutjarpa) to contain cultural materials in stratified contexts, and a detailed account of these surveys and test excavations will be provided in a future report.

The flat plain lying between the Warburton and Brown ranges attains elevations of around 1500 feet, although it slopes gradually from northeast to southwest. Water flows along this gradual slope, forming the Hughes Creek drainage. Geologists working with the Western Mining Corporation project and Ian Eliot, a graduate student in geography from the Australian National University and a member of the 1969-1970 field crew, assured me that the channels of Hughes Creek and its tributaries in this flat area of gradually sloping alluvium need not be very ancient. Flash flooding after heavy rains can quickly scour or redirect these channels. Hughes Creek

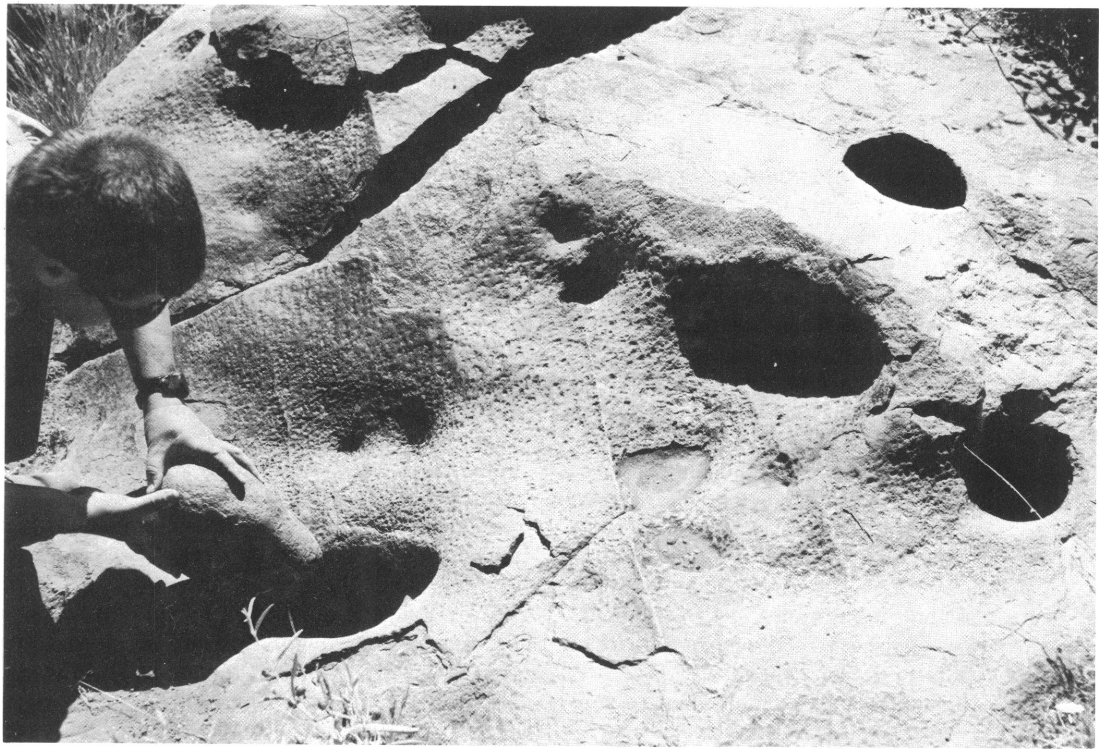


FIG. 8. Small rockholes (gnammas) containing water, at Tjangimurutjungku, Warburton Range. Note the stone plug.

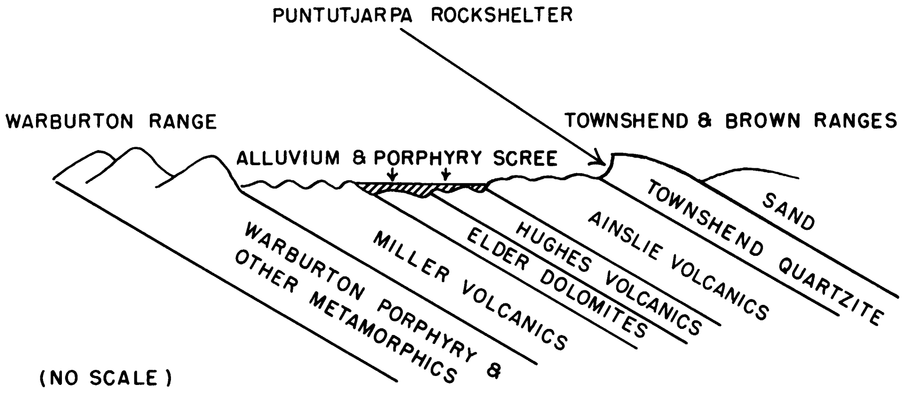


FIG. 9. Schematic North-South cross section of Warburton area, showing principal geological formations. Redrawn from sketch provided by Douglas Haynes based on geological description by Sofoulis, 1962b.

joins Elder Creek at the west end of the Brown Range, and the combined flows of these two creek systems flow southward and are dispersed into the sandhills. In considering the problem of general movement of soils in this area, the factor of wind erosion is at least as important as alluviation. No systematic observations of this have been made, but it is clear that after periods of prolonged drought and/or extensive burning large amounts of soil are transported by wind. Our rather limited observations in the course of the 1969-1970 field project suggested that easterly and southerly winds accounted for most soil movements on any large scale. Several times large sand clouds were seen moving from east to west between the Warburton and Brown ranges, and long-time inhabitants at the Mission (including both missionaries and aborigines) described occasions when strong winds from the south carried sand completely over the top of the Brown Range, causing it to cascade over the north facing escarpment. Taken together, these wind factors more than account for the presence at this time of a large and continuous sand slope leading from the alluvial deposits next to Hughes Creek up to the Brown Range escarpment. Note, however, that much of the present-day movement of soils by wind action in this area can be seen as partly resulting from the denudation of the area following the founding of the Mission. Conditions of wind erosion and transport of soils prior to the founding of the Mission are not well understood and may have differed from the present situation.

Although there is no clear pattern of zonation of flora in the Warburton area, some general concentrations are evident. At the present time the flat plain between the Warburton and Brown ranges is covered with broad areas of mulga scrub, still quite dense in some places, alternating with flats of neverfail grass (good fodder both for macropods and feral cattle that graze there today) and bare flats covered with a thin scatter of quartz and agate pebbles. To the east, in the direction of the Townshend Range, some of these flats have a pavement of pebbles similar, on a small scale, to the gibber plains seen in other desert areas in Australia, and the vegetation covering these flats is and probably always has been thin. Large eucalypts, mainly river gums (*Eucalyptus camaldulensis*), line the creekbeds, while on the rocky slopes one finds thin, mixed stands of mulga and corkwood trees. The sand slope running along the base of the north side of the Brown Range is dominated by spinifex, whereas the top of the Brown Range and the south slopes are covered by mixed mulga and corkwood. South of the Brown Range one finds scattered stands of eucalypts (probably deriving their moisture from the occasional outwash flow coming from Hughes and Elder creeks on the one hand and through Ainslie Gorge on the other) for perhaps 1/2 mile until the spinifex-covered sandhills are reached. Although a few isolated clumps of casuarina trees (so-called desert oaks) have been seen in sandhill country south of the Warburtons, these trees are generally much more abundant farther north, in the vicinity of the Rawlinson Range and beyond. Ghost gums are not seen at all in the Warburton area, and only a single concentration of native pines (*Callitris* sp.) has been observed, in Ainslie Gorge. To the west of the Warburton area one encounters large areas of ṛiṛa, both in the form of knolls and breakaways. Much of this terrain is covered with spinifex, but there are areas of mulga cover, too, some of which are extensive. More often, though, the mulga tends to grow along the gullies where two knolls come together, forming lines or "screens" of trees rather than areas of continuous cover.

In terms of availability of game, the flat plain between the Warburton and Brown ranges from Elder Creek eastward as far as the Townshend Range is, even today, the richest in the region for hunting large macropods and emus. Because of overgrazing and general overexploitation from

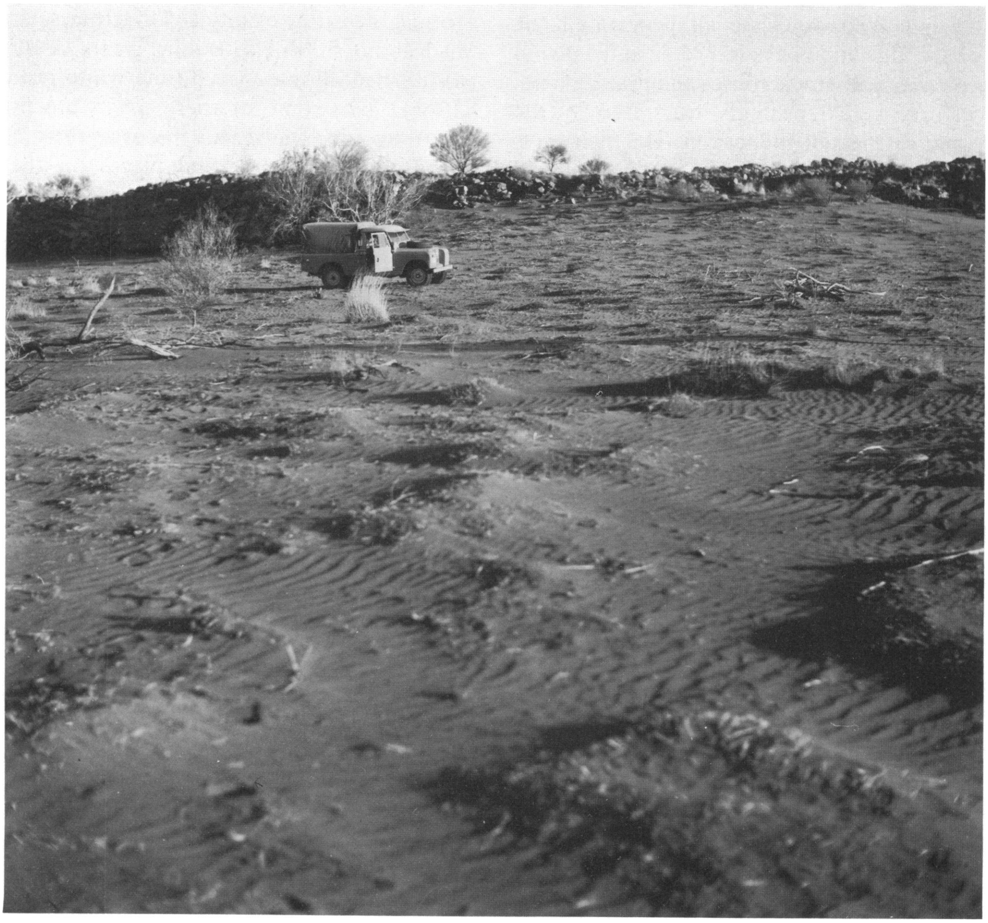


FIG. 10. Sand talus near Puntutjarpa Rockshelter, showing denudation due to burning by aborigines in 1967 (photographed in 1970).

the Mission, the density of game is much reduced from former times, although rabbits, a relatively new food resource for the aborigines, currently abound in the area. The sandhill and ṛiṛa country surrounding the Warburton region are relatively poor in larger game, although small lizards are fairly abundant.

II: NOTES ON CONTEMPORARY ABORIGINES OF THE WESTERN DESERT

EUROPEAN CONTACT

The early explorers of the Western Desert of Australia had brief contact with aborigines and did not attempt to learn their language or study their behavior in any detail. Philip Egerton-Warburton, Ernest Giles, John and Alexander Forrest, and William Gosse all penetrated the area for the first time between 1872 and 1876 in search of overland stock routes and grazing land. Their efforts were repeatedly frustrated by the aridity and vastness of the terrain. The next wave of explorers, although generally better equipped and forewarned of the hazards, fared little better. Mills, Carnegie, Wells, Lindsay, and Hann, who explored the region from 1883 to 1903, also recounted their hardships but had little to say about the aborigines.

Only A. W. Canning, who pioneered an 800-mile stock route from Wiluna to Halls Creek from 1906 to 1907, and Richard Helms, a member of the Elder Exploring Expedition of 1891 (the same that included Lindsay and Wells), did much to develop contacts with the aborigines. Canning obtained locations of waterholes from local aborigines, and he attributed much of the success of his exploration to this knowledge (Canning, 1911, p. 29). Helms made the first systematic study of the language and behavior of the Western Desert aborigines, particularly in the vicinity of the Blyth, Everard, Barrow, and Fraser ranges (Helms, 1896, pp. 237-332).

Intensive contact with whites first occurred on the margins of the desert. In 1892 gold was discovered at Coolgardie, Western Australia, and in the following year an even richer lode was found nearby at Kalgoorlie. These discoveries precipitated a rush of prospectors and miners into the area, followed by the building of water pipelines and railways. Gold mining extended into the Eastern Goldfields as far as Leonora, Laverton, and Kookynie and into the Western Goldfields to Meekatharra and Wiluna. Gold mining continues at Kalgoorlie (though on a much reduced scale) but has ceased at most of the towns, which have shrunk to a fraction of their former size. For example, Laverton, said to have had about 5000 white inhabitants shortly after 1900, had about 35 full-time white residents in 1966-1967. Some of these towns are now true ghost towns. The recent discovery of nickel and other minerals in several places on the desert fringe may soon revive the fortunes of some of these moribund communities.

During their heyday these towns attracted aborigines from the surrounding bush. Drawn by curiosity, the desire to acquire metal tools, matches, blankets, and other material goods, food, and the permanent water supplies from the white man's wells, these people settled in camps on the fringes of the towns where they rapidly succumbed to introduced diseases like measles and respiratory ailments. Many drifted to different settlements and formed the base for an ever increasing mixed-blood population. Few of these original inhabitants of the desert fringe remain today, but their place has been taken by other aborigines who, lured by the same attractions, arrived from farther away in the desert. Evidence of this early drift from the desert to white settlements has been noted by Elkin (1940, pp. 295-299) and Berndt (1959, p. 86). Some of the old mining towns presently have a larger aboriginal population settled nearby than there are whites living in the towns. For example, the 1967 census indicates that there are 306 full-blooded and 30 part aborigines residing at Laverton, where they outnumbered whites by almost 10 to 1.

There are few accurate accounts concerning aborigines from this phase of Australian history. The best are those provided by Daisy Bates in her studies of Western Australian aborigines and her descriptions of desert aborigines at Ooldea Water in western South Australia along the Transcontinental Railway Line from 1919 to 1935. T. G. H. Strehlow, however, has pointed out that Mrs. Bates's accounts are "riddled with inaccuracies, and marred by tales about widespread cannibalism which are as baseless as they are revolting" (Hilliard, 1968, p. 11). She rarely attempted to analyze the changes she saw taking place, but she described the effects of disease and inadequate food on the aborigines and saw no hope whatever that their culture would survive or adapt to meet the new circumstances of their lives. As she observed several times, she had merely tried "to make their passing easier" (Bates, 1938, p. 243).

With the abandonment of the goldfields, the first period of intensive contact with whites gradually came to an end. Contact continued during the 1930s and 1940s as sheep stations and missions were started. Missions appeared at Mt. Margaret (near Laverton), Ooldea, and Wiluna and also closer to the central desert areas at the Warburton Ranges and Ernabella, where they attracted modest numbers of aborigines from the desert. Following World War II, however, the pace of contact quickened again with the construction of the Woomera Rocket Range and a nuclear testing area at Maralinga, South Australia. From 1958 to 1963 missile-recovery roads were graded across the desert at several points. Government patrols were sent out regularly to locate aborigines and resettle them on missions and reserves, with the result that the desert is almost totally depopulated now.

The main collecting points for these aborigines have been the Warburton Ranges Mission, Papunya (in Northern Territory), Jigalong Mission, Marble Bar, Balgo Hills Mission, and Halls Creek. Although some aborigines have left the desert on their own, most have been brought in by successive patrols and resettled, usually hundreds of miles from their home country. These collecting points comprise a kind of "inner core" of settlements where acculturation is taking place rapidly, just as rapid change occurred in the gold-mining towns and along the Transcontinental Railway Line on the desert fringe more than 40 years ago.

DEMOGRAPHY AND LOCAL GROUPS

Berndt has suggested that before European contact there may have been as many as 10,000 to 18,000 aborigines inhabiting the Western Desert, whereas today numbers range between about 2000 and 3200 (Berndt, 1959, pp. 85-86). He admits to the approximate nature of the precontact estimate, but recent Australian government census counts tend to confirm the latter figures.

Meggitt's estimate of a precontact population density of one person per 35 to 40 square miles is more conservative (Meggitt, 1964, p. 31), but if we allow for Berndt's qualification that his estimate "reveals nothing of the concentration or 'actual' density of population within the area" (Berndt, 1959, p. 86), then it seems reasonable to accept Meggitt's estimate as true for certain particularly desolate regions within the Western Desert. Recent figures given by Yengoyan (1968, p. 189) estimate population densities at one person per 30 to 40 square miles in the Rawlinson Range area from Lake Christopher to the western edge of the Petermann Range, further substantiating Meggitt's figures. Taken together, these estimates furnish an idea of the scale of aboriginal population in this region and suggest how much the population has declined overall since European contact began.

The best hunting occurs in mulga-covered areas that have received heavy summer rains for at least one or two seasons (a condition not often met or easily predicted). Family groups tend to converge on such localities and remain together in groups of approximately 150. Tindale (1935, p. 199) reported gatherings of up to 270 in areas farther east, but this was in slightly better watered country. When the hunting gets poor and the intake of meat drops below 1¼ lbs. per person per day (Gould, 1967, p. 59), the group either moves to a new hunting area or begins to disperse into clusters of related families, which may continue to disperse and fragment even more if drought conditions persist. This process of fission culminates in individual families or small groups of related families numbering generally between 10 and 30 individuals centering their foraging activities on a series of more or less permanent water sources during extended periods of drought.

Thus under precontact conditions one can view the population of local groups in the Western Desert as in a constant state of flux, alternating along a continuum between occasional large gatherings of related families at places where water and game are temporarily abundant and small groups of one or two related families residing and foraging together near more or less reliable water-sources during periods of prolonged drought. This view is close to that advanced by Stanner concerning the "marked polarity" of the aboriginal life pattern (Stanner, 1965, p. 5). It will be noted however that this "polarity" of life pattern in the Western Desert does not conform to any regular pattern of annual seasonality.

During 1966 to 1967 there were 22 aborigines living a fully nomadic existence in the region between a locality called Taltiwara (east of Mt. Madley) and the Clutterbuck Hills–Tika-tika area (about 100 miles northwest of the Warburton Ranges Mission). Some of these were people who had visited the Mission and returned to the desert. One family of three had never been previously contacted by whites (Ian Dunlop, personal commun.). All spoke a dialect of Pitjantjatjara called Nyatunyatjara ("those having the word nyatunya: kangaroo") which is restricted to this roughly 7200 square mile area within which these people foraged. In 1969 an additional 10 aborigines were discovered by a Woomera patrol living in the vicinity of Mt. Madley (Gould, 1970, pp. 56-67).

Thus there was an overall density of .004 person per square mile at that time in this region. Even if we include 10 additional Nyatunyatjara-speakers who settled at the Mission in 1965 and a lone woman and her two children who are known to be living in an area to the southwest of Windy Corner (it is not known if she speaks Nyatunyatjara, but her foraging area impinges on that of the others), we arrive at an overall density figure of .006 person per square mile. These figures are far below the minimal estimates provided by either Berndt or Meggitt and demonstrate how far the process of depopulation had progressed by 1969. These figures further show that while a few families continued to live entirely by hunting and gathering in the Western Desert at this time, their isolation had increased to the point where long-term social relationships were no longer viable. For example, it became increasingly hard for individuals living in the desert to find potential marriage partners.

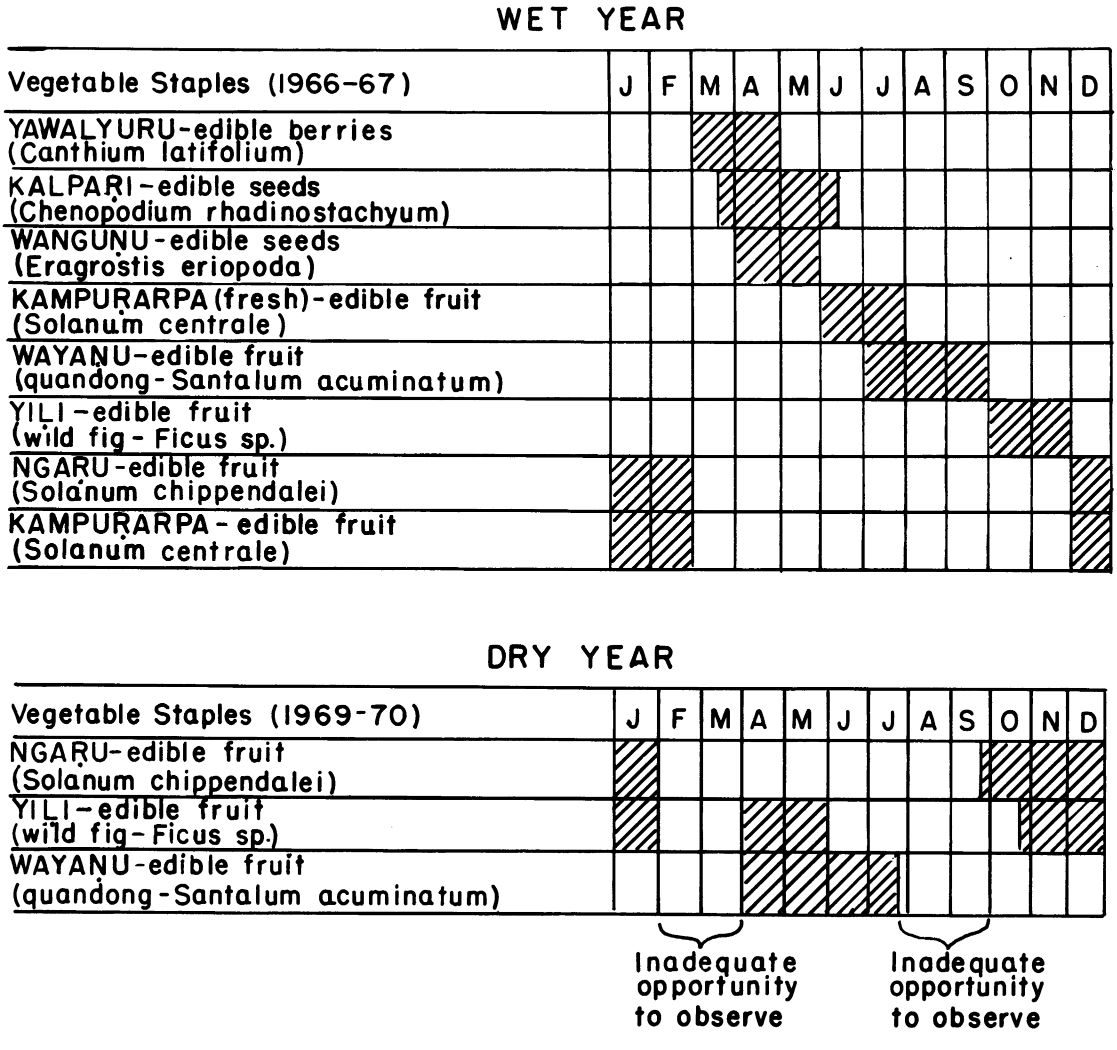
GATHERING

Despite the disruption of aboriginal demography in the Western Desert, it was still possible to observe traditional food-getting behavior for fairly long periods, both near the Mission and in the desert (mainly near the Clutterbuck Hills and in the vicinity of Mt. Madley). At times precise quantification was made difficult or impossible by the introduction of government rations. Intermittent measurements were possible, however, which permitted the recognition of staple vegetable foods at different times of the year. These are summarized in table 1. A "staple" here is defined as any plant species that accounted for at least 30 percent of the total diet during the period it was collected and consumed. In most cases this percentage was much higher than 30 percent, being more on the order of the "70 or 80 per cent of the total food supplies," suggested by Meggitt (1964, p. 33) as the place of vegetable food in the economy of Australian aboriginal societies. Table 1 lists only staples actually observed being collected during 1966-1967 and 1969-1970. 1966-1967 was a year of unusually heavy rains at various points in the desert including the Warburton Ranges but by 1968 drought conditions had set in and were continuing in 1969-1970.

In addition to these eight staples, there are many edible plants that serve to supplement the main fare. They add variety to the diet and sometimes become important when a staple is in short supply owing to drought or some other factor, but they are rarely found in quantities approaching those of the staples. A couple of botanical studies of native names of plants and their uses among Pitjantjatjara-speaking aborigines at the

TABLE 1

Staple Food Plants Collected by the Western Desert Aborigines in 1966-67 and 1969-70.



Musgrave Ranges and Yuendumu have named 36 edible plant species, including six of the seven staples listed in table 1 (Cleland and Johnston, 1938; Cleland and Tindale, 1954). I can add only one more staple and two more supplemental plant species, although I was told about several additional edible plants, which I did not see or have identified. Meggitt, in a study of vegetable foods of the Walbiri, noted that these aborigines distinguish 52 varieties of edible plants (Meggitt, 1957, pp. 143-144). Although they are not Pitjantjatjara-speakers, the Walbiri are of interest for comparison because they inhabit an environment similar to that of the Western Desert. Meggitt's thorough listing of native food-plants suggests that in a number of cases the aborigines distin-

FIG. 11. Aborigine woman preparing to grind wangunu seeds.

guish varieties that European-trained botanists classify as a single species. Sometimes this takes the form of terms distinguishing different edible parts of a single species of plant (flowers and roots, for example), a practice that occurs among Pitjantjatjara-speakers, too. In comparison with the !Kung Bushmen of the Kalahari Desert it is evident that even among desert foraging societies the Western Desert aborigines subsist in an area of the world which is exceptionally poor in variety and quantity of edible plants. Not only do the Bushmen have a single staple, the mongongo nut, which accounts for one-half to two-thirds of the total vegetable diet by weight, but they also distinguish 85 edible plant species (Lee, 1968, p. 12).

Except in certain places where local rainfall has been unusually heavy, game is scarce and, as has been suggested earlier, comprises a small percentage of the total subsistence. Once again by comparison the !Kung Bushmen are better favored. Lee stated that 54 animal species were classified by the Bushmen as edible, of which 10 species of mammals were regularly hunted for food (1968, pp. 12-13). During a four-week period in 1964 Lee calculated that meat comprised 37 percent of the total diet by weight for a Bushman camp containing an average of 32 people (1968, p. 21). I lack precise figures for comparison, owing mainly to the intermittent introduction of government rations, but on most occasions when I was able to make observations without the "interference" caused by white rations the percentage of meat in the overall diet was much less than in the case of the Bushmen. The Ngatatjara distinguish between mirka (vegetable and nonfleshy foods) and kuka (meat and fleshy foods). Kuka is invariably preferred over mirka, but there is no consistent ranking of preferences within these categories. The Ngatatjara hunt and collect at least 47 named varieties of kuka, 16 of them regularly. However, it must be remembered that at least three species of mammals, which were hunted regularly, are now becoming extinct, whereas three species of introduced mammals, the rabbit and to a lesser extent feral cats and mice, are now hunted regularly. Insects (included under kuka) are also important at times, particularly honey ants, termites, and at least two kinds of grub (neither of which was plentiful during 1966 to 1967, but which were moderately abundant in 1969 to 1970, though not to the extent of constituting a staple food). Hunting (for larger animals) is generally poor, and even the largest of the desert mammals do not compare in overall size and weight to the species of mammals regularly hunted for food by the Bushmen.

Finally, there is a considerable residue of supplemental foods classified by the aborigines as mirka which include such diverse resources as eucalyptus and mulga galls (the gall-wasps, however, are not eaten), acacia resin, the scaly exudations of an as-yet unidentified insect collected from eucalyptus leaves, and birds' eggs of all kinds, particularly those of the larger birds like emu, eagle, and wild turkey. Dingo and crow, both classed as kuka, are generally despised as meat but are eaten at times when meat is scarce.

Women forage for staple foods, most of the small game, and for supplemental foods. Staples can be recognized by the fact that they are invariably collected in such large quantities that they must be transported back to camp in bulk inside wooden bowls rather than being consumed where they were collected. Aborigines eat occasional fruits or berries as they forage, but staples are always brought to camp, first because they are too abundant to be consumed entirely in "snacks" and, second, because most staples require further processing by the women. Kaḷpari and wanguṇu seeds are winnowed and ground into flour that is mixed with water into a dough and baked into cakes (nyuma). Yawalyuru berries are washed, imparting a sweetish flavor to the wash water (which is eagerly drunk) and wrapped in grass bundles until needed. Ngaṛu fruits are split by means of a thin, sharp wooden stick 6 to 8 inches long called pangara and the inedible seeds are removed with one flick of the wrist. Ngaṛu can be eaten either fresh or parched by sun- or fire-drying. Sun-dried husks are generally impaled and strung on thin sticks; the fire-parched husks can be stored indefinitely as they are or mixed with a little water and ground to a paste then consolidated into a ball. For eating, the parched and dried husks need only be dipped in water to make them palatable. Kampuṛarpa collected when fresh is generally eaten immediately. When collected in its desiccated state during the summer, however, the fruits are crushed with a stone grinder, mixed with a small amount of water and then ground into a seedy paste which is finally compacted into balls as much as 10 inches in diameter and weighing up to 2 1/2 lbs. each. The outer surfaces of these balls dry into a crust, keeping the insides from spoiling.

Ngaṛu and kampuṛarpa, if kept dry, can both be stored indefinitely after preparation. I was told that sometimes they are placed in tree caches out in the bush and left for men who may go long distances in search of game. Food is always stored in tree caches or on top of shelters, away from the dogs. Wayaṇu (quandong) and yiḷi (wild fig) are generally eaten fresh, without special preparation. Although I was told that wayaṇu fruit is sometimes parched in the same way as ngaṛu, enabling the dried husks to be stored, I never observed this practice.

On an average day during December to February, 1966-1967, the women in a pair of related families of 13 individuals observed intermittently while living together in the Clutterbuck Hills region were able to collect just under 30 lbs. of kampuṛara and 10 lbs. of ngaṛu (weighed after removal of seeds and drying) in an average of 4 1/2 hours of collecting. The three adult women and one older girl in this group nearly always foraged together, leaving camp and returning at the same time. Although the ratio of kampuṛarpa to ngaṛu collected in a day fluctuated greatly, each woman generally managed to collect an average of just under 10 lbs. of edible vegetable food (after processing) each day. Although occasionally a woman might spend her time in the summer looking for nonedible plants or small game, in most cases every adult woman foraged for vegetable foods every day (a point arrived at partly by observation and partly through interviews, since I was not able to observe continuously). In addition to the time spent in food collecting, these four women worked together an average of 2 1/2 hours each day parching, grinding, and otherwise preparing these staples, which, whenever I was present, were entirely consumed by the group within the next 24 hours. At this time the two adult men in the group hunted unsuccessfully for emus but generally managed to find a few goannas during the hunts. The Clutterbuck Hills had not had much rain and were in a state of moderate drought, but in spite of this these people took in and consumed an average of 2 1/2 to 3 lbs. of vegetable foodstuffs each day along with a few ounces of lizard-meat per person. This is a rough average, of course, with children consuming somewhat less than adults, and the intake of supplemental foods was impossible to compute (although there were hardly any available during that period). The women relaxed an average of about five hours per day, mainly during the hottest part, from around 12:00 to 4:00 in the afternoon. The figures given here apply only to the summer season in a situation where torrential late summer rains had not yet fallen (they missed the Clutterbuck Hills almost entirely during 1966 and 1967). Their general applicability is limited by the small size of the group and the fact that my visits to these people, though frequent, were intermittent. However, observations made in April, 1970, of a similar group of 10 Pitjantjatjara-speaking aborigines at Pulykara, a "native well" near Mt. Madley, during the second year of a drought period tended to support these earlier observations.

As shown in table 1, there are times when the same staple may become available at widely different times of the year (note, for example, that wild figs were available in October-November in 1966 and in November-December, 1969 and April-May, 1970). This results from erratic, localized conditions of rainfall or drought that can lead to staples ripening at different times of year in different localities. Although the number of edible plant species is reduced during drought years, the quantities of these drought-staples are generally greater than is the case for the same plants during wet years. In the case of quandong (as observed at Pulykara and in the Warburton area) this is the result of natural preservation of the dessicated fruits while the weather remains dry, but for the other drought-staples it seems to be a case of larger yields stimulated by the prolonged dry weather.

HUNTING

In any consideration of aborigine hunting behavior, it is important to distinguish between the activity of hunting on the one hand and success in hunting on the other. Men devote much time to hunting for large game and collect other edibles incidentally, along the way. But, despite the many hours expended in this activity, their success in hunting is generally poor. Small game, such as lizards, rabbits, feral cats, and mice provide the only protein available most of the time. Only on occasions of heavy localized rainfall in areas where mulga scrub is present as cover is larger game abundant. These occasions do not occur often or with any real predictability, but when they do occur the men's hunting efforts provide the bulk of the diet. In a sense one can say that it is the dependable efforts of the women in collecting wild plant foods which free the men for the more chancy enterprise of hunting. Hunting is mainly by stealth rather than pursuit. The favorite method is to construct blinds of brush or rocks at points within easy spearthrowing distance of a water-source, generally near a defile or gorge that will restrict the movements of game when trying to escape. Nighttime hunting from blinds is sometimes practiced (particularly on moonlit nights) to take advantage of the nocturnal habits of the larger game. When an animal is sighted in the open, a hunter may stalk it by a direct approach, making as little noise as possible as he moves and avoiding any side-to-side motion that the animal might see. This writer has observed Ngatatjara hunters making approaches toward grazing kangaroos from distances of around 300 yards to within 50 feet of the animal in this way, even when there was no wind to cover the sound of the hunter's movements.

These aborigines use the typical desert spearthrower (Spencer and Gillen, 1938, fig. 111, 3 and 4) and single-barbed spear about 9 feet long, which experiments conducted at Warburton and Laverton showed to have a maximum accurate range of about 120 feet. That is, a practiced individual can consistently hit a 2 by 2 foot target at this distance. In recent years, aborigines living near reserves and missions have been acquiring rifles, but in 1966-1970 the desert people were still using spears for hunting.

Communal hunting by means of fire, brush pounds, and natural game traps is not common but does occur, mainly after periods of heavy rain when kangaroos, emus, and wallabies tend to be both numerous and gregarious. Helms reported elaborate brush game traps in the vicinity of the Everard Range (1896, pp. 256, 295) of a kind observed later by Basedow in the Musgrave, Mann, and Tomkinson ranges (1925, pp. 143-144). Finlayson has described the use of brush fences for communal hunting in the Petermann Range (1935, pp. 60-61) and fire in capturing large numbers of wallabies near the Musgrave Range (1935, pp. 45-48). Hunts of this kind still take place occasionally near the Warburton Ranges, though they are becoming rare now owing to the depletion of game brought about by the close proximity of the Mission.

The Western Desert aborigines have no way of storing or preserving meat. The longest I ever observed anyone keeping a piece of meat after the kill before eating it was six days. By that time it

FIG. 12. Aborigine man capturing goannas (*Varanus gouldii*).

had begun to rot, although it was still eaten without hesitation. Whenever I observed gatherings large enough for ceremonies to occur, however, the primary dependence at the time was on meat (mainly kangaroo and rabbit) rather than vegetable foods. These, of course, were occasions when white rations were not a factor or were of negligible importance. As emphasized earlier, such periods of fine hunting are relatively rare. It is possible that abundant seed or ground-fruit harvests could and did sustain such large gatherings, but at no time did I find any evidence of stored surpluses of vegetable food being used for this purpose. Instead, there is a tendency for group size to be based on natural as opposed to man-made surpluses with the technology of storage being reserved mainly, it seems probable, for emergency situations when severe shortages of food appear imminent.

In terms of the total economy it seems as if the desert aborigines are not utilizing their storage technology to its fullest advantage, preferring instead to relax and forage on a day-to-day basis in seasons of relative plenty. This statement must remain hypothetical to a degree, for in a situation where the traditional economy and demography are rapidly collapsing there has been no opportunity to make sustained observations of nomadic aborigines under extreme drought conditions (on the order of perhaps five to 10 years). The available evidence, limited as it is, points to storage of certain vegetable foods as a way the aborigines have of ensuring that there will be enough food for minimal groups in the worst seasons.

WATER SUPPLIES

The search for water dominates all other concerns of the aborigines, particularly in seasons of severe or even moderate drought. Certain areas where water holes are scarce, small, or unprotected from the sun cannot be entered and exploited for food unless there have been reasonably heavy rains. There is such an area to the east of the Warburton Ranges all the way to the South Australian border. Some good rockholes can be found in the Cavanagh and Barrow ranges as well as at Lightning and Winburn Rocks, but in between there are few reliable water sources. On the whole this is a good region for hunting and foraging, but tragedies are known to have occurred in it up until as recently as 1964, mainly when aborigines tried to utilize the resources of the area in seasons of marginal rainfall.

Since there are scarcely any springs or truly permanent rockholes and soakages anywhere in the Western Desert, movement must be frequent and opportunistic in character, taking advantage of heavy rains in one area which may be absolutely dry for several years thereafter. Chains of water sources, which often conform to the dreamtime tracks of totemic beings, are known throughout the desert, where they may cross and recross other, similar chains. Although the sequence and locations of many of these are memorized by men as part of the sacred life, women also have an extensive knowledge of these chains of waterholes when passing through the area where they occur, and often a person's knowledge of the sequence of names and approximate locations of water sources extends far beyond the regions he has visited personally in his lifetime. Proper names are applied to water sources, and the specific resources of each one must be learned. These will vary from magnificent pools containing thousands of gallons of fresh water shaded by the sides of a deep gorge, such as one finds at Wi:ntjara and Kutjuntari in the Rawlinson Range and Pangkupiri in the Walter James Range to a few cupfuls of water left in the basin-like crotch formed by the branches of a eucalyptus tree, as is the case at Nyara and Pukutjitjara, sites in remote parts of the sandhill country between the Rawlinson and Warburton ranges. Some of the "lines" contain only marginal water-sources but serve to connect areas where water is more abundantly available.

As suggested earlier, the fickle nature of rainfall in the Western Desert means that the aborigines do not follow an annual seasonal round. In general, the aboriginal pattern of movement is to go from one water source to the next, concentrating on the smaller rockholes and soakages while they still contain water so as to forage around them thoroughly (within about a 10-mile radius, that is, a reasonable day's walk both ways) before moving to the larger and more permanent waterholes. Direction of travel at any given time is determined by a consideration of where rain has been seen falling (in the open desert country heavy rains can be seen from as far away as 50 miles) in combination with the known presence of natural water catchments and their association with natural occurrences of staple food resources. Thus the direction, distance, and frequency of movement are directly dependent upon the aborigines' knowledge of the location of water catchments and staple food plants as balanced against actual occurrences of rainfall. Depending on where the rains may chance to lead them, the aborigines may visit and revisit a single reliable waterhole several times during the same year or they may be forced to move along a string of waterholes to an altogether different area, not to return for several seasons.

SETTLEMENT PATTERN AND SITE TYPES

In relating the economic, technological, and other activities of traditional Western Desert aborigines to localities where these activities are carried out, it is possible to classify their sites into seven basic types along with several subtypes. This is an anthropological classification, not a native one. Six of these types are concerned primarily with daily activities, whereas the seventh concerns sites of sacred importance. However, as will become clear, one must be careful not to overdo this distinction between sacred and nonsacred when correlating site-localities with different cultural activities.

HABITATION CAMPSITES

Large Campsites. These campsites represent

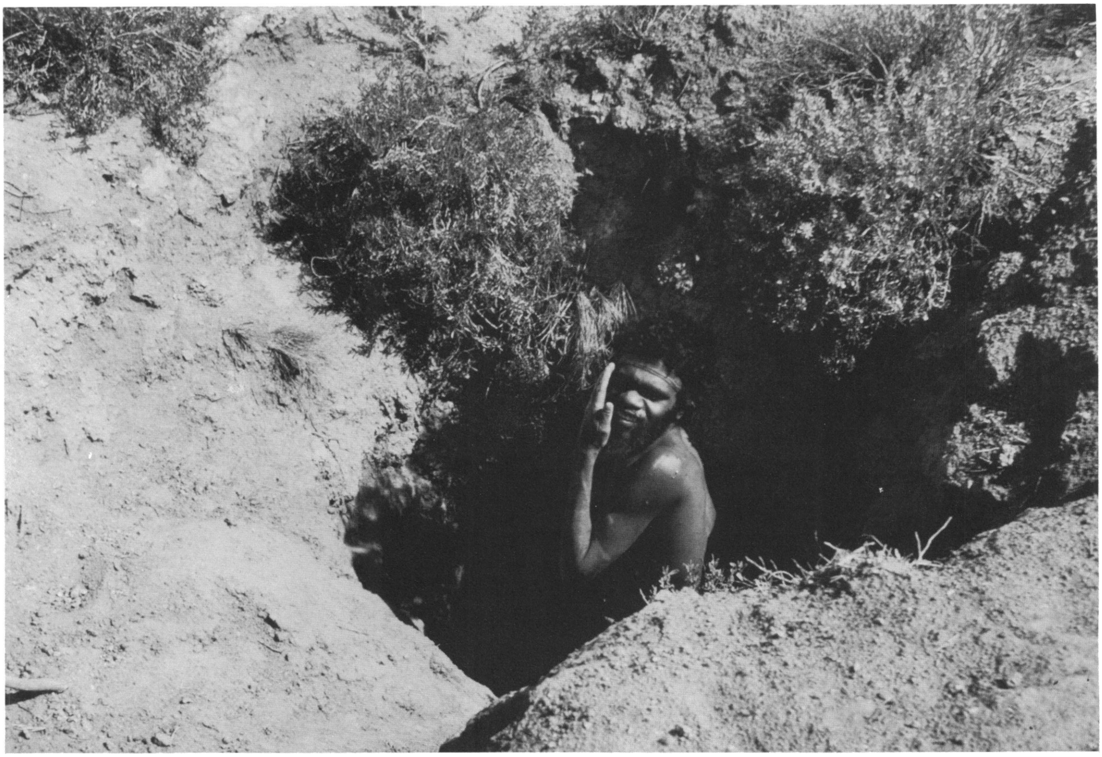


FIG. 13. A soakage or "native well" at Pulykara, near Mt. Madley.

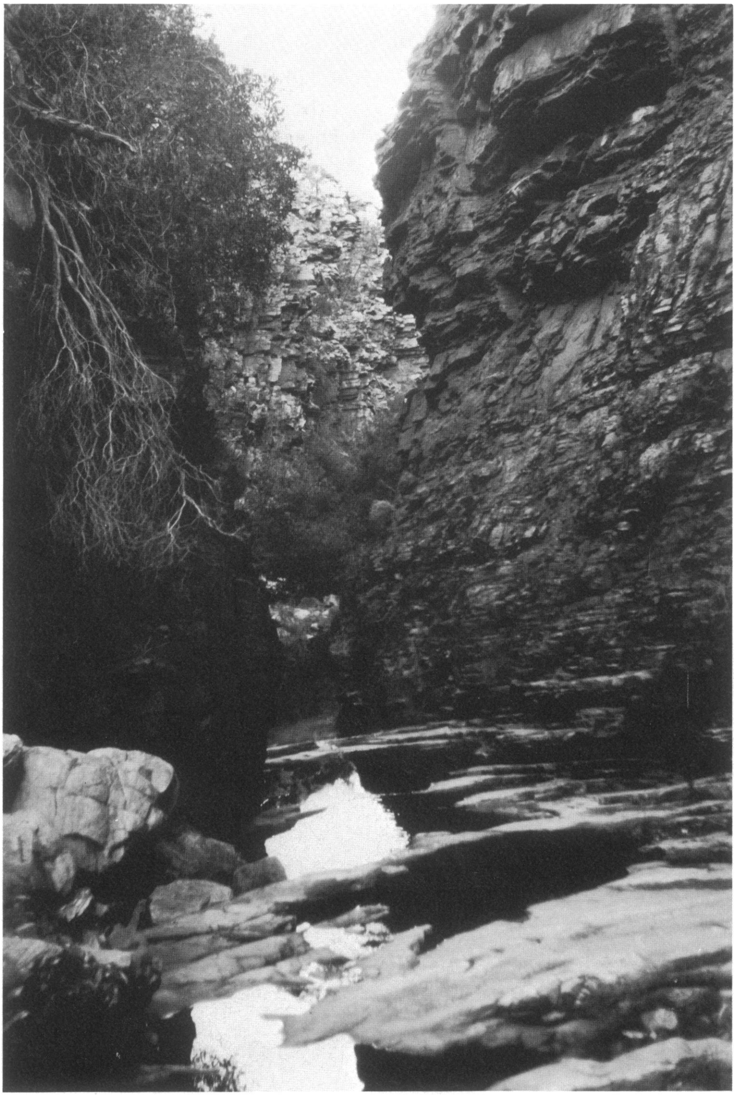


FIG. 14. Wi:ntjara Gorge (Glen Cumming), Rawlinson Range. Note the large, well shaded pools of water.

habitational remains created by the maximal groupings described earlier. A camp of this type (Waṇampi Well) was observed and mapped in 1966 and later reported (Gould, 1968a, pp. 109-111), and it remains the largest desert camp observed so far during this study. Several others, however, were observed that tended toward this extreme. A map of the Waṇampi Well camp as it appeared on December 13, 1966 is presented in figure 15. Figure 16 shows the total collection of stone artifacts from the surface at the Waṇampi Well camp on this date.

Small Campsites. At the other extreme, one finds the campsites left by minimal groups of desert aborigines, such as those observed at Tikatika and Partjaṛ in 1966-1967 and at Pulykara in 1970. In the first case the group consisted of 13 people and in the latter nine. A composite map

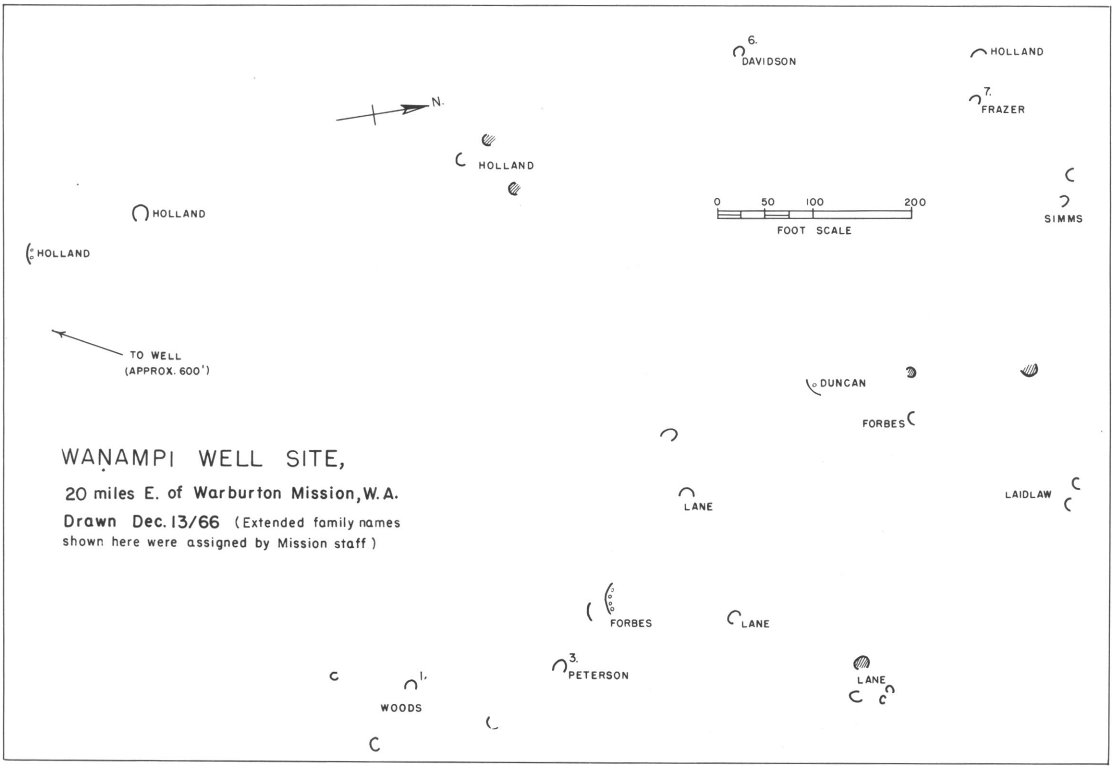


FIG. 15. Waṇampi Well site.

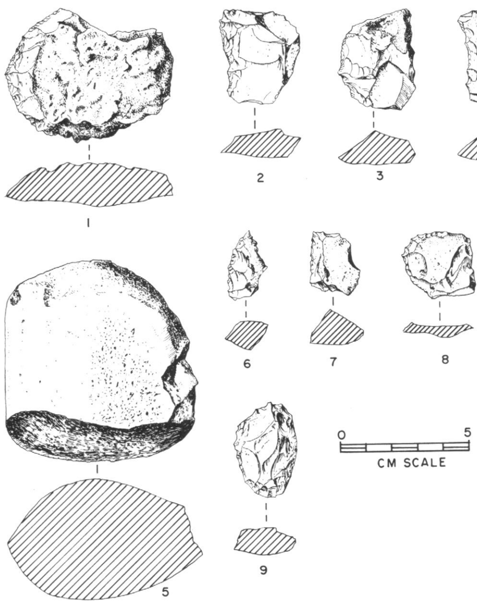


FIG. 16. Stone artifacts from surface of Waṇampi Well camp. Collected Dec. 13, 1966.

FIG. 17. Aboriginal camp at Wanampi Well, December 13, 1966.

of the camp at Pulykara is shown in figure 18, and one for Partjar is shown in figure 19.

The same aboriginal term (ngura) applies to habitation campsites of any size, and the individual camps within these campsites are constructed in the same manner, differing only according to the time of year. During the winter months, when temperatures dip down to freezing, open-air camps are constructed with low brush windbreaks to shield against ground winds. These are called yalta ngura ("cold camps"). In the summer months small, dome- shaped shelters are constructed of mulga boughs. These are intended primarily for shade during the heat of the day and are not waterproof during rains. They are called wiltja ("shade"). In terms of ground plan, spatial arrangements, and area these two camp types are basically similar, with the important exception that the summer-camp is enclosed by an oval or semicircular arrangement of small "post holes" dug for the upright boughs, thus offering the possibility of a distinctive archaeological feature. At the same time, this bough superstructure sets rough limits on the area of each summer camp (caused by limitations in the size of the mulga boughs used in the superstructure) that appear as a difference in mean campsite area in table 2.[1] It is the summer camps which tend to be small, with none having an area in excess of 70-79 square feet. Table 3 provides a summary of ethnographic data as applied to the contemporary camps and campsites observed during the entire study.

The contrast in ground plan and superstructure between cold-weather and summer camps is probably the most regular seasonal vari-

[1] A Wilcoxen test applied to the data used in table 2 provides a resulting value of 3.3, indicating a significant difference in area between contemporary summer and winter campsites.

ation in the whole corpus of what is known about desert aborigine settlement patterns. But the archaeological value of this contrast is diminished in most cases by the fact that, owing to the chancy distribution of rainfall and consequent opportunism of movement by aborigines, a single site may be occupied during the summer and then reoccupied in the winter of that same year. This latter was indeed the case at Tika-tika in 1966 to 1967, and similar situations are known to have happened recently at Partjaṛ and Pulykara, too, with the result that these campsites contain remains of both summer and winter camps.

In terms of archaeological visibility, habitation campsites all suffer from varying degrees of exposure to erosion and tend not to be well preserved for more than a few years. Individual camps may be preserved through a combination of lucky circumstances, but such occurrences are rare. For example, although termites consume the wooden uprights and artifacts left in most camps, one occasionally finds a shade-shelter that was destroyed by burning (thus preserving the charred posthole outline and sometimes even traces of the collapsed superstructure). In a few cases these burned sites may be in fairly sheltered spots where erosion is minimal, thus preventing or retarding their destruction. Some of these camps have remained visible on the surface for at least 30 years and may continue to be indefinitely. But Peterson's observation (1971, p. 242) that "Within a few years of abandonment, Arnhem Land campsites are largely obliterated by wind, sun, rain, fire and, most important of all, site reuse" is basically true with regard to surface sites in the Western Desert, too.

As described elsewhere (Gould, 1968a) there are no specialized areas set aside in contemporary camps or campsites for stone-chipping, the butchering and division of meat, grinding, and preparing vegetal foods, or other domestic activities. Usually these are all carried out within or close to the confines of each family camp by the members of the family residing there as these needs arise. Even relatively seasonal features like postholes and the area of each camp are of doubtful archaeological value, since they tend to be poorly preserved and would be ambiguous when seen in terms of whole campsites where both summer and winter camps would most often be found together. Since domestic camps are the archaeologist's main source of information about the daily activities of ancient aborigines, it seems reasonable to take the general view that contemporary habitation site features reflect an economic pattern which is opportunistic and more random than would be true for other, more seasonally based hunter-gatherer societies.

The same can be said for the artifact assemblages that occur at these modern habitation campsites. All the easily recognizable chipped stone tools in the present-day aborigine toolkit are intended primarily for making other tools of wood. These stone tools include hafted stone adzes and adze-slugs, handaxes, hand-held scrapers and scraper-planes, and spokeshaves. The need to make and repair wooden tools like digging-sticks, spears, and spear-throwers is basically constant throughout the year and operates regardless of local variations in the availability of resources, so these chipped stone tools cannot be linked to any seasonal occupations. Hand-held flake knives are used in cutting meat and sinew, but these are rarely retouched and thus are generally hard to identify as tools. It is conceivable that the presence of a high concentration of utilized stone flakes in an excavated site could indicate hunting and division of meat as major activities, and these activities tend (though not without exception) to occur under special conditions of heavy local rainfalls, generally in the summer. The problem with this interpretation seems to be the great difficulties which archaeologists have in identifying such minimal stone tools. Some, of course, can be picked out easily, but one never can be sure how many have gone unrecognized. Seed-grinders and grinding-slabs are used in preparing at least four of the plant staples shown in table 1. Stone seed-grinders and grinding-slabs are ubiquitous at aborigine campsites, so their absence could be more interesting to the archaeologist than their presence.

Faunal refuse at aborigine habitation campsites provide some clues to seasonality, but these are limited and must be used with caution. In general butchered bones of game animals are

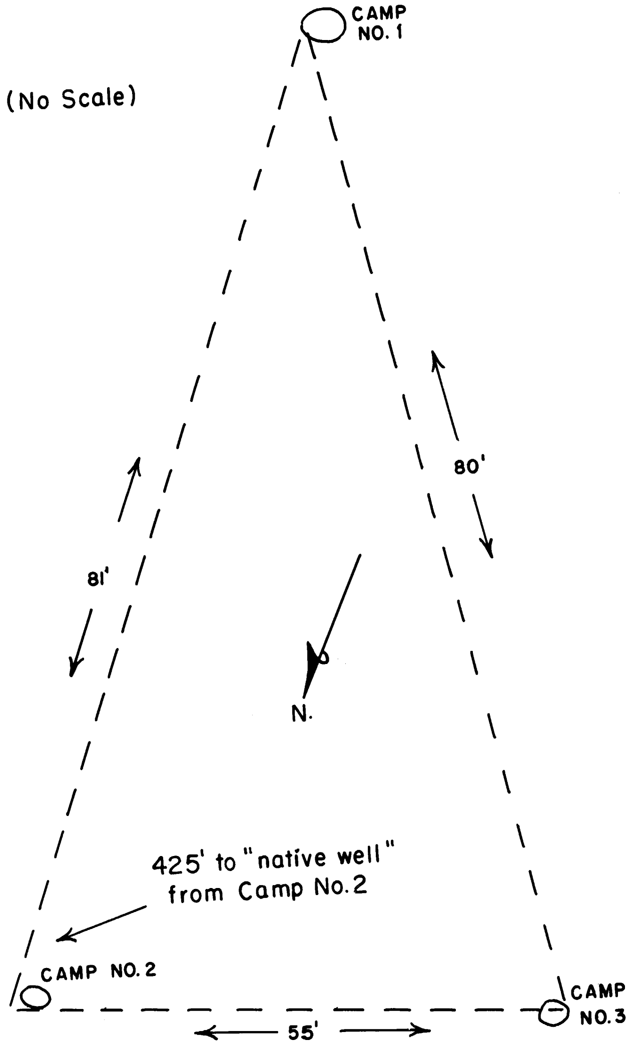
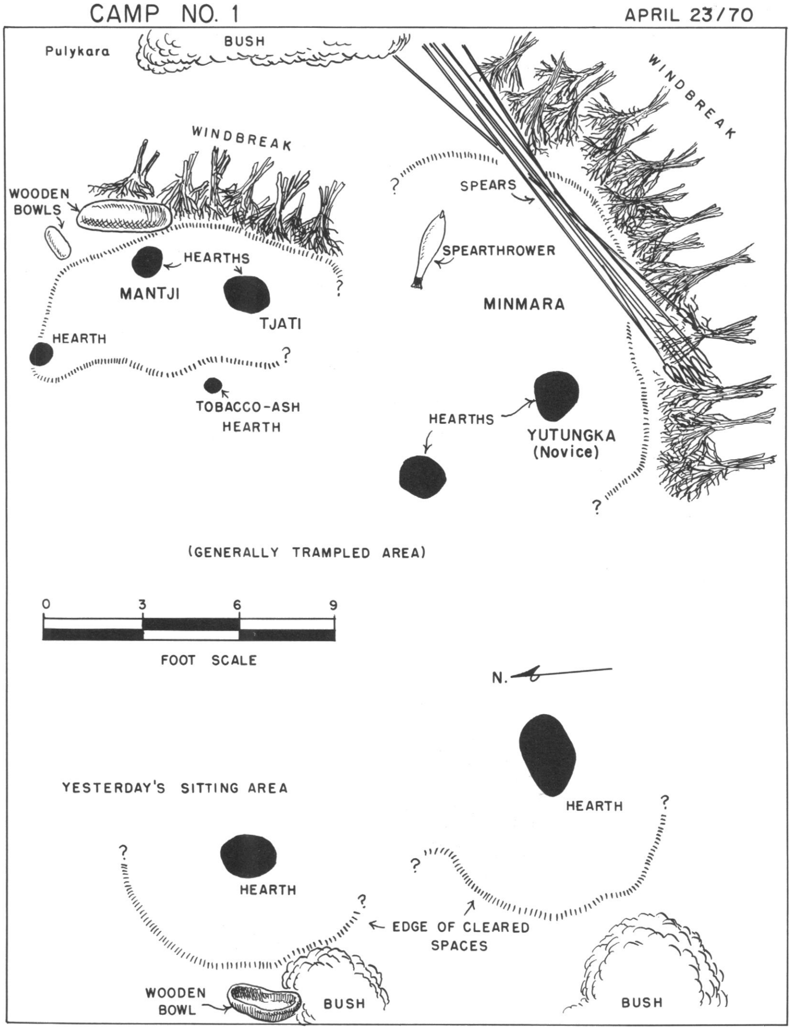
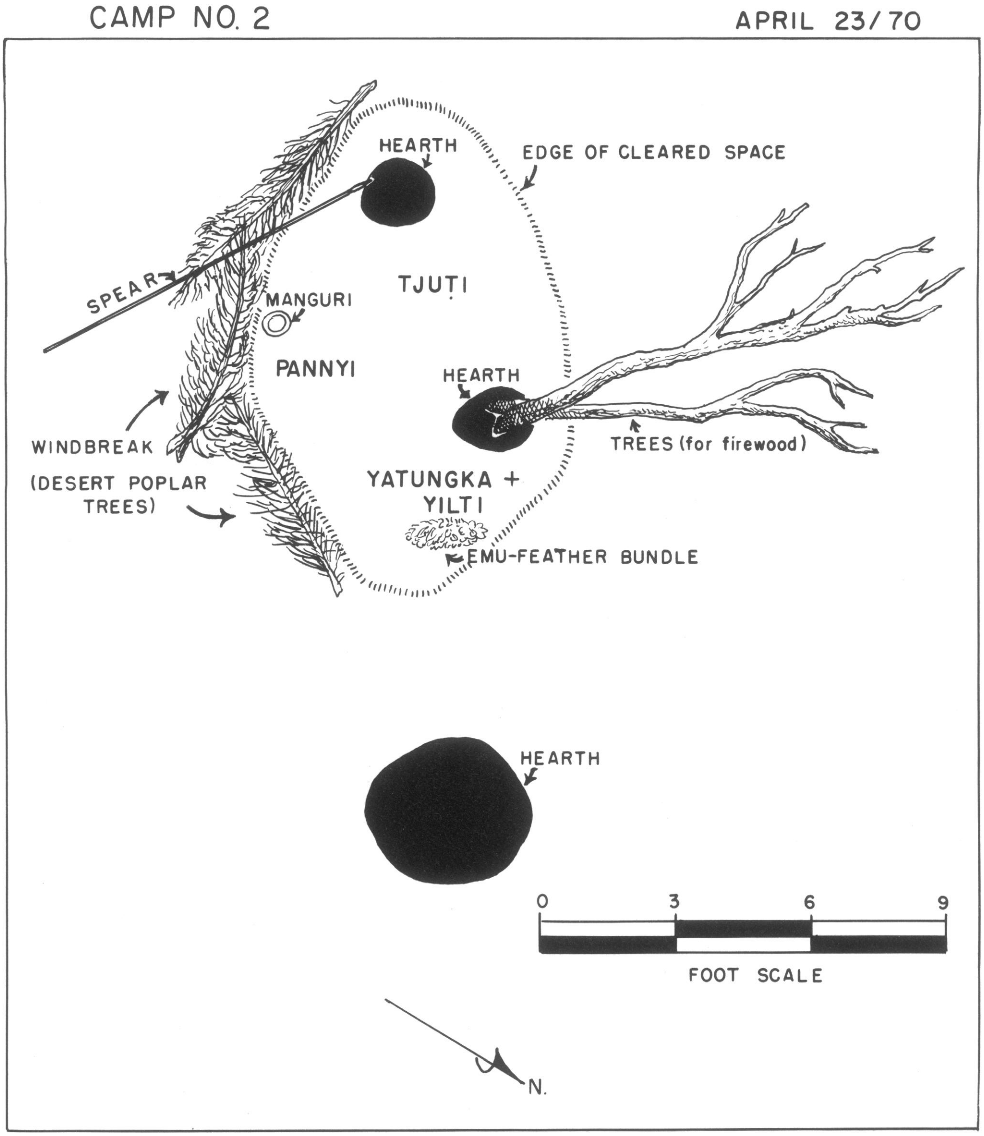


FIG. 18. Composite map, showing campsites 1, 2, and 3 (on three consecutive pages) of small habitation sites at Pulykara, near Mt. Madley.


CAMP NO. 1
APRIL 23/70
Pulykara
BUSH
WINDBREAK
WINDBREAK
WOODEN BOWLS
HEARTHS
MANTJI
TJATI
SPEARS
SPEARTHROWER
MINMARA
HEARTH
TOBACCO-ASH HEARTH
HEARTHS
YUTUNGKA (Novice)
(GENERALLY TRAMPLED AREA)
0 3 6 9
FOOT SCALE
N.
YESTERDAY'S SITTING AREA
HEARTH
HEARTH
EDGE OF CLEARED SPACES
WOODEN BOWL
BUSH
BUSH


CAMP NO. 2
APRIL 23/70
HEARTH
EDGE OF CLEARED SPACE
SPEAR
MANGURI
TJUTI
PANNYI
HEARTH
WINDBREAK
(DESERT POPLAR
TREES)
TREES (for firewood)
YATUNGKA +
YILTI
EMU-FEATHER BUNDLE
HEARTH
0
3
6
9
FOOT SCALE
N.

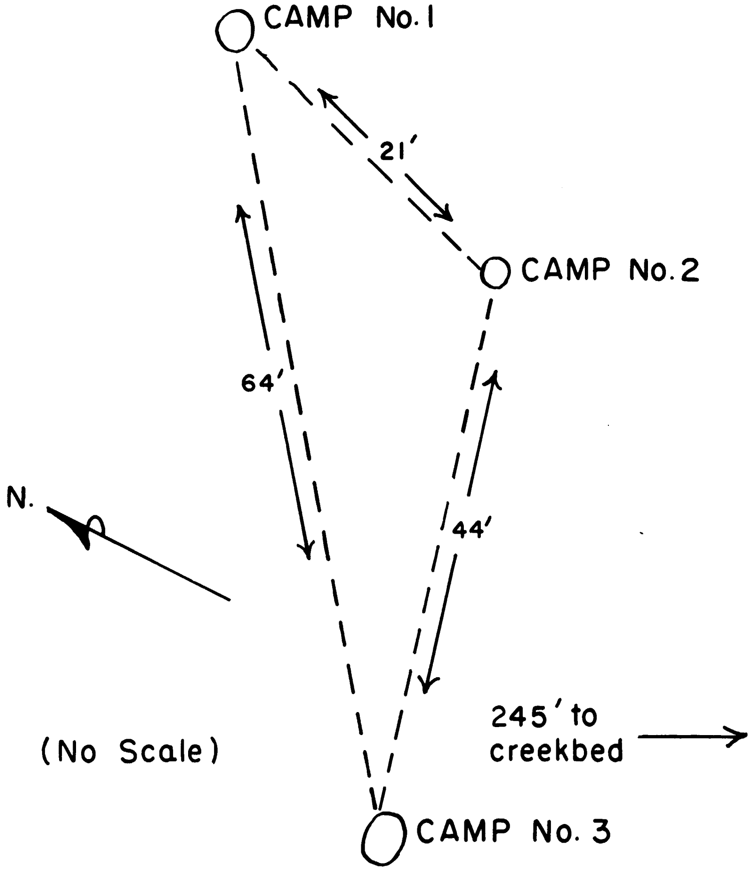
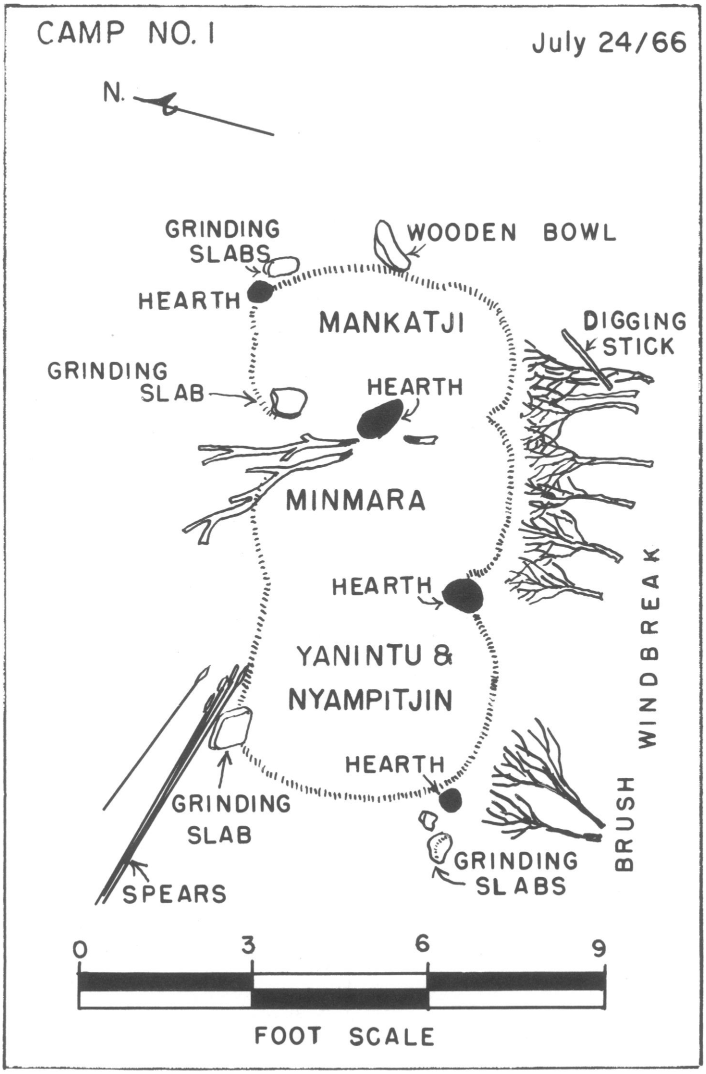
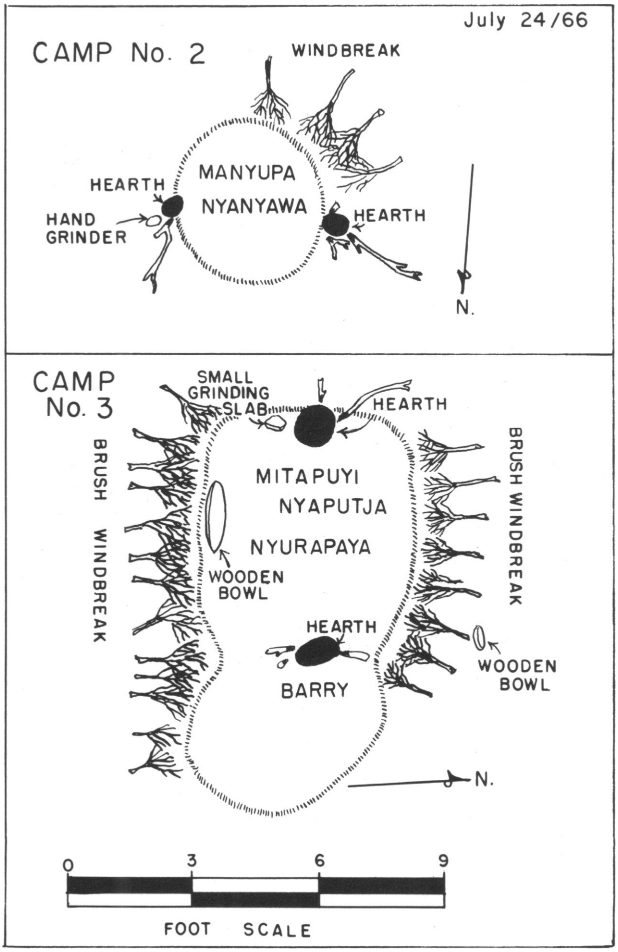


FIG. 19. Composite map, showing camps 1 and two (on two consecutive pages of small habitation camp at Partjar, Clutterbuck Hills.


CAMP NO. 1
July 24/66
N.
GRINDING SLABS
WOODEN BOWL
HEARTH
MANKATJI
DIGGING STICK
GRINDING SLAB
HEARTH
MINMARA
HEARTH
YANINTU &
NYAMPITJIN
HEARTH
GRINDING SLAB
SPEARS
GRINDING SLABS
BRUSH WINDBREAK
0
3
6
9
FOOT SCALE


July 24/66
CAMP No. 2
WINDBREAK
HEARTH
MANYUPA
NYANYAWA
HAND
GRINDER
HEARTH
N.
CAMP
No. 3
SMALL
GRINDING
SLAB
HEARTH
BRUSH WINDBREAK
MITAPUYI
NYAPUTJA
NYURAPAYA
WOODEN
BOWL
BRUSH WINDBREAK
HEARTH
WOODEN
BOWL
BARRY
N.
0 3 6 9
FOOT SCALE

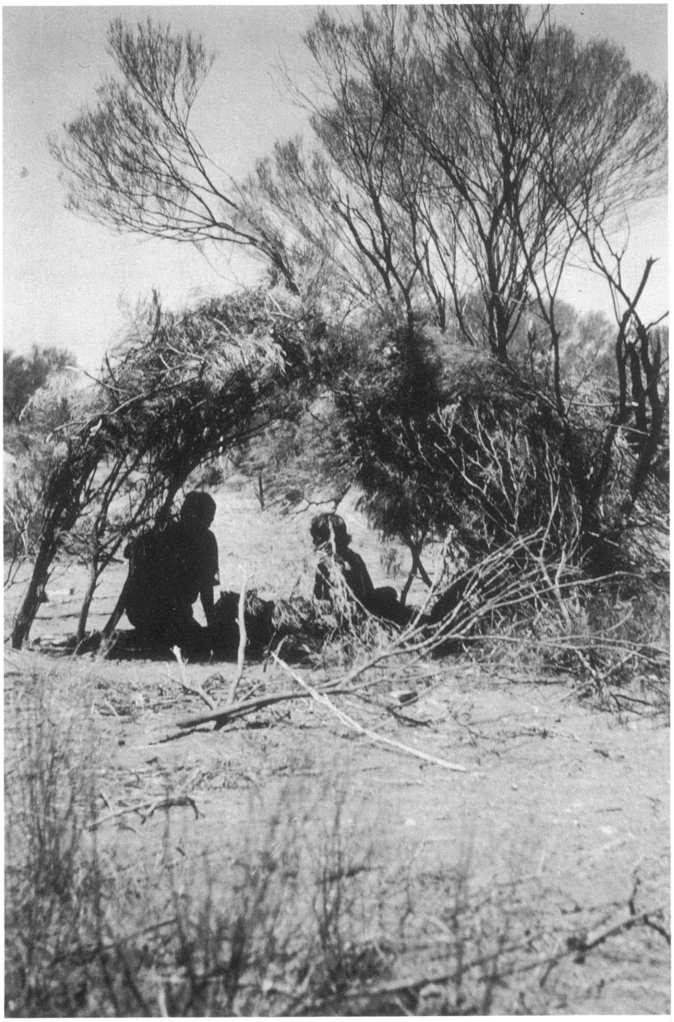


FIG. 20. An aboriginal summer shade-shelter (wiltja) at Mulyangiri, approximately 14 miles north of the Warburton Mission.

uncommon at aborigine campsites because the hunting is usually poor. So when large concentrations of butchered bones are found in modern camps their presence is usually due to the kind of "windfall" that occurs when heavy summer rains have increased the localized abundance of game, and it is on these occasions that there is a definite tendency toward large habitation campsites (i.e., maximal grouping). In most cases a large concentration of butchered animal bones (of modern desert species) together with associated artifacts (particularly flake knives), hearths, and camps could lead the archaeologist to make a reasonable inference that he is dealing with an instance akin to the maximal groupings that have been observed to occur ethnographically in response to localized natural surpluses of game. This is not a seasonal phenomenon in the strict sense, however, as it can happen only in summer, but not necessarily every summer (or, for that matter, in most summers) or in the same place every time. Nor does a high concentration of

FIG. 21. Aboriginal cold-weather camp (yalta ngura) at Pulykara, near Mt. Madley.

animal bones mean that the campsite was occupied only at times when there was good hunting. It may be occupied at other times, too, when there is good foraging in the area, and such indeed was the case several times at Waṉampi Well when small groups of related families camped there on other occasions to forage for plant foods. Along with these provisos about "seasonality" one must also remember that factors like erosion and the tendency for camp dogs to scatter the butchered bones work against the formation of such concentrations and act to decrease the archaeological visibility of the faunal evidence.

Men's Traveling Camps. Small groups of from two to a dozen aborigine men can often be found traveling together in the desert, frequently over long distances. Sometimes it is for the purpose of hunting, but more commonly it is to visit important sacred sites and/or to participate in an important initiatory ritual (like circumcision) for a novice with hunting as a secondary activity. Men traveling together under these conditions construct a distinctive type of camp called tawara ngura ("dug camp"), and these camps may be found in isolated localities (where the men stopped while en route) or in semi-isolated localities at a discreet distance from the main habitation camp being visited. By discreet I mean not so much at a fixed distance as at whatever distance offers a reasonable amount of seclusion given local conditions of terrain and cover. In most cases these men's camps are rarely more than 200 yards from the main camp. Figure 22 shows one of these men's traveling camps in plan. The construction of these camps does not vary with the time of year. They always consist of a row of scooped-out oval shaped spaces in the dirt (individual sleeping areas) alternating with hearths and with a low brush windbreak set along one side. In terms of social relationships, residence in one of these camps always marks one as a visitor, even if the visit is of long duration.

These camps are uniform in their patterning and vary only according to the number of men in the group. For example, a straight row of six

TABLE 2
Measured Areas of Contemporary Campsites (In Square Feet) At Seven Localities[a]

Areas	Winter (cold-weather) camps	Summer (shade-shelter) camps
9 – 19	0	1
20 – 29	1	10
30 – 39	2	12
40 – 49	2	2
50 – 59	2	3
60 – 69	1	1
70 – 79	2	1
80 – 89	0	0
90 – 99	1	0
Total samples	11	30

(Calculated from Ungrouped data)
Mean Campsite Area for Winter Camps 53.70 sq. ft.
Mean Campsite Area for Summer Camps 36.25 sq. ft.
$Z = 3.3$
$P < .01$

[a]These seven localities are Tika-tika (1966), Yaturi (1966), Piriya (1966), Maṭura (1966), Waṇampi Well (1966), Partjaṛ (1966-1967), and Pulykara (1970).

hearths would indicate that five men slept in that camp. Sometimes, too, one finds pieces of red ochre and rock-slabs stained with red ochre in these camps, which is not surprising considering the primarily sacred purposes of this kind of traveling. In terms of their archaeological visibility the same factors apply to these camps as to winter camps within habitation campsites. On the whole they tend not to be well preserved, but there are a few exceptions. The only possible link these camps might have with seasonality is a tendency for them to appear on the fringes of some large habitation campsites, when maximal groups are present and ceremonies (particularly initiations) sometimes occur. As mentioned earlier, these maximal groups usually arise as a result of heavy local rains and good hunting and thus occur in the summer months, but their presence can, for reasons given earlier, never be taken to indicate exclusive use of a campsite for summer hunting.

Hunting-Blinds. Like the men's traveling camps, hunting-blinds also follow a strictly regular pattern. In this study most aborigine hunting observed was carried out by men using blinds (Gould, 1969a, p. 262), and this hunting went on during the entire year, even at times when prospects for success were poor. There are four types of blinds: (1.) brush (2.) tree-platform, (3.) rock, and (4.) natural. The first three types are artificially constructed, with rock blinds varying in construction from simple, circular areas around 6 to 10 feet in diameter from which rocks have been cleared and piled loosely around, to similarly cleared spaces with carefully constructed walls of dry-laid stones set up on at least one side. Brush and tree-platform blinds are relatively impermanent, but rock blinds tend, on the contrary, to be well preserved and highly visible as potential archaeological features. Figure 23 shows the plan of a rock blind with a rock wall "screen" and figure 24 is a photograph of this same blind showing details of the wall construction. Natural blinds are simply crevices or small caves which happen to be close to a water-source where animals will come to drink. All blinds of whatever type must be situated within a radius of 120 feet of a water-source (that is, within easy

TABLE 3

Summary of Ethnographic Camp-Data, Western Desert Aborigines, 1966-70.

SITE	Date of Observation	Summer (Shade-shelter) camp	Winter (Cold-weather) camp	No. of Extended Families	Total No. of People	No. of Shade-shelters	No. of Open camps	Average No. of people per camp
Waṇampi Well	12/13/66	X		17	107	21	3	4.46
Mulyangiri	1/15/70	X		7	58	20	1	2.76
Warburton (newly arrived desert people	8/10/66		X	6	54	7	5	4.50
Tika-tika	7/18/66		X	2	10		3	3.33
Partjaṛ	7/22/66		X	2	10		3	3.33
Partjaṛ	12/27/66	X		3	14	3	1	3.50
Pulykara	4/22/70		X	2	9		3	3.00

Overall average no. of people per camp ------ 3.55

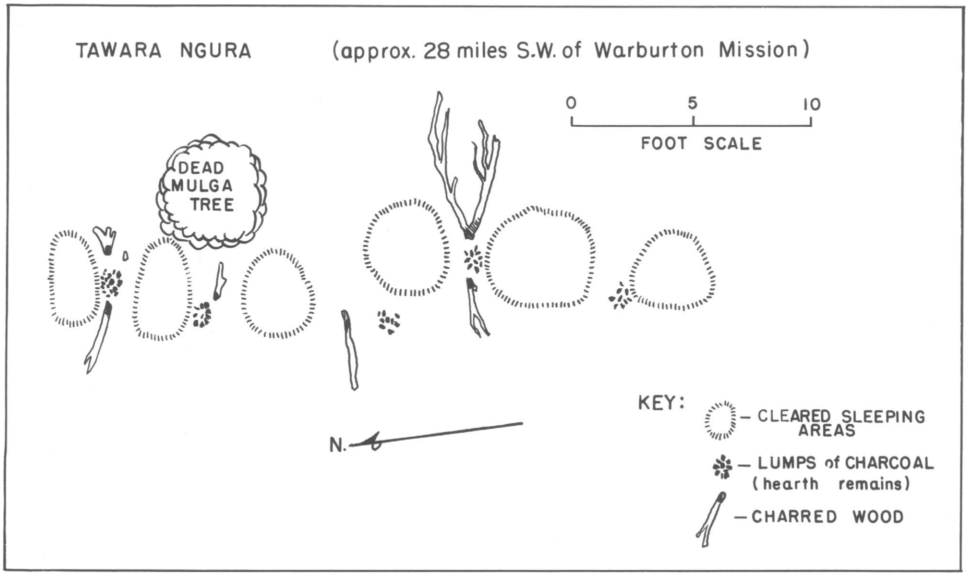


FIG. 22. Tawara ngura, approx. 28 miles SW of Warburton Mission.

spear-throwing distance) to be effective. Natural blinds in such places as rocky gorges and defiles that restrict the movements of game and prevent escape are also highly visible as potential archaeological features, since they often contain rock paintings depicting the tracks of various game animals. These designs are applied by hunters as they wait for game to arrive (Gould, 1968, pp. 108-109) and, because of the naturally sheltered condition of these places, they can remain permanently visible.

It is not unusual to find stone tools and flakes within and near hunting blinds, since aborigine men sometimes resharpen their spears while waiting for game to arrive. Stone tools, particularly hand-held and hafted scrapers, also need to be resharpened and, at times, rehafted as these tasks are performed. Habitation campsites and hunting-blinds are never close together, since camp noises would, of course, scare away the game. But because both animals and man in the Western Desert tend to use the same water-sources, one can expect to find hunting-blinds within a reasonable walking distance—commonly between 400 and 1500 feet, depending upon local conditions of topography and natural cover—of a habitation campsite.

Roasting and Butchering Sites. When large animals like kangaroos and emus are taken at any distance beyond about a mile from a habitation campsite, the men who participated in the kill roast the animal and carry out a preliminary division of the meat at a site close to where the kill was made. As is the case generally with other types of aborigine sites, roasting and butchering sites follow a regular and highly predictable pattern. First a small trench is dug into a surface of clay or sandy soil. The trench is about 18 to 20 inches wide, about 10 to 12 inches deep, and varies in length according to the number of animals to be roasted. Trenches observed in this study ranged from 3 to 10 feet in length, with a single animal being roasted in the shortest one and three animals in the long one. Then armloads of firewood are gathered and placed over the trench, ignited, and allowed to burn down to coals. While the fire burns the kangaroo is singed, and, when the coals are ready, it is placed in the trench on its back and coals are raked over it. It remains in this earth-oven until the coals cool, at which time it is judged to be ready and is removed to a bed of mulga or eucalyptus boughs nearby, where the butchering and preliminary sharing of meat takes place. Figure 25 shows a

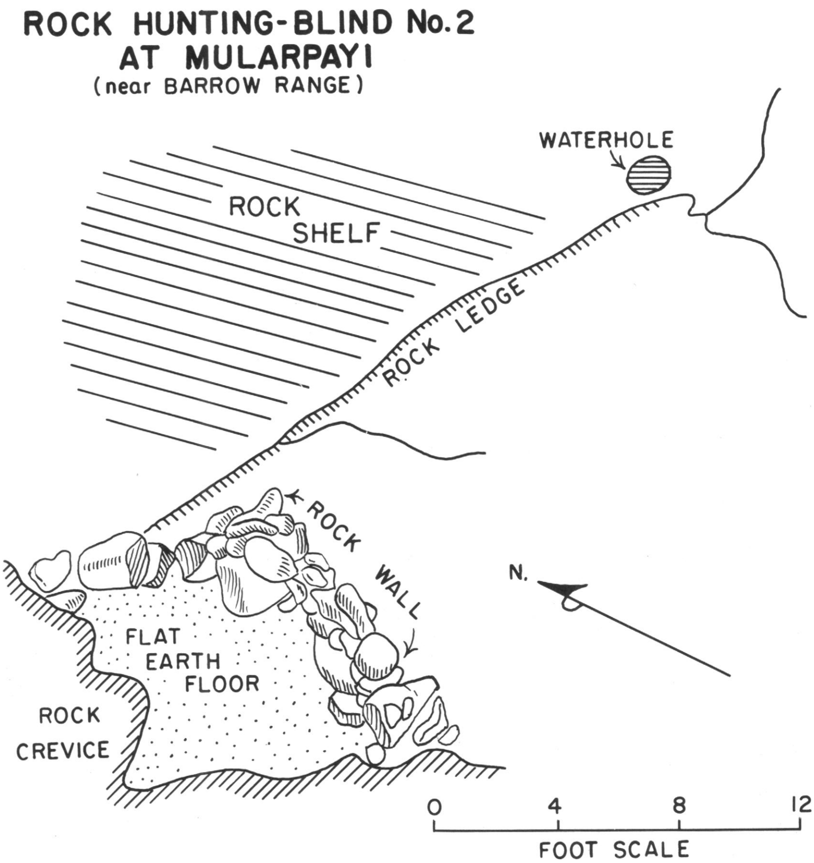


FIG. 23. Rock hunting-blind no. 2 at Mularpayi, near the Barrow Range.

large earth-oven with two kangaroos roasting in it.

In the absence of steel axes or knives, sharpened wooden wedges and large, unmodified stone pounders are used for the heavy butchering. The feet of kangaroos and euros are inedible and are left behind near the earth-oven along with the stone pounder and wooden wedges. While the men wait for the meat to cook they sometimes do a little repair work or sharpening on their spears, with the result that they may leave behind a few flakes and worn tools. But such activity is incidental to the main one of roasting and dividing the meat, and archaeologists are cautioned against inferring that all or most of these stone tools have anything to do with the butchering. Usually a single unmodified, hand-held flake serves to cut off the legs of the animal and to cut through the skin and tendons, and this is discarded immediately after use.

More roasting and butchering sites would be difficult if not impossible for an archaeologist to find, since they tend to occur in isolated areas far from habitation campsites and since the remains they contain are scanty and subject to destruction by erosion. Because each member of the hunt carries his share of meat back to the habitation campsite, few if any butchered bones are left behind at the roasting and butchering site. Instead, these appear in and around the camp of each hunt participant at the habitation campsite. At times, though, animals are taken close to the habitation campsite and are then roasted and divided there. Thus one can sometimes find the

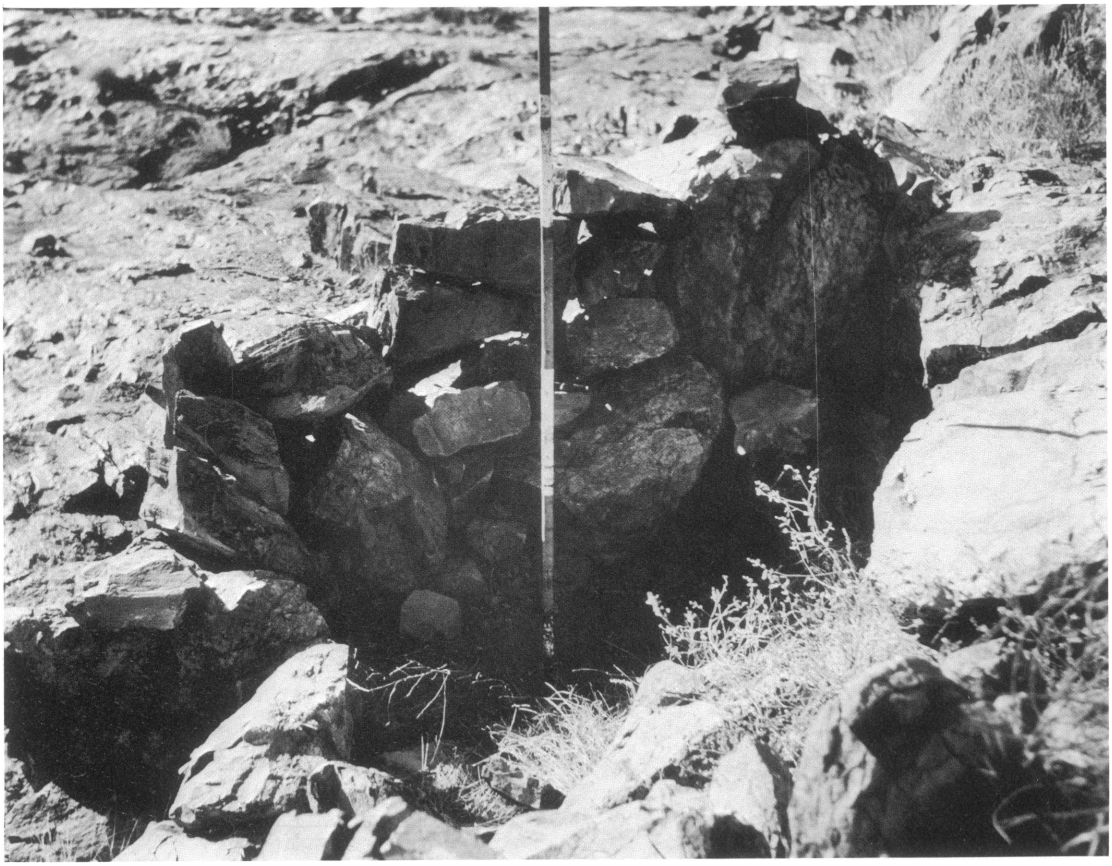


FIG. 24. Rock hunting-blind no. 2 at Mularpayi, near the Barrow Range.

distinctively elongated and deep hearths of earth-ovens within the confines of a habitation campsite.

Quarries. In many places in the Western Desert there are localized outcrops or exposures of chert, quartzite, and other lithic materials which can be used in making stone tools, and many of these are still visited by aborigines. Their occurrence and distribution over the landscape depends entirely upon the geology of the region and is rarely correlated with the occurrence of water-sources. This means that, with a few notable exceptions, quarry-sites are visited briefly and only for the purpose of obtaining the needed raw materials. In many parts of the desert, too, there are places where pebbles of quartz, agate, and other usable stones occur over extensive areas of ground surface, and these, too, may serve as sources of lithic material for stone toolmaking.

Chipping stations at large quarry-sites generally consist of nothing more than small, circular patches of ground swept of surface debris with occasional hammerstones lying nearby. These small clearings are mainly used when men are engaged in percussion-trimming flakes as opposed to the much heavier work of obtaining flakes by means of block-on-block percussion applied to the natural outcrops at the site. Thus most of the stone waste-flakes one finds around and on such clearings tend generally to be smaller than those found over the site as a whole. Stone flakes and cores trimmed in these places are then carried away to the nearest habitation campsite, where they are further worked as needed. Although the surface indications of chipping-stations at quarry sites are rather faint, they tend to be permanent and not highly subject to the effects of surface erosion. However, the need for usable lithic material is constant among the desert aborigines, and quarries are visited whenever men happen to be foraging in their vicinity rather than on a regular or seasonal basis.

Wood Extraction Sites. Dispersed widely throughout tracts of mulga there are large trees from which slabs of wood have been removed, to be fashioned into spearthrowers, throwing-sticks, and other implements. Under aboriginal conditions such a slab is removed by means of impromptu wooden wedges and one or more angular blocks of stone picked up nearby. The stones are used to make the initial V-shaped cut in the tree trunk and are used, additionally, to pound the wedges as the slab is pried away from the trunk. Sometimes the stones are unifacially sharpened by means of direct percussion-flaking. An unretouched stone chopper-pounder of the kind described here is illustrated in use by a Pitjantjatjara-speaking aborigine in Oakley, 1967, figure 1. When the wooden slab is removed and carried away to the habitation campsite for further shaping, the stone chopper-pounders and wooden wedges are abandoned, usually next to the base of the tree. Minimal, task-specific sites of this sort are common in areas of mulga scrub, resulting in the discard of large, unretouched and/or unifacially retouched stone implements over wide areas of the landscape, often far from habitation campsites.

Sacred Sites. Sacred sites are mentioned more for the sake of completeness than for any relevance they may have to the excavations at

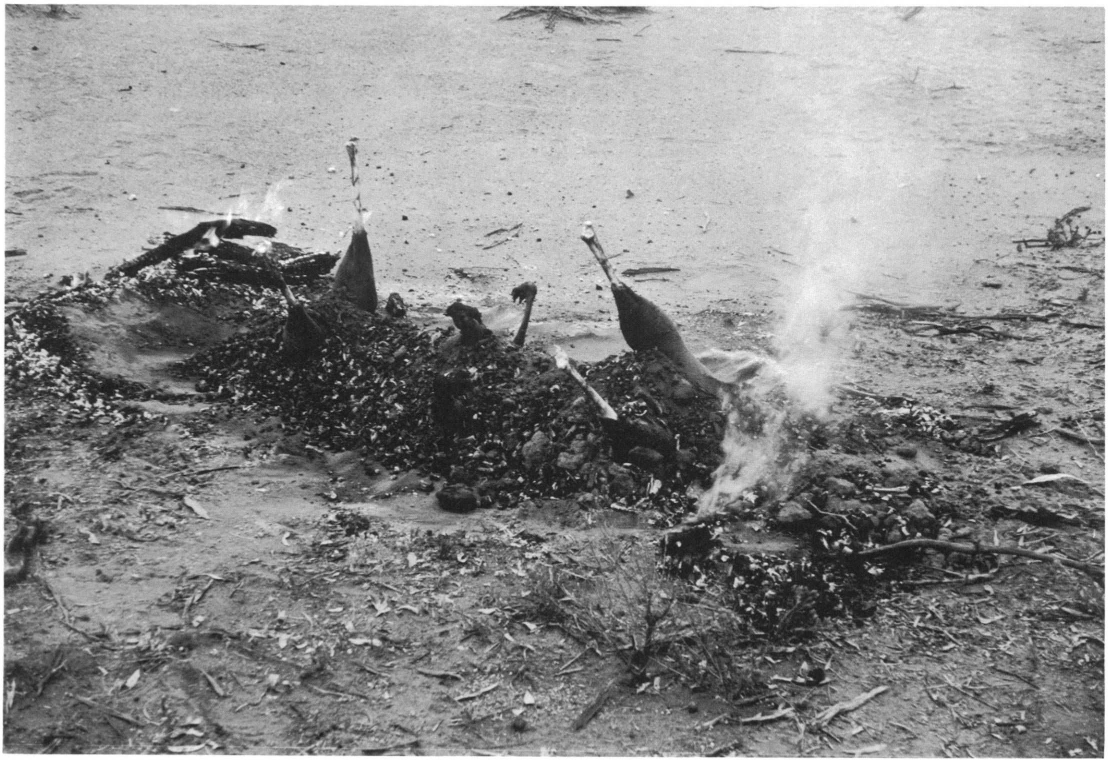


FIG. 25. Two kangaroos roasting in a large aborigine earth-oven.

FIG. 26. Small exposure of white chert, used as a quarry by aborigines, 15 miles southeast of Warburton Mission.

Puntutjarpa Rockshelter. This discussion is in general terms only owing to the politically sensitive nature of information relating to sacred sites at this time. Many sacred sites contain physical remains of a permanent nature, such as rock alignments, rockpiles, and art in the form of rock paintings and engravings, which an archaeologist would not have difficulty in recognizing. In most cases water-sources are also sacred sites, which means that in such cases one can expect to find a habitation campsite not too far away. Increase ceremonies are performed at these sacred sites or *in absentia* at ceremonies where novices are being initiated. Large-scale initiatory ceremonies tend to occur when maximal groupings are present, but they do not take place within the confines of the habitation campsite. Ceremonies of this kind occur far enough away from the main campsite to ensure that women and children are not able to observe the more secret parts of the ritual. Physical remains left at ceremonial grounds consist mainly of hearths and occasional pieces of red ochre and ochre-stained rock along with chipped stone flakes and tools used in woodworking tasks connected both with the manufacture of sacred paraphernalia and spears and other objects of daily use, both of which go on during ceremonial gatherings. In general ceremonial grounds (as contrasted with sacred sites) possess a low archaeological visibility and tend to be erased quickly by surface erosion.

PUNTUTJARPA ROCKSHELTER IN HISTORIC TIMES

Puntutjarpa Rockshelter today lies about 3 miles south of the Warburton Ranges Mission. It is not currently used as a habitation site by the aborigines living at Warburton but is visited often, mainly for the purpose of collecting wild figs which grow along the Brown Range escarpment and because there is a minor sacred site nearby. Sometimes, too, aborigines camp inside the cave during torrential rains. At the time the Mission was founded this site also served as a kind of game trap, in which animals, including kangaroos and wallabies, were chased over the edge of the escarpment by means of fires set along the south slopes of the Brown Range. Some hunters were positioned along the base of the escarpment with spears and clubs to finish off the injured animals, and roasting and preliminary butchering were carried out on the sandy slope immediately at the base of the escarpment. I am indebted to Mr. Harry Lupton, Projects Officer for the Native Welfare Dept. at the Warburton Ranges Mission in 1969 to 1970 and a member of the original surveying team for the Warburton Mission in 1934, for his firsthand description of these activities as he observed them then. These observations were substantiated by several accounts by aborigines originally from the Warburton Ranges area.

The named locality, Puntutjarpa, is a sacred site about 150 feet west of the rockshelter where the totemic goanna (Ngintaka, *Varanus giganteus*) dug into the ground to escape pursuers in the Dreamtime. Texts of this story were collected and published by United Aborigines Mission linguists Glass and Hackett (in Gould, 1968b, Appendix I, pp. 182-184). It should be pointed out that permission was obtained from the aborigine cult-lodge affiliated with this sacred tradition to explore and excavate at the site. I visited the site with a delegation of these men in

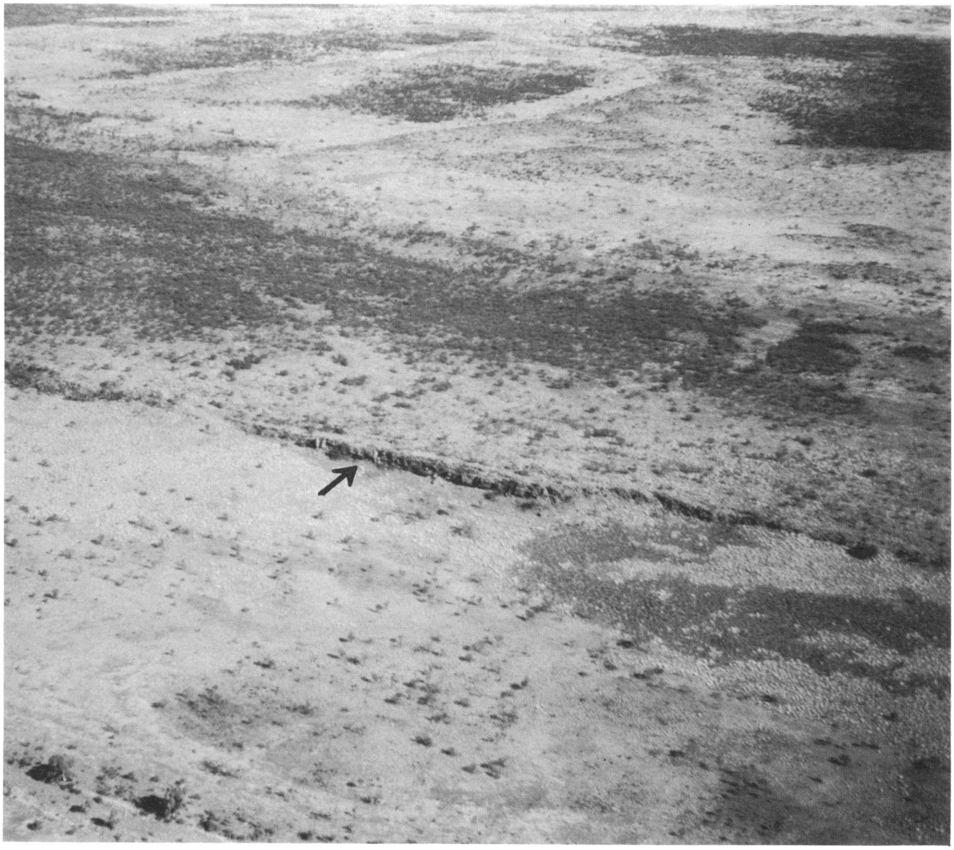


FIG. 27. Aerial view of Brown Range and Puntutjarpa Rockshelter (arrow), with Hughes Creek at lower left. View faces southeast.

1967, and it was established then that the area where excavations were planned had no sacred associations. Later, in the 1969-1970 season, these men were invited on other visits to the site both while excavations were in progress and afterward, to satisfy themselves that no sacred landmarks were being violated. This arrangement worked well, and other archaeologists planning to carry out excavations in the Western Desert where sacred associations may exist with particular sites are urged to consult with aborigines affiliated with such sites before embarking on any excavations.

III: EXCAVATION PROCEDURES AND STRATIFICATION AT PUNTUTJARPA ROCKSHELTER

LOGISTICS

In a critical review of my preliminary reports on the 1967 test-excavations at Puntutjarpa by Messrs. Glover and Lampert (1969) questions were raised about the advisability of making large-scale tests in archaeological sites. In my reply to this critique I defended the approach by pointing out that Puntutjarpa lies in such a remote part of Australia that one must be as certain as possible of the scientific value of a project in a place like this before embarking on the labor and expense of a major excavation. For example, one must have a strong case for doing such work in order to obtain a research grant large enough to carry out the excavations without compromising the quality of the research. Puntutjarpa Rockshelter and the Warburton Ranges Mission are approximately 370 miles northeast of Laverton, the nearest town, and about 450 miles northeast of Leonora, the nearest railhead and town of any size. The full-time field crew, from November 25, 1969, to January 24, 1970, consisted of seven individuals (not counting myself), with as many as seven additional workers on the site for several weeks at a time.

To maintain the project under these conditions, a research grant of $21,188.00 (U.S.), or $18,888.00 (Australian) was obtained from The Frederick G. Voss Anthropology and Archaeology Fund, at the American Museum of Natural History, which was found to be entirely adequate in covering the costs of the expedition. In order to be self-sufficient we had to operate two vehicles and make regular supply trips to Leonora. The test excavations of 1967 had enabled me to calculate with some precision the area and depth of the site and to estimate realistically how large a field crew would be needed and for how long. The work having now been carried out as planned, there is little doubt that this was the correct approach. The project accomplished its objectives without difficulty and by doing so proved that carefully controlled, stratigraphic archaeology can be done even in the most remote parts of the Australian desert.

PREPARATION OF THE SITE

Following the test excavations at Puntutjarpa in 1967, the main test trench (Trench 1) and test pits were filled in, and the surface of the site was inspected for any stone artifacts, flakes, or cores that might have been present. These were collected, and the site surface was then as clean as we could make it. Upon returning to the site 28 months later, the first step was to inspect the ground surface in and around the rockshelter as carefully as possible. One stone adze-slug, four retouched stone tools (probably hand-held scrapers), and 20 stone flakes of various sizes and types of raw material (all local in character) were found. It was noted, too, that several new designs had been added to the panel of rock paintings along the back of the cave since 1967. All of this evidence suggested that the site had been visited and perhaps even lived in briefly during the interval between our visits. Of course, some of these stone tools and flakes conceivably could have been lying just below the soil surface in 1967 and might have been exposed by wind action during the months that followed, but most showed clear signs of having been freshly chipped. If we can tentatively accept this small collection as a valid sample of materials deposited by aborigine visitors to the rockshelter between July, 1967, and October, 1969, then we can point to an average rate of deposition of stone tools during that period of just under one tool or flake per month.

As shown in figure 28 excavations were carried out in four main trenches. Trench 1 was excavated and refilled in 1967; trenches 2, 3, and 4 were excavated in 1969 to 1970. The three test pits indicated in figure 28 were all excavated in 1967. A grid of 3-foot squares was laid out and numbered according to the plan shown in figure 29. It should be noted that some squares were smaller than 3 by 3 feet, and that some were also shaped somewhat irregularly. Not all of these squares were actually excavated, since special problems arose during the excavations that called for extra labor and slow work. This grid system was set up in line with the grid for Trench 1, although it will be noted that the squares were smaller than the 5-foot squares of Trench 1. A transit level was set up at the north corner of square 41, Trench 2, where it remained throughout the excavations. This device enables the excavator to set up an imaginary plane above the ground surface. Using a standard surveyor's stadia rod (in this case marked in inches), the excavator measures the exact distance of the ground surface below this plane at each corner of every square (henceforth referred to as altitudes). Thus, for example, the north corner of square 12, Trench 2, lay at an altitude of 4 feet, 7 1/4 inches below the plane set by the site marker. As excavations in square 12 proceeded, depth control was maintained by taking successive readings with the stadia rod and transit level at successive depths below the original altitude of 4 feet, 7 1/4 inches. This technique accomplishes two objectives; 1. it measures in the irregularities of the original ground surface in terms of a fixed plane, and 2. it enables the excavator to maintain accurate control of depth below the original ground surface during excavation.

This technique is simple and more accurate than measuring depth by means of tape measures. At the same time, the transit level and other equipment are relatively inexpensive and rugged. One possible source of error in using this approach is that the transit level may, during the course of the excavation, shift its position. For example, the tripod may sink into the sand or tilt away from its original plane. To anticipate this problem, marks were made at several points along the face of the escarpment where it met the plane set up by the transit level after it was initially leveled and placed in position. Each day, before beginning work at the site, the transit level was rotated to see if it was level and lined up with the marks on the cliff face. If not, adjustments were made, although in fact few were needed.

All excavated materials were put through 1/4-inch mesh sifter-screens. There were three such screens, although only two were operating during most of the excavation period. Figure 30 shows the layout of the site, with one sifter-

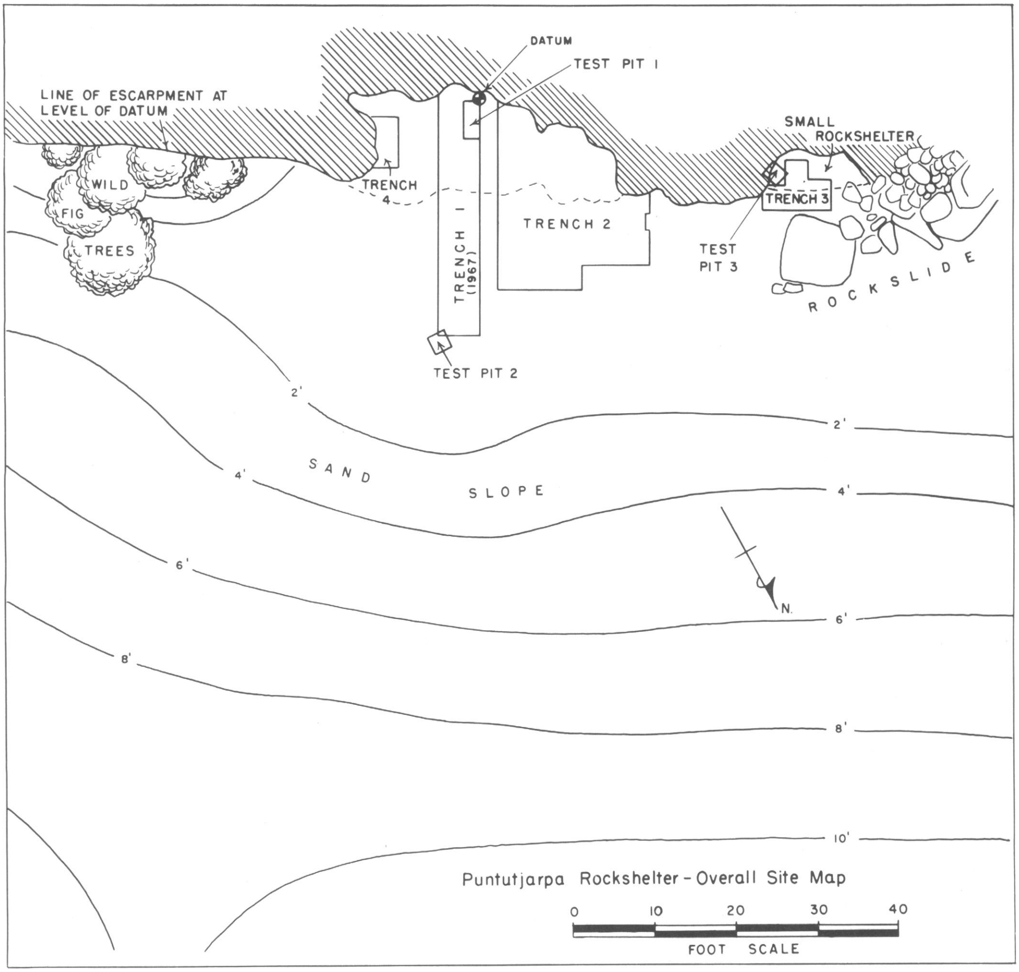


FIG. 28. Puntutjarpa Rockshelter, overall site map.

screen and the site marker set up in the foreground. The sifter-screens were suspended on ropes attached to the cliff face above. Mountaineering hardware proved useful both for securing the ropes firmly in the rock (rock pitons were used for this) and for connecting the main rope with those holding the screen itself (here a carabinier hook works best, since it can be adjusted without the necessity of retying the entire rope when it stretches or otherwise slips out of position). Plastic buckets were used to transport the excavated soil to the sifter-screens.

In laying out the grid system at the site, wooden pegs were used to set the strings, and problems were encountered with these pegs in the sandy soils. The pegs were offset from the sides of the trenches by 1 foot, but later experience showed that an offset of 2 feet would have worked better. As it was, the pegs had a way of loosening the sandy soils around them enough to cause small collapses near the tops of some sidewalls. Some of these collapses may have happened anyway, given the general looseness of the soils at the site, but in retrospect it looks as if setting the pegs farther back from the trench walls would have helped. Since these collapses in most cases occurred after the particular squares involved had been excavated and the particular sidewalls were drawn and photographed, they did not interfere with record-keeping during the excavations.

EXCAVATING PROCEDURES

Squares 1 through 18 in Trench 2 were all excavated by a combination of 3-inch arbitrary levels and natural levels, whereas squares 19′ through 25 and squares 42 through 48 in Trench 2, squares 49 through 51 and square 55 in Trench 3, and squares 52 through 54 in Trench 4 were all excavated by a combination of 6 inch arbitrary and natural levels. Square 23 in Trench 2 was not excavated owing to the presence of a boulder which was too large to move or break up in place. Squares 27 and 28 in Trench 2 were the scene of some difficult boulder removals, and no careful levels could be maintained there. The soils taken from these squares were screened, and the artifacts obtained were turned over to the Department of Anthropology, University of Western Australia, as a study collection. Squares 30 through 41 in Trench 2 were not excavated or disturbed in any way. These deposits, plus the deposits lying farther out on the sand slope to the north and northeast of Trench 2 as well as deposits inside the cave to the east of Trench 1 were left intact with the idea that excavators might want to do further work at Puntutjarpa in the future.

All excavating was done with trowels and brushes except when dense layers of rockfall were met and had to be removed. Several alternative methods for removing rockfall were considered, including the use of screw jacks with block-and-tackle. This latter was considered to be too dangerous, so it was decided to use sledge hammers and crowbars to break the rocks up in place and remove the rubble with shovels and buckets. Because Townshend quartzite has well defined fracture-planes, this approach worked well and with a minimum disturbance to surrounding soils. Most boulders came apart easily

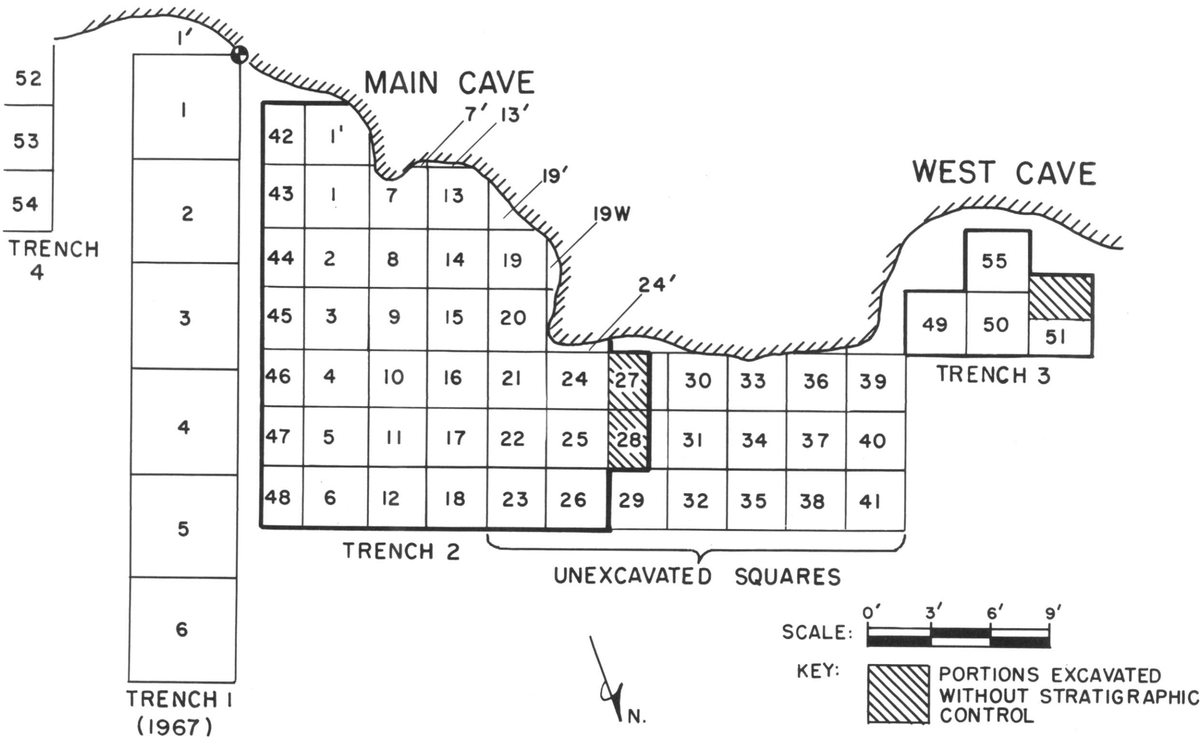


FIG. 29. Puntutjarpa grid plan.

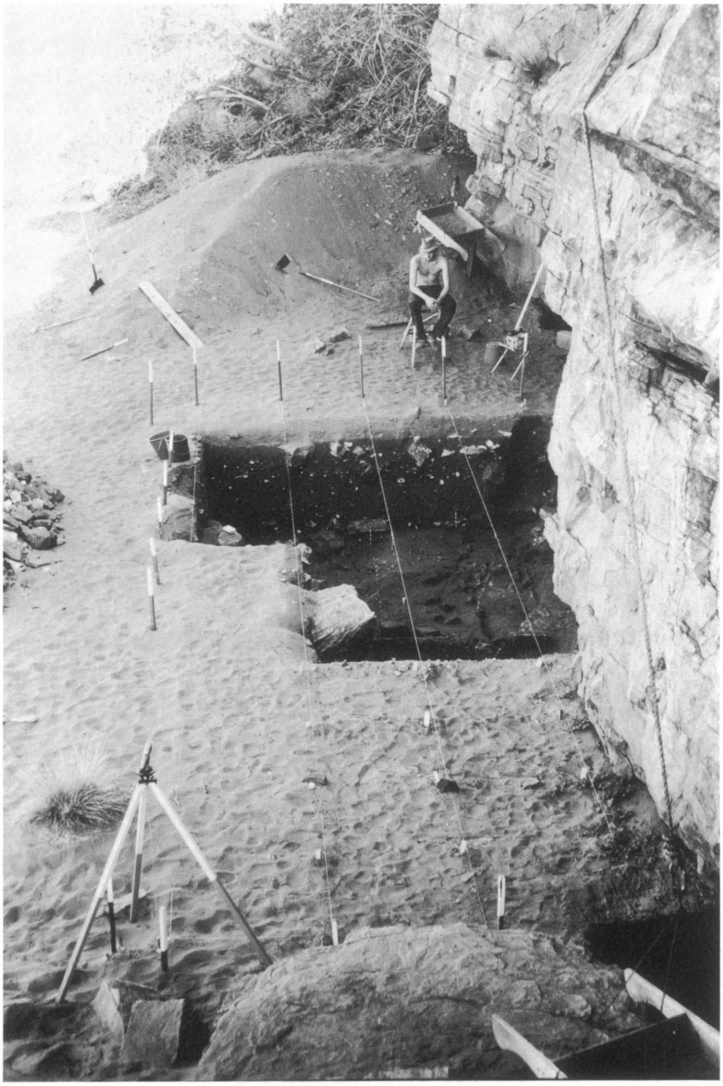


FIG. 30. Excavation layout at Puntutjarpa Rockshelter. Trench 3 lies in right foreground; Trench 2 is in center; and the corner of Trench 4 shows to right of seated figure.

in a "platelike" fashion and could be removed in bits. Each boulder of any size was measured horizontally and vertically before removal, and the recording and removal of rockfall layers at Puntutjarpa constituted the single most time-consuming operation of the entire excavation project.

There were two hazards to avoid during excavations; 1. the ever present danger of large boulders slumping out of position and falling into the trenches, and 2. the numerous scorpions within the deposits. Great care was taken at all times to avoid letting any protruding boulders become overbalanced (this, incidentally, was why square 23 was not excavated), but despite these precautions there was one near-miss when a rock fell in alongside an excavator. No one was actually stung by a scorpion, but there were several close calls, and all excavators were required to wear footgear and gloves when working in the trenches.

THE FIELD LABORATORY

A laboratory tent was set up at the base camp, about 3 miles from the site, and one, sometimes two, excavators were assigned on a rotation basis to work in the laboratory. Thus work in the laboratory proceeded simultaneously with the excavations. This work included cleaning and field-cataloguing of all excavated specimens, and by the end of the field season 13,801 entries had been made in the field catalogue. After cleaning and cataloguing, all materials were repacked into sacks labeled with the correct provenience.

Another duty performed by the field laboratory was the flotation processing of carbonized seed and vegetal remains from the excavated levels of the site in Trench 2, squares 1 through 18, following the approach suggested by Streuver (1968, pp. 353-361). Two gallons of sifted soil from each arbitrary and/or natural level within each of these squares were transported from the site to the laboratory, where they were placed in tubs of fresh water and the carbonized material skimmed off, dried, labeled, and placed in containers. Finally, the laboratory was also used for pH-testing of excavated soils from all arbitrary and/or natural levels in Trench 2, squares 1 through 18. These tests were conducted with a simple field pH meter (of a type commonly used in agricultural soil surveys) with an accuracy to within one-half of a pH number. A discussion of the pH-testing results appears in a separate chapter.

EXCAVATED SOIL AND ROCKFALL UNITS AT THE MAIN CAVE, PUNTUTJARPA

Vertical profiles and horizontal features such as living surfaces were drawn and mapped in detail. The Trench 2 profile (fig. 31) shows the soil units encountered during excavation. A brief description of these was provided in an earlier published report (Gould, 1971, pp. 148-151), so what follows is a more detailed description of these soil features and their relationships to each other.

Feature 2 Soil Unit. This was the uppermost soil layer at the site. It occurred over a large area of Trench 2 but was generally absent at the rear of the cave and on the sand slope to the north of Trench 2. Feature 2 consisted of a characteristically thin layer of dark, ashy soil with some stone flakes and tools as well as some pieces of butchered bones. It also contained some recent, historic artifacts, such as a plastic pen, a small flashbulb, tin can lid, etc. A shallow layer of this soil unit is shown in the figure 31 profile drawing at the surface of squares 16 and 17. It contrasted sharply in color and texture with the underlying unit of Feature 3 soil. Feature 2, in fact, was a thin remnant of backdirt left over from the 1967 excavations in nearby Trench 1. The artifacts it contained represented a mixture of items from different levels in that excavation and rubbish left at the site then and from later visits. During excavation, Feature 2 was carefully separated from the underlying Feature 3 soil to avoid any possibility of mixing of materials between these two soil layers.

Feature 3 Soil Unit. This was a unit of red, sandy soil representing the natural surface over most of Trench 2. In terms of color and texture it was almost indistinguishable from the modern desert sands that make up the sand slope to the north of the site, and, indeed, it is continuous with that sand slope. However, Feature 3 contained some stone artifacts and pieces of butchered bone, and was also noted to contain an elongated hearth in Trench 1, square 6, in the 1967 excavations. Like the sand slope to the north, this soil was grainy in texture and loose in consistency (giving rise to some of the small sidewall collapses mentioned earlier). In the 1967 excavations this unit was seen to merge with the underlying Feature 4 soil, but in Trench 2 the line of separation between Features 3 and 4 was more definite. Whereas in the 1967 excavation the profile drawings showed this color and texture separation in an approximate manner (Gould, 1968, pp. 164-165), in Trench 2 the line of separation appeared exactly as shown in the figure 31 profile.

It is easiest to interpret Feature 3 as a unit of wind-deposited sand mixed with a thin scatter of

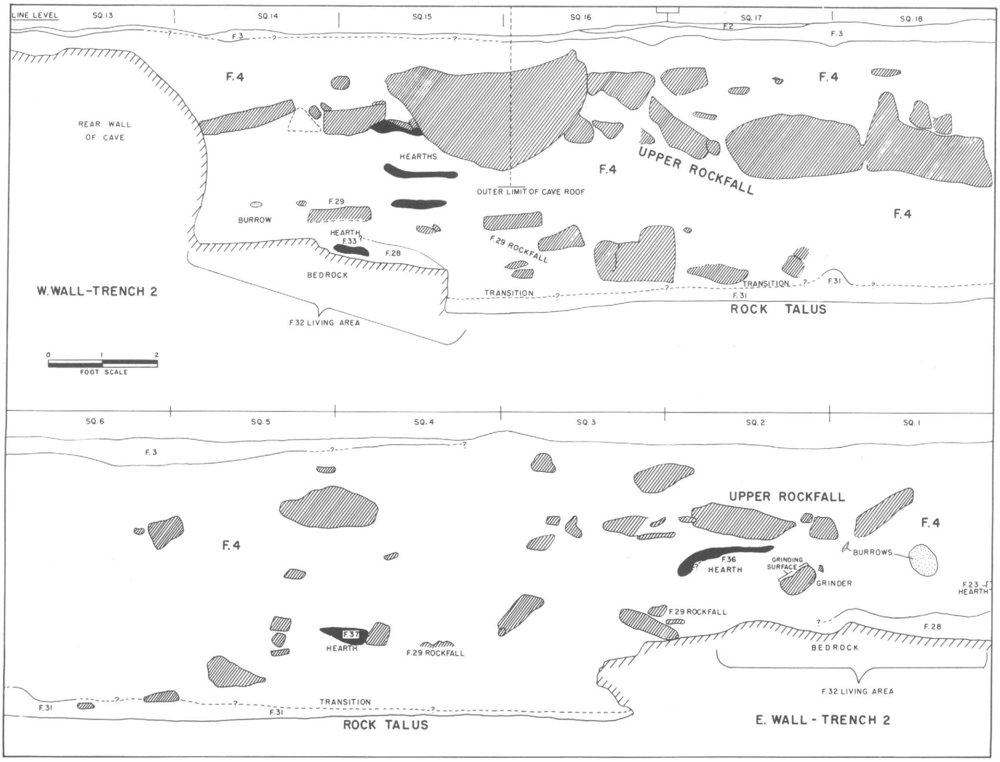


FIG. 31. Vertical profile, Trench 2, Puntutjarpa.

cultural debris. From observing the site during periods of high wind it seems clear that these desert sands are unstable and that deposition of this layer could have occurred quite rapidly, possibly within the space of a few days or even hours. Moreover, eddies from easterly winds along the Brown Range escarpment sometimes started small whirlwinds ("willy-willies") which entered the front of the cave and caused some surface stirring. Such scouring action by wind might also explain the apparent disconformity between the Feature 3 and 4 soils in Trench 2. The clear character of this soil separation made it relatively easy for the excavators to segregate artifacts and other cultural remains by natural levels within the 3-inch arbitrary levels that served as the primary units of excavation.

Feature 4 Soil Unit. This was a dark and relatively homogeneous soil that accounted for most of the fill in the excavated portions of the site apart from Trench 3 in the West Cave. It showed little or no internal stratification but was rich in stone tools, waste flakes and cores, ochre, and faunal remains. The soil tended to be ashy, ranging in color from a brown to brown-black. As noted earlier (Gould, 1969, pp. 235-236) there is evidence suggesting that a certain amount of natural sorting has occurred at the site, resulting in the presence of finer particles of soil near the rear wall of the rockshelter and relatively coarser particles near the entrance and in front of the cave. This observation was applied initially on data gathered in Trench 1 in 1967, but the same general pattern appears in the Feature 4 fill of Trench 2. This pattern of natural sorting was probably due to wind action, with finer and lighter particles being carried to the back of the relatively windless interior of the cave while the heavier particles were deposited out nearer to the cave entrance where there was more movement of wind. It will be noted that in the figure 31 profile drawing of Trench 2 the Feature 3 unit (consisting entirely of relatively heavy desert sands) tends to peter out near the back of the cave, probably for the same reason. Such natural sorting of heavy and light particles of soils suggests that wind was also the principal agent of deposition for the Feature 4 soils. Moreover, if ancient patterns of wind deposition were anything like those of today, there is no reason to expect soil deposition at Puntutjarpa to have proceeded at a uniform rate (although gross averages along the lines suggested by Glover and Lampert [1969, pp. 227-228] may be possible).

Several animal burrows and/or root holes were recognized within Feature 4, but aside from these the unit appeared to be generally undisturbed. The principal lines of evidence suggesting this were; a. the presence of numerous intact hearths within the deposit (11 within Trench 2, not to mention others found in Trench 1 in 1967), b. the presence of intact and recognizable living surfaces (i.e., ancient campsites), and c. the presence of two rockfall layers, each resting in its original position after falling. Present, too, within the Feature 4 unit were several concentrations of ash and/or charcoal. Owing to a lack of definition, these were not treated as hearths, although they may have been hearths originally. It may be that on certain occasions individual hearths were stirred by human or natural activity until their outlines were obscured, and such stirring may have given rise to the generally ashy quality and dark color of the Feature 4 unit as a whole.

The Upper Rockfall Layer. This rockfall layer was first discovered in Trench 1 and was later found to cover most of the interior of the main rockshelter. As shown in the figure 31 profile drawing, it consisted largely of massive boulders of Townshend quartzite. The sections in the cave roof from which these boulders fell are still

FIG. 32. Trench 2, showing portions of Upper and Lower Rockfall layers.

clearly visible and can be aligned horizontally with the positions of the boulders in the ground. The massive size and continuous distribution of this rockfall layer within the cave suggested in 1967 that the soil layers beneath would show a minimum of natural or cultural disturbance, and the presence of this rockfall layer was cited as an important reason for selecting this site as a place for further work (Gould, 1968, p. 165). To return to a point mentioned earlier in this chapter, no small test pit of the kind suggested by Glover and Lampert would have revealed the nature and extent of this rockfall layer. Trench 1, however, provided a clear picture of this feature and showed its importance in protecting the layers beneath, thus furnishing guidelines for the 1969-1970 excavations.

During excavations of the Upper Rockfall, it was noted that there were definite soil layers within parts of it. In terms of lateral area these were not especially large, but they indicated that this rockfall could not have been a single event but was the result of at least two, probably even three, distinct falls of rock slabs from the cave ceiling.

A glance at the figure 31 profile drawing of Trench 2 shows that there is a slight but noticeable dip downward from S to N on a line along the bottoms of the rocks. The depth of the bottom of each rock shown in the profiles was plotted with the transit level, and these readings showed that the rocks at the N end of Trench 2 were 12 1/2 inches lower than those at the S end, with the dip taking the form of a broad but continuous convex curve. It will be noted that the bottom of the massive boulder shown astride the junction of squares 15 and 16 in the profile of the west wall of Trench 2 projects downward about 8 to 10 inches below the line formed by the bases of the other rocks in the Upper Rockfall. This is an anomalous case caused no doubt by the great weight of this particular rock (it is the largest one shown in the profile) and its V-shaped bottom, both factors that would have allowed deeper penetration into the soil when it fell. Similar plots were taken along an E-W axis, but no tilt or dip of any kind was revealed. It appears that the rocks in the Upper Rockfall fell upon a soil surface that sloped downward out of the cave at a slightly steeper angle than the present-day soil surface. The difference between these two surfaces can be accounted for by the disproportionate filling action occasioned by the massiveness of many of the rocks in the Upper Rockfall. Thus the Upper Rockfall not only acted as a seal to minimize later disturbances to the underlying soil levels, but it also provided clues that enabled the excavators to trace the slope of the original soil surface at the site. In the lithic and faunal analyses appropriate adjustments are being made for the levels below the Upper Rockfall to ensure that these materials are considered in terms of depths below the original surface rather than the present-day surface.

The Lower Rockfall Layer. The Lower Rockfall, in contrast to the other, clearly fell as a single unit and was found over a considerably smaller area of the site. No trace of it was found in Trench 1 in 1967. Trench 2 was excavated in such a way as to reveal the entire extent of the Lower Rockfall, which was cleared and mapped *in situ* and appears in the Trench 2 plan (fig. 33). The rocks in the Lower Rockfall were small when compared with those of the Upper Rockfall, and they do not seem to have caused any significant displacement of the soil above. Note that in profile the Lower Rockfall shows the same dip as occurs along the bottom of the Upper Rockfall rocks.

The rear portion of the main cave had a roughly level rock floor that ended abruptly as a kind of "step" of about 8 to 10 inches down to a hard rock-talus that formed the bottom for the rest of the excavated portion of the site. The same steplike configuration for the cave floor was observed in Trench 1, and as the site filled it was this that gave rise initially to the dipping slope of the surface noted above.

Feature 41 Soil Unit. Feature 41 was a unit of extremely hard, light gray soil occurring as a thin layer at depths of 42 to 48 inches in Squares 20 and 21 within the Feature 4 soil in Trench 2. This soil unit was almost totally sterile of artifact and faunal materials and was limited in extent to the area that was free of rocks from the Lower Rockfall near the rear of the cave. Further notes on this feature are presented in the chapter dealing with these rock-free areas.

Feature 31 Soil Unit. More Feature 4 fill was found below the Lower Rockfall along with one large and clearly defined hearth and an abundance of cultural materials. In the rear of the cave Feature 4 fill continued down to the cave floor, but in the small dips and interstices of the rock floor a sterile red sand (similar in color and texture to Feature 3) was encountered. This was labeled as Feature 31, and it is interpreted as the original soil surface of the site upon which the first inhabitants of Puntutjarpa settled. Farther out, toward the front of the cave (i.e., below the "step") the Feature 31 zone was thicker—in some cases as much as 6 to 7 inches—and tended in some places to intergrade with the Feature 4 soil above. It was sterile of cultural materials near the bottom. This lowest layer of sterile or near-sterile reddish sand was also encountered in Trench 1.

This same basic sequence of soil and rockfall units appeared in Trench 1 and in Trench 3, with the major difference being that in neither of these two trenches did any trace of the Lower Rockfall unit occur. Trench 3, lying toward the rear of the Main Cave, showed little Feature 3 soil on top. The fill here was almost entirely Feature 4, as was the case of the fill in Trench 1 near the back of the cave.

RADIOCARBON DATES FROM THE MAIN CAVE, PUNTUTJARPA

Eight radiocarbon dates were obtained from the excavated fill inside the Main Cave at Puntutjarpa. All were processed by Isotopes, Inc. of Westwood, New Jersey, and the first series was reported by Buckley and Willis (1969, p. 87). Four of these samples were collected in Trench 1 in 1967, whereas the other four were collected in Trench 2 in 1969-1970. These radiocarbon dates and their archaeological associations are summarized in table 4. These dates have not been corrected according to the scale proposed by Ralph, Michael, and Han (1973).

One of these dates, no. I-3389, is discrepant and cannot be reconciled with the rest of the radiocarbon dates from the Main Cave. At first there seemed to be a way to reconcile it with the others, but I now agree with Glover and Lampert (1969, p. 227) that this reversal was probably

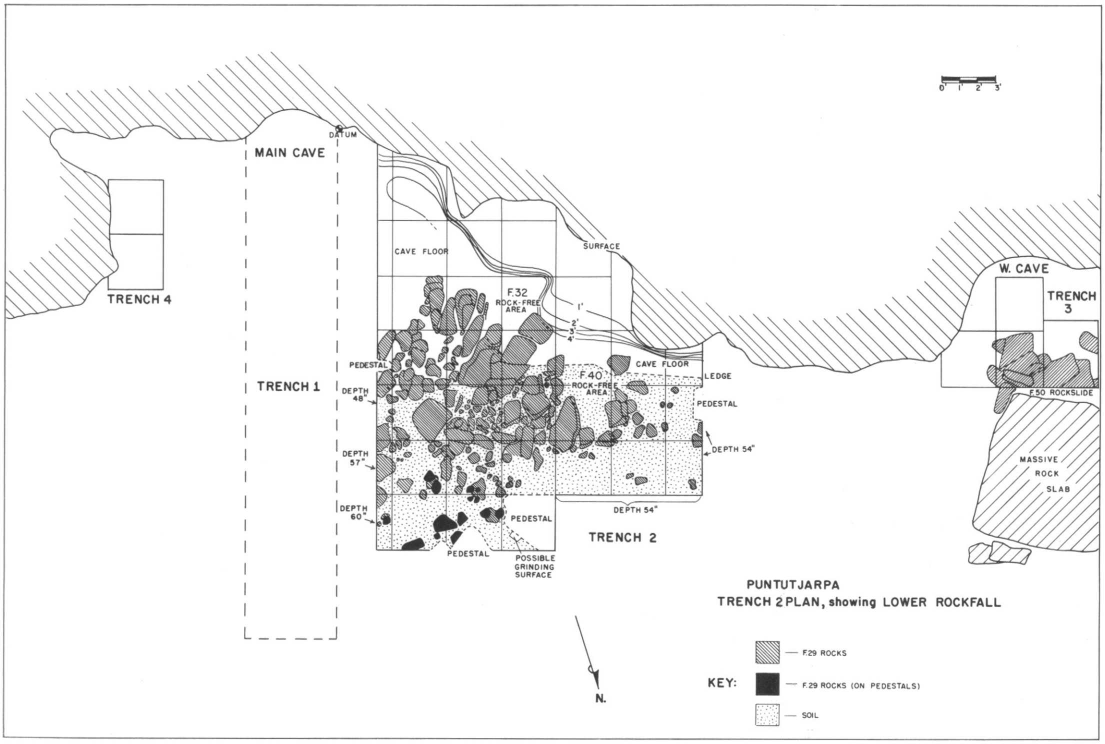


FIG. 33. Trench 2 plan showing Lower Rockfall, Puntutjarpa.

TABLE 4
Summary of Radiocarbon Dates from Puntutjarpa Rockshelter

Lab No. Teledyne Isotopes	Zone	Stratum	Association	Age in Years B.P.	Date
I-3386	A	AX-BX	Trench 1, Sq. 6, F.3 soil, depth 4-6″	<185	–
I-5320	A	FX-GX	Trench 2, Sq. 11, F.4 soil, depth 17-19″	435±90	1515 A.D.
I-5321	–	–	Trench 3, Sq. 49, F.42 soil, depth 11-15″	3,840±105	1890 B.C.
I-5475	B	M5	Trench 2, Sq. 11, F.4 soil, depth 30-34½″	6,710±125	4760 B.C.
I-3387	B	M5	Trench 1, Sq. 3, F.4 soil, depth 28-30″	6,740±120	4790 B.C.
I-5476	B	P5-Q5	Trench 2, Sq. 46, F.4 soil, depth 41-44″	4,010±105	2060 B.C.
I-3388	B	Q5-R5	Trench 1, Sq. 3, F.4 soil, depth 40-43″	6,590±140	4640 B.C.
I-5319	C	T5	Trench 2, Sq. 14, F.4 soil, depth 46-48″	10,170±230	8220 B.C.
I-3389 (This sample was probably contaminated)	C	T5	Trench 1, Sq. 5, F.31 soil, depth 60-62″	3,810±160	1860 B.C.

due to sample contamination of an unknown nature. The reversal of dates in the case of samples nos. I-3387 and I-3388 is less serious, since both samples occur within the same natural unit and are separated stratigraphically by only 10 inches of fill and chronologically by only about 150 years. Considering the normal tolerances for accuracy of radiocarbon dates of this antiquity in general plus the fact that there has been stirring of fill within each natural level caused by wind and reuse of the cave by the inhabitants, these dates can be taken as providing a general indication of the age of the middle levels of the Feature 4 soil unit at depths between 28 and 43 inches in line with square 3 in Trench 2. The same situation seems to apply to the reversal of dates in the case of samples nos. I-5475 and I-5476. Here the chronological separation is much greater (about 2700 years), although the stratigraphic separation is less (about 7 inches). Here, too, both samples occur within the same natural level. Given the results of these dating samples, it would be unwise to treat the 3-inch arbitrary units at the site as indicators of exact contemporaneity.

SUMMARY OF STRATIGRAPHIC RELATIONSHIPS OF NATURAL FEATURES IN THE MAIN CAVE

In order to compensate for the differences between the more or less level soil layers lying above the Upper Rockfall and the tilting soil layers below the Upper Rockfall, a strata code keyed to the diagram shown in figure 31 was developed. The diagram in figure 34 is a schematic profile of Trench 2 based upon arbitrary 3-inch levels as related to stratigraphy described above. Note the shift that occurs between the depths of 21 to 24 inches (Stratum HX) and 24 to 27 inches (Stratum M5). Strata IZ through LZ indicate those levels and squares where the Upper Rockfall was most massive (i.e., where the greatest displacement of fill at the site occurred). No attempt has been made in this diagram to show the relation of the natural soil units to the arbitrary 3-inch levels, but these relationships are covered by an additional code.

For purposes of analysis, the Trench 2 profile has been divided into three zones; *Zone A* (Strata AX-LZ), consisting of soils lying in and above the Upper Rockfall, *Zone B* (Strata M5-R5), consisting of soils lying between the rockfall layers, and *Zone C* (Strata S5-X5), consisting of soils lying below the Lower Rockfall layer down to bedrock. These zones are intended to correlate with the actual occurrences of the two main rockfalls, both of which appear as major events in the stratigraphic sequence. Later it will be possible to observe patterning of archaeological features and artifact materials not only in terms of natural and arbitrary levels but also in terms of these rockfall events. In this scheme, Stratum M5 may be regarded as approximately representing the old ground surface upon which the first major fall of Upper Rockfall rock occurred, and Stratum S5 represents the old ground surface upon which the Lower Rockfall came to rest.

Arbitrary levels employed in these excavations are seen as useful in providing a framework for

DEPTHS	SQ. 1, 7,+13	SQ.2, 8,+14	SQ.3, 9,+15	SQ.4, 10,+16	SQ. 5, 11,+17	SQ.6, 12,+18	STRATA
0"-3"							AX
3"-6"							BX
6"-9"							CX
9"-12"							DX
12"-15"							EX
15"-18"							FX
18"-21"							GX
21"-24"							HX
24"-27"	M5	M5	IZ	IZ	IZ	IZ	IZ
27"-30"	N5	N5	M5	JZ	JZ	JZ	JZ
30"-33"	O5	O5	N5	M5	KZ	KZ	KZ
33"-36"	P5	P5	O5	N5	M5	LZ	LZ
36"-39"	Q5	Q5	P5	O5	N5	M5	M5
39"-42"	R5	R5	Q5	P5	O5	N5	N5
42"-45"	S5	S5	R5	Q5	P5	O5	O5
45"-48"	T5	T5	S5	R5	Q5	P5	P5
48"-51"	U5	U5	T5	S5	R5	Q5	Q5
51"-54"			U5	T5	S5	R5	R5
54"-57"			V5	U5	T5	S5	S5
57"-60"			X5	V5	U5	T5	T5

ZONE A = STRATA AX- LZ
ZONE B = STRATA M5-R5
ZONE C = STRATA S5- X5

////// – ZONE OF DENSE ROCKFALL

FIG. 34. Schematic and coded profile of Trench 2, Puntutjarpa.

observing cultural changes within a natural level, especially when that level is thick and appears to have been laid down over a long period of time as is the case with Feature 4. But these arbitrary levels are not intended to represent ancient living surfaces or units of exact contemporaneity. Wind action plus stirring of soil caused by repeated reuse of the cave by its former inhabitants are assumed to have acted as disturbing factors throughout the entire sequence of human occupation at Puntutjarpa, although not always with equal intensity. Thus the arbitrary levels used in these excavations serve as a framework for observing varying frequencies of tool-types, debitage, quarry-types (i.e., types of lithic material from various quarry sources), and faunal remains. That is, they represent contemporaneity as a statistical proposition. In soils as soft as those encountered at Puntutjarpa it would be unrealistic to argue that artifacts and faunal remains once deposited always remained vertically within 3 inches of their original position, but neither should one expect a random vertical distribution of deposited cultural materials within each natural level.

In summary, it appears that all soils at Puntutjarpa were wind-deposited. Much of the site-fill, however, consists of large rockfall layers, so any consideration of the natural stratigraphy at the site must include a consideration of both soils and rockfall units. Mention should be made of the occurrence of some small pebbles (less than 1/2 inch in diameter) many of them waterworn, in the soils at every level immediately below the drip-line near the cave entrance. By volume, these do not constitute a significant part of the cave fill, but they indicate that on certain occasions, probably during and after heavy rains, water cascaded in rivulets over the escarpment and transported small amounts of gravel and pebbles onto part of the site surface. This fact, however, does not alter the basic judgment that the soils here were mainly wind-deposited.

The first people to arrive at the site around 10,000 years ago found a rockshelter with a ceiling as much as 2 to 3 feet lower than at present but with only a few inches of sterile desert sand covering the rock floor and rock talus on the bottom. In terms of headroom, the roof of the cave was somewhat higher relative to the floor than it is today. In terms of floor area, however, the level surface area inside the cave today is slightly greater than it was then owing to the inward and downward curvatures of the rock along the back wall of the cave. With regard to shade and protection from the prevailing winds, this rockshelter is currently the most ideal location in terms of human comfort anywhere in the Warburton Ranges-Brown Range region. During the 1967 test excavations and again in the 1969-1970 field season, both carried out during the peak of the Australian desert summer, the back of the cave was found to be in shade from about midmorning throughout the rest of the day, with shade moving progressively farther out from the back of the cave and the escarpment generally as the day advanced. This, of course, meant that direct sunlight penetrated only during the cooler morning hours, with the best shade occurring during the hot midafternoon period. Also, except for certain strong easterly or northeasterly winds referred to earlier, the interior of the rockshelter was completely calm. From the field crew's point of view, this was a comfortable site to excavate despite general heat, wind, and dust on the flats below. No doubt these factors of shade and protection from the wind made the site attractive to the ancient inhabitants as well.

This initial period of occupation, corresponding to Zone C, was interrupted by the Lower Rockfall, which covered the relatively thin layer of Feature 4 and mixed Feature 41 and 31 soils that had accumulated by that time. Radiocarbon sample no. I-5319 was obtained from a well-defined hearth that underlay some of the largest rocks in the Lower Rockfall layer, so it can be inferred that this collapse occurred sometime after 8220 B.C. but before the 4640-4790 B.C. dates obtained for hearths in Feature 4 fill above the Lower Rockfall. Since the Lower Rockfall lies stratigraphically close to the earlier date, it can be suggested that the actual date of this rockfall event was on the early side of this range, perhaps occurring around 7000 B.C.

Despite this interruption, the Main Cave continued to be visited and inhabited by its former occupants and their descendants. Indeed, this seems to have marked the beginning of a period of intensive use of the cave, as shown by evidence in succeeding chapters. This intensive use of the Main Cave, with its accumulation of Feature 4 soil containing a rich array of stone tools, debitage, faunal materials, and hearths continued without apparent interruption until the first major fall of the Upper Rockfall. Owing to the reversals in the radiocarbon dates from the Feature 4 soil unit between the rockfall layers, no certain date can be offered for this event. My best estimate is that the first phase of this Upper Rockfall occurred around 4000 years ago, but this is based on admittedly subjective grounds and may be subject to later modification. Whatever the date may be for this event, it marked the end of the sloping surface of the cave floor that had prevailed since the Main Cave had first formed and begun to fill. One might even wish to argue for a hiatus in the human occupation of the site at this point, since the radiocarbon dating for this stratigraphic level (i.e., the interface between the top of the soil surface when the Upper Rockfall came down and the bottom of the Upper Rockfall) is ambiguous at best. Although this possibility exists, it is not strongly supported by the analysis of cultural materials from these levels, to be discussed in a later chapter. Sand blew in and covered portions of this rockfall, which were in turn covered again by more rockfall, and it is apparent that human occupation of the cave went on throughout this time. These soil layers found sandwiched between layers of rockfall all had become dark Feature 4 soil containing large amounts of artifact and faunal material. One of these soil layers contained the Feature 7 living surface (part of which was overlain by rocks from what was probably the last phase of the Upper Rockfall). Radiocarbon sample no. I-5320 from the hearth within this living surface gave a date of approximately 435 years ago. Thus the various phases of the Upper Rockfall seem to have occurred over a period of at least 3600 years.

Filling subsequent to the last phase of the Upper Rockfall shows every sign of having been rapid and subject to wind action and cultural disturbances. The sharp line of separation between the top of the Feature 4 soil unit and the bottom of Feature 3 argues for a period of intense wind erosion which scoured the surface of Feature 4 before depositing the Feature 3 sand. The recent nature of the Feature 3 soil unit is confirmed not only stratigraphically but also by the recent date for radiocarbon sample no. I-3386, which probably lies within the post European-contact period for this region.

STRATIGRAPHY OF THE WEST CAVE

Eighteen feet to the west of the west edge of the Main Cave at Puntutjarpa lies another, smaller cave here designated as the West Cave (see also the site plan in fig. 33). The soil units and stratigraphy of Trench 3, within this cave, are strikingly different from those encountered in the Main Cave and call for a separate description. On the west side of this cave the excavators encountered a massive rockslide, designated as Feature 50, which extended continuously down from the face of the escarpment into the cave and filled approximately one-half of the interior of the cave (the west half). A huge rock slab, probably from the same rockslide, lay in front of the cave entrance. However, nothing quite like the rockfall layers in the Main Cave were encountered here. The rock bottom of this cave lies at a depth of 74 to 76 inches below the present ground surface, well below the maximum depth of 39 inches for the bedrock floor of the Main Cave or of 57 to 60 inches for the rock talus at the bottom of Trench 2 immediately outside the entrance to the Main Cave. The roof of the West Cave was correspondingly lower, too, and stood only about 18 inches above the present-day surface of the soil when excavations were begun. Thus the whole of the West Cave was situated about 3 to 4 feet lower on the Brown Range escarpment than the Main Cave, and a correspondingly greater percentage of the West Cave was filled with soil.

Feature 39 Soil Unit. The following soil units were identified in Trench 3 within the West Cave, and are shown in the figure 41 profile drawing of Trench 3; this unit appeared to be made up of two components that together formed the uppermost soil layer in the West Cave. The upper component was a reddish sand similar to Feature 3 but with a higher content of gray ash dispersed throughout it. This graded into a reddish sand identical in color and texture to Feature 3 at a depth of 3 to 4 inches. The lower component of

Feature 39 extended to a depth of 10 to 12 inches. Some artifacts and faunal materials were found in Feature 39 soils, but never in great abundance.

Feature 42 Soil Unit. The Feature 42 soil unit was made up of soft, fine-grained pink sand with light colored (i.e., white to light gray) ash dispersed throughout it. No sharp line of separation occurred between it and the overlying Feature 39 soil. Also present throughout this soil unit were tiny bits of charcoal, but no hearths were present aside from one encountered at a depth of 11 to 15 inches in Squares 49 and 50 and designated as Feature 43. The Feature 42 soil unit extended continuously from about 10 to 12 inches to the bottom of the cave, and within it were scattered occasional stone tools, flakes, and bits of butchered bone. One tiny flake of chert was found near the bottom at a depth of 74 inches in Square 55, and several small flakes of quartz were found in Square 55 at depths of 60 to 66 inches, but otherwise the Feature 42 soil unit at these lower depths contained nothing that would allow one to infer the presence of human habitation. The scattered bits of charcoal are most easily explained as coming from early bush fires which may have predated human occupation of the site. However, at depths of 48 inches and above the frequency of occurrence of stone artifacts and butchered bone was slightly greater. Within Feature 42 there appeared a large pit, henceforth referred to as Feature 44, which gives evidence of having been dug by the human inhabitants of the Main Cave and is considered in detail in the next chapter, under cultural or man-made features. Several animal burrows were noted in the profile, however, which may account for the presence of the few stone flakes at exceedingly low depths (quite possibly introduced via the Feature 44 pit or directly from higher levels within the Feature 42 soil). At present, the simplest interpretation seems to be that below depths of about 48 inches the Feature 42 soil unit was essentially sterile of cultural remains except for a few intrusive items.

Feature 50 Rockslide. The Feature 50 rockslide appears to reflect a single event, since all of the rocks were resting directly upon each other with no intervening layers of soil. The rocks had broken away from the cliff face above the cave and tumbled into the cave where they presently lie. The lowest rocks in this rockslide rested upon Feature 42 soil at a point 20 inches above the rock floor of the West Cave (that is, at a depth of about 56 inches). The base of the massive boulder in front of the West Cave also rested at this same depth. Thus the Feature 50 rockslide occurred when the West Cave had filled in with sterile Feature 42 soil to a depth of 20 inches, meaning, of course, that this massive accumulation of rocks on the west side of the West Cave was present when the first people arrived. The West Cave might have been a comfortable habitation site before this rockslide occurred, but afterward it became too cramped. It is hard to imagine anyone doing much more than visiting this tiny cave after the rockslide had filled about half of it and partially blocked the entrance. Such artifacts and other cultural materials as were present in the Feature 42 soil in the West Cave all accumulated after the Feature 50 rockslide had occurred.

A single radiocarbon date of 1890±105 B.C. (sample no. I-5321) was obtained for a hearth lying in the uppermost part of the Feature 42 soil (in the transition zone with the bottom of the Feature 39 unit) in square 49 in Trench 3, at a depth of 11 to 15 inches. More will be said about the cultural associations of this date in the next chapter. Like the soil units themselves, the radiocarbon date suggests a different depositional history for the West Cave as compared with the Main Cave. As in the Main Cave, wind seems to have been the principal depositional agent, but in this case there is a lack of compaction to the deposited soils. This is probably due to two factors; 1. the absence of any rockfall layers, the weight of which would compress underlying layers, and 2. the presence of the Feature 50 rocks (including the massive boulder lying across the cave entrance) that may have acted as a kind of sill permitting only the lightest sand particles to be carried into the cave interior. Evidence for this latter proposition appeared in the east end of Trench 3, where there is a narrow gap between the entrance boulder and the cave wall. Here heavier sand particles were able to enter without being lifted high by the wind, and the Feature 42 soils at this end of the trench were noticeably more coarse and generally like the sandy soils of

Feature 3 and Feature 39. The presence of fine ash particles in Feature 42 may also be viewed as evidence for sorting caused by the rock sill, since only the lighest particles could be transported by the wind over the sill. If this interpretation is correct, the Feature 42 unit may be nothing more than Feature 3-type sand (that is, the same kind of sands that occur over the entire sand slope in front of the escarpment), but with the heaviest particles filtered out by the presence of the rock sill at the cave entrance. As windblown sand tended to cover more and more of this sill, the filtering action of the sill was reduced and increasingly large particles could enter, resulting finally in the transition to the Feature 39 soil layer, which is the West Cave counterpart of Feature 3 in the Main Cave. The position of the radiocarbon-dated hearth suggests that this transition in the depositional history of the West Cave took place around 3800 years ago.

A final word of caution is needed at this point. Glover and Lampert correctly noted that "even professional geomorphologists working in Australia and specializing in arid landforms would not be prepared to make definitive statements without examining the actual site and its environs" (1969, p. 226). I am not a professional geomorphologist, and I will not claim that the interpretations presented here are the last word on the depositional history of Puntutjarpa Rockshelter. I was assisted in my interpretations by Ian Eliot, a member of the field crew and presently a graduate student of geology (with a specialization in geomorphology) at the Australian National University, Canberra. But responsibility for these interpretations remains my own. I only hope that scholars who may find fault with my interpretations will be themselves encouraged to do geomorphological work in the Western Desert of Australia, where basic information about soil movements and deposition is so badly needed.

IV: CULTURAL FEATURES

HORIZONTAL EXCAVATION OF LIVING SURFACES

Recently archaeologists have tended to emphasize the excavation of ancient living surfaces and campsites. Studies by de Lumley (1969, pp. 42-50); Bordes (1972, pp. 42-48); and Movius *in* Pfeiffer (1972, pp. 231-233, 322) carried out in Paleolithic sites in southern France have demonstrated an awareness of the need to go beyond considerations involving only vertical stratigraphy to show something of the horizontal patterning of cultural materials at definable levels. In these French excavations, moderate to extensive horizontal areas were cleared to reveal the shape and extent of ancient camps, the patterning of hearths, and the patterning of other remains such as artifacts and faunal materials on these cleared surfaces. The results of this approach in these cases showed that a much richer understanding of the prehistoric economy, technology, and other behavior patterns is possible than if one confines his approach solely to questions of chronology and artifact typology.

In preparing to work at Puntutjarpa Rockshelter after the 1967 test excavations I realized that here, too, there might be similar opportunities to discover the shape, extent, and character of ancient aborigine living surfaces. The presence of the Upper Rockfall layer suggested the possibility that the underlying soil layers were relatively undisturbed and might contain intact campsites, hearth arrangements, workshops or task-specific areas, and other remnants of cultural patterning. Such evidence was sought from the beginning of the 1969-1970 field season, and the excavation techniques employed were geared to finding such evidence. The excavators were trained not only to note changes in soil color but also to be aware of changes in compactness and the general density of lithic and faunal materials. In the end three complete and reasonably intact campsites were discovered as well as portions of another. This chapter describes in detail these excavated campsites along with other archaeological features that were clearly the result of cultural activities.

When attempting to clear and define such features within the confines of a rockshelter, I adopted a procedure similar to that described by Bordes (1972, p. 43) as "semivertical" (or, if one prefers, "semihorizontal"). Bordes's discussion of his approach to the problem of horizontal excavation within rockshelter sites is worth quoting:

> Excavation methods can and must vary according to site, depending on the specific problems and difficulties encountered. ... The horizontal excavation, uncovering layer after layer on a wide surface, is theoretically the best and should be used whenever possible. It is the one that can show structures and patterns on the living floors to the best advantage. The catchwords here are "whenever possible." In a cave site, this is very seldom the case. ... Horizontal excavation on wide surfaces in such a context leads most of the time to disaster, even if the excavators are careful and experienced. One goes from one layer to the next without knowing it and, after a while, is completely lost. Even in a case where the excavated layer rests on top of a sterile layer, it is necessary to be very wary. If the layer is thick, it is probably made up of lenses, since debris does not accumulate at the same rate everywhere, so that a structure in one part of the site may not be contemporary with another some meters away, even if they seem to be on the same level. ... Rich caves are not the best places for palethnological research: they can give a good stratigraphic and typological sequence, but as far as palethnology is concerned, not-too-rich sites (either in caves or shelters) or open-air sites, where the surface was not usually limited, are better. (Bordes, 1972, pp. 42-43)

With these strictures in mind, how are we to evaluate the situation at Puntutjarpa? Despite the fact that the fill at Puntutjarpa was rich in cultural remains, special conditions were present which qualify this site as an example of what Bordes would probably call a "not-too-rich shelter." These conditions are; 1. the fact that this is an open rockshelter with a habitation area extending out onto the sand terrace in front, well beyond the dripline, and 2. the presence of the Upper and Lower Rockfall layers, both of which tended to seal off and preserve living surfaces that might otherwise have been disturbed by natural factors such as wind and by human beings during successive reoccupations. In dealing with sites like this Bordes (1971, p. 43) has suggested: "For this purpose, semivertical (or if you prefer, semihorizontal) excavations are better than horizontal ones. This method consists of excavating moderately wide surfaces no more than 4 square meters at a time in each layer. ... When a structure is discovered, the excavation is enlarged, of course." Although the excavation units at Puntutjarpa were 3-foot squares rather than meters, the same general approach was used, with limited horizontal surfaces being traced and exposed whenever indications like a change in soil texture or compactness or unusual concentrations of artifact and/or faunal material seemed to warrant such action. As might be expected, some of these efforts to define living surfaces failed or achieved only partial results, but the successes justified the effort.

EXCAVATED LIVING SURFACES AT PUNTUTJARPA ROCKSHELTER

Feature 7 Living Surface. Evidence of this living surface was first discovered in the form of a layer of Feature 4 soil which was more compact and slightly redder than the surrounding Feature 4 soil. This layer was at a depth of 17 1/2 to 20 inches in square 11, Trench 2, directly below the Upper Rockfall in this part of the Main Cave. A small, flat slab of quartzite with an upper surface showing traces of rubbing wear and red ochre stains was found resting level directly upon the living surface along with a fragment of a stone seed-grinder, two backed blades, a micro-adze slug, and numerous stone flakes and pieces of butchered bone. The clearing of this living surface in this case was done by first peeling back the overlying layer of Upper Rockfall (mostly small rocks that could be removed easily by hand) and brushing clear the surface of Feature 7, leaving artifacts in place whenever possible to be measured in later. Further clearing within Square 11 revealed the presence of a small hearth or hearth-remnant, from which a radiocarbon sample was taken. This hearth lay directly upon the Feature 7 surface.

Clearing at this level was carried out initially in the adjacent squares (squares 5, 6, 12, 17, 18) with further clearing to follow out the Feature 7 level in squares 10 and 16. Feature 7 was found in most places to occur at depths of 18 to 21 inches. Although the exact margins of this living surface were hard to define and must remain slightly conjectural, there was no uncertainty at all about the essential characteristics of this feature. The floor of the feature was compact and hard throughout and was marked by a definite layer of cultural debris resting upon its surface. The Feature 7 living surface is shown in plan in figure 35. This plan shows the second hearth found there, at the southwest end. This hearth was larger than the first, and a radiocarbon sample was taken from it, too. Later the radiocarbon samples from these two hearths were combined to provide a more accurate reading, and a date of 435±90 B.P. was obtained (sample no. I-5320). Considering the direct association between these hearths and the Feature 7 living surface, and the overall stratigraphic position of Feature 7, this date appears to be a good indication of the antiquity of the whole living surface and its contents.

As the plan in figure 35 shows, additional grinding-slabs and grinding-slab fragments were discovered resting on this surface. All of these were in a level position, suggesting that they had been used there and were left by the inhabitants. In all, four grinding-slabs and grinding-slab fragments were found on the Feature 7 living surface along with another found resting at the same level in Square 6 but just outside the limits of the living surface. Other artifacts found *in situ* included a total of five adzes, four adze-slugs, eight micro-adzes, one horsehoof core, one large core, four micro-cores, three backed blades, two large flake-scrapers, one hammerstone, seven retouched fragments, and 886 flakes of chipped stone. Or, to summarize somewhat differently, the Feature 7 living surface contained 35 chipped and retouched stone tools, five tools of ground and pecked stone, and 886 stone waste flakes. It is possible that some of the items classified as stone flakes were used briefly as tools and dis-

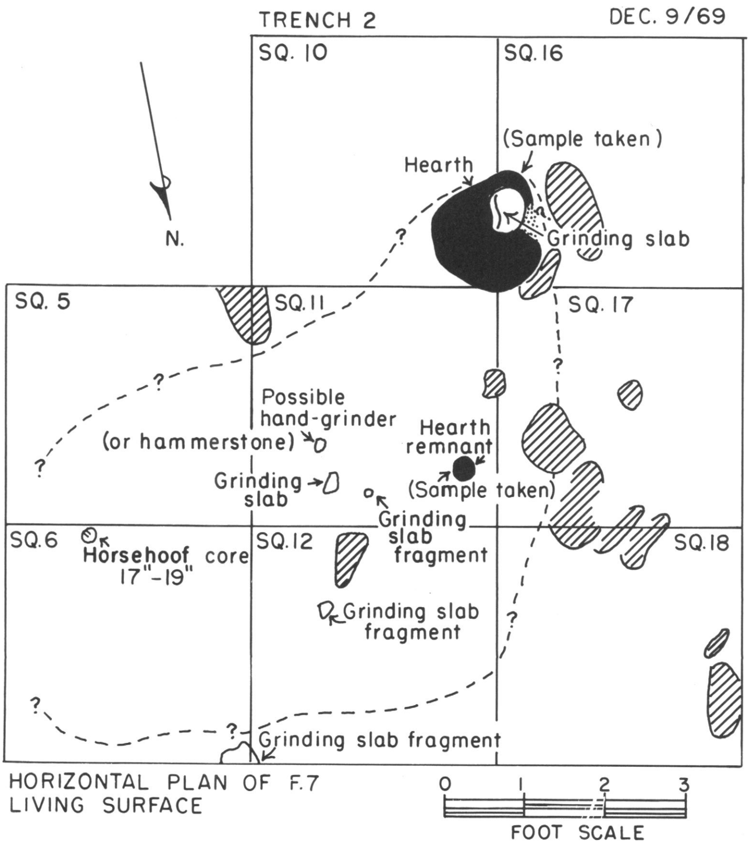


FIG. 35. Horizontal plan of Feature 7 living surface, Trench 2, Puntutjarpa.

carded, but no attempt has been made yet to identify such artifacts through microscopic studies of use-wear and edge-damage.

The Feature 7 living surface measured approximately 38.5 square feet in area. Owing to the poor definition of the margins of Feature 7, and some minor irregularities of shape, this estimate must be regarded as an approximation, even though it appears to be fairly close. A glance at table 2 shows that this living surface has an area that lies well within the range for ethnographic Western Desert aborigine camps, tending to be close to the mean campsite area for summer (shade-shelter) camps. In terms of shape, however, Feature 7 is not exactly like the ethnographic aborigine camps that were mapped during the earlier phases of this research. Most of these showed an oval or lozenge-shaped outline in plan, whereas Feature 7 tends to be ovate at one end and pointed at the other. This slight oddity of shape may be a function of the excavators' difficulties in defining the margins of the living surface, or it may indeed have been the actual shape of the living surface. So while the area of the Feature 7 living surface conforms to the range of areas for contemporary Western Desert campsites, the shape does not conform closely and is inconclusive. However, the artifact array on the surface of the Feature 7 living surface conforms generally to the kinds of materials generally found in contemporary Western Desert campsites (with the notable exception of certain tool types like backed blades which are no longer made in the Western Desert). This is especially true of the grinding-slabs, which are items which the ethnographic aborigines commonly leave in camp and reuse during subsequent visits. The two hearths found within the Feature 7 living surface resemble closely in size, shape, and location the hearths that appear in present-day Western Desert camps. Thus except for the criterion of shape, the Feature 7 living surface conforms closely in every respect to the characteristics of a present-day Western Desert aborigine campsite.

Contemporary Western Desert campsites are often reoccupied during subsequent visits to a particular site, resulting in the deposition of lithic materials and faunal remains over a prolonged period within what might be regarded as a single archaeological level in each campsite. Thus a single modern campsite may have on or just below its surface stone tools and flakes from several human occupations that are widely spaced in time. Could this be the case with Feature 7? Indeed it could be one way to explain the high concentration of stone tools and waste materials found on this living surface. Yet in stratigraphic terms all indications point to a single, well-defined campsite that perhaps was occupied for several visits but not over any long period of time (say in excess of 100 years). The human occupation at this campsite was abruptly terminated by what appears to have been the final phase of the Upper Rockfall collapse. No human bone was found, so it seems clear that the occupants were away at the time this portion of the Upper Rockfall came down, thus escaping injury.

Feature 32 Living Surface. Feature 32 was first noted as a rock-free area in squares 1, 7, and 8 in Trench 2 near the rear wall of the Main Cave. This feature, as it appeared at an excavated depth of 42 inches, is shown in plan in figure 33. The Lower Rockfall unit was first detected at a depth of 38 to 39 inches in squares 1, 2, 8 and 15. The rocks were left in place, and a concentration of fire-blackened fill (dark even for Feature 4) was noted extending from the back wall of the cave out to about 24 to 30 inches. As excavations proceeded down to the next 3-inch level this darkened area was seen to correlate roughly with a rock-free area between the south end of the Lower Rockfall and the rear of the cave. At a depth of 42 inches this darkened zone of soil stood out clearly in horizontal profile, highlighted by a zone of somewhat lighter soil which was originally designated as Feature 28 but which was later observed to be an eastward extension of Feature 41 soil.

This Feature 28/41 soil unit is not easy to interpret. As excavations continued this soil unit merged with Feature 4. It appears to have been a layer of soil light brown in color and highly variable in texture (ranging from almost concrete hardness in some places to powdery softness in others), with most of the harder and more compact portions of this unit lying at its west end. In the Feature 32 area it appears to have been shoved and mounded up against the south end of the Lower Rockfall, perhaps as "padding" for the floor of the living surface. This unusual soil lens was discussed at length by the members of the excavating crew and me, but no satisfactory explanation could be offered to account for its presence here.

Figure 33 provides a detailed plan view of Trench 2 in the Main Cave showing the entire Lower Rockfall unit and the two rock-free areas (Feature 32 and Feature 40) at the back of the cave. The rocks indicated in black were found resting on Feature 4 soil from 4 to 8 inches above the Lower Rockfall. These rocks do not form part of either rockfall layer at the site, and two alternative explanations for their presence are possible; 1. these rocks were a third but smaller rockfall layer that fell during a time intermediate between the others, or 2. these rocks were originally part of the Lower Rockfall and were thrown out by the cave inhabitants during the clearing of the Feature 32 and Feature 40 living surfaces at the back of the cave. If this latter alternative is correct, it means that a small amount of soil accumulated over the Lower Rockfall layer out near the rockshelter entrance during the absence of the occupants. It should be noted that these rocks rested at a convenient "stone's throw" in distance from the two rock-free areas. Both Feature 32 and Feature 40 lie in the best shaded zone of the cave, which may help to explain why the early inhabitants here were willing to go to the extra trouble of clearing away the rocks in this particular location instead of camping farther out on the sand slope. These campsites would also have been well protected from wind.

There is some ethnographic evidence to support the latter explanation. The present-day Western Desert aborigines invariably clear off a spot on the ground before they sit down or make camp. Usually this involves nothing more than sweeping a small space clear of pebbles and

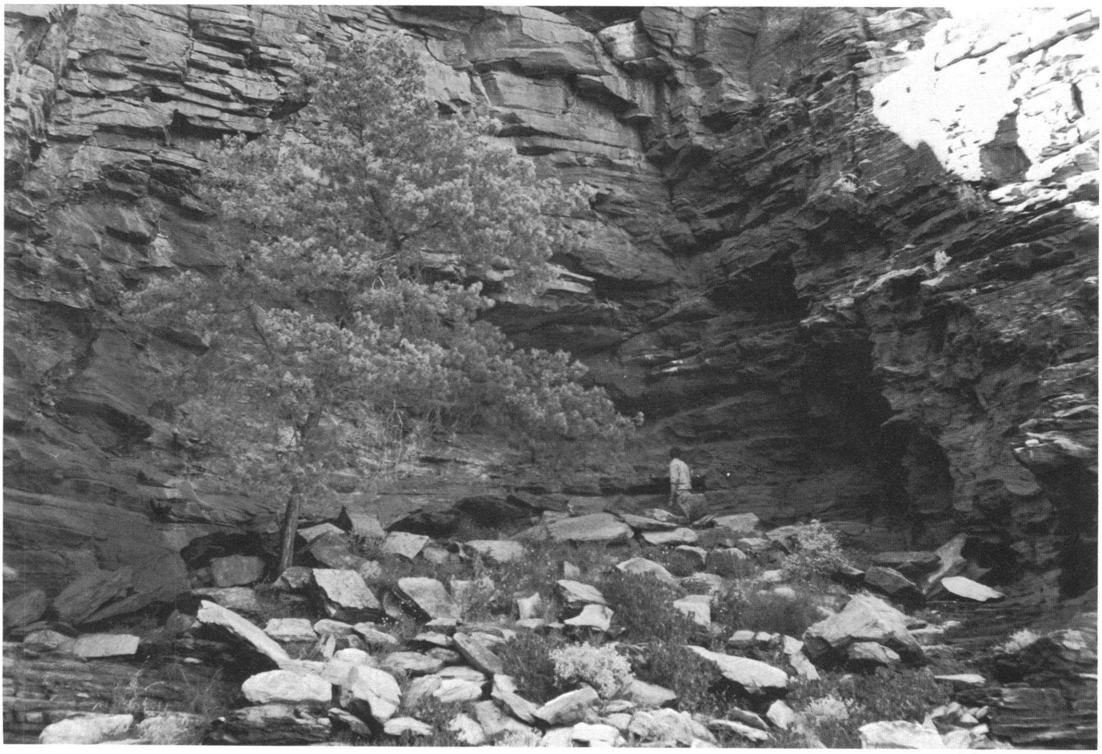


FIG. 36. Recent aborigine habitation campsite at Tjampingku, Mt. Gibralter, as seen from base of rock talus.

FIG. 37. Rock-free interior of recent aborigine habitation campsite at Tjampingku, Mt. Gibralter.

thorns, often using the blade of a spearthrower or a digging bowl. Men and women perform this task with about equal frequency. At two sites in the Western Desert in 1966, Murku (near the east end of the Rawlinson Range) and Tjampingku (at Mt. Gibralter), I observed evidence of rock clearance for the purpose of establishing a campsite. I did not see aborigines actually doing this at the time, but my guides stated that they sometimes found rocks lying on the old cleared campsites, and they described how they removed these. The campsites in each case stood out sharply as oval-shaped rock-free spaces upon areas of dense rock talus. Figures 36 and 37 show one of these rock-free modern campsites at Tjampingku. Each of these historic campsites contained hearths and cultural debris in the form of stone artifacts and faunal remains.

Unlike Feature 7, there were no compact floor surfaces within the limits of Feature 32. Although the horizontal perimeter of Feature 32 was more definite than was the case with Feature 7, the possibility of successive reoccupations of this campsite over a long period was much greater than with Feature 7. The dark zone of Feature 4 soil within Feature 32 is perhaps most easily interpreted as hearth fill which was scuffed and trampled by successive inhabitants of this campsite until the hearths themselves were no longer visible. The artifacts found within this feature did not rest in any single, clear association. So for purposes of analysis this feature is presumed to be composed of fill within the rock-free area between the south end of the Lower Rockfall and the rear wall of the cave at depths within Feature 4 and Feature 28/41 soils of 39 to 48 inches, that is, roughly at the same stratigraphic level as the Lower Rockfall. This assignment of depth is admittedly arbitrary, but it does have the merit of conforming to the horizontal limits set by the rock-free clearing. Contained within this limited area and depth were seven large cores, one micro-core, one large flake-scraper, two retouched fragments, and 1045 flakes of chipped stone.

On present evidence it is impossible to say just how long the Feature 32 habitation site was occupied, although stratigraphically it is bracketed between about 10,000 and 7000 years ago. Considering that this rock-free area may have been reoccupied many times over a period of several thousand years, the relatively low accumulation of identifiable stone tools is striking. Discussion on this matter will be reserved until the Feature 40 artifacts are described, since a similar situation occurred there. The total area of the Feature 32 rock-free area is approximately 38.5 square feet (coincidentally the same as Feature 7, and fitting within the area-range of present-day Western Desert campsites).

Feature 40 Living Surface. This surface appeared as a rock-free area within the Lower Rockfall unit immediately to the west of Feature 32. Although larger in area (56.7 sq. ft.), it occupied the same stratigraphic position as Feature 32 and can be considered a similar type of feature. Initially only the easternmost edge of this rock-free area was visible in Trench 2, which then had not been excavated westward beyond squares 14-18. This discovery was regarded as sufficiently important, however, to warrant an extension of Trench 2 into squares 19-26, primarily for the purpose of exposing the rest of Feature 40 and of clearing the Lower Rockfall to its outer limits (in the hope of finding more rock-free areas within it). Since this discovery occurred near the end of the excavating season, it was decided that work would proceed in these squares by 6-inch rather than 3-inch levels, thus speeding the work to a degree. As shown in the figure 31 plan, this extension of Trench 2 accomplished both aims.

The internal stratigraphy of Feature 40 differed little from that of Feature 32. The Feature 28/41 soil unit within Feature 40 was basically similar in appearance to its occurrence in Feature 32, and it was just as hard to interpret. Here this soil layer was extremely hard in places, but it showed the same mounded quality along the south edge of the Lower Rockfall layer. Otherwise Feature 40 contained only Feature 4 type soil, although very dark in color and suggestive of old, rather disturbed hearth remains.

The Feature 40 rock-free area between the depths of 39 inches and 48 inches contained four large cores, four micro-cores, one small end-scraper, one large flake-scraper, seven retouched fragments, and 3523 stone flakes. This feature also contained four pieces of red ochre and two stone seed-grinders (one complete and the other fragmentary). Considered together, the Feature 32 and Feature 40 living surfaces contained 28 chipped stone tools and cores, two tools of ground and pecked stone, two pieces of red ochre, and 4568 stone flakes. When compared with the totals from the Feature 7 living surface, several points stand out; 1. the number of stone flakes in Feature 32 and Feature 40 is much greater than in Feature 7 (by a ratio of over more than five to one). This difference is perhaps not so surprising, however, when one considers the internal stratigraphic differences between these features and notes that Feature 32 and Feature 40 may have been occupied and reused over a much longer period than Feature 7. Certainly in all three cases the density of stone waste flakes is high. 2. the actual number of chipped stone tools found in each of these three living surfaces differ markedly, with the lowest numbers being reported from the earliest living surfaces. 3. in terms of tool types, adzes, micro-adzes, and backed blades are conspicuously absent from the assemblages found in Feature 32 and Feature 40, whereas they abound in Feature 7. To what extent do these differences reflect changes in technology between the time periods represented? These differences will need to be considered in the context of later discussions about the overall stone tool assemblages at the site. 4. in terms of waste-flake to tool (and core) ratios, Feature 7 shows a much higher ratio of recognizable chipped stone tools and cores to waste flakes (one tool for every 25.3 flakes) than either Feature 32 (one tool for every 95.0 flakes) or Feature 40 (one tool for every 207.3 flakes). Again, these differences will be considered in terms of overall changes at the site in lithic assemblages. 5. tools of ground and pecked stone

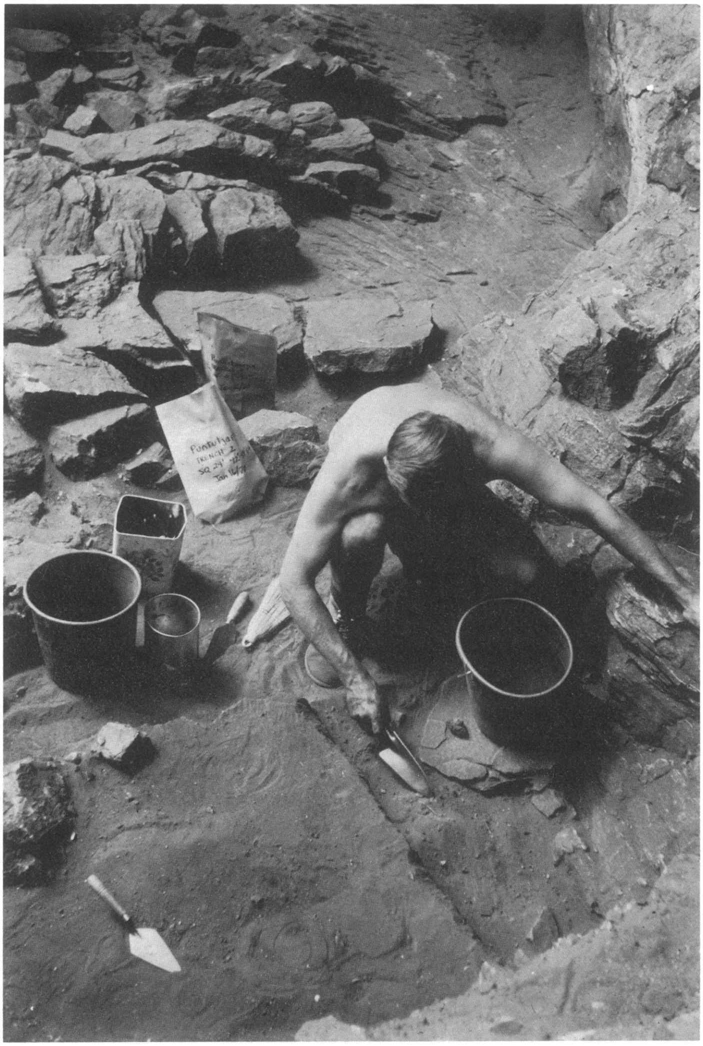


FIG. 38. View in Trench 2 across rear of Main Cave, Puntutjarpa, showing Feature 40 rock-free area being excavated, with Feature 32 rock-free area in background.

were found in Feature 7 and in Feature 40, in each case consisting of seed-grinding implements. 6. pieces of red ochre were found in Feature 40, and a small ochre-stained grinding-slab occurred in Feature 7.

In terms of overall site stratigraphy, Feature 32 and Feature 40 appear to belong together. That is, they both appear at the same level within the same Lower Rockfall formation, and they both fall chronologically somewhere between 10,000 and 7000 years ago. But there is no necessary reason to think that they were both constructed or occupied at precisely the same time or for the same length of time. This lack of certainty tends to restrict the usefulness of comparisons of the sort presented above. It would, of course, be better to compare several living surfaces which represent short periods of occupation (as seems to be the case with Feature 7), but such a tightly controlled comparison is not possible within Puntutjarpa Rockshelter. The comparisons presented here must be regarded in the light of these restrictions, and conclusions drawn from them must be limited accordingly. Both Feature 32 and Feature 40 have oval shapes closely resembling those of the contemporary Western Desert campsites, and in terms of area they both fit within the overall range defined for contemporary Western Desert campsites (although, it should be noted, near opposite ends of the scale). The artifact and faunal remains found within these living surfaces are generally similar to materials found in camps, although the internal stratigraphy of these two features is less clear than in Feature 7 and thus obscures the comparison somewhat. Of particular interest is the occurrence of seed-grinding implements in both Feature 40 and Feature 7, suggesting a common association similar to that found in modern Western Desert aborigine camps. Thus there is evidence, despite the ambiguities of the internal stratigraphy in Feature 32 and Feature 40, to indicate that, like Feature 7, these were campsites comparable with those of the modern aborigines of this region.

Feature 15 Living Surface. Feature 15 was a fragment of a possible living surface encountered in squares 3 and 9 in Trench 2 in Feature 4 soil at a depth of 24 inches. As with Feature 7, this partial living surface was identified as a compact layer of Feature 4 soil which contained an unusual horizontal concentration of stone artifacts and faunal remains. Like Feature 7, too, it lay within a layer of soil sandwiched between two phases of the Upper Rockfall. It contained within it the remains of a hearth. A radiocarbon sample was taken from this hearth, but it has not yet been dated. Among the artifacts found upon this fragmentary living surface were one horsehoof core, two pieces of red ochre, one seedgrinder fragment, and one micro-adze. The margins of Feature 15 were indistinct, and the surface could not be followed out for more than a few feet within squares 3 and 9.

Feature 34 Grinding-Slab Cache. Feature 34 consisted of a cluster of three large stone grinding-slabs arranged in a vertical position within square 6 in Trench 2 at a depth extending to 52 1/2 inches. All three grinding-slabs were made of Townshend quartzite. Each had one smooth grinding surface, although two faced south and one faced north (see fig. 39 plan of Feature 34). The three slabs tilted vertically toward the north at an angle of 15 to 20 degrees. Their bottom surfaces rested in Feature 31 soil, although their upper surfaces were completely enclosed by Feature 4 soil. The slabs were not shaped in any way; although they were roughly of the same thickness, they varied considerably in size. In every respect, these three stone slabs were indistinguishable from the seed-grinding slabs (tjiwa) used by the present-day Western Desert aborigines. It appears that the three stone slabs were stuck vertically into the Feature 31 sand during an early period of occupation at the site and left as a cache of some kind which was later forgotten by the inhabitants of the site. The Lower Rockfall did not extend out this far, so there is no direct way of inferring whether this cache of grinding-slabs was placed here before or after the Lower Rockfall came down. Certainly the person who placed them here had to dig or press them into the ground in order to make them stand up, and their recorded position suggests a penetration of about 9 inches into Feature 31 soil, which would have been more than adequate for supporting them in the position in which they were found. They may have been shoved down through some overlying Feature 4 fill as well, but there is no way of determining positively if this

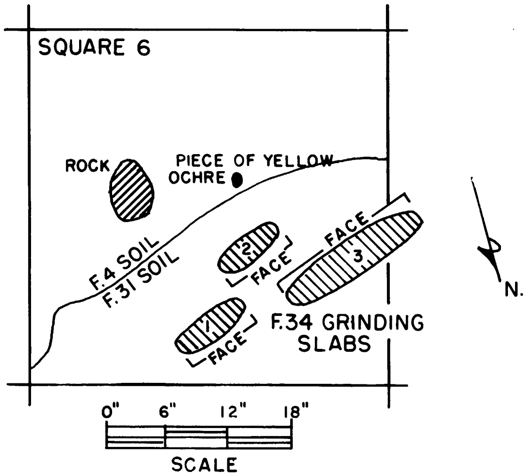


FIG. 39. Horizontal plan of Feature 34 grinding-slab cache, at depth of 50 inches.

was the case. In general terms, the Feature 34 grinding-slab cache lay at about the same level as the Lower Rockfall rocks which are thought to have been thrown out by the inhabitants when they were constructing the two rock-free living surfaces (Feature 32 and Feature 40), that is, to some time between 10,000 and 7000 years ago. But on stratigraphic grounds it would be hard to assign a more precise date or association to this cache within the site. In order not to create confusion, this cache of grinding-slabs was not shown in the figure 33 plan of Trench 2, but their original position can be visualized easily enough by noting their location in terms of the figure 39 plan drawing.

HEARTHS

Of the 12 distinct hearths found in Trench 2, nine were not directly associated with identifiable living surfaces. In Trench 1, four such hearths were noted, bringing the total to 16 found at various depths within the fill inside the Main Cave at Puntutjarpa. Numerous charcoal concentrations were also noted in trenches 1 and 2, but these were too indistinct to be counted as true hearths. Hearths associated with living surfaces are being included in this analysis as if they were like any other hearths found in the site.

These hearths varied greatly in size and shape. Each was mapped and profiled in detail, and any cultural associations were noted. Table 5 lists the hearths found in trenches 1 and 2 at Puntutjarpa along with their horizontal and vertical positions as well as their cultural and natural associations.

As the schematic plan drawing in figure 40 shows, there is a generalized pattern to the way these hearths occurred horizontally within the cave. Ten of the 16 hearths occurred between the line formed by the outer limit of the cave roof and the rear wall of the cave, that is, in those portions of the cave which; 1. have the most shade during the day; 2. lie inside the dripline and are dry during even the heaviest rains; and 3. have the most protection from wind. Even though sampling by means of excavation was about equal on both sides of this line, the number of hearths inside the cave was almost twice that of the number outside. Given the advantages of living within the cave, it is not hard to understand the tendency shown by the ancient inhabitants here at all times to settle toward the rear of the cave whenever possible, as reflected by the horizontal patterning of these hearths. This interpretation is further supported by the fact that three of the four whole or partial living surfaces identified within the Main Cave lay horizontally inside the line formed by the outer limit of the cave roof.

Feature 25 Ochre-Stained Rock. At a depth

TABLE 5
Hearths inside Main Cave, Puntutjarpa

Hearth Feature No.	Square	Depth (in inches)	Cultural or Natural Association
F.8 (Trench 2)	11	17-19	Feature 7 living surface
F.11 (Trench 2)	13 & 14	8-14	Feature 4 soil
F.13 (Trench 2)	10 & 16	15½-18½	Feature 7 living surface
F.14 (Trench 2)	9	21-27	Feature 15 living surface
F.18 (Trench 2)	8 & 14	24½-39¼	Feature 4 soil
F.21 (Trench 2)	15	24¼-28	Feature 4 soil
F.23 (Trench 2)	1 & 1	30½-32¾	Feature 4 soil
F.26 (Trench 2)	11	30¾-34½	Feature 4 soil
F.33 (Trench 2)	14	46½-48	Underneath Lower Rockfall
F.36 (Trench 2)	2 & 44	22¼-29	Feature 4 soil
F.37 (Trench 2)	5 & 46 & 47	41-44	Feature 4 soil
F.38 (Trench 2)	44 & 45	28½-30	Feature 4 soil
F.5 (Trench 1)	3	28-30	Feature 4 soil
F.10 (Trench 1)	6	4-6	Feature 3 soil
F.11 (Trench 1)	3	40-43	Feature 4 soil
F.12 (Trench 1)	5	60-62	Feature 31 soil

of 29 1/2 inches to 37 1/2 inches in Feature 4 fill in square 1, Trench 2, a large rock of Townshend quartzite was found that showed four large patches of yellow ochre on the bottom surface. This rock could not be attributed stratigraphically to either the Upper or Lower Rockfalls, yet it clearly fell at one time from the roof of the Main Cave, probably as an isolated occurrence sometime before the Upper Rockfall came down. Occasional patches of red and yellow ochre had been observed from time to time on the undersurfaces of several rocks in the Upper Rockfall layer, but Feature 25 was by far the most vivid occurrence of this phenomenon at the site. After its stratigraphic position was recorded the Feature 25 rock was removed for closer examination and for color photographs. No definite designs could be traced, however, and it cannot be judged at this time how similar these early examples of rock painting at the site may have been to the more recent paintings visible along the rear wall of the cave today. A conservative estimate based on the general stratigraphic position of this rock suggests that it fell sometime between around 4000 and 6000 years ago, making this one of the earliest dated occurrences of rock painting in Australia. Occasional pieces of red and yellow ochre were found in the excavations down to the earliest levels in the Main Cave, and a few rocks in the Lower Rockfall were definitely ochre stained. However, these rocks were all small and could conceivably have served as ochre grinding-slabs. Their presence within the Lower Rockfall layer does not conclu-

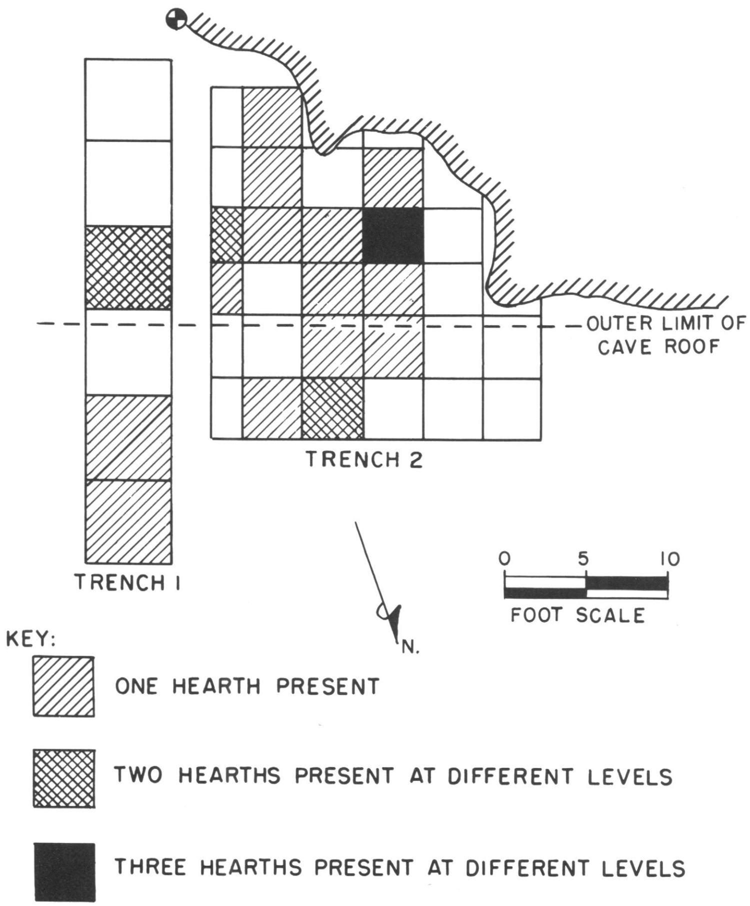


FIG. 40. Horizontal distribution of hearths in Main Cave, Puntutjarpa.

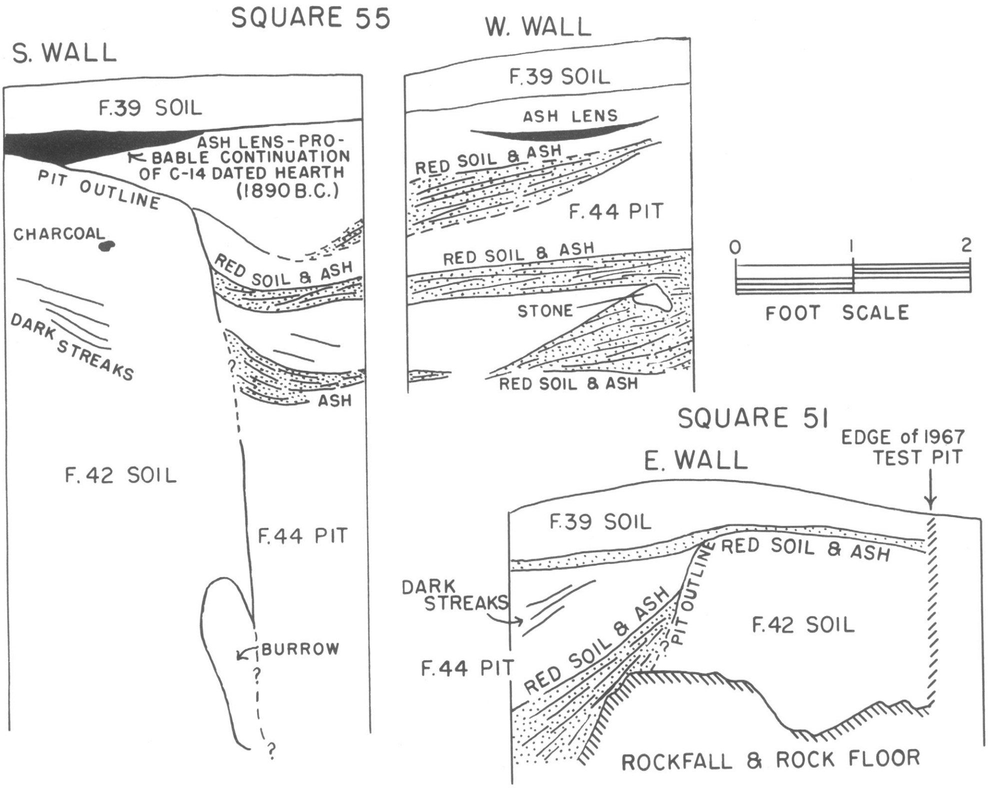


FIG. 41. Partial profile of Feature 44 pit, West Cave, Trench 3, Puntutjarpa.

sively prove that they represented remnants of actual rock paintings, although the possibility does exist.

Feature 44 Pit, West Cave. Feature 44, in squares 49-51 and 55 in Trench 3 within the West Cave at Puntutjarpa, was perhaps the most complex single stratigraphic feature encountered during the excavations. I am particularly indebted to Mrs. Sylvia Hallam, Department of Anthropology, University of Western Australia, for directing the excavation of this feature and for her meticulous and accurate recording of its complex internal stratification. Throughout these excavations problems were encountered with collapses of the powdery sidewalls in Trench 3, and no single profile was possible of the entire feature. Partial profiles, however, were obtained, and the most complete of these, showing the south wall of Square 55, is presented in figure 41. The photograph in figure 42 shows the profile of the entire feature as it was exposed in Trench 3.

The internal stratigraphy of Feature 44 consisted of numerous inwardly dipping (and frequently overlapping) lenses of soil which were sometimes marked not only by differences in color but by thin, dipping lenses of ash or charcoal as well. Some of these are visible in the figure 42 photograph. The Feature 44 pit was traced to a depth of 66 inches. The top of Feature 44 was first recognized at a depth of 17 inches, where it had a total diameter of approximately 8 1/2 feet. The horizontal shape of the pit was never determined with any real accuracy, but a roughly oval shape with the longest axis running north-south provides the best tie-in for the different readings and vertical profiles that were taken during the excavation. The pit was widest at the top, where it flared outward on all sides. At a depth of 29 inches it was only about 4 1/2 feet in maximum diameter, although below this depth the sides sloped inward less sharply. Near the bottom it had a maximum diameter of less than 4 feet, although the actual outline was rendered indistinct in places by several small sidewall collapses.

The only hearth found within the West Cave, Feature 43, overlapped the east edge of Feature 44 at a depth of 15 to 17 inches in Feature 42 fill in squares 49, 50, and 55. This overlap, part of which is shown in the figure 41 profile, indicates that the Feature 43 hearth must have been formed after the Feature 44 pit was entirely filled in. The radiocarbon date of 1890±105 B.C. thus provides a minimum estimate for the final abandonment or last use of this pit.

It rained only once at Warburton during the summer of 1969-1970, when 43 points of rain (i.e., just under a half-inch) fell on December 14. Excavation of the Feature 44 pit did not begin until a month later, in mid-January, so that it came as something of a surprise when the excavators discovered moist soil within the pit as they dug downward, level by level. Further investigation showed that moisture from this rainfall had collected on the top of the Brown Range escarpment and that later this moisture had percolated downward through fissures in the rock ultimately to emerge from the rear wall of the West Cave. There the moisture had remained despite a month of intense midsummer heat outside. It was this chance clue that first suggested to the excavators the possibility that the pit may have been part of an ancient water-catchment. Indeed, one of the unresolved questions about the ancient human occupation of Puntutjarpa Rockshelter has centered on the apparent lack of dependable water supplies. Hughes Creek, about 1600 feet from the site, holds water for only a short time in its bed after heavy rains. A couple of small rockholes in the Brown Range about a half-mile from the site had some claypans on the far side of Hughes Creek that hold fresh water for a few days after rains appeared to be the only locally available water-sources. A permanent soakage occurs at Milesia Well (the original location for the Warburton Ranges Mission in 1934) near the west end of the Brown Range about 2 1/2 miles away from the site—a little too far for convenient access but accessible nevertheless.

During the course of ethnographic studies it

FIG. 42. Trench 3, West Cave, Puntutjarpa, showing profile of Feature 44 pit.

had been noted that desert aborigines often depend upon so-called native wells for water, and that the interval between their visits to one might be several months or even years. A native well is nothing more than a place where it is known to the aborigines that a localized subsurface water table exists. In these places they dig to get water, using wooden digging-bowls and digging-sticks and collecting the water by letting it flow into a large wooden bowl placed at the bottom. Frequently during intervals between visits large amounts of grasses, weeds, and thorns accumulate within the pit, and the sides of the pit may also collapse to some extent. Upon revisiting such a place, the first step is generally to set fire to the brush within the pit (by far the easiest way to clear it), and the next step is to dig back down to the water table. The photograph in figure 13 shows the native well at Pulykara, an aboriginal camp about 330 miles northwest of Warburton where there were nomadic aborigines camped in April, 1970.

Activities of aborigines at Pulykara and other places like it suggest that the easiest way to interpret the complex stratigraphy within the West Cave is to view the Feature 44 pit as an ancient native well similar to those observed ethnographically. Such an interpretation takes into account the persistence of moisture within the West Cave after the December, 1969, rain and relates this in the most economical manner possible to the dipping soil and ash lenses within the pit (these latter are thought to be the traces of past burning and clearing during efforts by aborigines to obtain water there). It should be noted that a similar situation, of a cave containing a steady trickle of fresh water through fissures at the back and serving as a water-source for desert aborigines was observed in 1966 at the site of Wi:ntjara (Glen Cumming) in the Rawlinson Range (Gould, 1969d, p. 148).

The Feature 44 pit fill contained only two chipped stone artifacts (one retouched tool, and one core), one seed-grinder fragment, and 114 stone flakes, in contrast to the surrounding Feature 42 fill which contained 29 flaked stone tools and cores, four pieces of red ochre, three seed-grinders (two of them fragmentary), one hammerstone, and 3124 stone flakes. In addition, the overlying Feature 39 soil in the West Cave contained one stone core and 91 stone flakes. The low artifact density within Feature 44 reinforces the interpretation of this feature as an ancient native well, in which the only tools and flakes present were those that accidentally slipped into the deposit from the surrounding soil while the pit was being dug and cleared repeatedly by the inhabitants. Stone artifacts are occasionally introduced into present-day native wells in this way. Such low artifact frequencies argue against this pit having been used as a feature within the main habitation area. Even the artifact frequencies in the surrounding Feature 42 soil and overlying Feature 39 soil are low when compared with similar levels in Trench 1 and Trench 2 in the Main Cave, suggesting that the West Cave was always on the periphery of the habitation zone at Puntutjarpa. The fact that the Feature 50 rockslide was already present in the West Cave before the first human inhabitants arrived, indicates that this area would have been extremely cramped for any kind of intensive habitation even after the Feature 44 pit was no longer in use.

There remains one final question which is largely unanswerable at this time: What caused the Feature 44 native well (if this hypothesis is accepted) to go out of use sometime before or around 1900 B.C.? Although the West Cave captures and retains some water after heavy rains nowadays, it does not hold enough to make it a viable native well now. Ian Eliot conducted a geomorphological survey to determine the local flows of ground water following the single heavy rain in December, 1969. His findings, while they must be considered as a partial and tentative picture of the movements of ground water in and around the site, do provide a basis for discussion and further research by interested scholars. Eliot found that large amounts of rainwater were absorbed immediately into the sandy soils that cover the Brown Range and form the sand slope leading down from the Brown Range to Hughes Creek. This water collected below the surface and flowed downward, emerging about a week after the rain as a temporary spring along the south bank of Hughes Creek. There were some empty tin cans (left by aborigines who had been here before to collect water) lying nearby, showing that this small spring is well known to the local population. Fresh, drinkable water trickled from this spring for more than a week. Thus rainwater, which presumably would otherwise have collected within the West Cave at Puntutjarpa, is being largely diverted to a spring about 1600 feet to the northwest and downslope. Eliot also noted the presence of a weakly defined system of gullies descending from the escarpment to the west of the site in a northerly direction, toward the locality of the spring at Hughes Creek. It is suggested that these gullies may be the remnants of old flash flood channels which, when formed, cut into the slope and lowered the temporary water table here so as to divert rainwater to a lower level than that at which it had previously collected. At the present time such flood channels can form quickly, in some cases after a single series of torrential rains, and this conceivably could have happened at the site sometime around or before 1900 B.C. Water then may have flowed downslope, both on the surface in the flood channels and later below the surface, much as it does today, instead of collecting among the rocks near the top of the Brown Range and trickling down through fissures into the West Cave deposits as it appears to have done on a much larger scale in former times.

Although this approach was not tried at the time, a geomorphologist might be able to test this hypothesis by excavating a series of trenches through the gullies to determine their stratigraphic cross-section characteristics. It is assumed here that since their formation these gullies have been subjected to partial refilling by wind-blown sand (and perhaps even other phases of subsequent alluvial cutting and refilling through wind deposition), and this assumption could be tested by sectioning one or more of these gullies. Our failure to do this was, in retrospect, an oversight. However, dating the initial phase of gully formation and correlating this with the final use of the Feature 44 pit may still prove impossible, and these geomorphological interpretations must be viewed as tentative.

V: STONE ARTIFACTS–DESCRIPTION AND PRELIMINARY CLASSIFICATION

A total of 1466 recognizable stone tools and cores and 76,018 stone waste flakes was found in Squares 1′-18 in Trench 2 at Puntutjarpa. These squares represent a volume of 793 cubic feet of excavated fill. Overall this excavated portion of the site contained a density of 1.85 stone tools and cores per cubic foot and 95.85 stone waste flakes per cubic foot. These figures are much higher than those shown for the test excavations at Puntutjarpa in 1967, suggesting two possible interpretations; 1. that the estimate offered in 1967 of a 10 percent error in unscreened as opposed to screened fill is inaccurate and cannot be used as a guideline for archaeological testing, and 2. that the fill within Trench 2 contained more artifacts than the fill in Trench 1. At present, I suspect that both interpretations are correct, and, taken together, can account for the differences in artifact densities reported in 1967 and in 1969-1970. It was apparent during the course of excavation that Trench 2 was proving richer in artifact remains than had been the case in Trench 1 (for example, a single stratum in Trench 2, N5, contained 9809 stone flakes and 34 stone tools and cores). Expressed more subjectively, there were times during the excavation when the volume of artifact material excavated from a single 3-inch level in a single square exceeded the volume of soil from that same level and square, a situation that never occurred during the excavation of Trench 1. On the other hand, trenches 1 and 2 lay immediately next to each other within the site, making it inherently improbable that the artifact densities should differ as abruptly as it appears. On present evidence it seems likely that squares 1′-18 in Trench 2 enclosed the richest part of the site, as measured by stone artifact densities. These densities are greater than those published for most other excavated archaeological sites in Australia, although they may be exceeded by densities for materials found at Yarar Rockshelter (Flood, 1970) and at Ingaladdi (Mulvaney, personal commun.), both in Northern Territory.

There has developed among archaeologists in Australia a generally valid consensus based on the shared recognition for what might be termed a "feel" (Phillips, 1958, p. 123) for the way qualitative attributes are combined when artifacts are sorted into groups. However, many archaeologists today are taking steps to try to objectify their artifact classifications, mainly by determining metrical as well as qualitative attributes, and Australia is no exception. Thomas (1970, p. 33) has indicated the value of operational definitions of both attributes and classes of artifacts. By this he means definitions that are based on specified definienda, which will produce a high degree of agreement when reobserved. Such a classification should produce definitions that are objective and reliable. What follows is an attempt to make such a classification for the sample of stone tools excavated at Puntutjarpa and, to a lesser extent, for the samples collected from surface sites throughout the Western Desert.

This classification is intended to retain maximum consistency with the already existing typology in general use in the arid zones of Australia and should not be regarded as a repudiation of the typological system proposed by other scholars. It stands as a compromise between extreme precision of categorization on the one hand and looseness of categorization on the other. The stoneworking terminology used here follows that proposed by Crabtree (1972), and the format of presentation has been adapted from the typological key proposed by Tixier (1967) for Aterian points from the Maghreb and Sahara deserts of Africa.

SAMPLE SIZE AND GEOGRAPHIC COVERAGE

This classification is based entirely on samples of stone artifacts obtained: 1. from squares 1'-18 in Trench 2, Puntutjarpa Rockshelter. 2. From surface collections made at 122 sites in the Western Desert. Note that measurements of edge angle, weight, thickness, and width were obtained solely for excavated materials from Puntutjarpa. Examination of the surface collected materials has been limited to qualitative attributes only. Sample size here is considered adequate for all artifact types except Handaxes. Thus no typological description of handaxes will be offered here.

Figures 43 to 65 are Western Desert Stone Artifact Types.

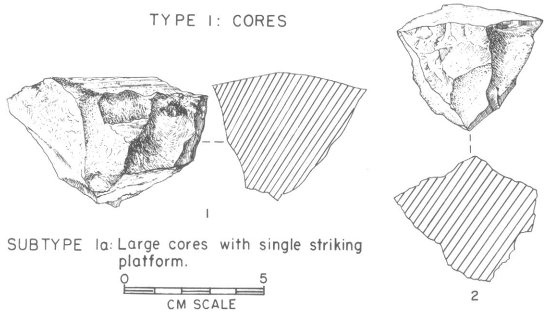


FIG. 43

Technique. Direct percussion with force applied in one direction along the margin of a single striking platform.

Defining Characteristics. Nuclei bearing scars resulting from flakes which have been detached from one direction. Range in weight from 472.9 to 9.7 grams, with a mean weight of 51.6 grams. Shape highly variable, but single striking platform always present. Cortex sometimes visible. No step terminations visible on flake scars.

References.
(1) Campbell and Edwards, 1966, fig. 18A.
(2) Gould, 1971, fig. 10.

SUBTYPE Ib: Horsehoof cores

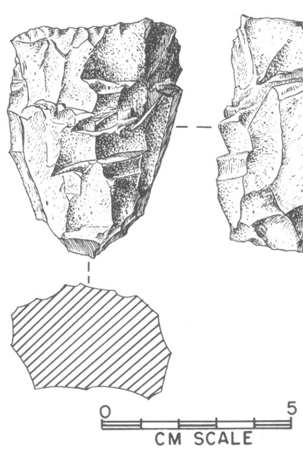


FIG. 44

Technique. Same as Subtype 1a.

Defining Characteristics. Same as Subtype 1a except for presence of step terminated flake scars (giving rise to an undercut edge along any portion of the striking platform). Range in weight from 460.2 grams to 21.0 grams, with a mean weight of 122.0 grams.

References.
(1) Tindale, 1937, pp. 49-56.
(2) Mulvaney and Joyce, 1965, pp. 176.
(3) Campbell and Edwards, 1966, fig. 18C-D.
(4) McCarthy, 1967, fig. 4-1.
(5) Mulvaney, 1969, figs. 31a-b; 34a.
(6) Gould, 1971, fig. 9.

SUBTYPE Ic: Large cores with multiple striking platforms

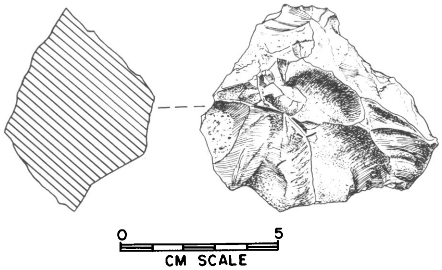


FIG. 45

Technique. Direct percussion with force applied in at least two directions.
Defining Characteristics. Nuclei bearing scars resulting from flakes which have been detached from two or more directions. Range in weight from 320.0 to 11.5 grams, with a mean weight of 48.3 grams. Cortex visible only on rare examples.
References.
(1) McCarthy, 1967, figs. 3-8.
(2) Gould, 1971, p. 152.

SUBTYPE Id: Micro-cores with single striking platforms

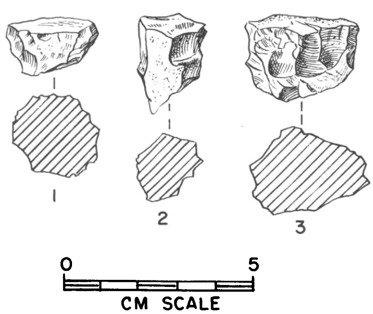


FIG. 46

Technique. Direct percussion with force applied in one direction along the margin of a single striking platform.
Defining Characteristics. Small nuclei bearing scars resulting from flakes which have been detached from one direction. Some specimens show presence of step terminated flake scars (giving rise to an undercut edge along any or all of the striking platform). Range in weight from 25.4 grams to 1.9 grams, mean weight 9.8 grams.
References. (1) Gould, 1971, fig. 16a-e.

SUBTYPE Ie: Micro-cores with multiple striking platforms

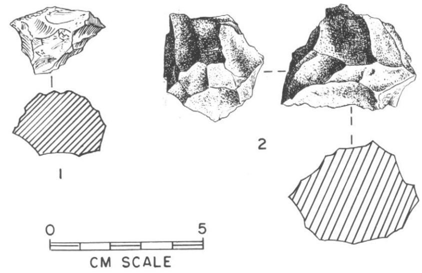


FIG. 47

Technique. Direct percussion with force applied in at least two directions.
Defining Characteristics. Small nuclei bearing scars resulting from flakes which have been detached from two or more directions. Range in weight from 18.9 grams to 1.6 grams, with a mean weight of 9.1 grams.
Reference. (1) Gould, 1971, fig. 16f.

TYPE 2: LARGE FLAKE-SCRAPERS

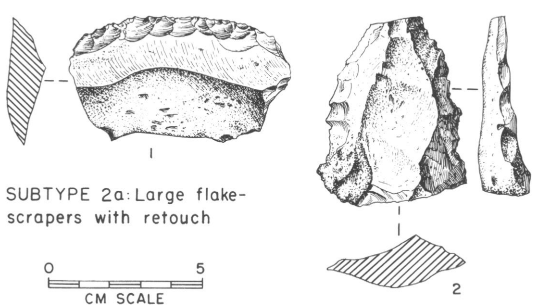


FIG. 48

Technique. Direct percussion flaking used to obtain flake and to shape the working edge.

Defining Characteristics. Unifacially retouched flakes, with retouch resulting from manufacture rather than use. No evidence of any effort to obtain flakes of regular size or shape either when initially struck from core or when trimmed. Retouch may be simple or scalar. On some specimens working edge is undercut by short step fractured flake scars. Range in weight from 108.2 grams to 2.0 grams, with a mean weight of 24.9 grams. Angle of working edge at mid-section ranges from 95° to 37°, with a mean of 70.5°. Range in maximum width from 7.3 cm. to 2.3 cm., with a mean of 4.3 cm. Range in maximum thickness from 3.5 cm. to 0.5 cm., with a mean of 1.7 cm.

References.
(1) Campbell and Edwards, 1966, fig. 20.
(2) McCarthy, 1967, pp. 28-29.
(3) Mulvaney, 1969, figs. 32, 36.
(4) Gould, 1971, fig. 11a-h.

SUBTYPE 2b: Spokeshaves

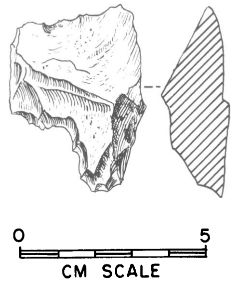


FIG. 49

Technique. Same as Subtype 2a except working edge shaped by use rather than by direct percussion.

Defining Characteristics. Unifacially retouched flakes, but retouch results from use-wear rather than manufacture. All specimens show varying degrees of concavity along working edge. Flakes irregular in shape. Range in weight from 42.3 grams to 3.2 grams, with a mean weight of 17.2 grams. Range in maximum width from 5.6 cm. to 2.7 cm., with a mean of 3.9 cm. Range in maximum thickness from 2.6 cm. to 0.6 cm., with a mean of 1.6 cm.

References.
(1) Campbell and Edwards, 1966, pp. 189-190.
(2) Gould, 1968, fig. 13, pp. 174-175.

TYPE 3: ADZES

SUBTYPE 3a: Tula adzes

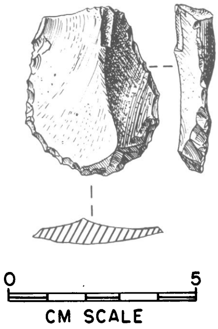


FIG. 50

Technique. Direct percussion to obtain flake and in most cases to provide retouch. Special mention should be made of retouch by pressure-flaking with teeth. This has been reported from the Western Desert (Thomson, 1964, p. 417; Tindale, 1965, p. 152; Gould, Koster, and Sontz, 1971, pp. 157-158), but it cannot be readily distinguished from direct percussion through examination of flake scars.

Defining Characteristics. Unifacially retouched scrapers fashioned on semi-discoidal flakes with working edge opposite striking platform though sometimes working edge may extend to lateral edges as well. Retouch may be simple or scalar. On some specimens working edge is undercut by short step fractured flake scars. Adze-flakes tend to be discoidal in shape. Range in weight from 19.0 grams to 2.7 grams, with mean weight of 6.8 grams. Angle of working edge at mid-section ranges from 87° to 39°, with a mean of 71.2°. Range in maximum width from 4.0 cm. to 2.0 cm., with a mean of 2.7 cm. Range in maximum thickness from 1.6 cm. to .7 cm., with a mean of 1.0 cm.

References.
(1) Campbell and Edwards, 1966, fig. 27, pp. 192-195.
(2) Gould, 1966, fig. 1A-D.
(3) McCarthy, 1967, figs. 11, 1-3, pp. 27-28.
(4) Mulvaney, 1969, figs. 10, 23, pp. 70-74.

SUBTYPE 3b: Tula adze slugs

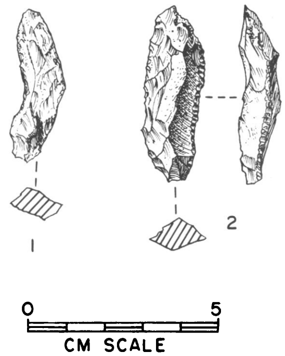


FIG. 51

Technique. Same as Subtype 3a.

Defining Characteristics. Same as Subtype 3a, but worn down through successive phases of use and re-sharpening to a narrow slug shape. On some specimens retouch appears on both the edge opposite the striking platform and on the striking platform itself (in a few cases obscuring the entire striking platform). Diamond-shaped (i.e., four-sided) cross section. Range in weight from 11.1 grams to 1.8 grams, with a mean weight of 4.4 grams. Angle of working edge at mid-section ranges from 96° to 39°, with a mean of 70.4°. Range in maximum width from 4.4 cm. to 1.0 cm., with a mean of 3.1 cm. Range in maximum thickness from 2.0 cm. to .6 cm., with a mean of 1.0 cm.

References.
(1) Campbell and Edwards, 1966, fig. 27.
(2) Gould, 1966, fig. 2A-E.
(3) McCarthy, 1967, figs. 11, 4-5.
(4) Mulvaney, 1969, figs. 10, 23.
(5) Gould, 1971, fig. 13a-f.

SUBTYPE 3c: Non-Tula adzes

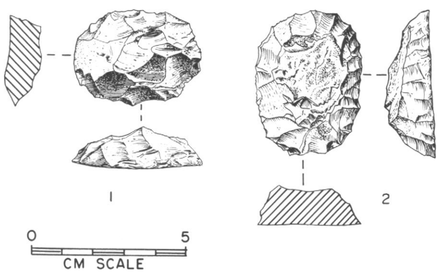


FIG. 52

Technique. Same as Subtype 3a.

Defining Characteristics. Same as Subtype 3a except that the working edge or edges occur along the lateral edges of the flake. Many flakes less regular in shape than Subtype 3a. Range in weight from 32.1 grams to 3.1 grams, with a mean weight of 8.7 grams. Angle of working edge at midsection ranges from 83° to 51°, with a mean of 68.3°. Range in maximum width from 4.6 cm. to 2.3 cm., with a mean of 3.1 cm. Range in maximum thickness from 1.5 cm. to 0.7 cm., with a mean of 1.0 cm. A few of these scrapers show retouch around the entire margin of the flake. Many of these have been termed "burren" adzes by McCarthy and other workers.

Reference. (1) Mulvaney, 1969, pp. 73-74.

SUBTYPE 3d: Non-Tula adze slugs

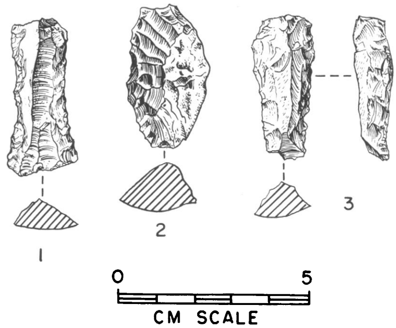


FIG. 53

Technique. Same as Subtype 3a.

Defining Characteristics. Same as Subtype 3c, but worn down through successive phases of use and resharpening to a narrow slug shape. On many specimens retouch appears on both lateral edges of the flake. Triangular or trapezoidal cross section. Range in weight from 16.8 grams to 0.8 grams, with a mean weight of 5.0 grams. Angle of working edge at midsection ranges from 94° to 57°, with a mean of 70.7°. Range in maximum width from 4.3 cm. to 2.3 cm., with a mean of 3.0 cm. Range in maximum thickness from 2.0 cm. to 0.6 cm., with a mean of 11.0 cm. Many of these have been termed "burren" adze slugs by McCarthy and other workers.

References.
(1) McCarthy, 1967, fig. 11, no. 6-10.
(2) Mulvaney, 1969, fog. 12.
(3) Gould, 1971, fig. 13g-k.

SUBTYPE 3e: Tula micro-adzes

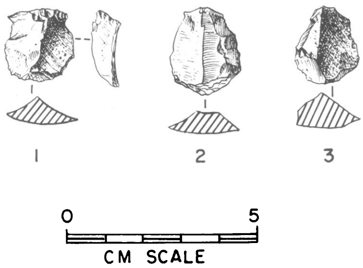


FIG. 54

Technique. Same as Subtype 3a.
Defining Characteristics. Same as Subtype 3a except for size. Range in weight from 5.8 grams to 0.8 grams, with a mean weight of 2.1 grams. Angle of working edge at midsection ranges from 91° to 38°, with a mean of 67.8°. Range in maximum width from 2.6 to 1.4 cm., with a mean of 1.9 cm. Range in maximum thickness from 2.0 cm. to 0.4 cm., with a mean of 0.7 cm. Sometimes referred to by McCarthy and other workers as "thumbnail scrapers."
Reference. (1) Gould, 1971, p. 155.

SUBTYPE 3f: Tula micro-adze slugs

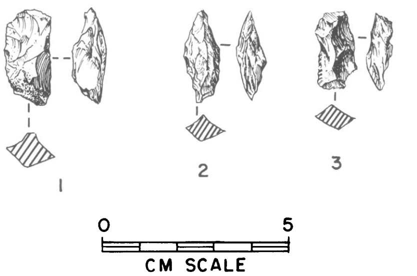


FIG. 55

Technique. Same as Subtype 3a.
Defining Characteristics. Same as Subtype 3e, but worn down through successive phases of use and resharpening to a narrow adze slug shape. Few specimens show signs of retouch and use wear on more than one edge (i.e., the edge opposite the striking platform). Diamond-shaped (i.e., four-sided) cross section. Range in weight from 2.1 grams to 0.6 grams, with a mean weight of 1.3 grams. Angle of working edge at midsection ranges from 86° to 53°, with a mean of 70.6°. Range in maximum width from 2.4 cm. to 1.4 cm., with a mean of 2.0 cm. Range in maximum thickness from 0.9 cm. to 0.4 cm., with a mean of 0.6 cm.
Reference. (1) Gould, 1971, fig. 12k-m.

SUBTYPE 3g: Non-Tula micro-adzes

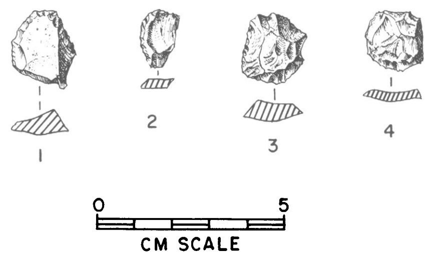


FIG. 56

Technique. Same as Subtype 3a.
Defining Characteristics. Same as Subtype 3c except for size. Range in weight from 5.1 grams to 0.6 grams, with a mean weight of 1.9 grams. Angle of working edge at midsection ranges from 89° to 27°, with a mean of 66.9°. Range in maximum width from 2.9 cm. to 0.6 cm., with a mean of 1.8 cm. Range in maximum thickness from 2.0 cm. to 0.5 cm., with a mean of 0.8 cm. Sometimes referred to by McCarthy and others as "thumbnail scrapers."
References.
(1) Campbell and Edwards, 1966, fig. 33H.
(2) McCarthy, 1967, fig. 25, no. 237.
(3) Gould, 1971, p. 155.

SUBTYPE 3h: Non-Tula micro-adze slugs

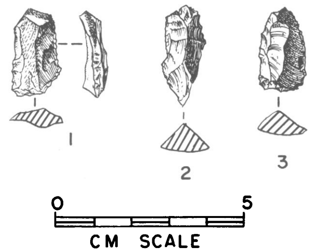


FIG. 57

Technique. Same as Subtype 3a.
Defining Characteristics. Same as Subtype 3g, but worn down through successive phases of use and resharpening to a narrow slug shape. Few specimens show signs of retouch and use wear on more than one edge (i.e., one lateral edge of the flake). Triangular or trapezoidal cross-section. Range in weight from 2.3 grams to 0.5 grams, with a mean weight of 1.2 grams. Angle of working edge at midsection ranges from 85° to 45°, with a mean of 63.6°. Range in maximum width from 2.5 cm. to 1.2 cm., with a mean of 1.8 cm. Range in maximum thickness from 0.8 cm. to 0.3 cm., with a mean of 0.6 cm.
Reference. (1) Gould, 1971, fig. 12n-p.

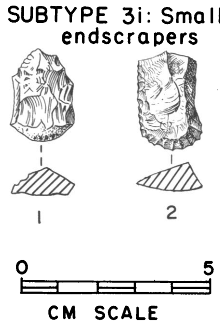


FIG. 58

Technique. Same as Subtype 3a.
Defining Characteristics. Unifacially retouched scrapers fashioned on end of elongated flakes (at least twice as long as they are wide), with working edge opposite striking platform. Retouch may be simple or scalar. On some specimens working edge is undercut by short step fractured flake scars. Range in weight from 8.6 grams to 2.1 grams, with a mean weight of 3.7 grams. Angle of working edge at midsection ranges from 85° to 44°, with a mean of 66.0°. Range in maximum width from 3.9 cm. to 2.0 cm., with a mean of 2.6 cm. (Note: this is in fact a measurement of the maximum length of the flake, for, unlike the other adzes and micro-adzes, these tools are characteristically longer than they are wide.) Range in maximum thickness from 2.0 cm. to 0.5 cm., with a mean of 0.9 cm.
References.
(1) Campbell and Edwards, 1966, fig. 24.
(2) McCarthy, 1967, fig. 25, no. 235-236.
(3) Gould, 1971, fig. 14a-c.

TYPE 4: BACKED BLADE

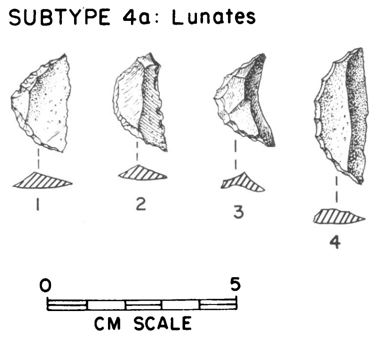


FIG. 59

Technique. Percussion-flaked or "chimbled" (Dickson, 1973) blade or elongated flake which has had one margin dulled by removing a series of flakes from the lateral margin opposite the sharp edge.
Defining Characteristics. Blades with symmetrical crescentic outline, blunted along entire curved edge. Cross section may be triangular or semi-trapezoidal. Range in weight from 4.3 grams to 0.4 grams, with a mean weight of 1.4 grams. Range in maximum length from 3.0 cm. to 1.1 cm., with a mean of 2.1 cm. Range in maximum thickness from .7 cm. to 0.3 cm., with a mean of 0.5 cm.
References.
(1) Campbell and Edwards, 1966, fig. 33C-D, F-G.
(2) McCarthy, 1967, fig. 25, nos. 185, 187, 190, 224-225, 231.
(3) Mulvaney, 1969, fig. 29a, c-e, g.
(4) Gould, 1971, fig. 15a-c.

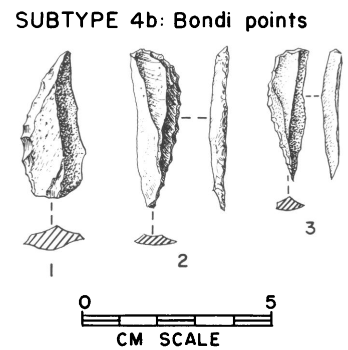


FIG. 60

Technique. Same as Subtype 4a.

Defining Characteristics. Same as Subtype 4a except for asymmetrical outline, with one end rounded and the other to a point. Range in weight from 2.2 grams to 0.3 grams, with a mean weight of 0.9 grams. Range in maximum length from 2.9 cm. to 1.3 cm., with a mean of 2.0 cm. Range in maximum thickness from 1.0 cm. to 0.2 cm. with a mean of 0.5 cm.

References.

(1) Campbell and Edwards, 1966, fig. 33E.
(2) McCarthy 1967, fig. 24, nos. 134, 137, 145-146.
(3) Mulvaney, 1969, plate 48a-b.
(4) Gould, 1971, fig. 15d.

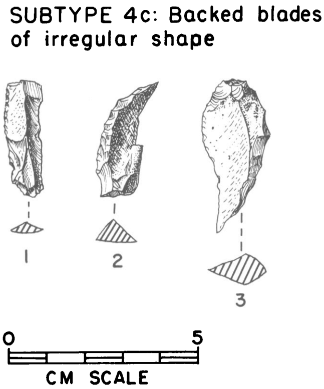


FIG. 61

Technique. Same as Subtype 4a.

Defining Characteristics. Same as Subtype 4a except for variability of outline and tendency on some specimens for blunting to extend over only parts of the curved edge. Range in weight from 3.0 grams to 0.4 grams, with a mean weight of 1.3 grams. Range in maximum length from 3.0 cm. to 1.4 cm., with a mean of 2.1 cm. Range in maximum thickness from 0.6 cm. to 0.4 cm., with a mean of 0.5 cm.

References.

(1) McCarthy 1967, fig. 24, nos. 132, 151; fig. 25, nos. 194, 201, 217.
(2) Gould, 1971, fig. 15, e-g.

PROVISIONAL TYPE 5: HANDAXES

Remarks. A single large, unifacially retouched stone tool was found at Puntutjarpa which resembles the modern Western Desert Aborigine handaxe described by Tindale (1941). On the basis of technological and formal criteria it would be reasonable to include this specimen with Subtype 1a, Large Core with Single Striking Platform, in a manner analogous to that suggested by Crosby under the heading of "cliffed scrapers" (Crosby, 1971, pp. 162-163, fig. 5). No doubt many of the largest examples of Type 1 Large Cores could have served as handaxes and scraper-planes, but this does not mean that all large cores were used in this manner. Many may have served as a source of flakes and nothing more. This provisional type category was introduced mainly for the purpose of calling attention to this problem.

References.

(1) Tindale, 1941, pl.E.
(2) Gould, Koster, and Sontz, 1971, fig. 6.

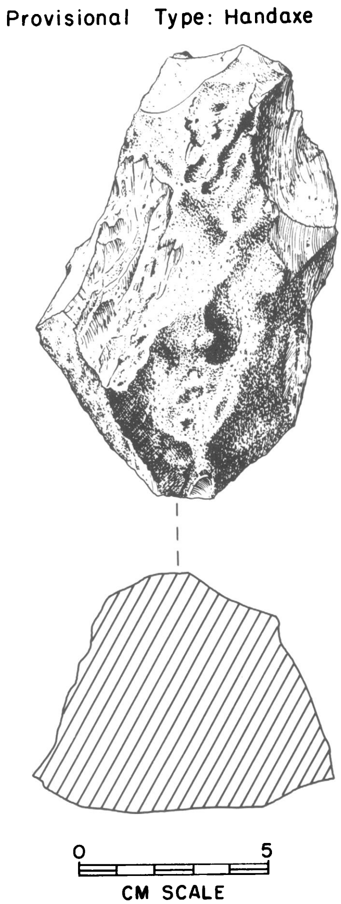


FIG. 62

TYPE 6: SEED-GRINDERS

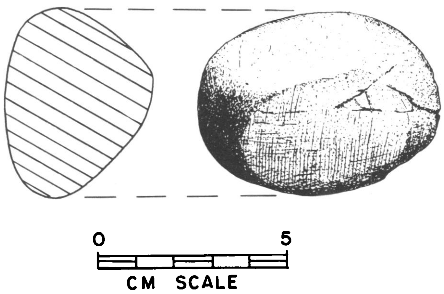


FIG. 63

Techniques. Faceted cobbles which have acquired their final shape entirely as a result of abrasion against other rocks during use.

Defining Characteristics. Cobbles with faceting or signs of abrasion appearing on at least one surface. In many cases, abrasion appears on the ends as well as the top and bottom surfaces, and the ends may, at times, be pitted, indicating use in pounding as well as grinding. Most specimens at Puntutjarpa and in surface collections were fragmentary, so no measurements or weights were attempted.

References.
(1) Campbell and Edwards, 1966, figs. 14-16.
(2) McCarthy, 1967, fig. 45, nos. 4-6, 9-10.
(3) Gould, Koster, and Sontz, 1971, fig. 14a-d.
(4) Gould, 1971, fig. 19.

TYPE 7: GRINDING-SLABS

Technique. Worn surfaces formed by rock abrasion during use.

Defining Characteristics. Flat rock slabs with at least one surface showing signs of abrasion. Slabs are otherwise unshaped and vary greatly in size.

References.
(1) Campbell and Edwards, 1966, fig. 16, p. 179.
(2) Gould, Koster, and Sontz, 1971, fig. 13.

TYPE 8: HAMMERSTONES

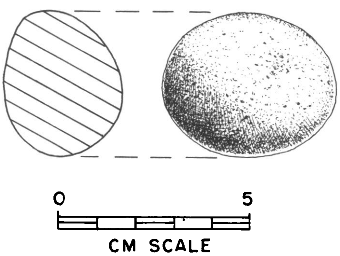


FIG. 64

Technique. Pitting resulting from direct percussion in shaping other stone tools.

Defining Characteristics. Small pebbles showing signs of pitting on one or more ends or edges. Otherwise unshaped.

References.
(1) Campbell and Edwards, 1966, fig. 11.
(2) McCarthy, 1967, fig. 41, nos. 6, 8.

PROVISIONAL TYPE 9: RETOUCHED FRAGMENTS AND UTILIZED FLAKES

Remarks. This is a residual category made up of retouched fragments and tools which cannot be classified into the preceding types and subtypes. No attempt is made here to distinguish between retouch resulting from intentional trimming and retouch as a result of use-wear and edge-damage. Future analysis may provide further information about this category of materials, and close examination of flake material from Puntutjarpa is urged in order to detect patterns of use-wear and edge-damage.

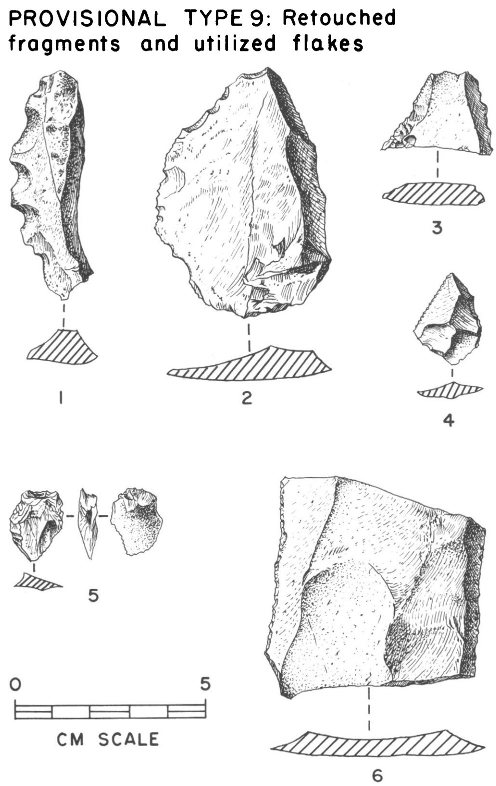


FIG. 65

In this preliminary classification of stone artifacts from the Western Desert of Australia, note that the differences between types are multiple in nature, but the differences between subtypes are unitary. That is, types stand apart on the basis of differences in several attributes, whereas subtypes differ with respect to a single attribute. In cases where a type consists of several subtypes, I have chosen to present the specific attributes in terms of the subtypes. The reader may, if he wishes, deduce the multiple attributes that make up each type by comparing the subtypes, but from a practical point of view this is rarely necessary, since most comparisons and identifications based on materials collected in the field occur on the subtype level of generalization. This approach to artifact description was found to be more convenient for the fieldworker and laboratory typologist than a presentation in which each type was described in detail followed by single-attribute descriptions of each subtype.

To get a clearer idea of how this classification works, one should look at the different subtypes under the type heading, *Adzes*. To begin with, Adzes as a type differ from Large Flake-scrapers with respect to; 1. overall size (that is, weight, maximum width, and maximum thickness). Large Flake-scrapers, of whatever subtype, are larger with respect to the means of all three of these measurements than are all adzes, of whatever subtype. Although the extremes of some of these measurements may overlap in individual specimens belonging to different types and/or subtypes, in no case in this classification will one find that all three size attributes overlap simultaneously in any one specimen; 2. retouch, which differs both in terms of quality and positioning on the flake: and 3. overall regularity of flake shape. On the subtype level, Tula Adzes differ from Non-Tula Adzes primarily in terms of the position of the retouched edge or edges in relation to the striking platform of the flake. Tula Adze Slugs differ from Non-Tula Adze Slugs primarily in terms of cross section, which is in turn a function of the position of the retouched edge or edges in relation to the striking platform. Slugs, of course, differ from Adzes mainly in size (mainly as reflected in weights, since maximum width and thickness are not much affected by the process of adze reduction through use and resharpening). Micro-adzes and Micro-Adze slugs conform to the same general pattern of Adzes but are much smaller overall. Tables 6 through 8 summarize the differences in size between these Adze and Flake-scraper subtypes.

This classification also describes uniformities that cut across types and subtypes but which may prove useful in making functional comparisons. Compare, for example, the distribution

TABLE 6
Summary of Maximum Width Measurements (in Cm.) of Large Flake-scrapers (Type 2) and Adzes (Type 3)

Subtype	Maximum	Mininum	Mean
Large Flake-scrapers			
2a	7.3	2.3	4.3
2b	5.6	2.7	3.9
Adzes			
3a	4.0	2.0	2.7
3b	4.4	1.0	3.1
3c	4.6	2.3	3.1
3d	4.3	2.3	3.0
Micro-Adzes			
3e	2.6	1.4	1.9
3f	2.4	1.4	2.0
3g	2.9	0.6	1.8
3h	2.5	1.2	1.8
3i	3.9	2.0	2.6

TABLE 7
Summary of Weight Measurements (in Grams) of Large Flake-scrapers (Type 2) and Adzes (Type 3)

Subtype	Maximum	Minimum	Mean
Large Flake-scraper			
2a	108.2	2.0	24.9
2b	42.3	3.2	17.2
Adzes			
3a	19.0	2.7	6.8
3b	11.1	1.8	4.4
3c	32.1	3.1	8.7
3d	16.8	0.8	5.0
Micro-Adzes			
3e	5.8	0.8	2.1
3f	2.1	0.6	1.3
3g	5.1	0.6	1.9
3h	2.3	0.5	1.2
3i	8.6	2.1	3.7

TABLE 8
Summary of Maximum Thickness Measurements (in Cm.) of Large Flake-scrapers (Type 2) and Adzes (Type 3)

Subtype	Maximum	Minimum	Mean
Large Flake-scrapers			
2a	3.5	0.5	1.7
2b	2.6	0.6	1.6
Adzes			
3a	1.6	0.7	1.0
3b	2.0	0.6	1.0
3c	1.5	0.7	1.0
3d	2.0	0.6	1.1
Micro-Adzes			
3e	2.0	0.4	0.7
3f	0.9	0.4	0.6
3g	2.0	0.3	0.7
3h	0.8	0.3	0.6
3i	2.0	0.5	0.9

of edge-angle measurements of the midsection of the working edge of Adzes (Subtypes 3a-d) and Micro-adzes (Subtypes 3e-i) shown in tables 9 and 10. The low value for t in table 10 indicates virtual identity for these two populations of artifacts in terms of this particular attribute, despite differences in the size of the artifacts. Furthermore, the mean edge angle measurement for Subtype 2a (Large Flake-scrapers with Retouch) is 70.5°, a difference of less than 3° from the edge angles of both Adzes and Micro-adzes. Looked at another way, the mean edge angle of the working edge for Large Flake-scrapers with Retouch, all Adzes and Adze Slugs, all Micro-adzes and Micro-adze Slugs, and Small End-scrapers varied between 63.6° and 71.2°, a difference of only 7.6°. In a sample of 535 specimens this evidence indicates a remarkable uniformity in this one attribute in spite of other typological differences. Here we have distinguished between these types; later on it will be necessary to examine this and other uniformities, particularly in the light of possible functional explanations. Conversely, all Cores described in this key were sources of flakes, regardless of whether or not some of them may have served a secondary function as handaxes or scraper-planes. Possible distinctions between Cores that served solely as sources for flakes and Cores that served additionally as tools did not enter into this classification and remain a problem awaiting further study. Thus the key should be regarded as a first step toward a fully operational classification of the stone artifacts of the Western Desert of Australia.

THE "SMALL TOOL TRADITION" AT PUNTUTJARPA

In their discussion of the stone tools found at the Lake Mungo sites in western New South Wales, Jones and Allen offer a basic typology for this important early collection (Bowler, Jones,

TABLE 9
Summary of Edge-Angle Measurements (in Degrees) of Midsection of Working Edge of Adzes (Subtypes 3a-d) and Micro-Adzes (Subtypes 3e-i)

Subtype	Steepest	Most Acute	Mean
Adzes			
3a	87	39	71
3b	96	39	70
3c	83	51	68
3d	94	57	71
Micro-Adzes			
3e	91	38	68
3f	86	53	71
3g	89	27	67
3h	85	45	64
3i	85	44	66

TABLE 10
Distribution of Edge-Angle Measurements of Midsection of Working Edge of Adzes (Subtypes 3a-d) and Micro-Adzes (Subtypes 3e-i)

Degrees	Adzes	Micro-Adzes
19-29	0	1
30-39	3	1
40-49	2	11
50-59	19	31
60-69	47	51
70-79	41	53
80-89	30	34
Totals	142	182
Mean Edge-Angle	69.5	67.2
t 1.8303		

Allen, and Thorne, 1970, pp. 48-52). The assemblage they describe contains artifacts like horsehoof cores and a variety of large flake-scrapers that bear some obvious resemblances to much of the material excavated at Puntutjarpa and collected at surface sites in the Western Desert, not to mention the resemblances with excavated materials from many other sites elsewhere in Australia. Jones and Allen have proposed that the Mungo assemblage and others like it be termed the "Australian core tool and scraper tradition." Bowler, Jones, Allen, and Thorne (1970, p. 52) observed that:

"Within this tradition there were many variants both in time and space; however, it survived on the mainland [of Australia] from at least 25,000 or 30,000 years ago to about 6,000 B.P. when it was replaced, or added to, by a complex of point, backed microlith and adze flake elements."

In 1969 I proposed that a similar kind of framework be applied to all small stone tools in Australia—the "Australian small-tool tradition" (Gould, 1969, p. 235). This concept embraces a wide range of types, including pirri points, Kimberley points, backed blades of various shapes and sizes, Micro-adzes and Micro-adze slugs, Adzes and Adze slugs, and others. While it is presumed likely that most or all of these types of small chipped stone tools were hafted when used (Mulvaney, 1966, pp. 87-88), it should also be noted that certain ethnographic New Guinea people have been observed making use of tiny, untrimmed stone flakes for cutting purposes, suggesting that small size alone is not necessarily indicative of hafting (J. P. White, personal commun.).

The concept of stone toolmaking "traditions" in these two cases is not all-encompassing in terms of culture or technology as a whole. A tradition can exist alongside other traditions, as indeed appears to be the case at Puntutjarpa and other stratified sites in Australia. Also, variations or subtraditions can exist within a tradition, providing a conceptual framework for considering localized variations in time and space. Implicit, too, in the idea of technological traditions of these kinds is the element of historical continuity. In the Western Desert generally and at Puntutjarpa in particular, Subtypes 1a-c and 2a-b fit within the "core tool and scraper tradition," whereas Subtypes 1d-e, 3a-i, and 4a-c belong within the "small tool tradition." This broad distinction is based mainly on differences in size, with the comparison of these two toolmaking traditions based entirely upon recognition and analysis of recognizable chipped stone tools or cores. Since the tradition concept does appear to have some utility and is showing signs of gaining acceptance in Australia, an attempt at a quantitative expression of the differences between these traditions seems in order, especially in light of the large sample of artifact material afforded by the Puntutjarpa excavation.

Looked at in these terms, the Puntutjarpa sample contains 403 stone tools and cores classifiable within the core tool and scraper tradition and 614 stone tools and cores within the small tool tradition. Table 11 shows a comparison between the weights of Large Cores (Subtypes 1a-c) and Micro-cores (Subtypes 6a-b). Table 7 shows a comparison between the weights of Large Flake-scrapers (Subtypes 2a-b) and small scrapers (i.e., Adzes and Micro-adzes, including Subtypes 3a-i). These same subtypes are compared in the same manner in terms of maximum width and maximum thickness in tables 6 and 8, respectively. As all four of these tables indicate there is a significant difference in overall size between the stone artifacts that make up these two traditions at Puntutjarpa. Subtypes 4a-c (Backed Blades) are not presented in these tables, but, as the measurements recorded in the key suggest, they, too, fit well within the framework of the small tool tradition.

TABLE 11
Summary of Weight Measurements (in Grams) of Large Cores (Subtypes 1a-c) and Micro-Cores (Subtypes 1d-e)

Subtype	Maximum	Minimum	Mean
Large Cores			
1a	472.9	9.7	51.6
1b	460.2	21.0	122.2
1c	320.0	11.5	48.3
Micro-Cores			
1d	25.4	1.9	9.9
1e	18.9	1.6	9.1

VI: STONE ARTIFACT ANALYSIS

The preceding classification of stone tools has not attempted to present any interpretations regarding possible functions of the different classes of stone artifacts found at Puntutjarpa. It could be argued, of course, that use of terms like adze and micro-adze presupposes some kind of functional interpretation aimed at inferring woodworking usage, but it should be noted that these terms have gained widespread acceptance among Australian archaeologists to the point of becoming conventions. Rather than inject a note of confusion by introducing a new term I chose instead to conform to current usage, even at the risk of some ambiguity. My earlier use, in Chapter V, of terms like adze and micro-adze was not intended to assume function. Rather, the correlation of form and function is regarded here as a proposition in constant need of testing by various means.

FORM AND FUNCTION IN WESTERN DESERT STONE ARTIFACTS

There are several ways in which one may approach the question of function in the study of stone tools. One may, for example, examine the contemporary uses of stone artifacts either in the area where one is excavating or in other areas. In the latter case, it is sometimes possible to develop useful models of tool-use which can be applied to comparable cultures with comparable technologies. In the Western Desert of Australia, however, it has been possible to study at firsthand the uses of present-day aborigine stone artifacts, many of which bear close resemblances to certain classes of prehistoric artifacts excavated at Puntutjarpa. A detailed description of the present-day Western Desert aborigine stone toolkit, including observed functions of these tools, has been published (Gould, Koster, and Sontz, 1971). Also, one can adopt an experimental approach to the replication and close examination of such attributes as retouch, use-wear, and edge-damage patterns, using a microscope for this examination. Important pioneer work along these lines was carried out by Semenov (1964), and a recent bibliography on this approach has been compiled by Hester and Heizer (1973).

In this chapter I look at each stone artifact subtype, as defined in Chapter V, in terms of whatever correlative data may presently be available from ethnographic observations and/or replicative experiments and microscopic examination. Note that in this study the primary emphasis was on ethnographic observation, because it was clear that replacement of stone tools by tools made of metal was proceeding rapidly in the Western Desert. During 1966-1970 it was still possible to observe stone tools in regular use among some Western Desert people, but this was already a matter of some urgency. I and my associates carried out some limited replicative experiments and microscopic studies focused on particular problems related to the interpretation of specific classes of Western Desert tools, but these were never as extensive as the ethnographic observations. The results of these experiments are, to an extent, tentative, and should not be applied at this time to comparable materials from other parts of the world except in a trial fashion.

Except for Type 6 (Seed-grinders) and Type 7 (Grinding-slabs), all of the stone tool types and subtypes found at Puntutjarpa appear to be representative of what Binford and Binford (1969, p. 71) called "maintenance" tools–that is, tools for making and maintaining other tools. Only the seed-grinding implements appear to qualify as "extractive" tools related directly to the procurement of food and necessary raw materials. This fact, which is common to many Australian archaeological assemblages, means that it may always be difficult to draw inferences about prehistoric economic activities directly from stone tools. Or, stated in another way, conclusions drawn from analysis of stone tools at Puntutjarpa pertain primarily to technological patterns and changes do not of necessity imply corresponding changes in economic patterns. One could, in fact, conceive of a situation in which an archaeological sequence showing dramatic changes in economy (such as a shift from hunting-and-gathering to cultivation) at the same time shows little if any change in stone technology. Present evidence suggests that something like this may indeed be true for the prehistory of much of New Guinea (White, 1972), but the reverse proposition could also operate, namely that changes in stone tool technology may occur even when the economic adjustment of the culture remains stable throughout the sequence. These cautionary remarks should suggest something of the magnitude of the problem the archaeologist faces (especially at Puntutjarpa) when attempting to analyze stone tools in terms of past human behavior. The analysis here is only a first step in that direction, and a fairly tentative step at that. As the analysis proceeds I shall try to indicate areas where further work is needed and suggest approaches which might accomplish more with the data. I hope that colleagues of mine will eventually make use of the Puntutjarpa collections to pursue these questions with new and more sophisticated techniques.

Type 1–Cores. Subtypes 1a (Large Cores with Single Striking-platform) and 1c (Large Cores with Multiple Striking-platforms) have been observed in use among present-day Western Desert aborigines both as sources of flakes and, sometimes, as tools in their own right. The weights of six contemporary cores which were collected and turned over to the American Museum of Natural History fitted within the ranges indicated for these two subtypes in Chapter V. Large Cores with Single Striking-platform in particular were used as hand-held choppers and scraper-planes for heavy-duty woodworking tasks such as removal and primary finishing of spearthrower blanks and for roughing-out implements like clubs and throwing-sticks. On all occasions observed in this study these large cores were used to work only the very hardest woods–*Acacia aneura* (mulga), from which most Western Desert implements are made. At no time were these large cores observed in use as weapons, projectiles, digging implements, or percussors. When used as woodworking tools these cores were applied either with a chopping motion (as in making the V-shaped incision on the trunk of a mulga tree, preparatory to prying off a slab of wood for making into a spearthrower) or a scraping motion toward the operator. Macroscopically visible damage to the working edge of the tool usually appeared quickly, and the core-tool was discarded as it became dull. I never observed any attempt to resharpen such a tool. All the large cores that were seen ethnographically being secondarily used as heavy woodworking tools were made of coarse-grained stone like Warburton porphyry or quartzite, and from macroscopic inspection I was often unable to distinguish the edge-damage arising through use of this kind from battering caused by percussion-flaking during flake removal. A blow with a hammerstone directed too far in from the edge of the striking platform tends to crush the edge of the striking platform, and this kind of rather careless percussion flaking was fairly common among the aborigines observed. Also, at no time did I see any effort made to grind the edge of the striking platform before the blow was struck. Without such preparation even an experienced stoneworker may damage the edge of the striking platform during the process of flake removal.

Thus while many of the Large Cores with Single-striking Platform (and note also some of the Horsehoof Cores) from the Puntutjarpa collection show battering and damage along the edge of the striking platform, I hesitate to ascribe this edge-damage to use in working hard woods. In fact, most of the Large Cores (Subtypes 1a and 1c) I observed among the Western Desert aborigines were used exclusively as a source of flakes and were never secondarily used as tools. So one should be especially careful not to assume that the presence of battering along the edge of the striking platform on such cores indicates secondary use in woodworking or for any other purpose. Perhaps microscopic studies of large cores from ethnographic and archaeological collections in Australia can reveal patterns that will enable archaeologists to discriminate between these alternatives, and such examination should be encouraged.

True Horsehoof Cores (Subtype 1b) were never observed being manufactured or used by the present-day aborigines, although two Large Cores with Single Striking-platform seen manufactured at Partjaṛ, in the Clutterbuck Hills, in January, 1967, were fairly similar to Horsehoof Cores in general shape and had one or two large, abruptly terminated flakes removed from the perimeter of the core. These two examples could perhaps be classified as Horsehoofs, but I do not regard them as conclusive evidence that contemporary aborigines of this region are still making this type of core. Informal discussions with Birdsell and Tindale have suggested the strong possibility that true Horsehoof Cores were being produced and sometimes secondarily used as choppers and scraper-planes for heavy woodworking by historic aborigines in the Western Desert, but it is equally clear that the ethnographic sampling on this point has been both inadequate and uncontrolled. From a technological rather than a formal point of view, there is little difference between a Large Core with Single Striking-platform and a Horsehoof Core (the main difference being in the degree to which the stone-chipper attempted to remove more than one row of flakes from the perimeter of his single striking-platform core), and it may be that Australian archaeologists have tended to treat Horsehoofs as a more distinct and special category than is warranted. Another possibility is that the additional flake removal, which is so characteristic of Horsehoofs and tends to give them their distinctive domed shape, may have been intended to resharpen the working edge in an effort to extend their useful life as secondary woodworking tools. I should emphasize again that this is not a pattern which I ever observed among Western Desert aborigines, but it is a logical possibility which ought to be considered.

Finally, one general point to consider in connection with all Large Cores (i.e. Subtypes 1a, 1b, and 1c) is the tendency, mentioned earlier, of such cores to be manufactured out of relatively coarse-grained stone. Among the artifacts excavated from Trench 2 at Puntutjarpa in 1969-1970, 214 of these Large Cores were found. Of these 186 were Subtypes 1a and 1c, and 82.3 percent, or 153 specimens, were made either of quartz, quartzite, or Warburton porphyry—all exceedingly coarse-grained rocks. In the case of Horsehoof Cores (Subtype 1b) the correlation is even closer. Here, out of 28 specimens, 27—that is, 96.4 percent—were made of quartz, quartzite, or Warburton porphyry. Microscopic examination of striking-platform edges of samples of these Large Cores at different magnifications up to 50X failed to reveal any clear signs of striations, polish, or micro-fractures, mainly because these features, if they were present, could not be distinguished from the irregularities of the natural surface of the raw material. Until a way is found to detect such microscopic wear patterns on the surfaces of coarse-grained rocks like quartz, quartzite, and porphyry it will be hard to say with any certainty which of these Large Cores ever saw secondary use as choppers and scraper-planes in working hardwoods.

Nothing like the Micro-cores (Subtypes 1d and 1e) from Puntutjarpa were ever seen being produced in the Western Desert, with one possible exception. An elderly Pitjantjatjara-speaking man, originally from the area near Mt. Davies, South Australia, but then residing at the Warburton Ranges Mission, showed me a Micro-Core with Multiple Striking-Platforms made of clear quartz. He insisted that he had made this core and used both the core and the flakes from it as mapaṇpa, that is, as objects of sorcery in curing. This Micro-Core is now in the collections of the American Museum of Natural History. In terms of weight and other attributes this was a good example of a Micro-Core with Multiple Striking-Platforms, as defined in Chapter V, but its ethnographic context is somewhat unusual. I never actually saw the flakes from this Micro-Core, and I cannot confirm that this aborigine made it himself, as he had claimed.

Type 2—Large Flake-Scrapers. Examples of Subtypes 2a (Large Flake-scrapers) and 2b (Spokeshaves) were widely seen in use as handheld woodworking tools among Western Desert aborigines in 1966-1970. Both subtypes were used in the same way, held at an angle of between about 20 and 40 degrees from the surface being worked and drawn toward the operator with one hand while the other hand steadied the piece of hardwood being worked. All the ethnographic examples of Subtype 2a were retouched initially by means of direct freehand percussion with a hammerstone, and subsequent resharpenings were accomplished in the same way. Once I observed an elderly Ngatatjara-speaking man from the Rawlinson Range area using a Large Flake-scraper with a handle of spinifex resin about 3-1/2 inches long, but in every other case the tool lacked even this kind of minimal hafting. The process of resharpening eventually leads to rows of small step-fractures along the working edge of the tool, and the angle of the working edge at midsection among these ethnographic specimens conforms closely to the range of edge-angle measurements shown for this subtype in Chapter V. These modern tools were used exclusively for scraping hardwoods such as mulga and various eucalypts used in making spearshafts. The same was true of Spokeshaves (Subtype 2b), which, however, lacked any kind of intentional retouch. These were used mainly for smoothing spearshafts and sometimes for shaping and sharpening spearpoints of mulga wood. Viewed macroscopically, the pattern of use-retouch on tools of this subtype is fairly distinctive, resulting in a concave and sometimes step-fractured working edge. In general, the thickness of the flakes on which Spokeshaves were fashioned appeared to be more variable than was the case with Flake-scrapers, but this point was not checked metrically.

To a lesser extent than in the case of Large Cores, there was a tendency for Flake-scrapers and Spokeshaves to be made of coarse-grained stone. Out of 189 examples of these two subtypes excavated in Trench 2 at Puntutjarpa in 1969-1970, 111 (that is, 58.8%) were made of quartz, quartzite, or Warburton porphyry. Thus the same problem of discriminating between use-wear patterns and the rough natural surface texture of the stone as seen in the case of Large Cores arose when the bulbar face of the working edge was examined microscopically on each artifact. On examples made from fine-grained stone like white chert there is at least a possibility of detecting signs of edge-damage and/or wear arising from use, but for the majority of specimens microscopic edge-wear study proved inconclusive.

Type 3–Adzes and Adze-Slugs. Of all the types and subtypes reported on here, Subtypes 3a-3d are perhaps the best documented ethnographically and at the same time among the most distinctive and commonly encountered varieties of stone tool found at sites in the Western Desert. A detailed description of the characteristics of ethnographically observed Adzes and Adze-Slugs is presented in Gould, Koster, and Sontz, 1971.

In this publication my colleagues and I reported on the observed occurrence of minute step-terminated flakes along the bulbar face of the working edge of the ethnographic adzes and adze-slugs. These micro-fractures were observed under a microscope under a magnification of 36X, and occurred on all 26 adzes in the ethnographic collection, in numbers varying from 26 on two specimens to 12 on four others. A small-scale experiment demonstrated that micro-flakes of this kind do occur as the result of adzing hard wood (mulga) in the same manner as the contemporary aborigines, and further experiments of the same kind, performed with adzes made of different kinds of stone and with the adze held at controlled angles to the piece of wood being worked, have shown further examples of this type of use-wear. A recent critique of these results (Hayden and Kamminga, 1973) has raised the possibility that other kinds of wear besides those arising from scraping hard woods might be responsible for these micro-fractures. Such a possibility does exist, but in my reply to this critique (Gould, 1973), I have stressed the importance of the angle of the working edge as a determinant in the occurrence of these tiny step-terminated flakes. Hayden and Kamminga's arguments notwithstanding, stone flakes with wide edge angles of the kind usually associated with ethnographic Western Desert adzes are not so prone to the kind of micro-fracture edge damage through "general handling" which may frequently occur on acute edge-angle flakes. While some of the micro-flakes observed on the ethnographic adzes (and later seen on archaeological examples from Puntutjarpa) may have arisen due to "general handling" as Hayden and Kamminga suggest, most, if not all, of those observed are abruptly terminated in the manner of those seen in our experiments. It should be remembered, too, that the original presentation of the ethnographic data on Western Desert adzes relied on a unique configuration of qualitative and metrical attributes including considerations of the measurement of the edge-angle of the midsection of the working edge of the tool, tool size, nature of retouch along the working edge (especially with respect to the presence of small step-fractures), and microscopic step-terminated flakes on the bulbar face of the working edge to establish a basis for inferring prehistoric use as tools for scraping hard wood. A single attribute, like microwear, by itself is not conclusive, but taken together as they occur in the ethnographic

Western Desert pattern, such attributes form a unique configuration that points in the direction of hard woodworking use. To summarize, ethnographic aborigine woodworking adzes observed in this study show the following combination of attributes:

1. Angle of working edge at midsection between 87° and 40° (mean angle, 67°)
2. Maximum thickness between 2.20 and 1.20 cm. (mean thickness, 1.58 cm.)
3. Maximum width between 6.60 and 3.30 cm. (mean width, 5.13 cm.)
4. Weight between 15 grams and 70 grams (mean weight, 41.4 grams)
5. Presence of unifacial, simple or scaled retouch; scaled retouch is sometimes referred to as step-flaking. All retouch in this case is intentional; there are no unretouched adzes.
6. Presence of step fractures on the bulbar face of the working edge, visible under 36X magnification.

To what extent do the excavated Adzes and Adze-Slugs from Puntutjarpa conform to this total pattern? In terms of qualitative attributes the correspondences are close indeed. The archaeological Adzes and Adze-Slugs show the same overall shapes and specific characteristics of retouch, including the occurrence of step-flaking along the working edge of almost every specimen. Australian archaeologists have long argued for a distinction between Tula and "Non-Tula" (sometimes called Burren) Adzes, and I have embodied this distinction in classification (Subtypes 3a and 3b vs. Subtypes 3c and 3d). The defining characteristics and references on these two subtypes are presented in Chapter V. Although the contemporary Western Desert Aborigines produce both Tula and Non-Tula Adzes and Adze-Slugs in roughly equal numbers, they do not distinguish between them either in terms of terminology or function. With regard to characteristics of general shape and retouch, these subtypes conform closely with their ethnographic counterparts in the Western Desert. In terms of metrical attributes, however, the comparison of ethnographic and archaeological examples is less convincing, mainly because of the discrepancy in sample sizes. Tables 12 to 15 summarize these comparisons in terms of four attributes; angle of the working edge at midsection, maximum thickness, and maximum width, and weight. Since 13 of the 26 ethnographic specimens were hafted, we were unable to measure half of the specimens without removing the tools from their hafts (which we were not willing to do). This meant that only unhafted

TABLE 12
Edge-Angles (of Working Edge at Midsection) of Contemporary Western Desert Adzes and Adze-Slugs (Subtypes 3a-3d) and Excavated Specimens from Trench 2, Puntutjarpa

	Contemporary	Archaeological
Degrees		
19-29	0	0
30-39	0	3
40-49	3	2
50-59	7	19
60-69	4	47
70-79	6	41
80-89	6	30
90-99	0	3
Total samples	26	145
Mean working edge-angle of contemporary specimens		67.0°
Mean working edge-angle of archaeological specimens		69.5°

TABLE 13
Maximum Thickness of Contemporary Western Desert Adzes and Adze-Slugs (Subtypes 3a-3d) and Excavated Specimens from Trench 2, Puntutjarpa

	Contemporary	Archaeological
Cm.		
0-0.4	0	0
0.5-0.9	0	56
1.0-1.4	5	75
1.5-1.9	3	12
2.0-2.4	1	2
2.5-2.9	0	0
Total samples	9	145
Mean maximum thickness of contemporary specimens		1.58 cm.
Mean maximum thickness of archaeological specimens		1.35 cm.

TABLE 14

Maximum Width of Contemporary Western Desert Adzes and Adze-Slugs (Subtypes 3a-3d) and Excavated Specimens from Trench 2, Puntutjarpa

	Contemporary	Archaeological
–Cm.		
1.0-1.9	0	3
2.0-2.9	0	60
3.0-3.9	1	73
4.0-4.9	2	9
5.0-5.9	3	0
6.0-6.9	3	0
7.0-7.9	0	0
Total samples	9	145

Mean maximum width of ethnographic specimens 5.13 cm.
Mean maximum width of archaeological specimens 2.94 cm.

TABLE 15

Weights of Contemporary Western Desert Adzes (Subtypes 3a and 3c) and Excavated Specimens from Trench 2, Puntutjarpa

	Contemporary	Archaeological
Grams		
0- 9	0	0
10- 19	1	0
20- 29	0	2
30- 39	2	7
40- 49	2	8
50- 59	3	6
60- 69	0	6
70- 79	1	4
80- 89	0	1
90- 99	0	5
100-109	0	9
110-119	0	0
Total samples	9	48

Mean weight of contemporary specimens 41.4 grams
Mean weight of archaeological specimens 7.8 grams

specimens could be measured accurately in terms of size, thus reducing the ethnographic sample to 13 examples. From a statistical point of view this is too small a sample for any meaningful comparisons, and the tables presented here are mainly intended to summarize available data. Also, note that only complete or slightly worn Adzes were weighed, since progressive use and resharpening makes Adzes lighter as they approach the slug condition. Thus in terms of weight only whole Adzes (Subtypes 3a and 3c) were compared.

In addition to the small size of the ethnographic sample, another factor that may account for the differences in the distribution and means between ethnographic and archaeological weights was the tendency on the part of me and my associates in the laboratory to be somewhat overcautious in placing large, adzelike Flake-scrapers in the category of Adzes because they appeared to have been large enough to have been handheld when used in scraping hard woods. From our adzing experiments it is clear to us that there exists a rather wide and ill-defined size range which encompasses both large, hafted Adzes and small Flake-scrapers. Some of the smaller and more regularly shaped Flake-scrapers could easily have served as hafted Adzes (indeed, some of them differ hardly at all from some of the more irregularly shaped ethnographic Adzes). And, similarly, some of the largest ethnographic Adzes, although hafted by the aborigines, could have been hand-held when used for scraping hard woods and could have produced edge-angles, step-flaking, and micro-wear patterns similar to those seen on hafted specimens. All that is required is a flake large enough to have been gripped firmly by the ancient aborigine toolmaker. When in doubt during the process of classification, we tended to place measurably large Adzes (i.e., more than 2.0 cm. thick, 4.6 cm. wide, or 3.2 grams in weight) in the category of Large Flake-scrapers.

Further experimentation and analysis of micro-wear along the working edges of Adzes and Adze-Slugs allowed us to narrow the criteria for micro-flakes that can probably be attributed to wear arising from scraping hard woods. In all of these experiments green mulga wood was used as the material to be worked, and the hafted adze was held at a constant angle between 30 and 45 degrees, using motor patterns similar to those of the contemporary Western Desert aborigines. Different lithic raw materials collected for this purpose from quarries in the Warburton area were made into adzes, hafted and used in two separate ways; 1. drawn for 1000 strokes along the grain of the wood, and 2. drawn along the grain of the wood until no more shavings were removed (indicating that the working edge had become dulled through use). Different workers examined the bulbar face of the working edge under a magnification of 30X, and their observations did not always agree. For one thing, it was difficult—indeed, virtually impossible—to recognize small terminated flakes in grainy rocks like porphyry and quartzite. For another, one micro-flake would sometimes overlap with another, making the counting difficult. Finally, these small flakes differed in the nature of the termination, with two main classes of termination being observed; abrupt (or "stepped") and feathered. Disagreement arose over whether or not to include feather-terminated micro-flakes in our totals, and the decision was made to include in our counts only step-terminated micro-flakes. Our reasons for doing this were based on recognition of the fact that micro-flakes with feathered terminations can arise from an assortment of factors, not all having to do with woodworking use. We did not point to any specific factor that might have caused these feather-terminated micro-flakes, but we continued to regard step-terminated micro-flakes as products of woodworking. In working hardwoods like mulga in the manner of the Western Desert aborigines, the mechanics of force against the bulbar face of the working edge of the adze are directed inward, into the body of the flake, causing the micro-flake to step off. A more detailed description of this process appears in Gould, 1973, although it should be noted that the experiments leading to this conclusion were performed at the American Museum of Natural History in 1971 before the first version of the Hayden-Kamminga critique appeared.

As a result of this narrowing of the criteria for recognizing micro-flakes arising from woodworking use-wear, our counts of the number of micro-flakes observed at a magnification of 30X are slightly lower in some cases than the counts made on ethnographic Western Desert adzes in 1968. The micro-flake counts for the Adzes and Adze-Slugs from Puntutjarpa are summarized in tables 16, 17. Note in particular the slightly higher counts of step-terminated micro-flakes occurring on Adze-Slugs, suggesting, as one might expect, cumulative evidence of progressive hard woodworking use. As indicated earlier, these micro-flake counts are somewhat arbitrary, but when looked at in terms of the large samples presented here they do give a general picture of the "micro-deformation" (Semenov, 1964, p. 13) of the Puntutjarpa Adzes and Adze-Slugs. A reexamination someday of the micro-flakes on the bulbar face of the working edge of the ethnographic Western Desert Adzes at the American Museum of Natural History might be expected to produce lower totals, since it is possible that the original counts made on these tools in 1968 included some feather-terminated micro-flakes.

Type 3–Micro-Adzes and Micro-Adze Slugs. In terms of form, retouch, and edge wear characteristics Subtypes 3e-3h are virtually identical to Subtypes 3a-3d. This virtual identity of form, retouch, and edge-wear extends to the Micro-

TABLE 16

Tabulation of Step-terminated Flake Scars on Adzes Excavated at Puntutjarpa, Trench 2, 3

Material	N	Mean Number of Step-terminated Flake Scars Observed under microscope at 30X	Range of Variation
White Chert	45	13.6	1-25
Exotic Chert	28	14.39	5-31
Quartz	1	4.0	4
Warburton Porphyry	2	11.0	11
Totals	79	13.78	1-31

TABLE 17

Tabulation of Step-terminated Flake Scars on Adze Slugs Excavated at Puntutjarpa, Trench 2, 3

Material	N	Mean Number of Terminated Flake Scars Observed under microscope at 30X	Range of Variation
White Chert	57	15.07	3-33
Exotic Chert	48	14.35	3-27
Totals	105	14.74	3-33

Adze Slugs (3f and 3h), which closely resemble their Adze-Slug counterparts (3b and 3d). The only significant difference is in size, with Micro-Adzes and Micro-Adze Slugs being much smaller overall than Adzes and Adze-Slugs. Drawing a line between Adzes and Micro-Adzes was an arbitrary matter in which size ranges for attributes of weight, width, and thickness were compared, and tools were sorted according to which were below the minimum measurements indicated for Adzes on any one of these attributes. However, this set of minimum measurements approximates those for ethnographic Adzes and Adze-Slugs as well, bearing in mind, of course, the small sample of measurements available for the ethnographic specimens. No Micro-Adzes or Micro-Adze Slugs were observed in use by Western Desert aborigines, with a single possible exception. This was an extremely small Adze observed in use at the Warburton Ranges Mission by an aborigine originally from the Rawlinson Range area. The Adze was hafted to the handle of the man's spearthrower and thus could not be measured adequately, but it was the smallest ethnographic Adze observed at any time in this study. Also, two stone scrapers apparently similar to the Micro-Adzes described here were observed in use among the Warramunga aborigines of the Northern Territory and were illustrated in their hafts (Spencer and Gillen, 1904, p.639, figs. 174, 175). These cases suggest the possibility that Micro-Adzes, like Horsehoof Cores, may have been in use in recent times although with so few cases to point to these could just as easily be viewed as examples of idiosyncratic behavior in stone tool-making.

Given the specific similarities of form between Adzes and Micro-Adzes, it seems reasonable to assume a similarity of function. In particular, the presence of Micro-Adze Slugs, similar in all attributes except size to Adze Slugs, which are amply documented through ethnography to be the worn-out remnants of hafted scrapers used in shaping hard wood implements, supports this interpretation. The size measurements for Subtypes 3e-3h have been summarized in tables 6 to 8, and the occurrence of micro-wear flakes on Micro-Adzes and Micro-Adze Slugs is presented in tables 18, 19, subject to the same provisos as indicated for micro-wear on Adzes and Adze Slugs. As in the case of Adzes and Adze Slugs, slightly more step-terminated micro-flakes were observed on the slugs than on the Micro-Adzes, suggesting a possible correlation between the increased occurrence of these micro-flakes and the advanced state of re-use and wear represented by the slug. To sum up, the available evidence points to use as scrapers for shaping hard woods, principally mulga and various hard eucalypts, for Micro-Adzes in a manner closely analogous to ethnographically documented Adzes. It may be that, as Spencer and Gillen originally proposed (1904, p. 639), Micro-Adzes were used for fine finishing of wooden implements, including the

TABLE 18

Tabulation of Step-terminated Flake Scars on Micro-Adzes Excavated at Puntutjarpa, Trench 2, 3

Material	N	Mean Number of Terminated Flake Scars Observed under microscope at 30X	Range of Variation
White Chert	133	7.30	1-30
Exotic Chert	42	9.52	0-31
Quartzite	2	12.0	7-17
Agate	8	7.37	1-16
Totals	185	7.86	0-31

TABLE 19

Tabulation of Step-terminated Flake Scars on Micro-Adze Slugs Excavated at Puntutjarpa, Trench 2, 3

Material	N	Mean Number of Terminated Flake Scars Observed under microscope at 30X	Range of Variation
White Chert	39	8.53	0-16
Exotic Chert	21	11.04	1-22
Quartzite	1	12.0	12
Agate	4	8.0	2-14
Quartz	2	11.0	9-13
Opaline	1	21.0	21
Totals	68	9.58	0-22

extremely fine parallel fluting along the surface of many of the oldest wooden tools from the Central and Western deserts in various museum collections.

Type 3–Small Endscrapers. Functionally, Subtype 3i (Small Endscraper) is similar in all respects to the Micro-Adze, and the formal distinction between Subtypes 3e and 3h on the one hand and Subtype 3i on the other should not be allowed to obscure what is probably a similarity of function and use. It is possible that many artifacts that have been classified as Micro-Adzes are, in fact, partially worn Small Endscrapers. It is possible and indeed reasonable to visualize a Small Endscraper becoming progressively worn through re-use and resharpening through an intermediate stage (i.e., the Micro-Adze) to a final stage as a discarded slug. It is for this reason that Subtype 3i has been shown along with Micro-Adzes in tables 6 to 8. As in the case of Subtypes 3a-3h, Small Endscrapers show step-terminated micro-flakes along the bulbar face of the working edge, and these occurrences are summarized in table 20. The relatively low number of these micro-flakes may correlate with the relatively unworn condition of these tools, presuming, of course, that they were hafted and used for scraping hard woods in the suggested manner of Subtypes 3a-3h.

Type 4–Backed Blades. No present-day or historic Western Desert aborigines have ever been reported as making Backed Blades of any kind, although they sometimes pick up ancient Backed Blades off the surface of old sites and re-use these for a variety of purposes. In Europe, Africa, and the Middle East Backed Blades have been found archaeologically in their hafts, indicating use as arrowheads, sickle-blades, and barbs for spears (Bordaz, 1970, pp. 92-93; Oakley, 1967, pp. 67-68), and there has always been a temptation for archaeologists working in Australia to assume similar uses for ancient Australian Backed Blades. McCarthy (1967, p. 47) has tended to accept this assumption, whereas Campbell and Edwards (1966, pp. 206-208) argue strongly that no direct evidence for hafting exists for this class of tools and call for caution in making interpretations of this kind. Perhaps the best recent summation of this issue is that offered by Mulvaney (1969, p. 126): Evidence is accumulating to establish that in "prehistoric times Backed Blades were hafted, perhaps either as projectile tips and barbs, or set in series as saw-knife blades, with the blunted back embedded in the adhesive. Informative specimens with traces of the resin preserved have been excavated at Fromm's Landing and at Graman (where the implements are more than 2000 years old). It is recorded in recent times that geometric microliths were held between thumb and forefinger during human blood-letting and scarifying ceremonies, but in such instances there are indications that these were simply re-used, discarded prehistoric tools; surface scatters of microliths are as visible to recent Aborigines as to avid cabinet collectors."

None of the Backed Blades uncovered at Puntutjarpa showed any traces of resin, so no direct evidence exists for hafting of these items. Nevertheless, the basic shapes and technological characteristics of these tools (especially Subtypes 4a and 4b) so closely resemble those of Backed Blades reported elsewhere in Australia and the Old World that a strong presumption of hafting and use along the lines suggested above remains.

Subtype 4c, Backed Blades of Irregular Shape, are difficult to interpret. Any comments about them at this point must remain conjectural, but some effort at interpretation is needed, however tentative. A total of 20 Lunates, 21 Bondi Points, and 6 Backed Blades of Irregular Shape was recovered from Trench 2 at Puntutjarpa, or, in other words, Backed Blades of Irregular Shape made up 16 percent of the total Backed Blade inventory. Published reports do not make it clear

TABLE 20
Tabulation of Step-terminated Flake Scars on Small End Scrapers Excavated at Puntutjarpa, Trench 2, 3

Material	N	Mean Number of Terminated Flake Scars Observed under microscope at 30×	Range of Variation
White Chert	12	8.75	5-12
Exotic Chert	8	8.87	3-19
Totals	20	8.80	3-19

whether such irregular forms are as common in other archaeological sites in Australia. Two related possibilities, both of them highly tentative and without much supporting evidence, can be considered; 1. these irregularly shaped Backed Blades represent experiments by the ancient inhabitants at Puntutjarpa to master an unfamiliar technology, and 2. they may reflect the technical difficulties inherent in trying to produce Backed Blades in the absence of a developed tradition of blade-making. Although a few Micro-Cores show elongated flake scars that suggest the possibility of occasional production of blades, there is no clear evidence so far in the Western Desert for true blade-production on any large scale. Thus viewed from a technological point of view it could be argued that Backed Blades of Irregular Shape are the products of attempts to make true Backed Blades on irregularly shaped blades or flakes of the sort oridinarily produced in the Western Desert.

At this point it may be worth noting that while the overall occurrence of Backed Blades of Irregular Shape is 16 percent of the total Backed Blade inventory, this percentage is by no means evenly divided between stratigraphic levels. In Zone B (Strata M5-R5) Subtype 4c comprises 33 percent of the total Backed Blade inventory, whereas in Zone A (Strata AX-LZ) it comprises 11 percent of the total Backed Blade inventory. The relatively higher percentage at stratigraphically lower levels shows that these irregularly shaped Backed Blades were more important when Backed Blades first began to appear at Puntutjarpa, and this could possibly be interpreted as evidence of a period of experimentation. Perhaps the local inhabitants had seen or heard of Backed Blades and wished to make these themselves. The techniques of manufacture are fairly simple but would require some practice, and Backed Blades of Irregular Shape may have resulted from these practice efforts. Furthermore, in Zone B 100 percent of all Backed Blades were made from locally derived lithic materials, whereas in Zone A only 48 percent of Backed Blades were of local material, and the rest were made of lithic materials derived from somewhat outside the area of a 25-mile radius around Puntutjarpa. I have termed such lithic materials "exotic," in the sense that they apparently come from a considerable distance away from the Warburton-Brown Range area, although it should be cautioned that the locations of the quarries and other sources for these exotic materials are not yet known. Thus there is an inverse correlation between a decreasing percentage of Backed Blades of Irregular Shape and an increase in the percentage of exotic raw materials used in manufacturing Backed Blades of all kinds. Tenuous though it is, we have evidence here for suggesting that the patterning of Backed Blade manufacture became stabilized and more like patterns seen in other parts of Australia as exotic raw materials became more commonly used in their manufacture. In short, these patterns suggest the possibility of increased trade and other outside contacts during the period when Backed Blades were at the peak of their popularity at Puntutjarpa.

Provisional Type 5–Handaxes. Large, unifacially retouched handaxes, choppers, and scraper planes have been described ethnographically in the Western Desert by Tindale (1941), Mountford (in Oakley, 1967, fig. 1), and Thomson (1964, pp. 412-413). Sometimes these are large cores which are secondarily used as woodworking tools (see discussion earlier in this chapter), although more commonly large stones are picked up on the surface and retouched at or near the place where they are used. These tools are generally used for making the initial cut in the trunk of a mulga tree preparatory for removing a slab of wood to use as a blank for making an implement like a spearthrower or throwing-stick. Tools of this sort are generally discarded after use and are left where they were used. No attempt is made to resharpen or to keep them around for further use. Slightly smaller, hand-held pieces of rock, usually with one percussion retouched working edge, are used as scraper-planes for the heavy initial shaping of wooden implements, in approximately the manner described by Thomson (1964, p. 413). These stone scraper-planes are usually discarded immediately after use.

Can tools of this kind be recognized archaeologically? The problem of distinguishing between Large Cores used solely as sources for flakes and those used secondarily as handaxes, choppers, and scraper-planes has already been discussed. So, too, has the problem of identifying patterns of edge-damage arising from these uses and the problem of distinguishing these patterns from those caused by manufacture. Finally, there is the important problem of archaeological context. Most ethnographically observed handaxes, choppers, and scraper-planes were used and discarded in localities far removed from the habitation campsites of the aborigines. If this pattern of behavior occurred in the past as well it would mean that few tools of this kind would be likely to turn up in ancient campsites, as indeed seems to be the case at Puntutjarpa. It is for these reasons that this type has been listed as provisional.

Types 6-8–Tools of Ground and Pecked Stone. These tools are perhaps best described in terms of their simplicity. Seed-Grinders, Grinding-Slabs, and Hammerstones found at Puntutjarpa are virtually indistinguishable from the ones made by the present-day Western Desert aborigines. But this comparison is more notable in terms of negative attributes than for any positive resemblances there may be. In none of these three types, either in the case of archaeological or ethnographic examples, is there any sign of shaping or preparation of the tool prior to use. All shaping and marks that these artifacts possess resulted from the uses to which they were put. Seed-Grinders (Type 6) are perhaps the most complex, since they show some variety of form. Some, for example, are multifaceted, with heavy abrasion appearing in the form of two or perhaps three planar surfaces. Others are abraded more or less entirely around the pebble, with no definite abrasion planes appearing. Sometimes the planes of abrasion are present but show up poorly, while on other examples they intersect to form sharp ridges along the surface of the pebble. On many examples one or more ends show signs of pecking or pounding wear. And on some of these tools one of the faceted surfaces will have a concave pecked depression about 1/2-inch in diameter.

Together with Grinding-Slabs (Type 7) these tools have frequently been observed in use as seed grinders among Western Desert aborigines. Specifically, these have been seen in use grinding dry kalpaṛi seeds (*Chenopodium rhadinostachyum*), dry wanguṇu seeds (*Eragrostis eriopoda*), "wet" kampuṛarpa fruit (*Solanum centrale*), and "wet" ngaṛu husks (*Solanum chippendalei*). The dry seeds are ground into a fine flour which is mixed with water into a cake or "damper" and baked. The "wet" fruits are dried, either naturally, as in the case of kampuṛarpa, or by intentional parching, as is the case for the husks of ngaṛu fruit, and later mixed with water and ground into a paste, then packed into balls which were eaten. These were all staple food plants, so these processes of preparation were repeated often. I was told that the concave pecked depression on some of these Seed-Grinders resulted from preparation of hard seeds from the desert kurrajong tree (*Brachychiton* sp.), but I never actually observed this activity. Seed-Grinders and Grinding-Slabs were generally left in or near habitation campsites as more or less permanent fixtures of the camp, for re-use whenever the camp was visited.

Among the contemporary Western Desert people Hammerstones (Type 8) were often collected and cached in habitation campsites and were easily identified by the conspicuous pitting on one or more ends resulting from use as percussors in flaking stone tools. Aside from the fact that these tools were invariably of a size that could be held conveniently in one hand, there was no other patterning visible on them. Ethnographically, most production and resharpening of Adzes and Flake-scrapers took place in and around individual campsites within the habitation camp. Thus one may expect to find Hammerstones, Large Cores, Adzes, Flake-scrapers and Spokeshaves, and numerous unretouched flakes associated together in this context. A total of 21 Seed-Grinders (Type 6), 16 Grinding-Slabs, and nine Hammerstones was recovered from Trench 2 at Puntutjarpa.

Provisional Type 9–Retouched Fragments and Utilized Flakes. Ethnographically there have been many cases observed where aborigines pick up a stone flake, use it for some task, and discard it immediately. Sometimes a small amount of retouch is added to the flake, especially if the task involves wood scraping. These minimal tools were an important and pervasive part of the aboriginal technology. They occurred both in the context of habitation camps and in various task-specific sites as well (particularly in and around hunting-blinds and roasting hearths for game).

The Puntutjarpa collection abounds with obvious examples of such implements, where the retouch and/or edge damage is readily visible without magnification. A total of 427 tools of this kind was observed from the Trench 2 deposits at Puntutjarpa, although it is expected that additional artifacts of this sort could be identified if observed microscopically. No attempt has been made here to classify these tools or to propose what their possible functions may have been, but the hope here is that further work along these lines will be carried out one day with this collection.

STRATIGRAPHIC ANALYSIS OF STONE TOOLS

Most of the discussion up to now of the stone artifacts at Puntutjarpa has proceeded without regard for their stratigraphic context. There are, of course, dangers in such a unitary approach, since it may tend to mask important changes in the technology through time. The preceding classification and discussion of possible functions of artifacts does not assume absolute uniformity of these subtypes and their attributes through time; rather this question of uniformity from one time period to another requires examination. Change or lack of it in various aspects of the stone tool assemblage at Puntutjarpa can provide evidence for making conclusions about conservatism of technological traditions, particularly when these are compared with the faunal and pollen sequences at the site.

Figure 66 provides a summary of the relative frequencies of the different stone tool types by stratum in Trench 2 at Puntutjarpa. The frequencies are shown in graphic form, whereas absolute numbers of specimens for each type are shown immediately to the right of the percentages. The reader is once again reminded that the 3-inch strata shown in this table are not intended to be viewed as absolute units of contemporaneity. Rather, the presentation by 3-inch strata provides a framework for showing change (or lack of it) throughout the sequence at the site. Strata IZ-LZ represent the Upper Rockfall layer, which, as discussed earlier, contains certain stratigraphic peculiarities that help to explain the somewhat aberrant frequency distributions of different artifact and lithic raw material types. It must be remembered that most of the fill in Strata IZ-LZ consists of enormous rocks that occupy a disproportionate amount of volume relative to soil and artifact remains. Also, a glance at figure 34 shows that these strata occupy fewer squares and contain less fill than any others in Trench 2 except Stratum X5. Thus one encounters substantially lower absolute numbers of stone artifacts in these strata, which in turn give rise to variable frequencies (as always tends to happen where small samples are involved). It would, in fact, be more realistic to regard Strata IZ-LZ as if they were a single 3-inch stratum. The gaps that appear in the table in the sequences of certain tool types, most notably Adzes, Micro-Adzes, Backed Blades, and Large Cores, are more apparent than real. These gaps, along with corresponding reductions in frequency of several other tool types and increased frequencies of others (particularly Micro-Cores), all occur in Strata IZ-LZ and can be viewed as a function primarily of the stratigraphic situation caused by the presence of massive and closely packed boulders in the Upper Rockfall rather than as a reflection of cultural preferences or selection. In the case of the Lower Rockfall, however, there are no apparent gaps or fluctuations, probably because this feature contained smaller rocks that could easily be moved by the inhabitants and did not alter the general pattern of deposition of soil and cultural materials in the Main Cave.

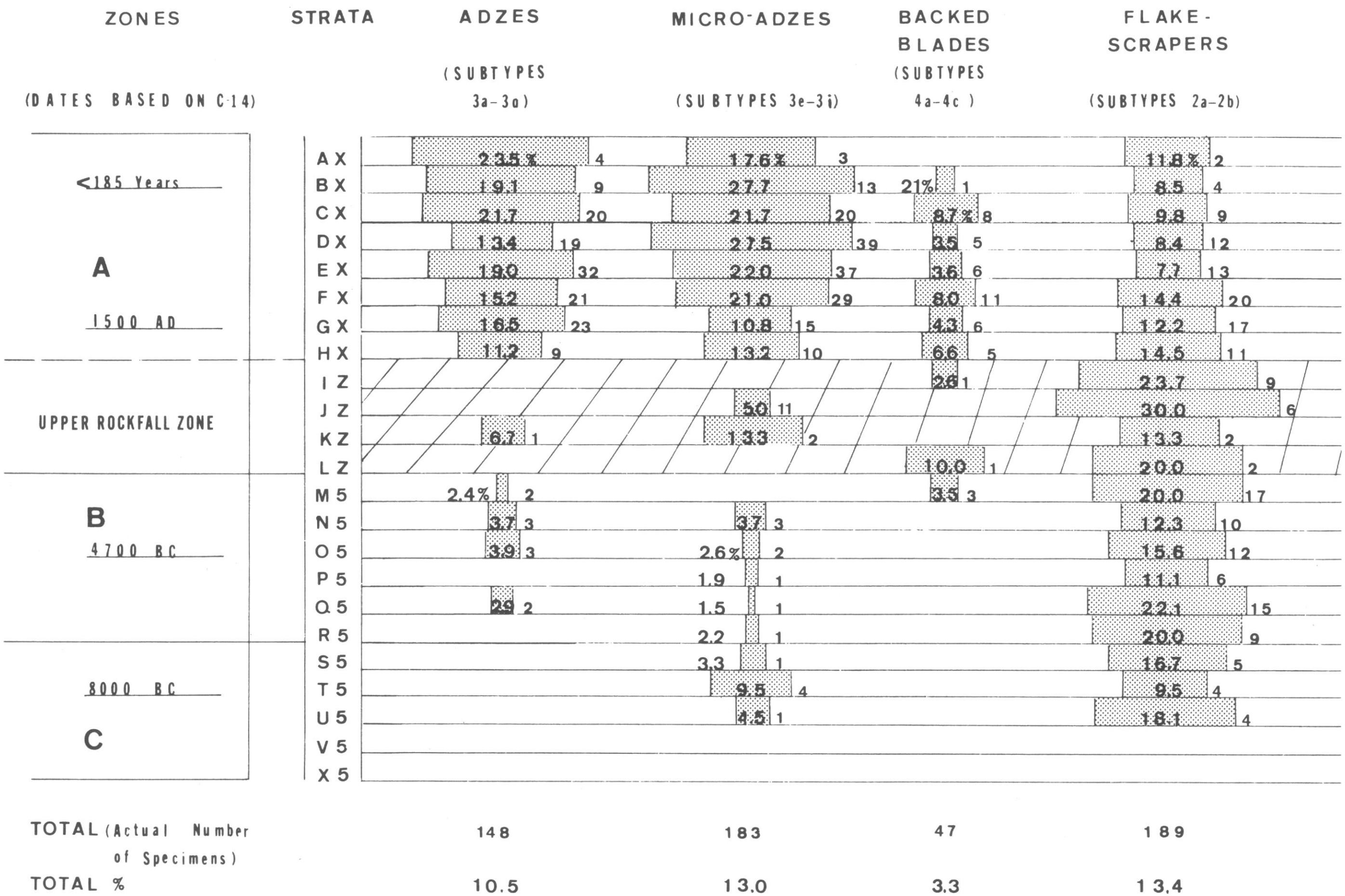
So if one compresses the artifact data from Strata IZ-LZ in the manner suggested above, the picture in figure 66 becomes one of remarkable long-term continuities of all artifact types with little if any fluctuation in their relative percentages in each stratum. Here one does not encounter the familiar "battleship curve" distribution seen in many other archaeological sites as certain artifact types increase, peak, and then decline in popularity. Instead, the graphic picture is a "columnar" one, indicating that the artifact types defined in Chapter V have in most cases persisted in about the same relative frequencies throughout the 10,000-year-long sequence at Puntutjarpa. The only significant exception to this statement occurs with Backed Blades, which first appear at the interface between the bottom of the Upper Rockfall and the top of the soil surface on which these rocks first fell, estimated on stratigraphic grounds at around 4000 years ago. Backed Blades also appear to have passed out of use at Puntutjarpa within about the last 200 years, as did, it appears, Micro-Cores. Adzes seem to have got off to a late start (between 7000 and 10,000 years ago), but this is not especially significant when one notes that Micro-Adzes were established at the site by 10,000 years ago. As stressed earlier, the only formal differences between Adzes and Micro-Adzes as subtypes pertain to attributes of size, and one could just as easily view Adzes and Micro-Adzes as part of the same tool type, which indeed has been the approach here all along.

Glover and Lampert (1969, pp. 223-224) emphasized the need to distinguish between Tula and Burren (or, as I have called them, Non-Tula) Adzes and Micro-Adzes, and I agreed in my reply (Gould, 1969c, p. 232) that I would bear this distinction in mind when analyzing the results of the Puntutjarpa excavations, and I further pointed out that this information would be available in the final excavation report. Table 21 summarizes the absolute numbers, relative percentages, and ratios of Tula and Non-Tula Adzes, Micro-Adzes, and Slugs throughout the sequence in Trench 2. As this table shows, the relative frequencies of these two formal subtypes have been remarkably similar throughout the entire sequence. In other words, it looks as if Tula and Non-Tula Adzes, Micro-Adzes, and Slugs were produced in about equal amounts at Puntutjarpa throughout the last 10,000 years. The production of these two subtypes in about equal amounts by the modern Western Desert aborigines appears to be a present-day continuation of this long-term pattern. Tindale (1965, p. 160) has argued that: "Allowing for casual variations in the method of use and rehafting which can determine the final appearance, the difference between the *burren* slug and the '*worn tula*' bear witness to the existence of two entirely different procedures of manufacture which probably had entirely different histories of origin." Tindale's first proposition is weakened by ethnographic observations in the Western Desert which show that Tula and Non-Tula Adzes and Slugs are produced by virtually identical techniques of manufacture and use (Gould, 1969c, p. 232; Gould, Koster, and Sontz, 1971, pp. 153-154). The archaeological evidence from Puntutjarpa tends to challenge Tindale's second proposition, since both Tula and Non-Tula Adzes and Slugs occur together there as parts of the same assemblage in about equal amounts throughout the sequence. If Tula and Non-Tula varieties arose from separate origins it appears that this did not happen within the last 10,000 years at Puntutjarpa. Perhaps there are older sites in the Australian Desert which will show the existence of separate origins for these formal subtypes, but so far such supporting evidence is lacking.

Table 22 presents the absolute numbers, relative frequencies, and ratios of stone artifacts grouped under the heading of "small tools" (see Chapter V for details) vs. those grouped together as "core tools and flake-scrapers" by stratum in Trench 2 at Puntutjarpa. Here a modest change can be detected, with small tools gradually increasing in importance relative to core tools and flake-scrapers, especially in the contexts of AX-HX. There is no evidence here of dramatic replacement; rather the picture is one of gradually increasing preferences for small tools. As was the case with other tables of this kind, Strata IZ-LZ (the Upper Rockfall) show results that tend to depart slightly from the overall trend, which in this case is one of increasing use of small tools from Stratum N5 upward. As suggested earlier, this departure is best understood in terms of the stratigraphic peculiarities occasioned by the rockfall layer itself rather than as a shift in cultural preferences.

Tables 23 and 24 show the absolute number, relative frequencies, and ratios of Adzes and Micro-Adzes to Slugs, respectively. In the case of Adzes vs. Adze-Slugs, the pattern is clearly and consistently one of greater numbers of Slugs than Adzes in an overall ratio of almost 2 to 1. That is, one may expect to find almost twice as many Adze-Slugs than Adzes at Puntutjarpa in any given stratum. Logically this is not too surprising, since one would expect that the only unworn Adzes present would be those lost by accident, whereas Adze-Slugs were intentionally discarded

STONE TOOL TYPES by STRATUM
TRENCH 2, PUNTUTJARPA



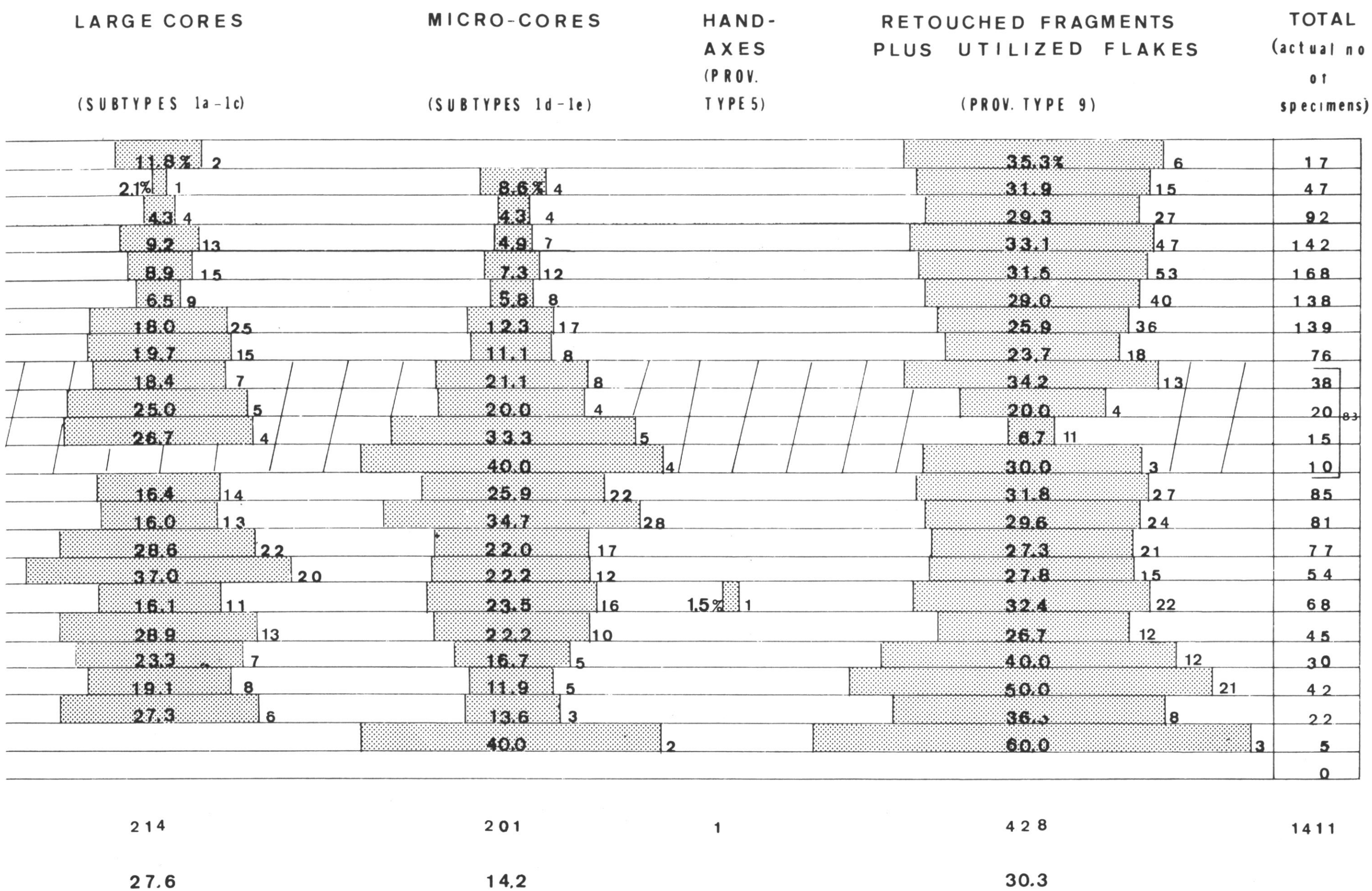


FIG. 66. Relative frequencies of stone tool types by Stratum, Trench 2, Puntutjarpa.

TABLE 21

Ratio of Tula (Subtypes 3a-b, 3d-f) to Non-Tula (Subtypes 3c-d, 3g-h) Adzes, Micro-Adzes and Slugs

Stratum	Tula	Non-Tula	Ratio (Tula/Non-Tula)
AX	5 71.4%	2 28.6%	2.50
BX	12 54.5%	10 45.5%	1.20
CX	24 60.0%	16 40.0%	1.50
DX	36 62.1%	22 37.9%	1.64
EX	33 47.8%	36 52.2%	.92
FX	21 42.0%	29 58.0%	.72
GX	19 50.0%	19 50.0%	1.00
HX	11 57.9%	8 42.1%	1.37
IZ	–	–	–
JZ	–	1 100.0%	–
KZ	2 66.7%	1 33.3%	2.00
LZ	–	–	–
M5	–	2 100.0%	–
N5	2 33.3%	4 66.7%	.50
O5	2 40.0%	3 60.0%	.67
P5	–	1 100.0%	–
Q5	1 33.3%	2 66.7%	.50
R5	–	1 100.0%	–
S5	1 100.0%	–	–
T5	–	4 100.0%	–
U5	1 100.0%	–	–
V5	–	–	–
X5	–	–	–
Totals	170 51.4%	161 48.6%	1.06

TABLE 22

Ratio of "Small Tools" (Subtypes 1d-1e, 3a-3i, 4a-4c, and Prov. Type 9 showing backed retouch) to "Core Tools and Flake-Scrapers" (Subtypes 1a-1c, 2a-2b, Provisional Type 5, and Prov. Type 9 except for examples showing backed retouch)

Stratum	"Small Tools"	"Core Tools and Flake-Scrapers"	Ratio (Small Tools/CTFS)
AX	10 66.7%	5 33.3%	2.00
BX	36 83.7%	7 16.3%	5.14
CX	70 80.5%	17 19.5%	4.12
DX	101 77.1%	30 22.9%	3.37
EX	122 77.7%	35 22.3%	3.49
FX	92 73.6%	33 26.4%	2.79
GX	79 61.7%	49 38.3%	1.61
HX	45 62.5%	27 37.5%	1.67
IZ	12 42.9%	16 57.1%	.75
JZ	5 27.8%	13 72.2%	.38
KZ	8 57.1%	6 42.9%	1.33
LZ	6 75.0%	2 25.0%	3.00
M5	36 51.4%	34 48.6%	1.06
N5	38 56.7%	29 43.3%	1.31
O5	26 40.0%	39 60.0%	.67
P5	15 35.7%	27 64.3%	.56
Q5	21 38.2%	34 61.8%	.62
R5	12 34.3%	23 65.7%	.52
S5	7 31.8%	15 68.2%	.47
T5	14 50.0%	14 50.0%	1.00
U5	7 36.8%	12 63.2%	.58
V5	3 60.0%	2 40.0%	1.50
X5	–	–	–
Totals	765 62.0%	469 38.0%	1.63

TABLE 23
Ratio of Adzes (Subtypes 3a + 3c) to Adze-Slugs (Subtypes 3b + 3d)

Stratum	Adzes	Adze-Slugs	Ratio (Adzes/ Adze-Slugs)
AX	–	4 100.0%	0
BX	2 22.2%	7 77.8%	.29
CX	1 5.0%	19 95.0%	.05
DX	6 31.6%	13 68.4%	.46
EX	14 43.8%	18 56.3%	.78
FX	9 42.9%	12 57.1%	.75
GX	10 43.5%	13 56.5%	.77
HX	5 55.6%	4 44.4%	1.25
IZ	–	–	–
JZ	–	–	–
KZ	–	1 100.0%	0
LZ	–	–	–
M5	–	2 100.0%	0
N5	1 33.3%	2 66.7%	.50
O5	2 66.7%	1 33.3%	2.00
P5	–	–	–
Q5	1 50.0%	1 50.0%	1.00
R5	–	–	–
S5	–	–	–
T5	–	–	–
U5	–	–	–
V5	–	–	–
X5	–	–	–
Totals	51 34.5%	97 65.5%	.53

TABLE 24
Ratio of Micro-Adzes (Subtypes 3e + 3g) to Micro-Adze Slugs (Subtypes 3f + 3h)

Stratum	Micro-Adzes	Micro-Adze Slugs	Ratio (Micro-Adzes/Slugs)
AX	3 100.0%	–	–
BX	13 100.0%	– –	–
CX	17 85.0%	3 15.0%	5.67
DX	31 79.5%	8 20.5%	3.88
EX	28 75.7%	9 24.3%	3.11
FX	27 93.1%	2 6.9%	13.50
GX	14 93.3%	1 6.7%	14.00
HX	9 90.0%	1 6.7%	9.00
IZ	–	–	–
JZ	1 100.0%	–	–
KZ	2 100.0%	–	–
LZ	–	–	–
M5	–	–	–
N5	3 100.0%	–	–
O5	2 100.0%	–	–
P5	1 100.0%	–	–
Q5	–	1 100.0%	–
R5	1 100.0%	–	–
S5	1 100.0%	–	–
T5	4 100.0%	–	–
U5	1 100.0%	–	–
V5	–	–	–
X5	–	–	–
Totals	158 86.3%	25 13.7%	6.32

TABLE 25
Ratio of Horsehoof Cores (Subtype 1b) to Other Large Cores (Subtypes 1a + 1c)

Stratum	Horsehoof Core	Large Cores	Ratio (Horsehoof/ Large Cores)
AX	–	2 100.0%	0
BX	–	1 100.0%	0
CX	–	4 100.0%	0
DX	–	13 100.0%	0
EX	1 6.7%	14 93.3%	.07
FX	–	9 100.0%	0
GX	3 12.0%	22 88.0%	.14
HX	2 13.3%	13 86.7%	.15
IZ	3 42.9%	4 57.1%	.75
JZ	1 20.0%	4 80.0%	.25
KZ	–	4 100.0%	0
LZ	–	–	–
M5	3 21.4%	11 78.6%	.27
N5	1 7.7%	12 92.3%	.08
O5	3 13.6%	19 86.4%	.16
P5	4 20.0%	16 80.0%	.25
Q5	2 18.2%	9 81.8%	.22
R5	1 7.7%	12 92.3%	.08
S5	1 14.3%	6 85.7%	.16
T5	1 12.5%	7 87.5%	.14
U5	2 33.3%	4 66.7%	.50
V5	–	–	–
X5	–	–	–
Totals	28 13.1%	186 86.9%	.15

when they could no longer be held in their hafts. One would not expect aborigines to throw away new and unused Adzes on purpose.

Seen from this point of view, table 24 presents a problem. Micro-Adze Slugs were far less common relative to unworn or partially worn Micro-Adzes, with Micro-Adzes and Slugs appearing in a ratio of around six to one. Clearly one cannot apply the same interpretation to the results shown in these two tables. Experiments (reported on in detail in Chapter VII) were carried out to attempt an explanation for this phenomenon, but the results were not conclusive. We had postulated that, owing to their small size, Micro-Adzes might not be gripped as firmly in their hafts as would Adzes with larger gripping surfaces. Thus one might expect Micro-Adzes to show a tendency to break loose from their hafts before becoming worn down to Slugs (in contrast to Adzes, which, it was thought, would remain in their hafts longer and thus would tend to become more progressively worn into a Slug condition). This postulate was not borne out by our limited experiments, which showed instead that most Micro-Adzes can continue to work efficiently as hardwood scrapers into a Slug configuration. Obviously some other explanation will have to be found for these ratios, and at the moment all one can do is offer ideas that remain untested and thus speculative. Earlier in this chapter, for example, I suggested the possibility that Micro-Adzes and Small Endscrapers could have been used to shape the fine parallel fluting found on many older ethnographic wooden bowls, throwing-sticks, and other artifacts from the Western and Central deserts. To work effectively at this task, these stone implements would need to have working edges that retained a substantial degree of convexity. A flat or concave working edge (such as one gets as one approaches the Slug condition) would scrape the wood, but it would probably not produce the desired fluting. If this were the case it might explain why so many Micro-Adzes were discarded before they reached Slug condition, since they may have begun to lose the degree of convexity needed for shaping the flutes on wooden artifacts. Further work is needed to test this proposition.

Tables 26-30 show the numbers and relative percentages of different lithic raw materials used in producing Large Cores and Micro-Cores. In the case of Large Cores with Single-Striking Platform (Subtype la), Large Cores with Multiple-Striking Platforms (Subtype 1c), and Horsehoof Cores (Subtype 1b), coarse-grained rocks were overwhelmingly favored at all times during the occupation of Puntutjarpa. Warburton porphyry and quartzite were preferred in the manufacture of Horsehoof Cores, whereas quartz stands out as the primary raw material for making other Large Cores. These preferences appear to have been more or less constant throughout the entire sequence. Micro-Cores, on the other hand, show slightly higher percentages of fine-grained stone, especially white chert, along with slightly greater use of agate and various exotic stones. Only one Micro-Core was found made of Warburton porphyry, but quartz was heavily favored in the case of both Micro-Core subtypes. The contrasting preferences for grainy vs. nongrainy rocks in the production of Large Cores and Micro-Cores, respectively, suggest obvious differences in ease and regularity of flaking of these raw materials, but no experiments were performed to test this proposition, because insufficient amounts of these lithic raw materials were brought back for such experiments. In a general way, however, it seems clear that the ancient inhabitants of Puntutjarpa found it possible to remove flakes from cores of fine-grained stones like white chert and agate to the point of producing Micro-Cores with relative ease. Warburton porphyry and quartzite were preferred in the production of Horsehoof Cores, and it seems likely that there was a direct relationship between the selection of lithic raw material in this case and the extent of flake removal. Further analysis of waste flakes involving a variety of measurements along with replicative experiments would probably resolve this question.

As noted earlier in this chapter, exotic stone materials were favored in manufacturing Backed Blades (to an overall percentage of 31.9%) despite the fact that exotic stones made up only 2.6 percent of the total lithic raw material inventory from Trench 2 at Puntutjarpa. Stratigraphically, this tendency to prefer exotic stone for Backed Blade production was most pronounced in Zone A, that is, probably within the last 1000 years, despite their appearance in Zone B, immediately beneath the Upper Rockfall. Most of the exotic stones at Puntutjarpa were extremely fine-grained and lent themselves to flaking into small, precise shapes, so it is not hard to imagine why this material was favored. On the other hand, several Backed Blades were made of quartz, a most intractable stone for this kind of artifact production, and the use of quartz for this purpose remains somewhat puzzling in light of the technical difficulties involved.

In Chapter V the stone artifacts from Puntutjarpa are presented together with the stratigraphic distributions of these artifact types. Now the skeptical reader is entitled to ask if any effort was made in the lithic analysis to examine variability through time of the different metrical attributes which define each stone tool type or subtype. Qualitative attributes are visibly constant for each tool type or subtype throughout the Puntutjarpa sequence, but metrical attributes must be tested quantitatively between levels at the site to determine if indeed these, too, remained more or less constant throughout the sequence. To accomplish this the measurement of each metrical attribute of each subtype involving such attributes was tested for the value of t between each stratigraphic Zone in Trench 2. Tables 34 through 43 summarize these results. Tables 34 through 36 compare the attributes of all Adzes and Micro-Adzes (including Slugs except for the variable of weight, for which only unworn tools can be compared). Comparisons were made for the variables of; 1. angle of working edge (at midsection) 2. maximum thickness (in cm.) 3. maximum width (in cm.), and 4. weight (in grams) between Zones A and B; B and C; and A and C, respectively. This same pattern of analysis was used in comparing attribute measurements for Adzes and Adze-Slugs (table 37), Micro-Adzes and Micro-Adze Slugs (tables 38 through 40), and Flake-scrapers (tables 41 through 43). Adzes and Micro-Adzes, whether considered separately as subtypes or together as a single Type show consistently low values for t for all attributes with the limited exception of the maximum widths and weights shown in tables 35 and 36. These tables compare attributes

TABLE 26
Number and Percentage of Lithic Raw Materials Used in Producing Large Cores with Single-Striking Platform (Subtype 1a)

Stratum	Warburton Porphyry	Quartz	Quartzite	Red Chert	Opaline	White Chert	Agate	Exotic	Zone
AX	–	2 100.0%	–	–	–	–	–	–	
BX	–	–	1 100.0%	–	–	–	–	–	
CX	1 100.0%	–	–	–	–	–	–	–	
DX	1 12.5%	4 50.0%	2 25.0%	–	–	1 12.5%	–	–	A
EX	1 11.1%	7 77.8%	–	–	–	1 11.1%	–	–	
FX	–	3 75.0%	1 25.0%	–	–	–	–	–	
GX	–	10 83.3%	–	–	–	2 16.7%	–	–	
HX	–	5 62.5%	1 12.5%	–	–	1 12.5%	–	1 12.5%	
IZ	–	–	2 66.7%	–	–	–	1 33.3%	–	
JZ	–	1 33.3%	2 66.7%	–	–	–	–	–	Upper Rockfall
KZ	3 100.0%	–	–	–	–	–	–	–	
LZ	–	–	–	–	–	–	–	–	
M5	1 20.0%	4 80.0%	–	–	–	–	–	–	
N5	–	2 50.0%	1 25.0%	–	–	1 25.0%	–	–	
O5	1 10.0%	4 40.0%	1 10.0%	–	–	3 30.0%	1 10.0%	–	B
P5	2 18.2%	7 63.6%	1 9.1%	–	–	1 9.1%	–	–	
Q5	–	1 25.0%	1 25.0%	–	–	–	1 25.0%	1 25.0%	
R5	–	2 40.0%	3 60.0%	–	–	–	–	–	
S5	–	3 100.0%	–	–	–	–	–	–	
T5	–	–	1 50.0%	–	–	1 50.0%	–	–	
U5	–	1 50.0%	–	–	–	1 50.0%	–	–	C
V5	–	–	–	–	–	–	–	–	
X5	–	–	–	–	–	–	–	–	
Totals	10 10.0%	56 56.0%	17 17.0%	–	–	12 12.0%	3 3.0%	2 2.0%	

TABLE 27
Number and Percentage of Lithic Raw Materials Used in Producing Horsehoof Cores (Subtype 1b)

Stratum	Warburton Porphyry	Quartz	Quartzite	Red Chert	Opaline	White Chert	Agate	Exotic	Zone
AX	–	–	–	–	–	–	–	–	A
BX	–	–	–	–	–	–	–	–	
CX	–	–	–	–	–	–	–	–	
DX	–	–	–	–	–	–	–	–	
EX	–	–	1 100.0%	–	–	–	–	–	
FX	–	–	–	–	–	–	–	–	
GX	–	1 33.3%	2 66.7%	–	–	–	–	–	
HX	–	–	1 50.0%	–	–	–	–	1 50.0%	
IZ	–	–	3 100.0%	–	–	–	–	–	Upper Rockfall
JZ	–	–	1 100.0%	–	–	–	–	–	
KZ	–	–	–	–	–	–	–	–	
LZ	–	–	–	–	–	–	–	–	
M5	1 33.3%	–	2 66.7%	–	–	–	–	–	B
N5	–	1 100.0%	–	–	–	–	–	–	
O5	1 33.3%	–	2 66.7%	–	–	–	–	–	
P5	1 25.0%	–	3 75.0%	–	–	–	–	–	
Q5	–	–	2 100.0%	–	–	–	–	–	
R5	1 100.0%	–	–	–	–	–	–	–	
S5	1 100.0%	–	–	–	–	–	–	–	C
T5	1 100.0%	–	–	–	–	–	–	–	
U5	1 50.0%	–	1 50.0%	–	–	–	–	–	
V5	–	–	–	–	–	–	–	–	
X5	–	–	–	–	–	–	–	–	
Totals	7 25.0%	2 7.1%	18 64.3%	–	–	–	–	1 3.6%	

TABLE 28
Number and Percentage of Lithic Raw Materials Used in Producing Large Cores with Multiple-Striking Platforms (Subtype 1c)

Stratum	Warburton Porphyry	Quartz	Quartzite	Red Chert	Opaline	White Chert	Agate	Exotic	Zone
AX	–	–	–	–	–	–	–	–	A
BX	–	–	–	–	–	–	–	–	
CX	–	3 100.0%	–	–	–	–	–	–	
DX	1 20.0%	2 40.0%	–	1 20.0%	–	–	1 20.0%	–	
EX	–	5 100.0%	–	–	–	–	–	–	
FX	–	1 20.0%	1 20.0%	–	–	–	3 60.0%	–	
GX	–	7 70.0%	–	–	–	1 10.0%	1 10.0%	1 10.0%	
HX	2 40.0%	1 20.0%	1 20.0%	–	–	–	1 20.0%	–	
IZ	–	–	1 100.0%	–	–	–	–	–	Upper Rockfall
JZ	–	–	1 100.0%	–	–	–	–	–	
KZ	–	–	1 100.0%	–	–	–	–	–	
LZ	–	–	–	–	–	–	–	–	
M5	–	5 83.3%	1 16.7%	–	–	–	–	–	B
N5	1 12.5%	4 50.0%	1 12.5%	–	–	1 12.5%	1 12.5%	–	
O5	1 11.1%	6 66.7%	2 22.2%	–	–	–	–	–	
P5	–	3 60.0%	1 20.0%	–	–	1 20.0%	–	–	
Q5	–	4 80.0%	1 20.0%	–	–	–	–	–	
R5	1 14.3%	3 42.9%	1 14.3%	–	–	2 28.6%	–	–	
S5	–	–	2 66.7%	–	–	–	1 33.3%	–	C
T5	1 20.0%	–	3 60.0%	–	–	1 20.0%	–	–	
U5	1 50.0%	1 50.0%	–	–	–	–	–	–	
V5	–	–	–	–	–	–	–	–	
X5	–	–	–	–	–	–	–	–	
Totals	8 9.3%	45 52.3%	17 19.8%	1 1.2%	–	6 7.0%	8 9.3%	1 1.2%	

TABLE 29
Number and Percentage of Lithic Raw Materials Used in Producing Micro-Cores with Multiple-Striking Platforms (Subtype 1d)

Stratum	Warburton Porphyry	Quartz	Quartzite	Red Chert	Opaline	White Chert	Agate	Exotic	Zone
AX	–	–	–	–	–	–	–	–	
BX	–	1 50.0%	–	–	–	1 50.0%	–	–	
CX	–	1 100.0%	–	–	–	–	–	–	
DX	–	1 50.0%	–	–	–	1 50.0%	–	–	A
EX	–	1 33.3%	–	–	–	1 33.3%	–	1 33.3%	
FX	–	–	–	–	–	–	–	–	
GX	–	2 33.3%	–	1 16.7%	–	1 16.7%	–	2 33.3%	
HX	–	1 50.0%	–	–	–	1 50.0%	–	–	
IZ	–	2 100.0%	–	–	–	–	–	–	
JZ	–	1 100.0%	–	–	–	–	–	–	Upper Rockfall
KZ	–	1 100.0%	–	–	–	–	–	–	
LZ	–	1 100.0%	–	–	–	–	–	–	
M5	–	4 80.0%	–	–	–	1 20.0%	–	–	
N5	–	4 80.0%	–	–	–	1 20.0%	–	–	
O5	–	3 75.0%	–	–	–	1 25.0%	–	–	B
P5	–	1 33.3%	–	–	–	2 66.7%	–	–	
Q5	–	5 100.0%	–	–	–	– –	– –	– –	
R5	–	2 100.0%	–	–	–	–	–	–	
S5	–	–	–	–	–	1 100.0%	–	–	
T5	–	–	–	–	–	1 100.0%	–	–	C
U5	–	–	–	–	–	–	–	–	
V5	–	–	–	–	–	–	–	–	
X5	–	–	–	–	–	–	–	–	
Totals	–	31 66.0%	–	1 2.1%	–	12 25.2%	–	3 6.4%	

TABLE 30
Number and Percentage of Lithic Raw Materials Used in Producing Micro-Cores with Single-Striking Platform (Subtype 1e)

Stratum	Warburton Porphyry	Quartz	Quartzite	Red Chert	Opaline	White Chert	Agate	Exotic	Zone
AX	–	–	–	–	–	–	–	–	
BX	–	2 100.0%	–	–	–	–	–	–	
CX	–	1 33.3%	1 33.3%	–	1 33.3%	–	–	–	
DX	–	4 80.0%	–	–	–	–	–	1 20.0%	
EX	–	4 44.4%	–	–	–	2 22.2%	3 33.3%	–	A
FX	–	2 25.0%	1 12.5%	–	–	4 50.0%	1 12.5%	–	
GX	–	8 72.7%	–	–	–	–	2 18.2%	1 9.1%	
HX	–	4 66.7%	–	–	–	2 33.3%	–	–	
IZ	–	5 100.0%	–	–	–	–	–	–	
JZ	–	3 100.0%	–	–	–	–	–	–	Upper Rockfall
KZ	–	1 25.0%	2 50.0%	–	–	–	–	1 25.0%	
LZ	–	2 66.7%	1 33.3%	–	–	–	–	–	
M5	–	13 76.5%	1 5.9%	–	–	3 17.6%	–	–	
N5	–	17 81.0%	1 4.8%	–	–	2 9.5%	1 4.8%	–	
O5	–	11 91.7%	1 8.3%	–	–	–	–	–	
P5	–	8 88.9%	–	–	–	–	–	1 11.1%	B
Q5	–	10 90.9%	1 9.1%	–	–	–	–	–	
R5	–	2 25.0%	2 25.0%	–	–	4 50.0%	–	–	
S5	–	2 50.0%	–	–	–	1 25.0%	–	1 25.0%	
T5	1 25.0%	3 75.0%	–	–	–	–	–	–	
U5	–	1 33.3%	–	–	–	1 33.3%	1 33.3%	–	C
V5	–	1 50.0%	–	–	–	1 50.0%	–	–	
X5	–	–	–	–	–	–	–	–	
Totals	1 0.7%	105 69.5%	11 7.3%	–	1 0.7%	20 13.2%	8 5.3%	5 3.3%	

TABLE 31

Number and Percentage of Lithic Raw Materials Used in Making Backed Blades (Subtypes 4a-4c)

Stratum	Warburton Porphyry	Quartz	Quartzite	Red Chert	Opaline	White Chert	Agate	Exotic	Zone
AX	–	–	–	–	–	–	–	–	A
BX	–	1 100.0%	–	–	–	–	–	–	
CX	–	3 37.5%	–	–	–	2 25.0%	–	3 37.5%	
DX	–	2 40.0%	–	–	–	1 8.3%	–	2 40.0%	
EX	–	1 16.7%	2 33.3%	–	–	1 16.7%	–	2 33.3%	
FX	–	2 18.2%	–	–	–	2 18.2%	2 18.2%	5 45.5%	
GX	–	–	2 33.3%	–	1 16.7%	2 33.3%	–	1 16.7%	
HX	–	–	2 40.0%	–	1 20.0%	1 20.0%	–	1 20.0%	
IZ	–	–	–	–	–	–	–	1 100.0%	Upper Rockfall
JZ	–	–	–	–	–	–	–		
KZ	–	–	–	–	–	–	–	–	
LZ	–	1 100.0%	–	–	–	–	–	–	
M5	–	1 33.3%	–	–	1 33.3%	1 33.3%	–	–	B
N5	–	–	–	–	–	–	–	–	
O5	–	–	–	–	–	–	–	–	
P5	–	–	–	–	–	–	–	–	
Q5	–	–	–	–	–	–	–	–	
R5	–	–	–	–	–	–	–	–	
S5	–	–	–	–	–	–	–	–	C
T5	–	–	–	–	–	–	–	–	
U5	–	–	–	–	–	–	–	–	
V5	–	–	–	–	–	–	–	–	
X5	–	–	–	–	–	–	–	–	
Totals	–	11 23.4%	6 12.8%	–	3 6.4%	10 21.3%	2 4.3%	15 31.9%	

TABLE 32
Number and Percentage of Lithic Raw Materials Used in Making Flake-scrapers (Subtypes 2a-2b)

Stratum	Warburton Porphyry	Quartz	Quartzite	Red Chert	Opaline	White Chert	Agate	Exotic	Zone
AX	1 50.0%	1 50.0%	–	–	–	–	–	–	
BX	–	1 100.0%	–	–	–	–	–	–	
CX	–	2 22.2%	2 22.2%	–	–	1 11.1%	2 22.2%	2 22.2%	
DX	2 16.7%	2 16.7%	3 25.0%	–	–	1 8.3%	2 16.7%	2 16.7%	
EX	2 15.4%	–	4 30.8%	–	–	5 38.5%	2 15.4%	–	A
FX	3 15.0%	3 15.0%	2 10.0%	–	1 5.0%	7 35.0%	–	4 20.0%	
GX	2 11.8%	2 11.8%	4 23.5%	1 5.9%	–	4 23.5%	3 17.6%	1 5.9%	
HX	2 18.2%	–	3 27.3%	–	–	5 45.5%	1 9.1%	–	
IZ	1 11.1%	–	4 44.4%	–	–	2 22.2%	1 11.1%	1 11.1%	
JZ	1 16.7%	–	1 16.7%	–	–	2 33.3%	1 16.7%	1 16.7%	Upper Rockfall
KZ	2 100.0%	–	–	–	–	–	–	–	
LZ	1 50.0%	–	1 50.0%	–	–	–	–	–	
M5	6 35.3%	2 11.8%	6 35.3%	–	–	1 5.9%	–	2 11.8%	
N5	2 20.0%	1 10.0%	5 50.0%	–	–	2 20.0%	–	–	
O5	2 16.7%	3 25.0%	1 8.3%	1 8.3%	–	5 41.7%	–	–	
P5	–	1 16.7%	2 33.3%	–	–	1 16.7%	2 33.3%	–	B
Q5	7 46.7%	1 6.7%	5 33.3%	–	–	2 13.3%	–	–	
R5	2 22.2%	–	4 44.4%	1 11.1%	–	2 22.2%	–	–	
S5	1 20.0%	–	2 40.0%	–	–	1 20.0%	–	1 20.0%	
T5	2 50.0%	–	2 50.0%	–	–	–	–	–	C
U5	2 50.0%	–	–	–	–	1 25.0%	1 25.0%	–	
V5	–	–	–	–	–	–	–	–	
X5	–	–	–	–	–	–	–	–	
Totals	41 21.7%	19 10.1%	51 27.0%	3 1.6%	1 0.5%	43 22.8%	16 8.5%	15 7.9%	

TABLE 33
Number and Percentage of Lithic Raw Materials Used in Making Adzes and Micro-Adzes (Subtypes 3a-3i)

Stratum	Warburton Porphyry	Quartz	Quartzite	Red Chert	Opaline	White Chert	Agate	Exotic	Zone
AX	–	–	–	–	–	2 28.6%	–	5 71.4%	
BX	–	1 4.5%	–	–	–	16 72.7%	1 4.5%	4 18.2%	
CX	–	–	–	–	1 2.4%	20 48.8%	4 9.8%	16 39.0%	
DX	–	1 1.6%	3 4.9%	–	3 4.9%	37 60.7%	1 1.6%	16 26.2%	
EX	–	–	3 4.3%	–	2 2.9%	42 60.0%	4 5.7%	19 27.1%	A
FX	1 1.9%	1 1.9%	1 1.9%	–	1 1.9%	36 67.9%	–	13 24.5%	
GX	1 2.6%	5 12.8%	3 7.7%	–	1 2.6%	19 48.7%	3 7.7%	7 17.9%	
HX	–	–	–	–	–	16 76.2%	1 4.8%	4 19.0%	
IZ	–	–	–	–	–	–	–	1 100.0%	
JZ	–	–	–	–	–	1 100.0%	–	–	Upper Rockfall
KZ	–	–	–	–	–	2 66.7%	–	1 33.3%	
LZ	–	–	–	–	–	–	–	–	
M5	–	–	–	–	–	1 50.0%	– –	1 50.0%	
N5	–	–	1 16.7%	–	–	4 66.7%	–	1 16.7%	
O5	–	–	1 20.0%	–	–	4 80.0%	–	–	
P5	–	–	–	–	–	1 100.0%	–	–	B
Q5	–	1 33.3%	–	–	–	1 33.3%	–	1 33.3%	
R5	–	–	1 100.0%	–	–	–	–	–	
S5	–	–	–	–	–	1 50.0%	–	1 50.0%	
T5	–	–	–	–	–	3 75.0%	–	1 25.0%	C
U5	–	–	–	–	–	1 100.0%	–	–	
V5	–	–	–	–	–	–	–	–	
X5	–	–	–	–	–	–	–	–	
Totals	2 0.6%	9 2.6%	13 3.8%	–	8 2.3%	207 60.3%	14 4.1%	90 26.2%	

TABLE 34
T-Test Comparison of all Adzes and Micro-Adzes (Subtypes 3a-3i) Between Zone A (Strata AX-LZ) and Zone B (Strata M5-R5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone A	319	68.3072	11.868	0.664	−0.75	−0.80
Zone B	18	70.4444	11.020	2.597		
Maximum Thickness						
Zone A	319	0.85455	3.193	0.179	−1.00	−0.75
Zone B	18	0.93333	4.393	1.035		
Maximum Width						
Zone A	319	2.35643	7.322	0.410	−0.86	−0.69
Zone B	18	2.51111	9.393	2.214		
Weight (excluding slugs)						
Zone A	189	3.31481	38.386	2.792	−1.62	−1.33
Zone B	11	5.27273	47.875	14.435		

TABLE 35
T-Test Comparison of all Adzes and Micro-Adzes (Subtypes 3a-3i) Between Zone B (Strata M5-R5) and Zone C (Strata S5-X5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone B	18	70.4444	11.020	2.597	0.00	0.00
Zone C	7	70.4268	9.108	3.442		
Maximum Thickness						
Zone B	18	0.93333	4.393	1.035	0.09	0.09
Zone C	7	0.91429	4.811	1.818		
Maximum Width						
Zone B	18	2.51111	9.393	2.214	1.58	2.27
Zone C	7	1.92857	3.450	1.304		
Weight (excluding slugs)						
Zone B	11	5.27273	47.875	14.435	1.56	2.11
Zone C	6	2.16667	6.976	2.848		

TABLE 36

T-Test Comparison of all Adzes and Micro-Adzes (Subtypes 3a-3i) Between Zone A (Strata AX-LZ) and Zone C (Strata S5-X5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone A	319	68.3072	11.868	0.664	–0.47	–0.61
Zone C	7	70.4286	9.108	3.442		
Maximum Thickness						
Zone A	319	0.85455	3.193	0.179	–0.48	–0.33
Zone C	7	0.91429	4.811	1.818		
Maximum Width						
Zone A	319	2.35643	7.322	0.410	1.54	3.13
Zone C	7	1.92857	3.450	1.304		
Weight (excluding slugs)						
Zone A	189	3.31481	38.386	2.792	0.73	2.88
Zone C	6	2.26667	6.976	2.848		

TABLE 37

T-Test Comparison of all Adzes and Adze-Slugs (Subtypes 3a-3d) Between Zone A (Strata AX-LZ) and Zone B (Strata M5-R5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone A	136	70.1176	11.268	0.966	–0.13	–0.14
Zone B	10	70.6000	10.731	3.393		
Maximum Thickness						
Zone A	136	1.03676	2.672	0.229	0.39	0.22
Zone B	10	1.00000	5.207	1.647		
Maximum Width						
Zone A	136	2.99044	5.933	0.509	0.39	0.23
Zone B	10	2.91000	10.959	3.466		
Weight (excluding slugs)						
Zone A	44	7.71818	59.976	9.042	–0.68	–0.76
Zone B	4	9.82500	52.386	26.193		

TABLE 38
T-Test Comparison of all Micro-Adzes and Micro-Adze Slugs (Subtypes 3e-3h) Between Zone A (Strata AX-LZ) and Zone B (Strata M5-R5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone A	169	66.9645	12.168	0.936	−0.75	−0.75
Zone B	8	70.2500	12.116	4.283		
Maximum Thickness						
Zone A	169	0.70769	2.767	0.213	−1.41	−1.22
Zone B	8	0.85000	3.251	1.150		
Maximum Width						
Zone A	169	1.82840	3.226	0.248	−1.58	−1.72
Zone B	8	2.01250	2.949	1.043		
Weight (excluding slugs)						
Zone A	145	1.97862	8.794	0.730	−1.94	−1.09
Zone B	7	2.67143	16.640	6.290		

TABLE 39
T-Test Comparison of all Micro-Adzes and Micro-Adze Slugs (Subtypes 3e-3h) Between Zone B (Strata M5-R5) and Zone C (Strata S5-X5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone B	8	70.2500	12.116	4.283	−0.58	−0.64
Zone C	6	73.3333	5.354	2.186		
Maximum Thickness						
Zone B	8	0.85000	3.251	1.150	−0.37	−0.34
Zone C	6	0.93333	5.241	2.140		
Maximum Width						
Zone B	8	2.01250	2.949	1.043	1.01	1.01
Zone C	6	1.85000	3.017	1.232		
Weight (excluding slugs)						
Zone B	7	2.67143	16.640	6.290	0.69	0.73
Zone C	6	2.16667	6.976	2.848		

TABLE 40
T-Test Comparison of all Micro-Adzes and Micro-Adze Slugs (Subtypes 3e-3h) Between Zone A (Strata AX-LZ) and Zone C (Strata S5-X5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone A	169	66.9645	12.168	0.936	−1.27	−2.68
Zone C	6	73.3333	5.354	2.186		
Maximum Thickness						
Zone A	169	0.70769	2.767	0.213	−1.89	−1.05
Zone C	6	0.93333	5.241	2.140		
Maximum Width						
Zone A	169	1.82840	3.226	0.248	−0.16	−0.17
Zone C	6	1.85000	3.017	1.232		
Weight (excluding slugs)						
Zone A	145	1.97862	8.794	0.730	−0.52	−0.64
Zone C	6	2.16667	6.976	2.848		

TABLE 41
T-Test Comparison of all Flake-scrapers (Subtype 2a) Between Zone A (Strata AX-LZ) and Zone B (Strata M5-R5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone A	96	72.0729	11.535	1.177	2.56	2.45
Zone B	66	66.7879	14.695	1.809		
Maximum Thickness						
Zone A	96	1.59479	5.862	0.598	−1.46	−1.47
Zone B	66	1.73030	5.716	0.704		
Maximum Width						
Zone A	96	4.19167	11.672	1.191	−1.38	−1.38
Zone B	66	4.45151	11.826	1.456		
Weight						
Zone A	96	22.77813	202.218	20.639	−1.05	−1.08
Zone B	66	25.98938	173.987	21.416		

TABLE 42
T-Test Comparison of all Flake-scrapers (Subtype 2a) Between Zone B (Strata M5-R5) and Zone C (Strata S5-X5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone B	66	66.7879	14.695	1.809	–1.29	–1.87
Zone C	12	72.4167	8.361	2.414		
Maximum Thickness						
Zone B	66	1.73030	5.716	0.704	–1.97	–1.95
Zone C	12	2.08333	5.766	1.664		
Maximum Width						
Zone B	66	4.45151	11.826	1.456	–1.05	–1.04
Zone C	12	4.84167	11.935	3.445		
Weight						
Zone B	66	25.98938	173.987	21.416	–1.95	–1.59
Zone C	12	37.21665	233.543	67.418		

TABLE 43
T-Test Comparison of all Flake-scrapers (Subtype 2a) Between Zone A (Strata AX-LZ) and Zone C (Strata S5-X5)

Variable	No. of Cases	Mean	Standard Deviation	Standard Error	T-value (Pooled Variance estimate)	T-value (Separate Variance estimate)
Angle of Working Edge						
Zone A	96	72.0729	11.535	1.177	–0.10	–0.13
Zone C	12	72.4167	8.361	2.414		
Maximum Thickness						
Zone A	96	1.59479	5.862	0.598	–2.73	–2.76
Zone C	12	2.08333	5.766	1.664		
Maximum Width						
Zone A	96	4.19167	11.672	1.191	–1.81	–1.78
Zone C	12	4.84167	11.935	3.445		
Weight						
Zone A	96	22.77813	202.218	20.639	–2.29	–2.05
Zone C	12	37.21665	233.543	67.418		

of all Adzes and Micro-Adzes, and it must be remembered that Zone C contained only Micro-Adzes. Thus in this case we can account for the relatively high values for t by pointing out that the samples from Zones A and B contained both Adzes and Micro-Adzes, whereas Zone C contained only Micro-Adzes which, of course, tend to have reduced measurements for these two attributes. This exception aside, the low values for t shown in these tables demonstrate the virtual identity of these populations of attributes through time at the site. They offer evidence that these tool types are indeed constant in nature throughout the Puntutjarpa sequence.

For Flake-scrapers, however, the value of t is slightly higher with respect to these variables, suggesting less uniformity through time than was the case for the tool types that are presumed to have been hafted. Of these variables, weights vary the most, reflecting a trend toward reduced weights in the later phases of occupation at the site, and a similar trend appears with respect to maximum thickness. From a technological point of view, hand-held Flake-scrapers are subject to fewer size constraints than hafted ones would be, and, as was pointed out in Chapter V, Subtypes 2a and 2b have wide parameters for attributes of size. The variations shown here suggest slight trends within the range of these parameters, with a modest tendency toward reduced size through time, but these shifts are seen as insufficient to call for a revision of the type and subtype classification offered in Chapter V.

LITHIC RAW MATERIALS

A total of eight classes of lithic raw material was distinguished among the 77,484 stone tools, cores, and waste flakes found in Trench 2 at Puntutjarpa:

1. *Warburton porphyry*. A hard, dark bluish gray stone with pronounced granular inclusions but with little tendency toward internal planes of cleavage.
2. *Quartz*. Hard white or semitranslucent stone with pronounced internal planes of cleavage. Occasionally, small pieces of transparent quartz crystal were also found. These lacked internal planes of cleavage.
3. *Quartzite*. A variable category of stones with noticeable fine granular texture and few, if any, internal planes of cleavage. Color varies from pale yellow to dark red and reddish brown. Most examples were hard, with a semisilicious surface shine, but some specimens tended toward a dull surface and were rather "sugary" in texture.
4. *Red chert*. A hard, fine-grained dark red chert with some tendencies to fracture along internal planes of cleavage. No large pieces of this material were found.
5. *Opaline*. White stone with shiny surface but soft internal texture, tending at times to crumble into a white powdery consistency.
6. *White chert*. Hard white to semitranslucent stone with no internal planes of cleavage. Varies in surface texture from dull to smooth. Rough cortex often present on pieces of this material, and some pieces show a partial slight pinkish to dark reddish brown coloration.
7. *Agate*. Hard, brown to semitranslucent stone sometimes with pronounced internal banding. Smooth texture with few internal planes of cleavage. Few large pieces of this material were found.
8. *Exotic*. This is a residual category consisting of lithic materials known not to occur within a 25-mile radius of Puntutjarpa Rockshelter. They vary greatly in terms of color, texture, and hardness, with mottled and banded cherts in colors such as black, gray, purple, red, yellow, brown—to mention a few. The source of only one of these lithic materials is known—a bright- to pale-green, semitranslucent chryso-

TABLE 44
Contemporary Quarry Sites in Vicinity of Puntutjarpa

Location	Approx. Direct-line Mileage and Direction from Puntutjarpa	Lithic Material
1. Spring Granite (Kunapuruḷ)	20 mi. northeast	white chert
2. Quarry 3 mi. W. of Spring Granite	20 mi. north	white chert
3. Warburton Range (immediately S. of Mt. Talbot)	6 mi. northeast	Warburton porphyry
4. The Sisters	10 mi. southeast	dark red chert
5. Mulyangiri	14 mi. north	white chert
6. Quarry 1 mi. S. of Waṇampi Well	20 mi. east	white chert
7. Quarry 1/2 mi. N. of Mulyayiti	15 mi. southeast	white chert

RELATIVE PERCENTAGES of LITHIC MATERIAL by STRATUM TRENCH 2, PUNTUTJARPA

ZONES (DATES BASED ON C-14)	STRATA	WARBURTON PORPHYRY %	WARBURTON PORPHYRY No.	QUARTZ (including quartz crystal) %	QUARTZ No.	QUARTZITE %	QUARTZITE No.
	AX	4.4%	34	50.0%	396	8.8%	68
<185 Years	BX	5.7	93	52.8	865	6.7	113
	CX	7.1	187	52.0	1363	7.9	208
	DX	6.0	246	54.5	2073	6.7	256
A	EX	5.7	269	53.7	2434	7.2	327
	FX	6.2	253	51.0	1899	8.4	313
1500 AD	GX	9.1	438	48.7	2333	10.9	523
	HX	10.3	400	47.5	1751	12.5	462
	IZ	14.7	457	41.2	1285	16.8	524
UPPER ROCKFALL ZONE	JZ	13.6	181	45.7	610	16.3	218
	KZ	19.8	318	43.1	725	14.6	234
	LZ	15.7	100	50.2	319	13.1	83
	M5	14.3	1168	46.7	3803	19.9	1622
B	N5	11.1	1093	54.0	5321	16.7	1645
4700 BC	O5	10.1	885	55.1	4835	15.4	1353
	P5	11.3	696	52.8	3241	15.7	974
	Q5	14.3	665	46.8	2181	18.5	862
	R5	15.7	596	40.4	1530	20.9	792
	S5	15.7	299	39.4	751	19.2	366
8000 BC	T5	14.5	205	35.8	505	15.7	222
C	U5	12.3	56	28.7	131	12.1	55
	V5	10.5	8	34.2	26	9.2	7
	X5			22.2	4	5.6	1
TOTAL Actual Number of specimens)			8,647		38,381		11,228
TOTAL %		11.2		49.5		14.5	

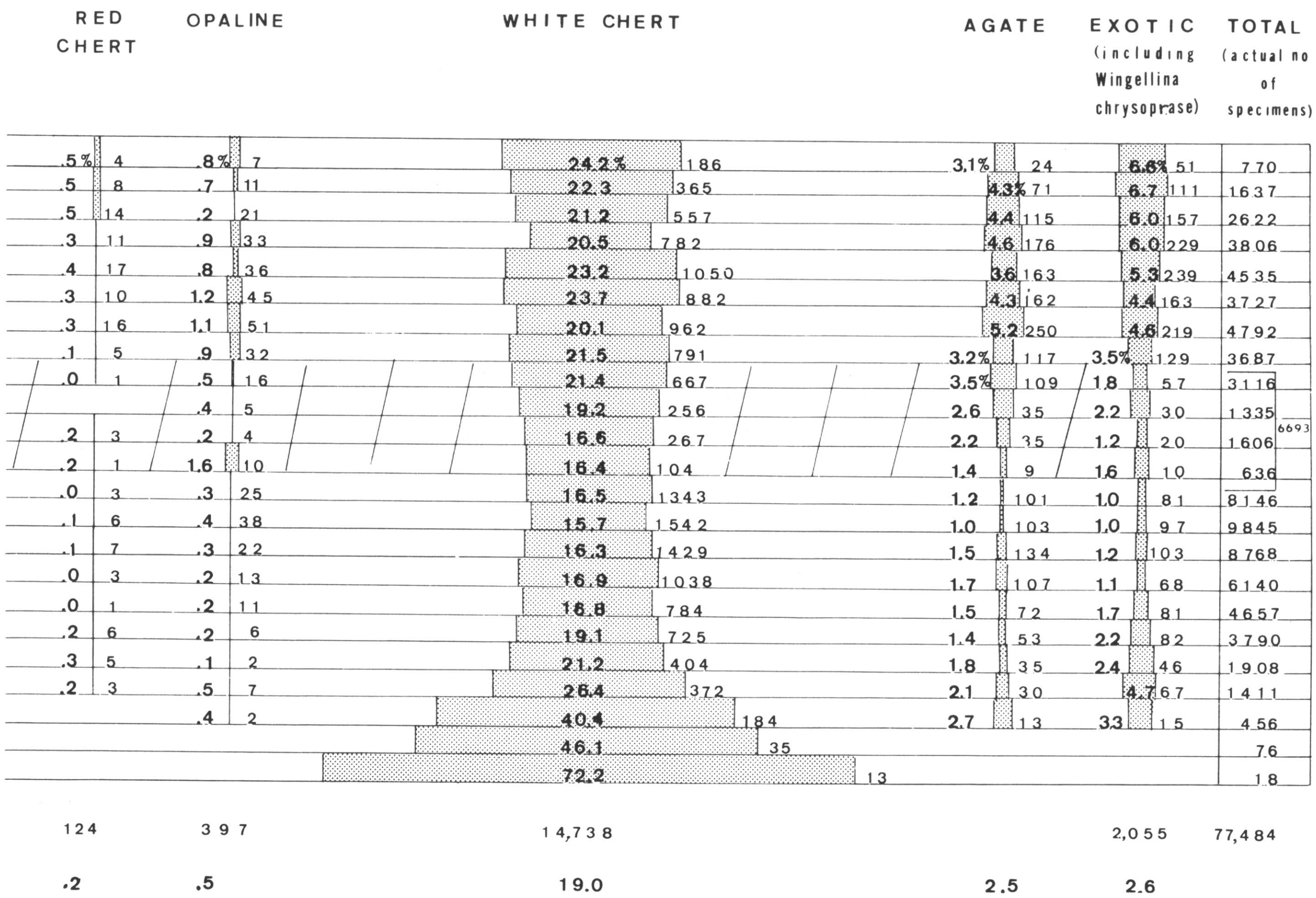


FIG. 67. Relative percentages of lithic material types by Stratum, Trench 2, Puntutjarpa.

prase from the Wingelinna Hills about 180 miles east of the Warburton Mission. Only two pieces of Wingelinna chrysoprase were found in the Trench 2 fill at Puntutjarpa.

With the exception of the items listed under the heading Exotic, all of these lithic raw materials have natural sources occurring within a 25-mile radius of Puntutjarpa Rockshelter. These sources take two forms: localized quarry sites and nonlocalized surface occurrences. The localized quarry sites found in the vicinity of Puntutjarpa are summarized in table 44. These take the form of modest surface outcrops (often nearly flush with the ground surface), although at some (particularly those containing white chert) some shallow digging is necessary in order to extract usable material. The quarries for red chert and Warburton prophyry are no longer used by the local aborigines, but the other quarry sites are still visited from time to time. Nonlocalized surface occurrences are mainly surface scatters of quartz, quartzite, and agate on extensive flats and gibber plains that lie in the area between the Brown Range and the Warburton Range and immediately to the north of the Warburton Range. Another important nonlocalized source consists of creekbeds lying between the Brown and Warburton ranges. Hughes Creek, which passes close to Puntutjarpa, contains many usable pieces of quartzite and opaline as well as redeposited Warburton porphyry. Thus copious supplies of quartz and quartzite as well as modest quantities of agate and opaline were available to the ancient inhabitants of Puntutjarpa Rockshelter within 1/2- to 1/4-mile of the site.

Figure 67 summarizes the stratigraphic occurrence of the different lithic raw materials in Trench 2 at Puntutjarpa. It presents the relative percentages of each raw material type by stratum in graphic form with the absolute numbers of specimens presented immediately to the right. The reader will note that although reduced numbers of specimens occur in Strata IZ-LZ (the Upper Rockfall), the amounts remaining are large enough to provide valid samples which do not significantly affect the relative percentages shown. As this figure shows, there have been no significant changes in the relative percentages of lithic raw materials used during the sequence at Puntutjarpa, thus leading one to infer that there were no important changes in lithic preferences by the ancient inhabitants of Puntutjarpa Rockshelter throughout the site's roughly 10,000-year occupation. Quartz has always been of overwhelming importance as a lithic raw material at Puntutjarpa despite its obvious disadvantages in terms of doing controlled flaking, a fact that suggests that the advantages of having this raw material available nearby in large amounts outweighed the disadvantages involved with manufacture and use of stone tools made of quartz. White chert, on the other hand, is not close at hand, and special trips—although short ones to be sure—had to be made to quarry sites to obtain this raw material. In this case, probable advantages in terms of controlled flaking and edge-holding properties apparently outweighed the inconvenience of having to make special trips to

TABLE 45
Stone Tools and Cores vs. Waste Flakes Arranged by Stratum from Trench 2, Puntutjarpa

Stratum	Stone Tools and Cores	Waste Flakes	Ratio
AX	17	753	1:44
BX	47	1590	1:34
CX	92	2530	1:28
DX	142	3664	1:26
EX	168	4367	1:26
FX	138	3589	1:26
GX	139	4653	1:33
HX	76	3611	1:48
IZ	38	3078	1:81
JZ	20	1315	1:66
KZ	15	1591	1:106
LZ	10	626	1:63
M5	85	8061	1:95
N5	81	9764	1:121
O5	77	8691	1:113
P5	54	6086	1:113
Q5	68	4589	1:67
R5	45	3745	1:83
S5	30	1878	1:63
T5	42	1369	1:33
U5	22	434	1:20
V5	5	71	1:14
X5	–	18	–
Totals	1411	Overall Ratio	1:59

get the material. A limited series of experiments was performed on the various lithic materials represented at the site in an effort to isolate some of the factors that might account for these and other patterns, and the results of these experiments appear in Chapter VII.

Finally, table 45 presents an overall summary of stone tools and cores vs. waste flakes by stratum. The excavated material from Trench 2 shows a high number of stone waste flakes relative to the number of recognizable stone tools and cores throughout the entire sequence. The overall ratio for all strata was 54 waste flakes for every tool or core, but considerable variation was also found to occur between strata. The highest ratios of waste flakes to tools and cores were found consistently between Strata IZ and R5, although figures for Strata IZ-LZ must be viewed with caution because of the large pieces of Upper Rockfall material in these strata. In a gross way, at least, these figures indicate that stone-chipping was an important cultural activity at Puntutjarpa throughout the sequence of human occupation there. The presence of large numbers of Large Cores and Micro-Cores throughout the sequence along with nine hammerstones also supports this interpretation. No hypothesis can be offered at this time to explain the relatively high ratios of waste flakes to tools and cores in Strata IZ-R5, since this peak does not appear to correlate with any other observed cultural or natural phenomena in the sequence. However, given the earlier findings on lithic raw materials, it seems clear that at all times during the human occupation of Puntutjarpa Rockshelter people were carrying most of their stone materials from local quarries and surface sources within a distance of two easy days' walk from the site (and generally much less, since quartz and certain other stones were available within a distance of one mile) to Puntutjarpa where they were reduced further by direct percussion to provide usable woodworking scrapers and cutting implements.

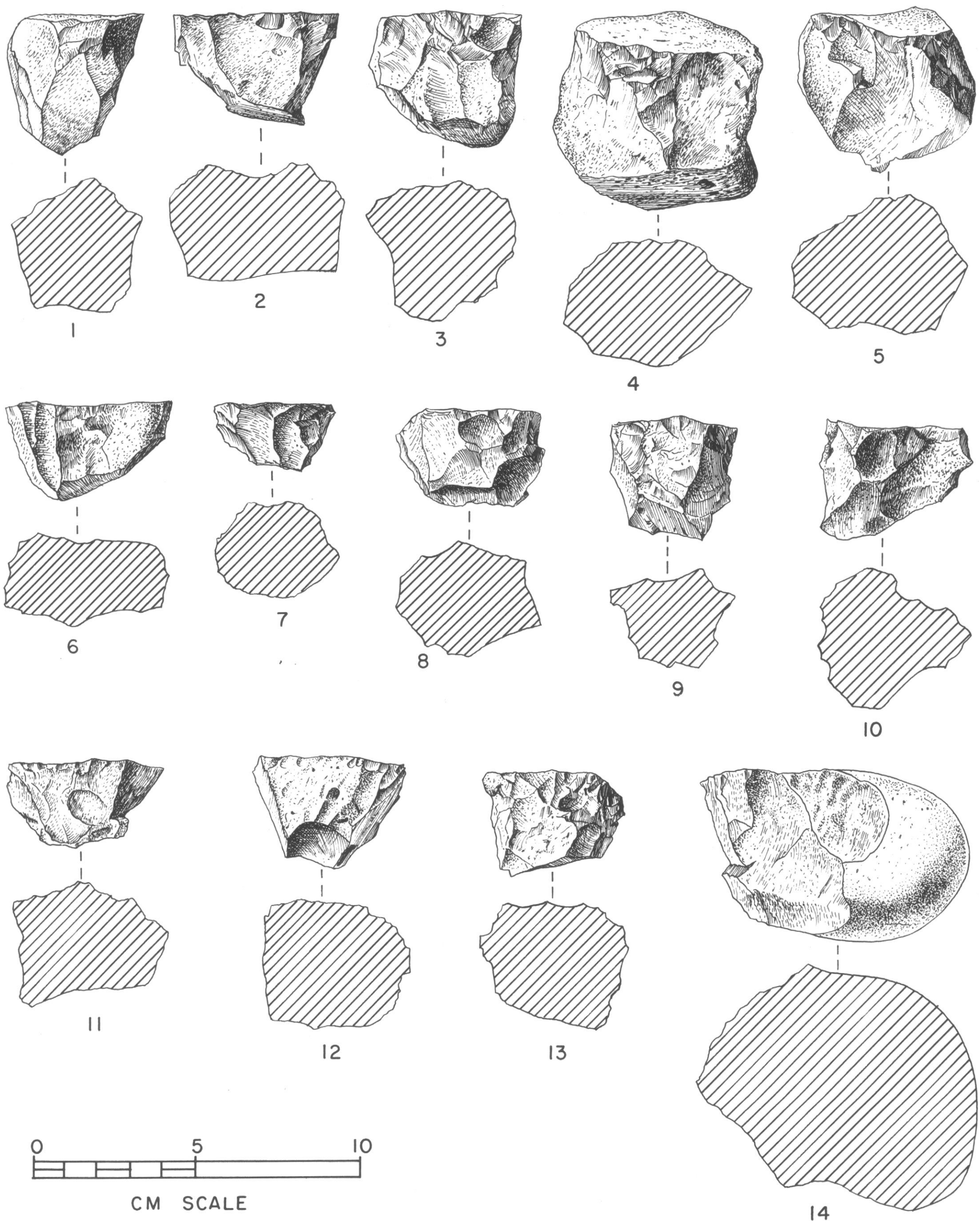


FIG. 68. Subtype 1a, Large Cores with Single-Striking platform.

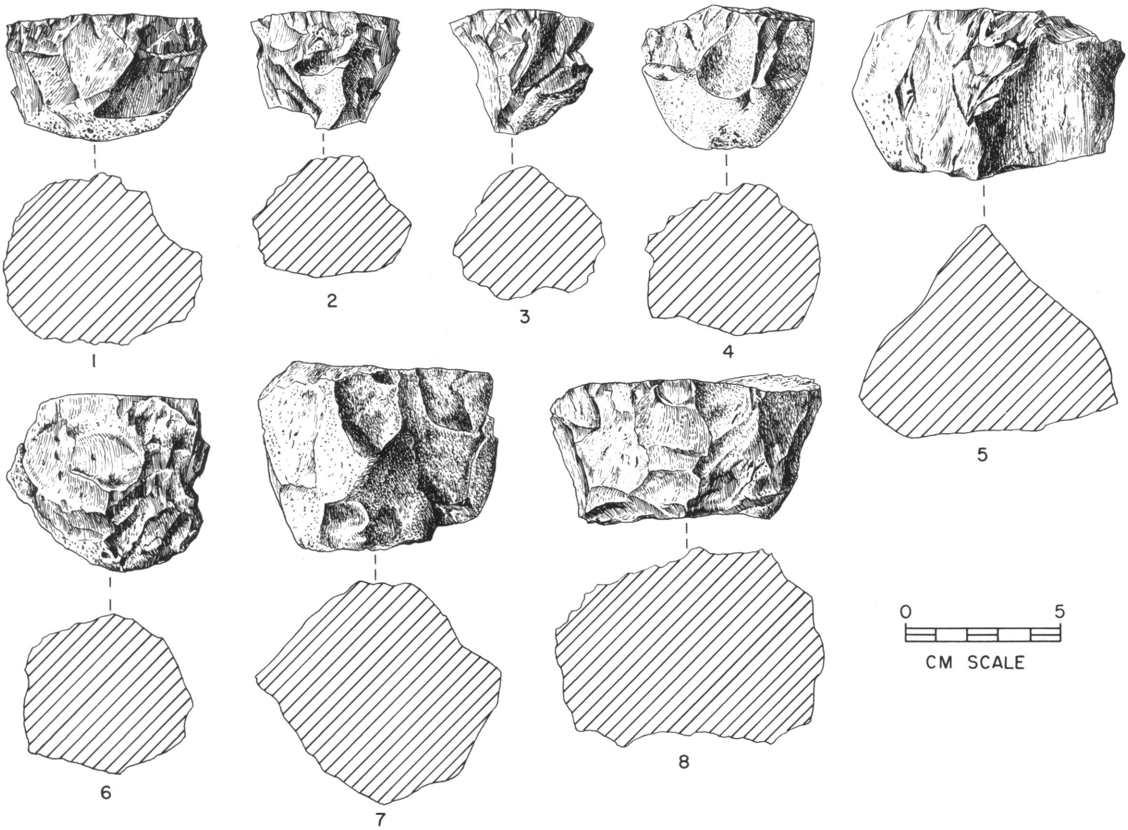


FIG. 69. Subtype 1b, Horsehoof Cores.

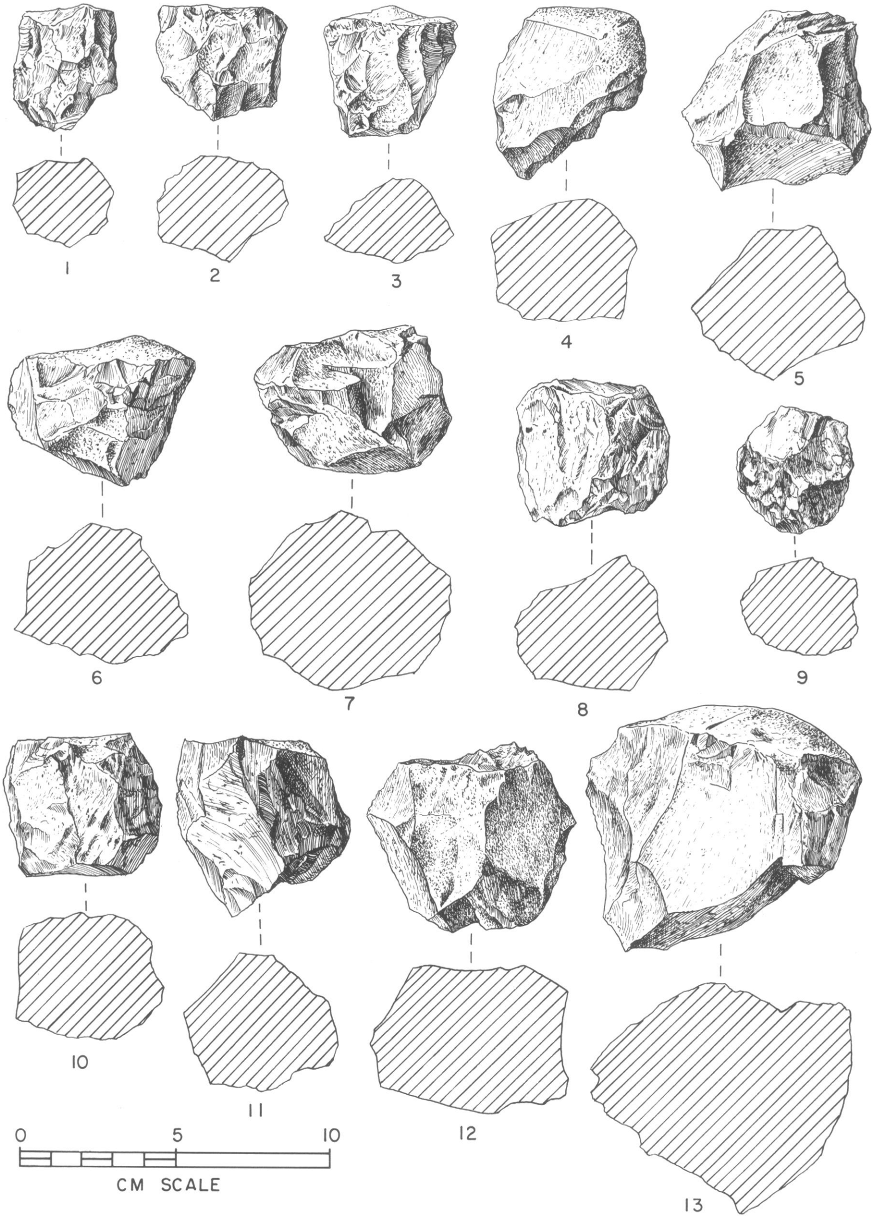


FIG. 70. Subtype 1c, Large Cores with Multiple-Striking Platforms.

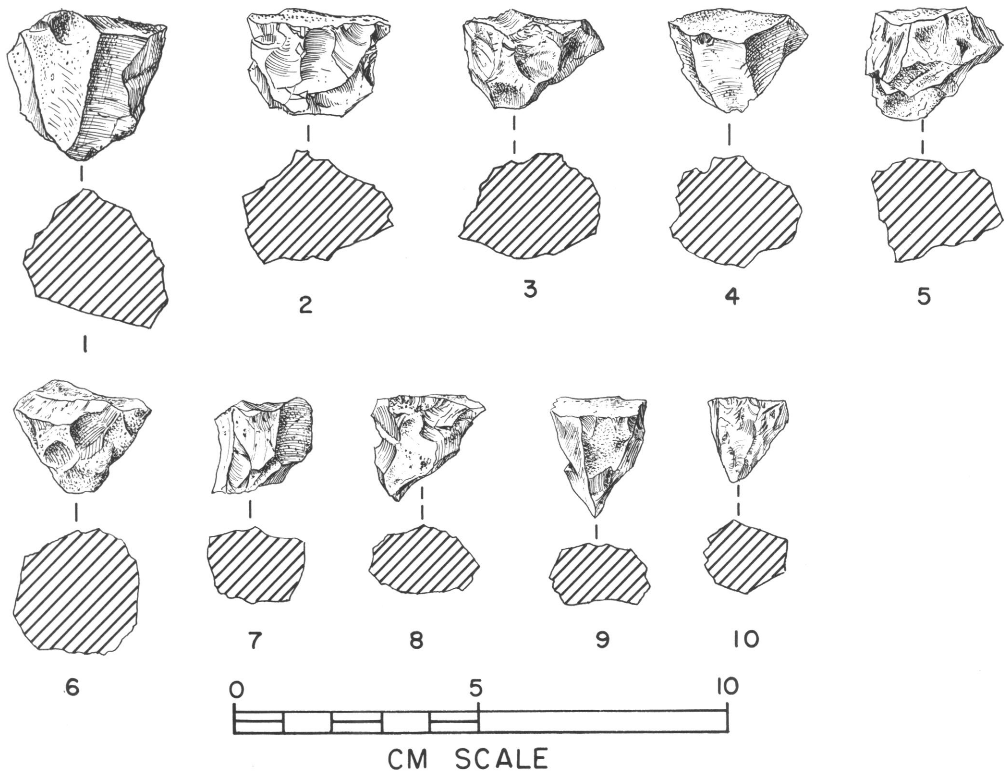


FIG. 71. Subtype 1d, Micro-Cores with Single-Striking Platform.

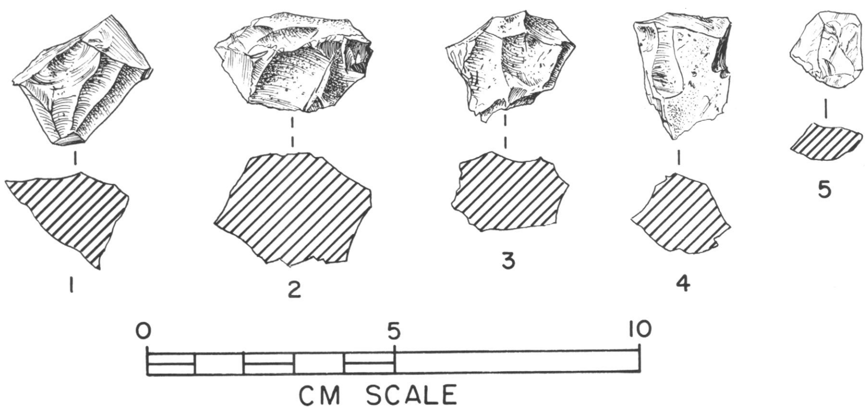
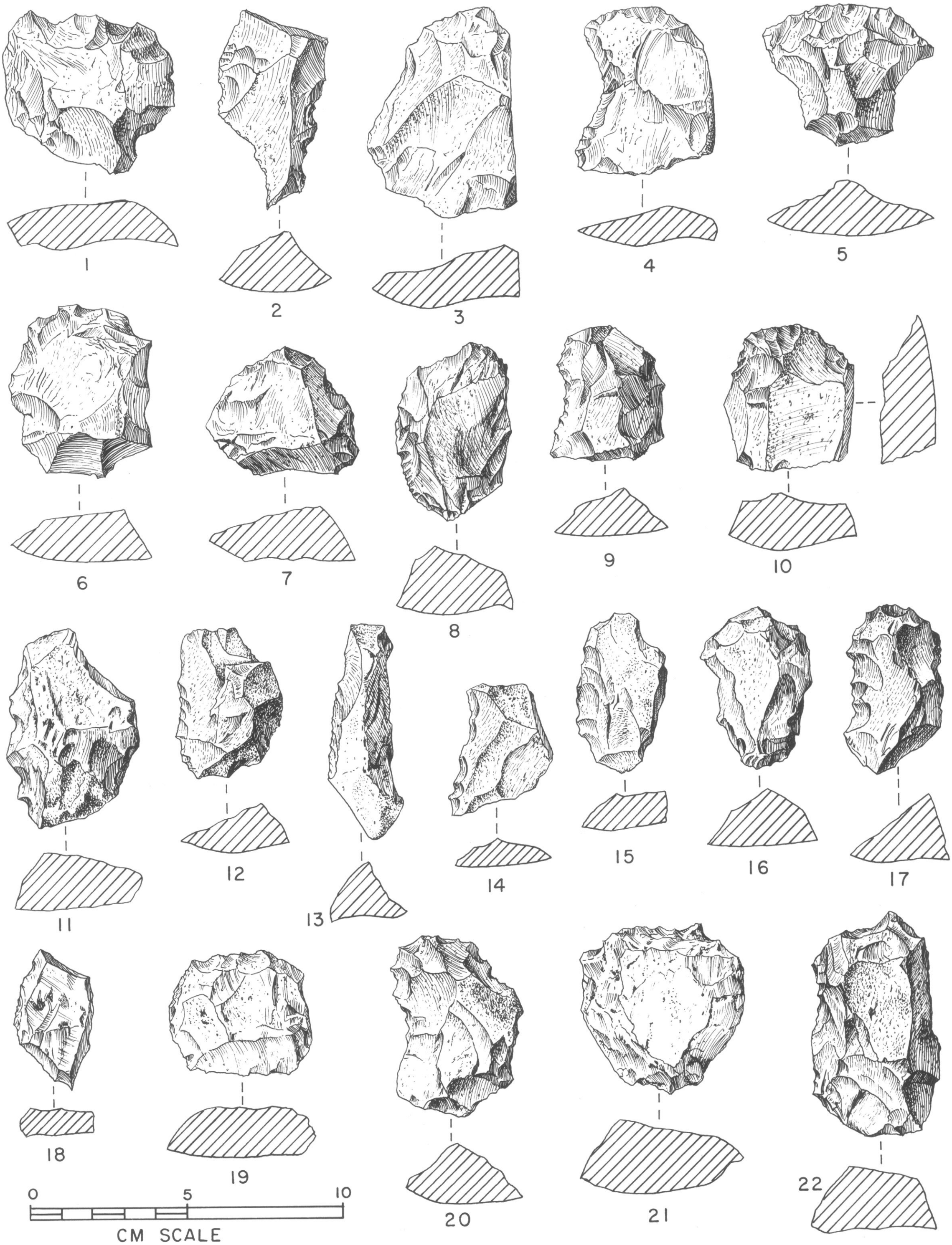


FIG. 72. Subtype 1e, Micro-Cores with Multiple-Striking Platforms.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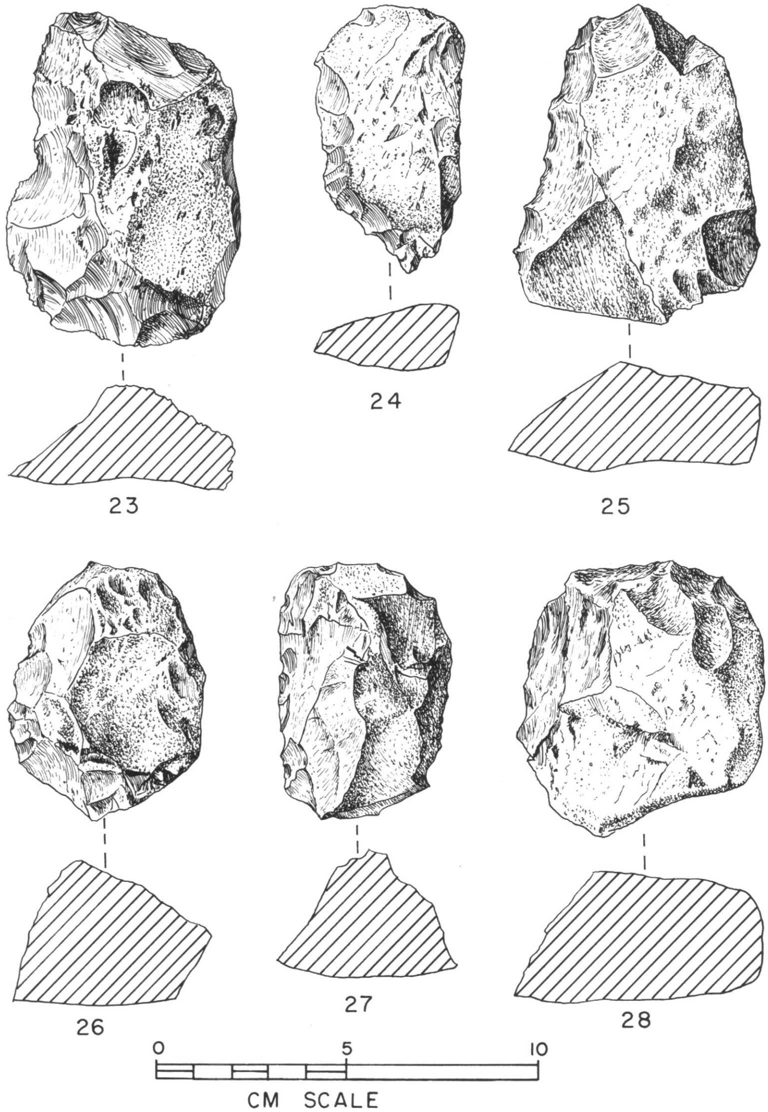


FIG. 73. Subtype 2a, Large Flake-scrapers with Retouch.

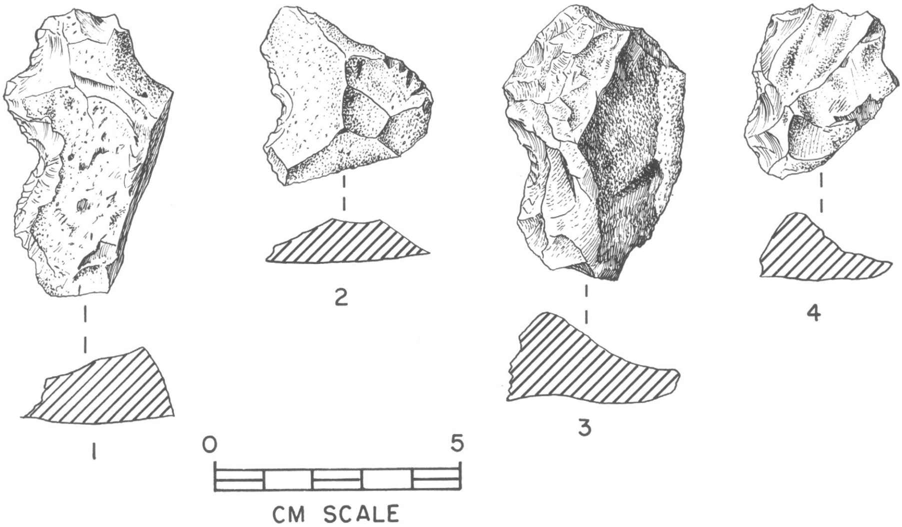


FIG. 74. Subtype 2b, Spokeshaves.

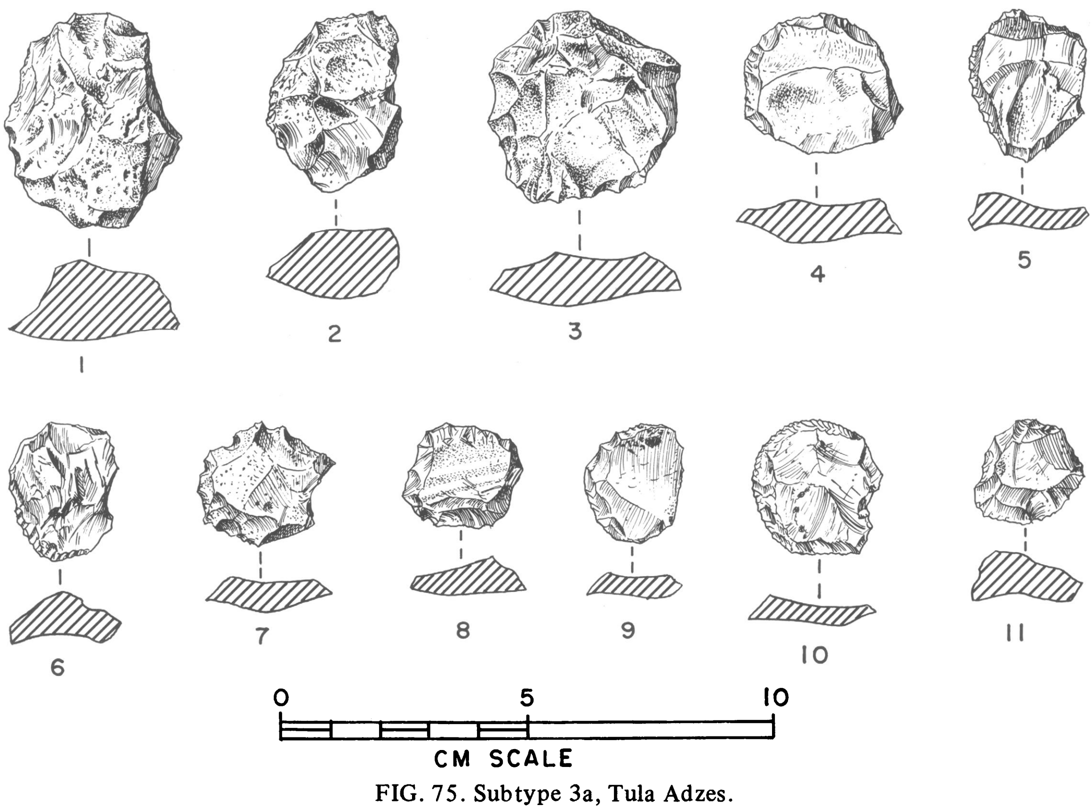


FIG. 75. Subtype 3a, Tula Adzes.

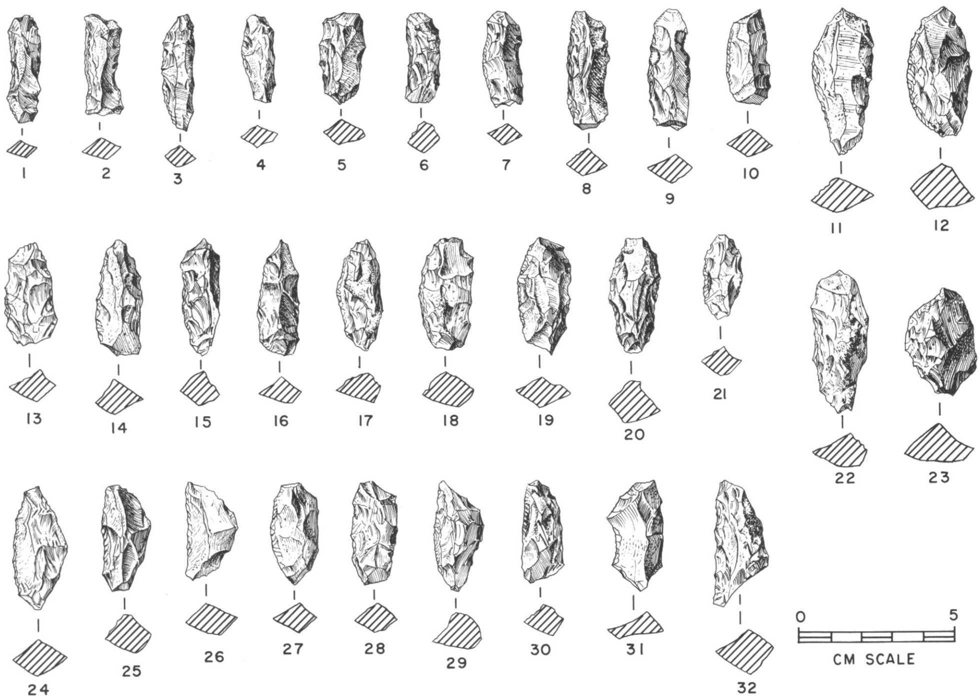


FIG. 76. Subtype 3b, Tula Adze Slugs.

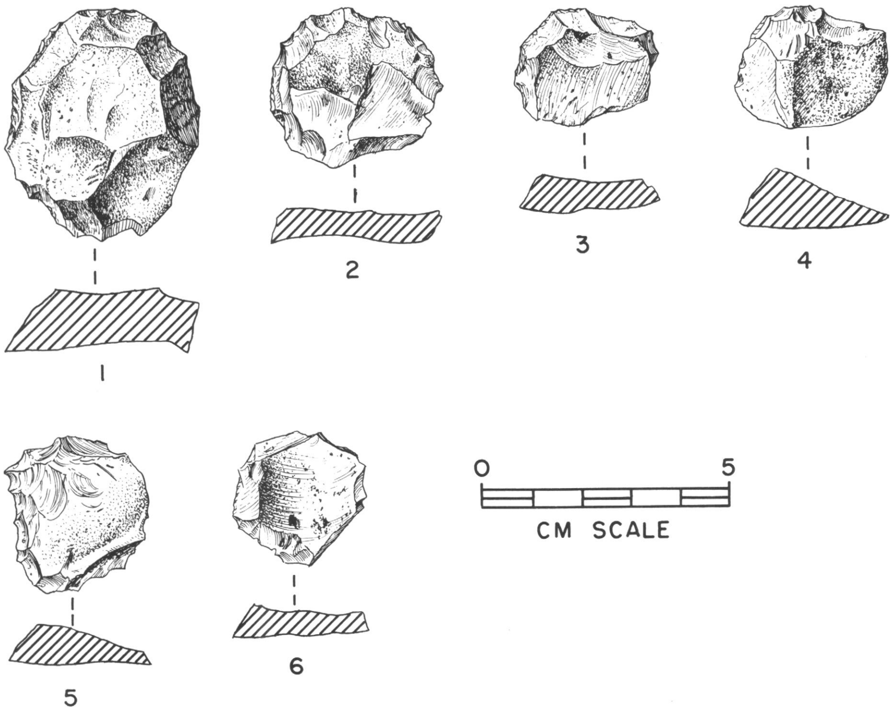


FIG. 77. Subtype 3c, Non-Tula Adzes.

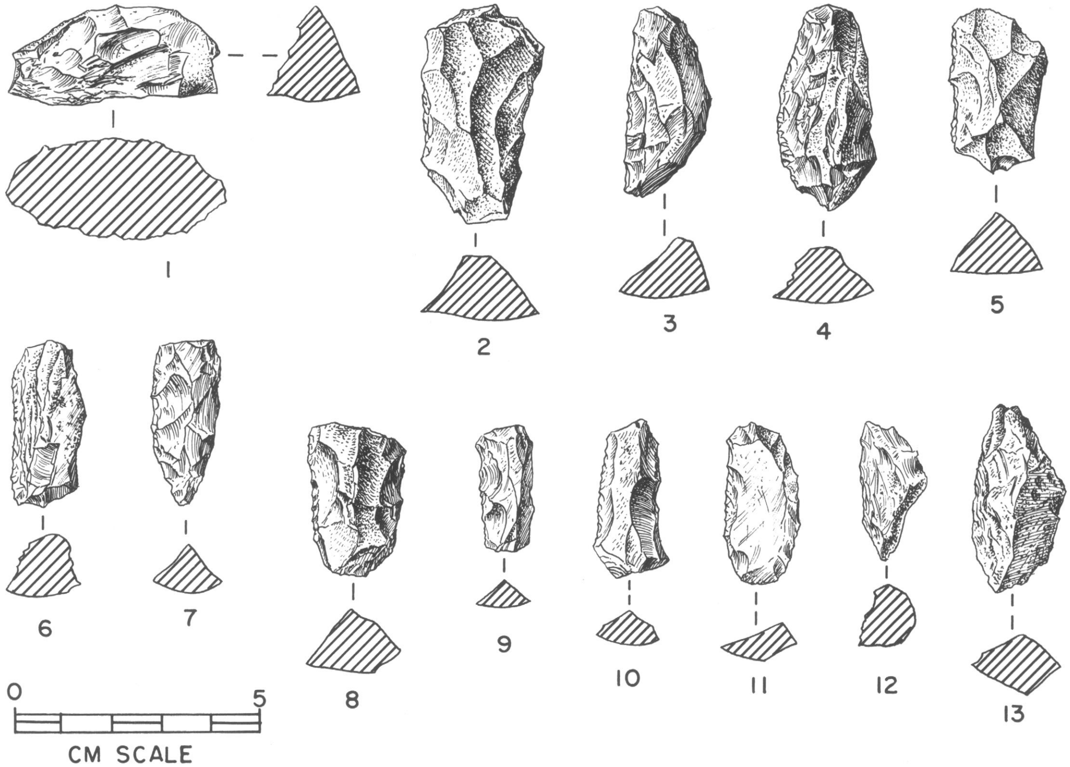


FIG. 78. Subtype 3d, Non-Tula Adze Slugs.

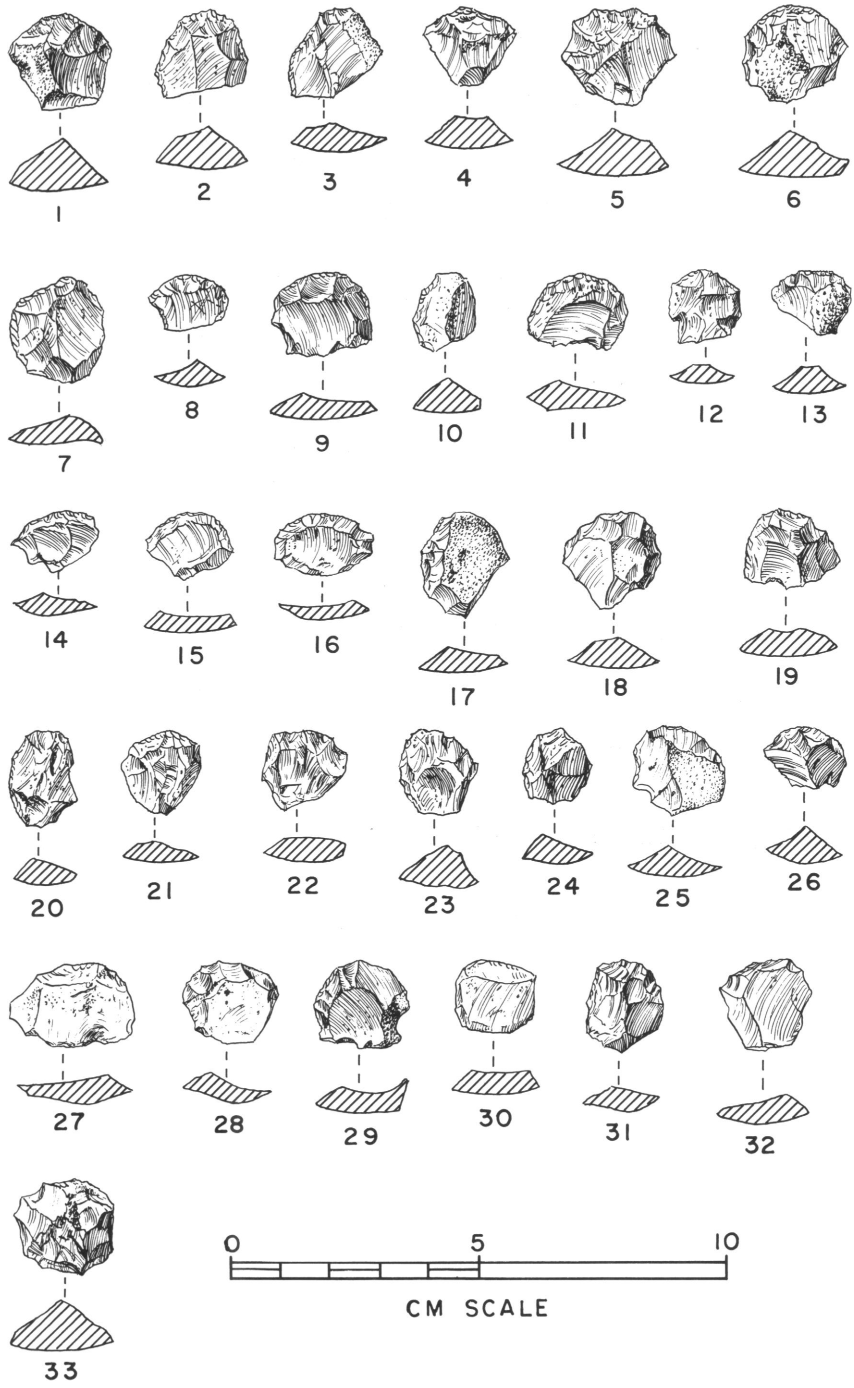


FIG. 79. Subtype 2e, Tula Micro-Adzes.

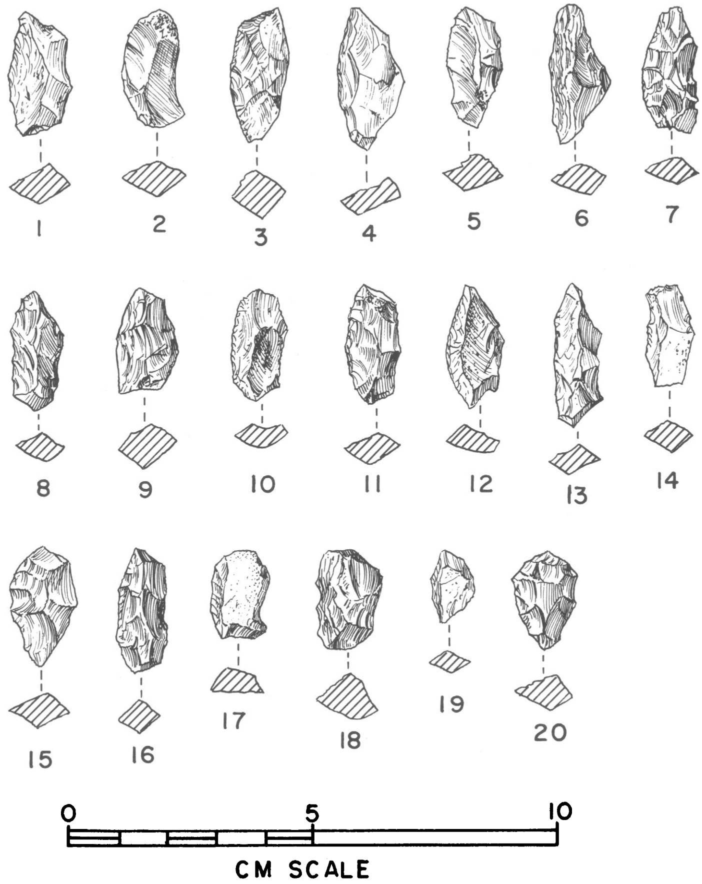


FIG. 80. Subtype 3f, Tula Micro-Adze Slugs.

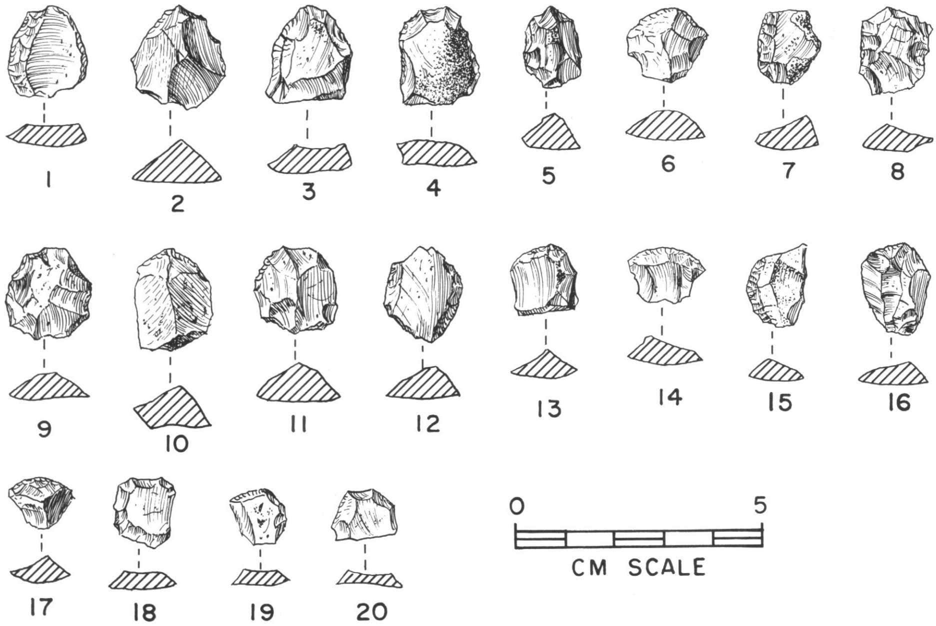


FIG. 81. Subtype 3g, Non-Tula Micro-Adzes.

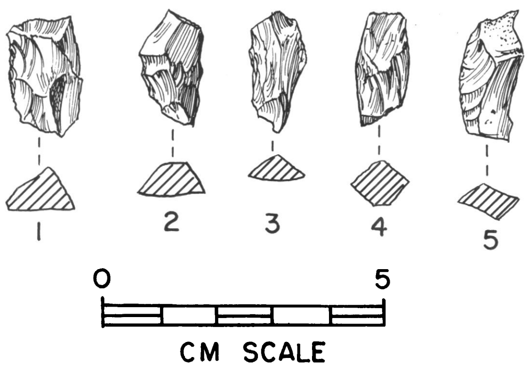


FIG. 82. Subtype 3h, Non-Tula Micro-Adze Slugs.

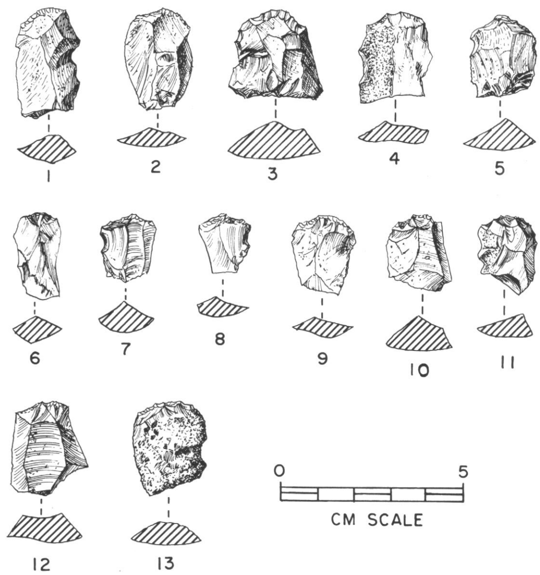


FIG. 83. Subtype 3i, Small Endscrapers.

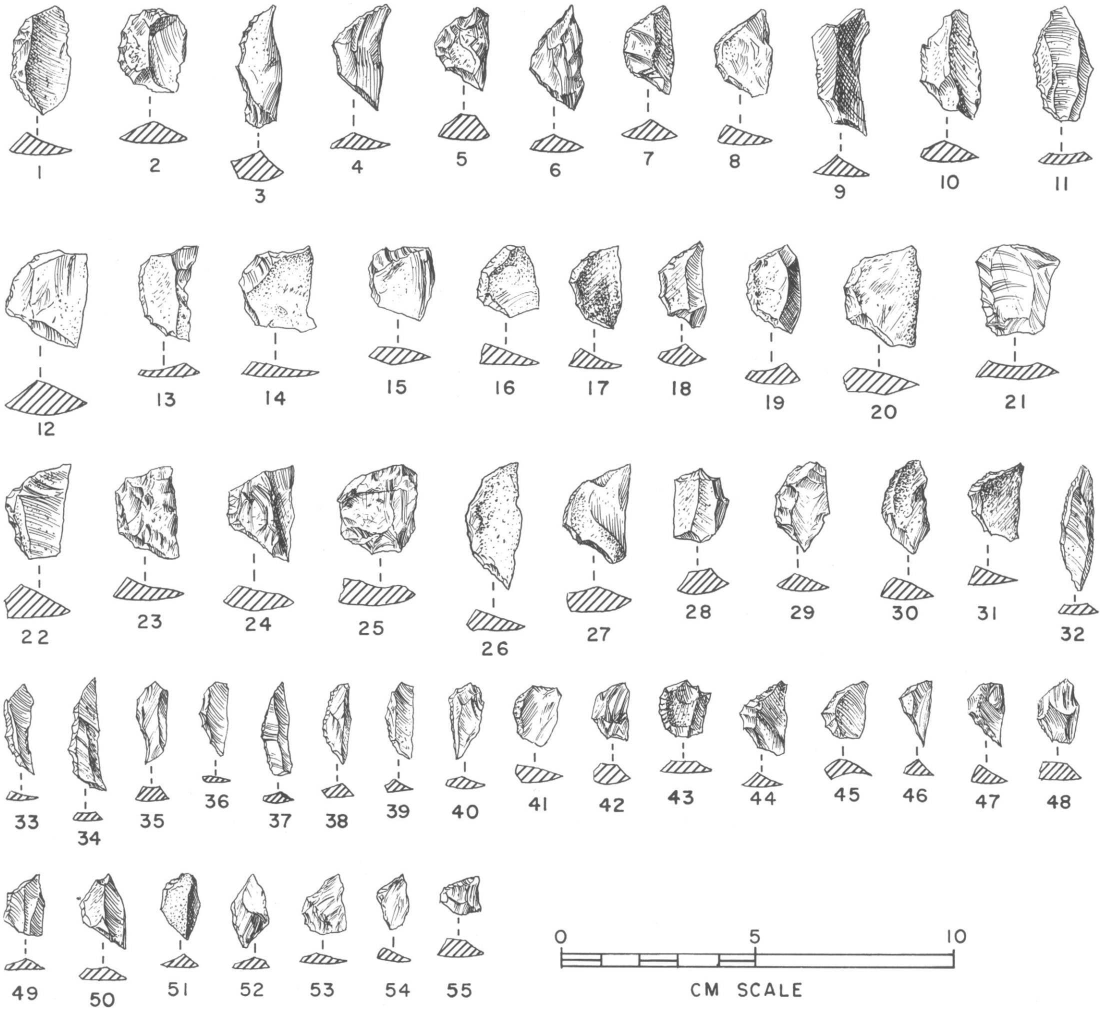


FIG. 84. Type 4, Backed Blades.

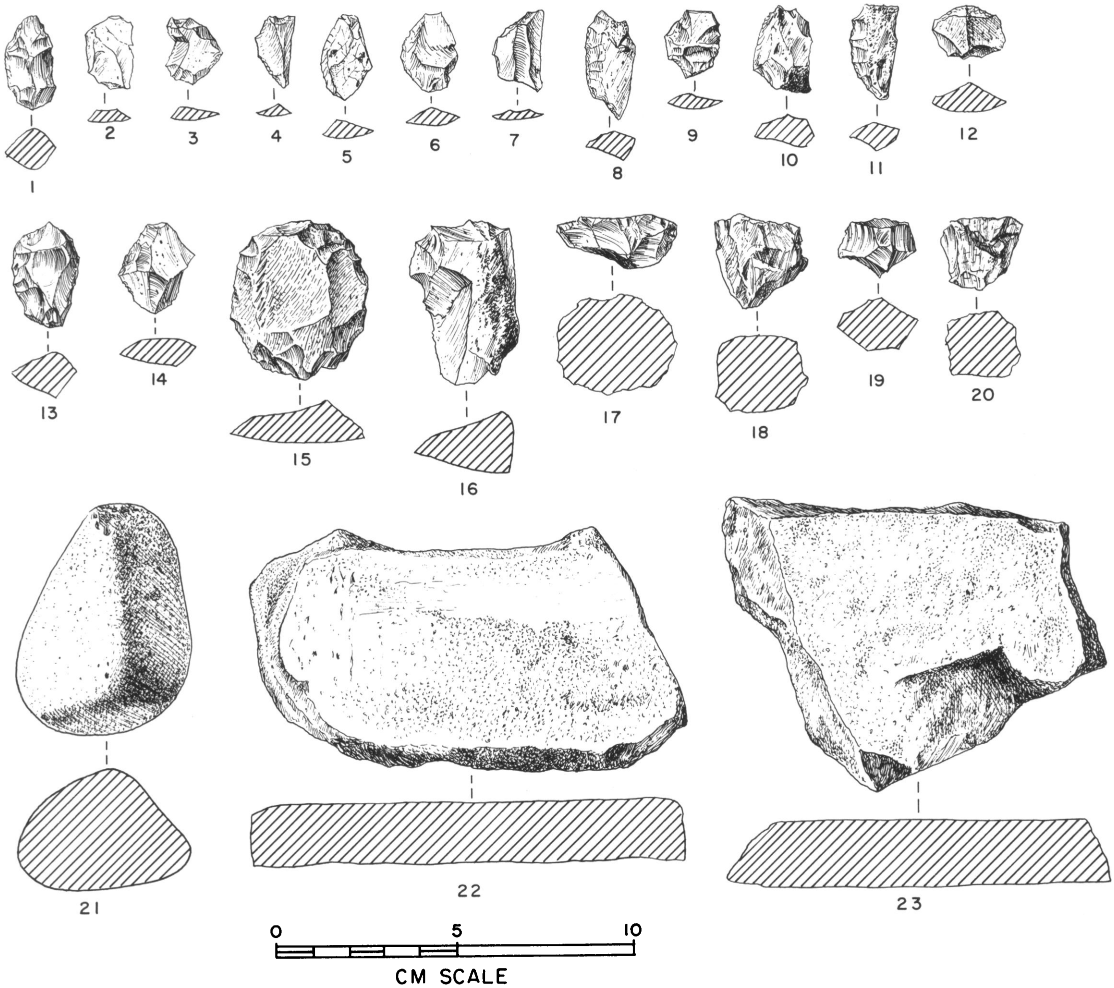


FIG. 85. Stone artifacts from F.7 living surface, Trench 2, 18-21 in., Stratum GX.

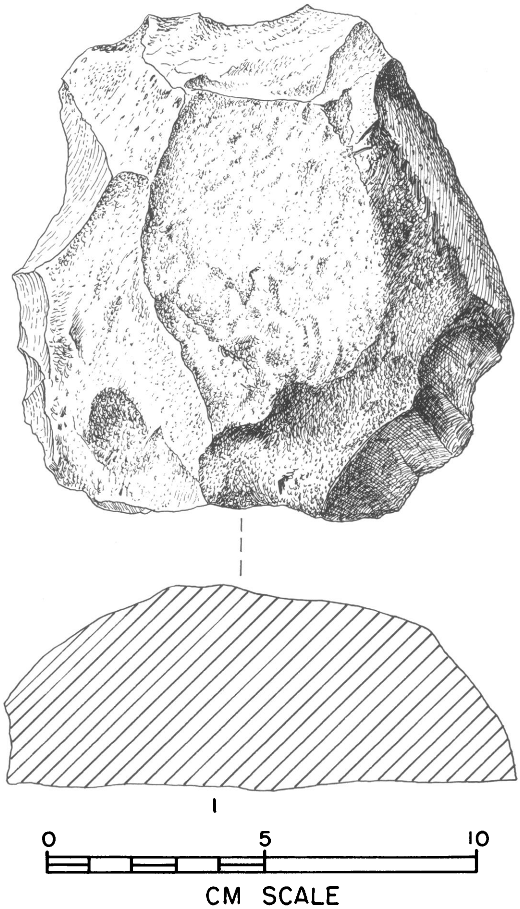


FIG. 86. Provisional Type 5, Handaxe.

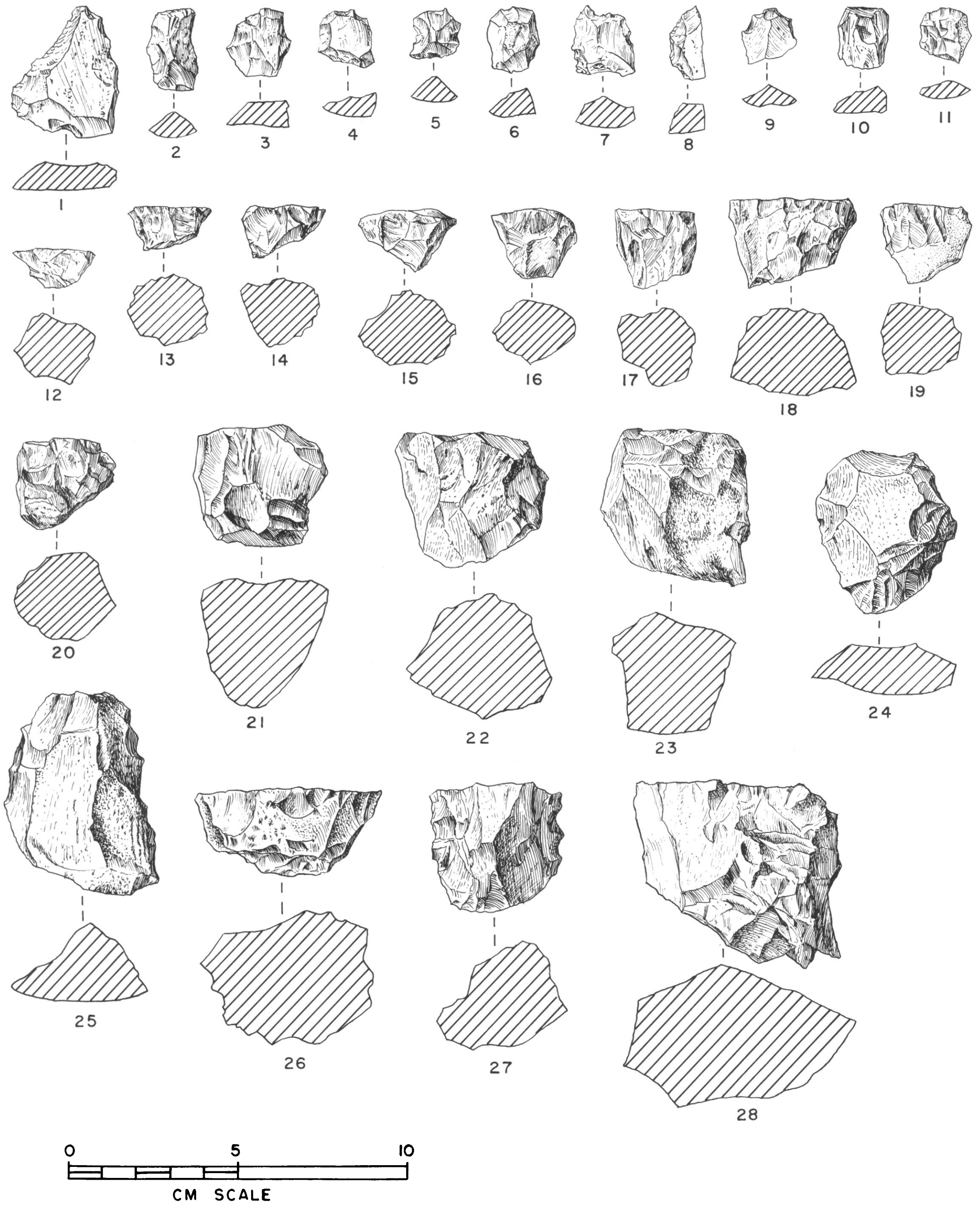


FIG. 87. Flaked Stone artifacts, Trench 2, Zone C (Strata S5-X5).

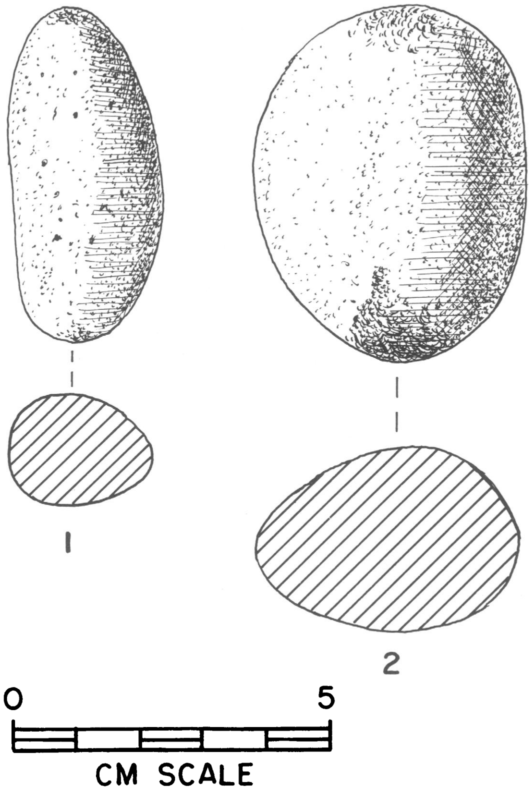


FIG. 88. Type 8, Hammerstones.

EXPLANATION OF FIGURES 68-88
STONE ARTIFACTS EXCAVATED AT PUNTUTJARPA ROCKSHELTER, 1969-1970

No.	Western Australian Museum Catalogue Number	Trench	Square	Depth below surface	Soil Unit	Stratum(a)
68. Subtype 1a, Large Cores with Single-Striking Platform.						
1	21378	2	25	36-42 in.	F.4	N5-O5
2	20105	2	11	42-45 in.	F.4	P5
3	21327	2	22	30-36 in.	F.4	KZ-M5
4	20940	2	21	30-36 in.	F.4	M5-N5
5	19818	2	10	33-36 in.	F.4	N5
6	20728	2	21	6-12 in.	F.4	CX-DX
7	21241	3	49	18-24 in.	F.42	–
8	20885	2	21	12-18 in.	F.4	EX-FX
9	20727	2	19	18-21 in.	F.4	GX
10	20013	2	4	39-42 in.	F.4	P5
11	19017	2	4	18-21 in.	F.4	GX
12	19640	2	17	30-33 in.	F.4	KZ
13	19828	2	11	33-36 in.	F.4	M5
14	19594	2	3	24-27 in.	F.4	IZ
69. Subtype 1b, Horsehoof Cores.						
1	21449	2	24	36-42 in.	F.4	O5-P5
2	19219	2	3	21-24 in.	F.4	HX
3	21246	2	25	30-36 in.	F.4	KZ-M5
4	23886	2	21	12-18 in.	F.4	EX-FX
5	19586	2	7	33-36 in.	F.4	P5
6	21565	3	50	36-42 in.	F.42	–
7	19412	2	17	27-30 in.	F.4	JZ
8	20285	2	44	27-30 in.	F.4	N5
70. Subtype 1c, Large Cores with Multiple-Striking Platforms.						
1	20899	2	20	12-18 in.	F.4	EX-FX
2	21380	2	25	36-42 in.	F.4	N5-O5
3	19494	2	18	24-27 in.	F.4	IZ
4	20351	2	46	0-6 in.	F.3	AX-BX
5	20812	2	4	42-45 in.	F.4	Q5
6	21233	2	24'	18-24 in.	F.4	GX-HX
7	21377	2	25	36-42 in.	F.4	N5-O5
8	21475	2	24	42-48 in.	F.4	O5-R5
9	20887	2	21	12-18 in.	F.4	EX-FX
10	20514	2	43	12-18 in.	F.4	EX-FX
11	20608	2	46	18-24 in.	F.4	GX-HX
12	19220	2	3	21-24 in.	F.4	HX
13	21543	2	25	48-54 in.	F.4	R5-S5
71. Subtype 1d, Micro-Cores with Single-Striking Platform.						
1	19982	2	15	42-45 in.	F.4	R5
2	18230	2	3	9-12 in.	F.4	DX
3	18365	2	3	12-15 in.	F.4	EX
4	18365	2	3	12-15 in.	F.4	EX

EXPLANATION OF FIGURES 68-88 – (*Continued*)

No.	Western Australian Museum Catalogue Number	Trench	Square	Depth below surface	Soil Unit	Stratum(a)
71. Subtype 1d, Micro-Cores with Single-Striking Platform (*continued*).						
5	19692	2	4	30-33 in.	F.4	M5
6	20982	2	20	30-36 in.	F.4	N5-O5
7	21466	2	24	36-42 in.	F.4	O5-P5
8	19257	2	18	21-24 in.	F.4	HX
9	19677	2	3	30-33 in.	F.4	N5
10	21482	2	24	42-48 in.	F.4	Q5-R5
72. Subtype 1e, Micro-Cores with Multiple-Striking Platforms.						
1	20108	2	11	42-45 in.	F.4	P5
2	19308	2	16	18-21 in.	F.4	GX
3	20188	2	11	45-48 in.	F.4	Q5
4	18363	2	3	12-15 in.	F.4	EX
5	21176	3	49	12-18 in.	F.42	–
73. Subtype 2a, Large Flake-scrapers with Retouch.						
1	21451	2	24	36-42 in.	F.4	O5-P5
2	19692	2	4	30-33 in.	F.4	M5
3	18712	2	1	15-18 in.	F.4	FX
4	18034	2	2	0-3 in.	F.4	AX
5	18505	2	8	6-9 in.	F.4	CX
6	19824	2	16	33-36 in.	F.4	N5
7	20556	2	44	18-24 in.	F.4	GX-HX
8	20616	2	46	24-30 in.	F.4	IZ-JZ
9	20864	2	20	18-24 in.	F.4	GX-HX
10	21224	2	24	36-39 in.	F.4	O5
11	19033	2	16	9-12 in.	F.4	DX
12	20053	2	11	39-42 in.	F.4	O5
13	18979	2	4	12-15 in.	F.4	EX
14	19681	2	8	39-42 in.	F.4	R5
15	21447	2	24	30-36 in.	F.4	M5-N5
16	19355	2	5	27-30 in.	F.4	JZ
17	18929	2	10	6-9 in.	F.4	CX
18	18131	2	3	6-9 in.	F.4	CX
19	19846	2	11	36-39 in.	F.4	N5
20	21450	2	24	36-42 in.	F.4	O5-P5
21	20717	2	1′	18-24 in.	F.4	GX-HX
22	20181	2	4	42-45 in.	F.4	Q5
23	21542	2	25	48-54 in.	F.4	R5-S5
24	21110	2	24	0-6 in.	F.4	AX-BX
25	20995	2	21	24-30 in.	F.4	IZ-JZ
26	21390	2	22	42-48 in.	F.4	P5-Q5
27	20865	2	20	18-24 in.	F.4	GX-HX
28	21217	2	25	18-24 in.	F.4	GX-HX
74. Subtype 2b, Spokeshaves.						
1	19426	2	12	24-27 in.	F.4	IZ
2	18547	2	3	15-18 in.	F.4	FX

EXPLANATION OF FIGURES 68-88 – (*Continued*)

No.	Western Australian Museum Catalogue Number	Trench	Square	Depth below surface	Soil Unit	Stratum(a)
74. Subtype 2b, Spokeshaves (*continued*).						
3	20188	2	11	45-48 in.	F.4	Q5
4	19028	2	16	9-12 in.	F.4	DX
75. Subtype 3a, Tula Adzes.						
1	21146	2	24	12-18 in.	F.4	EX-FX
2	19578	2	14	30-33 in.	F.4	O5
3	18941	2	10	9-12 in.	F.4	DX
4	21366	3	55	24-30 in.	F.44	–
5	18383	2	5	15-18 in.	F.4	FX
6	19114	2	12	18-21 in.	F.4	GX
7	20636	2	47	30-36 in.	F.4	KZ-M5
8	19273	2	12	21-24 in.	F.4	HX
9	20455	2	44	0-6 in.	F.3	AX-BX
10	20566	2	47	18-24 in.	F.4	GX-HX
11	18511	2	8	15-18 in.	F.4	FX
76. Subtype 3b, Tula Adze Slugs.						
1	18488	2	2	9-12 in.	F.4	DX
2	18117	2	6	3-6 in.	F.3	BX
3	20474	2	45	0-6 in.	F.3	AX-BX
4	18480	2	11	12-15 in.	F.4	EX
5	20564	2	47	18-24 in.	F.4	GX-HX
6	18714	2	15	12-15 in.	F.4	EX
7	19442	2	5	21-24 in.	F.4	HX
8	18842	2	15	9-12 in.	F.4	DX
9	19095	2	16	6-9 in.	F.4	CX
10	18233	2	3	9-12 in.	F.4	DX
11	21068	2	25	6-12 in.	F.4	CX-DX
12	19069	2	16	3-6 in.	F.4	BX
13	18702	2	15	6-9 in.	F.4	CX
14	18892	2	15	0-3 in.	F.3	AX
15	20830	2	21	6-12 in.	F.4	CX-DX
16	18403	2	12	15-18 in.	F.4	FX
17	20507	2	43	12-18 in.	F.4	EX-FX
18	20718	2	1′	18-24 in.	F.4	GX-HX
19	18715	2	15	12-15 in.	F.4	EX
20	18543	2	9	9-12 in.	F.4	DX
21	18704	2	15	6-9 in.	F.4	CX
22	18686	2	14	6-9 in.	F.4	CX
23	20720	2	1′	18-24 in.	F.4	GX-HX
24	18870	2	15	9-12 in.	F.4	DX
25	18095	2	2	0-3 in.	F.4	AX
26	18101	2	3	0-3 in.	F.4	AX
27	19075	2	4	12-15 in.	F.4	EX
28	18447	2	2	6-9 in.	F.4	CX
29	18244	2	3	9-12 in.	F.4	DX
30	18374	2	5	15-18 in.	F.4	FX

EXPLANATION OF FIGURES 68-88 – (*Continued*)

No.	Western Australian Museum Catalogue Number	Trench	Square	Depth below surface	Soil Unit	Stratum(a)
76. Subtype 3b, Tula Adze Slugs (*continued*)						
31	20346	2	47	0-6 in.	F.3	AX-BX
32	19418	2	11	21-24 in.	F.4	HX
77. Subtype 3c, Non-Tula Adzes.						
1	18732	2	3	15-18 in.	F.4	FX
2	18713	2	3	12-15 in.	F.4	EX
3	18457	2	2	12-15 in.	F.4	EX
4	20903	2	21	18-24 in.	F.4	GX-HX
5	20470	2	45	0-6 in.	F.3	AX-BX
6	21054	3	49	0-6 in.	F.3	–
78. Subtype 3d, Non-Tula Adze Slugs.						
1	21130	2	24′	6-12 in.	F.4	CX-DX
2	19263	2	3	18-21 in.	F.4	GX
3	18454	2	2	12-15 in.	F.4	EX
4	20565	2	47	18-24 in.	F.4	GX-HX
5	18911	2	10	12-15 in.	F.4	EX
6	18020	2	5	0-3 in.	F.2	AX
7	19384	2	1	24-27 in.	F.4	M5
8	19021	2	4	19-21 in.	F.4	GX
9	18411	2	1	9-12 in.	F.4	DX
10	19035	2	2	0-3 in.	F.3	AX
11	18355	2	3	12-15 in.	F.4	EX
12	18710	2	15	6-9 in.	F.4	CX
13	18921	2	10	12-15 in.	F.4	EX
79. Subtype 2e, Tula Micro-Adzes.						
1	19359	2	6	30-33 in.	F.4	KZ
2	19081	2	16	0-3 in.	F.2	AX
3	20377	2	45	12-18 in.	F.4	EX-FX
4	18538	2	9	9-12 in.	F.4	DX
5	19077	2	4	3-6 in.	F.4	BX
6	20427	2	45	6-12 in.	F.4	CX-DX
7	21169	2	22	12-18 in.	F.4	EX-FX
8	21106	2	22	6-12 in.	F.4	CX-DX
9	19075	2	2	12-15 in.	F.4	EX
10	20366	2	44	6-12 in.	F.4	CX-DX
11	20760	2	20	6-12 in.	F.4	CX-DX
12	18243	2	3	9-12 in.	F.4	DX
13	19251	2	18	21-24 in.	F.4	HX
14	19264	2	3	18-21 in.	F.4	GX
15	18716	2	15	12-15 in.	F.4	EX
16	18486	2	11	12-15 in.	F.4	EX
17	18444	2	2	6-9 in.	F.4	CX
18	19296	2	6	21-24 in.	F.4	HX
19	18388	2	7	12-15 in.	F.4	EX
20	20424	2	45	6-12 in.	F.4	CX-DX

EXPLANATION OF FIGURES 68-88 – (*Continued*)

No.	Western Australian Museum Catalogue Number	Trench	Square	Depth below surface	Soil Unit	Stratum(a)
79. Subtype 2e, Tula Micro-Adzes (*continued*)						
21	18241	2	3	9-12 in.	F.4	DX
22	19090	2	4	6-9 in.	F.4	CX
23	21199	3	51	12-18 in.	F.42	–
24	20958	2	42	30-36 in.	F.4	O5-P5
25	20873	2	20	0-6 in.	F.4	AX-BX
26	19209	2	16	9-12 in.	F.4	DX
27	18726	2	17	12-15 in.	F.4	EX
28	18781	2	17	15-18 in.	F.4	FX
29	21129	2	24′	6-12 in.	F.4	CX-DX
30	21121	2	24	0-6 in.	F.4	AX-BX
31	18159	2	9	6-9 in.	F.4	CX
32	18730	2	15	9-12 in.	F.4	DX
33	18431	2	9	12-15 in.	F.4	EX
80. Subtype 3f, Tula Micro-Adze Slugs.						
1	21116	2	24	0-6 in.	F.4	AX-BX
2	20692	2	1′	6-12 in.	F.4	CX-DX
3	19116	2	18	18-21 in.	F.4	GX
4	20611	2	46	18-24 in.	F.4	GX-HX
5	18986	2	4	9-12 in.	F.4	DX
6	20423	2	45	6-12 in.	F.4	CX-DX
7	20456	2	44	0-6 in.	F.4	AX-BX
8	20361	2	44	6-12 in.	F.4	CX-DX
9	21178	2	24′	0-6 in.	F.4	AX-BX
10	20746	2	13′	0-6 in.	F.3	AX-BX
11	18480	2	11	12-15 in.	F.4	EX
12	18992	2	4	9-12 in.	F.4	DX
13	21082	2	25	0-6 in.	F.4	AX-BX
14	18127	2	3	6-9 in.	F.4	CX
15	20952	2	42	12-18 in.	F.4	EX-FX
16	18821	2	18	15-18 in.	F.4	FX
17	18982	2	4	9-12 in.	F.4	DX
18	19216	2	3	21-24 in.	F.4	HX
19	18377	2	5	15-18 in.	F.4	FX
20	18992	2	4	9-12 in.	F.4	DX
81. Subtype 3g, Non-Tula Micro-Adzes.						
1	18171	2	11	3-6 in.	F.4	BX
2	19260	2	3	18-21 in.	F.4	GX
3	18398	2	12	15-18 in.	F.4	FX
4	18765	2	17	12-15 in.	F.4	EX
5	18133	2	3	6-9 in.	F.4	CX
6	18376	2	5	15-18 in.	F.4	FX
7	19253	2	18	21-24 in.	F.4	HX
8	18275	2	6	15-18 in.	F.4	FX
9	18211	2	3	3-6 in.	F.4	BX
10	18234	2	3	9-12 in.	F.4	DX

EXPLANATION OF FIGURES 68-88 – (*Continued*)

No.	Western Australian Museum Catalogue Number	Trench	Square	Depth below surface	Soil Unit	Stratum(a)
81. Subtype 3g, Non-Tula Micro-Adzes (*continued*)						
11	21044	3	50	0-3 in.	F.3	–
12	18351	2	3	12-15 in.	F.4	EX
13	18358	2	3	12-15 in.	F.4	EX
14	20754	2	20	6-12 in.	F.4	CX-DX
15	18787	2	17	15-18 in.	F.4	FX
16	18987	2	4	9-12 in.	F.4	DX
17	20139	2	5	45-48 in.	F.4	Q5
18	18902	2	10	15-18 in.	F.4	FX
19	18776	2	17	15-18 in.	F.4	FX
20	20774	2	21	0-6 in.	F.4	AX-BX
82. Subtype 3h, Non-Tula Micro-Adze Slugs.						
1	20235	2	12	45-48 in.	F.4	P5
2	19904	2	2	36-39 in.	F.4	Q5
3	19099	2	16	6-9 in.	F.4	CX
4	18541	2	9	9-12 in.	F.4	DX
5	21117	2	24	0-6 in.	F.4	AX-BX
83. Subtype 3i, Small Endscrapers.						
1	18610	2	5	9-12 in.	F.4	DX
2	19257	2	18	21-24 in.	F.4	HX
3	21174	3	49	12-18 in.	F.42	–
4	19143	2	11	18-21 in.	F.4	GX
5	18897	2	10	15-18 in.	F.4	FX
6	18706	2	15	6-9 in.	F.4	CX
7	20364	2	44	6-12 in.	F.4	CX-DX
8	20532	2	47	6-12 in.	F.4	CX-DX
9	18368	2	7	9-12 in.	F.4	DX
10	18296	2	5	12-15 in.	F.4	EX
11	18583	2	1	15-18 in.	F.4	FX
12	18315	2	11	15-18 in.	F.4	FX
13	18610	2	5	9-12 in.	F.4	DX
84. Type 4, Backed Blades.						
1	18505	2	8	6-9 in.	F.4	CX
2	19245	2	1	21-24 in.	F.4	HX
3	19914	2	18	36-39 in.	F.4	M5
4	20851	2	20	0-6 in.	F.2	AX-BX
5	21128	2	24′	6-12 in.	F.4	CX-DX
6	18894	2	10	15-18 in.	F.4	FX
7	19262	2	3	18-21 in.	F.4	GX
8	19032	2	16	9-12 in.	F.4	DX
9	20723	2	1′	18-24 in.	F.4	GX-HX
10	18231	2	3	9-12 in.	F.4	DX
11	18444	2	2	6-9 in.	F.4	CX

EXPLANATION OF FIGURES 68-88 – (*Continued*)

No.	Western Australian Museum Catalogue Number	Trench	Square	Depth below surface	Soil Unit	Stratum(a)
84. Type 4, Backed Blades (*continued*).						
12	20640	2	48	36-42 in.	F.4	M5-N5
13	18783	2	17	15-18 in.	F.4	FX
14	18898	2	10	15-18 in.	F.4	FX
15	18998	2	4	15-18 in.	F.4	FX
16	20379	2	45	12-18 in.	F.4	EX-FX
17	20756	2	20	6-12 in.	F.4	CX-DX
18	18904	2	10	15-18 in.	F.4	FX
19	20421	2	45	6-12 in.	F.4	CX-DX
20	18163	2	9	6-9 in.	F.4	CX
21	19388	2	1	24-27 in.	F.4	M5
22	18136	2	3	6-9 in.	F.4	CX
23	20530	2	46	12-18 in.	F.4	EX-FX
24	18597	2	7	6-9 in.	F.4	CX
25	20674	2	1′	24-30 in.	F.4	M5-N5
26	19502	2	2	24-27 in.	F.4	M5
27	19271	2	12	24-27 in.	F.4	HX
28	18451	2	2	12-15 in.	F.4	EX
29	18895	2	4	9-12 in.	F.4	DX
30	20651	2	1′	12-18 in.	F.4	EX-FX
31	19133	2	10	18-21 in.	F.4	GX
32	18845	2	13	12-15 in.	F.4	EX
33	20875	2	20	0-6 in.	F.4	AX-BX
34	19106	2	16	15-18 in.	F.4	FX
35	19134	2	10	18-21 in.	F.4	GX
36	18347	2	3	12-15 in.	F.4	EX
37	21371	3	55	24-30 in.	F.42	–
38	18237	2	3	9-12 in.	F.4	DX
39	18505	2	8	6-9 in.	F.4	CX
40	18900	2	10	15-18 in.	F.4	FX
41	18435	2	9	12-15 in.	F.4	EX
42	18540	2	9	9-12 in.	F.4	DX
43	18352	2	3	12-15 in.	F.4	EX
44	18283	2	8	12-15 in.	F.4	EX
45	19092	2	4	6-9 in.	F.4	CX
46	18304	2	11	6-9 in.	F.4	CX
47	18436	2	9	12-15 in.	F.4	EX
48	20831	2	21	6-12 in.	F.4	CX-DX
49	19414	2	11	21-24 in.	F.4	HX
50	19493	2	18	24-27 in.	F.4	IZ
51	18631	2	13	0-3 in.	F.3	AX
52	19103	2	16	15-18 in.	F.4	FX
53	18491	2	2	9-12 in.	F.4	DX
54	18268	2	1	3-6 in.	F.4	BX
55	19797	2	12	33-36 in.	F.4	LZ

EXPLANATION OF FIGURES 68-88 – (*Continued*)

No.	Western Australian Museum Catalogue Number	Square	Artifact Description
85. Stone Artifacts from F.7 Living Surface, Trench 2, 18-21 in., Stratum GX.			
1	18794	17	Subtype 3d, Non-Tula Adze Slug
2	18817	18	Type 4, Backed Blade
3	18666	12	Subtype 3g, Non-Tula Micro-Adze
4	19158	11	Type 4, Backed Blade
5	18690	12	Subtype 3e, Tula Micro-Adze
6	18806	18	Subtype 3g, Non-Tula Micro-Adze
7	19156	11	Type 4, Backed Blade
8	18627	5	Subtype 3d, Non-Tula Adze Slug
9	18791	17	Subtype 3b, Tula Adze Slug
10	18563	6	Subtype 3a, Tula Adze
11	18729	5	Subtype 3b, Tula Adze Slug
12	18816	18	Subtype 3e, Tula Micro-Adze
13	18807	18	Subtype 3a, Tula Adze
14	18815	18	Subtype 3a, Tula Adze
15	18978	5	Subtype 3c, Non-Tula Adze
16	18727	5	Subtype 2a, Large Flake-scraper with Retouch
17	19154	11	Subtype 3c, Non-Tula Adze
18	18663	5	Subtype 1d, Micro-Core with Single-Striking Platform
19	18819	18	Subtype 1e, Micro-Core with Multiple-Striking Platforms
20	18788	17	Subtype 1d, Micro-Core with Single-Striking Platform
21	19172	11	Type 8, Hammerstone
22	19170	11	Type 7, Grinding-Slab
23	19171	11	Type 7, Grinding-Slab fragment

No.	Western Australian Museum Catalogue Number	Trench	Square	Depth below surface	Soil Unit	Stratum(a)
86. Provisional Type 5, Handaxe.						
1	20972	2	22	15-18 in.	F.4	FX

No.	Western Australian Museum Catalogue Number	Square	Depth below surface	Soil Unit	Stratum(a)	Artifact Description
87. Flaked Stone Artifacts, Trench 2, Zone C, Strata S5-X5.						
1	21518	21	48-54 in.	F.4	S5-T5	Subtype 2a, Large Flake-scraper with Retouch
2	21602	15	45-48 in.	F.4	S5	Subtype 3i, Small Endscraper
3	21784	25	54-60 in.	F.4	S5-T5	Subtype 3g, Non-Tula Micro-Adze
4	20389	6	57-60 in.	F.31	T5	Subtype 3g, Non-Tula Micro-Adze
5	21589	17	54-57 in.	F.4	T5	Subtype 3g, Non-Tula Micro-Adze
6	20392	6	57-60 in.	F.31	T5	Subtype 3g, Non-Tula Micro-Adze

EXPLANATION OF FIGURES 68-88 – (*Continued*)

No.	Western Australian Museum Catalogue Number	Square	Depth below surface	Soil Unit	Stratum(a)	Artifact Description
87. Flaked Stone Artifacts, Trench 2, Zone C, Strata S5-X5 (*continued*).						
7	21659	9	48-51 in.	F.4	T5	Subtype 3g, Non-Tula Micro-Adze
8	21741	25	57-60 in.	F.4	T5-U5	Subtype 3h, Non-Tula Micro-Adze Slug
9	21737	4	54-57 in.	F.4	U5	Subtype 3e, Tula Micro-Adze
10	21497	20	48-54 in.	F.4	T5-U5	Subtype 3g, Non-Tula Micro-Adze
11	20331	6	54-57 in.	F.31	S5	Subtype 3e, Tula Micro-Adze
12	20225	17	51-54 in.	F.4	S5	Subtype 1d, Micro-Core with Single Striking Platform
13	21597	3	45-48 in.	F.4	S5	Subtype 1d, Micro-Core with Single Striking Platform
14	21519	21	48-54 in.	F.4	S5-T5	Subtype 1d, Micro-Core with Single Striking Platform
15	21667	17	57-60 in.	F.4	U5	Subtype 1d, Micro-Core with Single Striking Platform
16	21588	17	54-57 in.	F.4	T5	Subtype 1d, Micro-Core with Single Striking Platform
17	21732	24	54-60 in.	F.4	U5-V5	Subtype 1d, Micro-Core with Single Striking Platform
18	20844	48	54-60 in.	F.31	S5-T5	Subtype 1a, Large Core with Single Striking Platform
19	21782	25	54-60 in.	F.4	T5-U5	Subtype 1d, Micro-Core with Single Striking Platform
20	21732	17	54-57 in.	F.4	T5	Subtype 1d, Micro-Core with Single Striking Platform
21	20388	6	57-60 in.	F.31	T5	Subtype 1c, Large Core with Multiple Striking Platforms
22	21631	16	48-51 in.	F.4	S5	Subtype 1c, Large Core with Multiple Striking Platforms
23	21781	25	54-60 in.	F.4	T5-U5	Subtype 1c, Large Core with Multiple Striking Platforms
24	21662	4	48-51 in.	F.4	S5	Subtype 2a, Large Flake-scraper with Retouch
25	20226	17	51-54 in.	F.4	S5	Subtype 2a, Large Flake-scraper with Retouch
26	21525	24	48-54 in.	F.4	S5-T5	Subtype 1b, Horsehoof Core
27	21705	4	48-51 in.	F.4	S5	Subtype 1c, Large Core with Multiple Striking Platforms
28	21660	4	48-51 in.	F.4	S5	Subtype 1b, Horsehoof Core

No.	Western Australian Museum Catalogue Number	Trench	Square	Depth below surface	Soil Unit	Stratum(a)
88. Type 8, Hammerstones.						
1	21098	2	24	6-12 in.	F.4	CX-DX
2	18393	2	12	15-18 in.	F.4	FX

VII: REPORT ON A REPLICATIVE EXPERIMENT IN THE MANUFACTURE AND USE OF WESTERN DESERT MICRO-ADZES

NANCY BRONSTEIN

HYPOTHESES

The case for replicative experiments and microscopic studies of use-wear and edge-damage patterns of stone tools is well illustrated in the Western Desert of Australia. At Puntutjarpa Rockshelter in particular the degree of cultural conservatism and continuity is such that the ancient archaeology corresponds closely with ethnographic patterns. As a sort of model laboratory for the reconstruction of ancient technological processes, the Western Desert both raises and answers questions. Some of these questions were taken back to the laboratory, and hypotheses were developed to be tested by an experiment correlating both archaeological and ethnographic observations. This experiment was aimed not only at the controlled results it might produce but at improving procedures of lithic experimentation.

A simple experiment was designed involving the manufacture of 25 stone tools replicating Western Desert Micro-Adzes (Subtypes 3e-3h). Preliminary analysis of stone artifacts from Puntutjarpa along with analyses of lithic raw materials suggested the following hypotheses which required testing:

1. Was the roughly six to one preponderance of Micro-Adzes to Micro-Adze Slugs in Trench 2 at Puntutjarpa (as reported in Chapter VI and table 24) due primarily to the small size of these tools? The hypothesis here is that the small size of these tools relative to the size of ethnographic and archaeological Western Desert Adzes resulted in a reduced surface on which the resin haft could attach, thus resulting in a tendency for Micro-Adzes to break free from their hafts when in use before reaching a slug condition.

2. As shown in Chapter VI and table 33, there was a marked tendency for white chert to be used in the manufacture of Adzes and Micro-Adzes throughout the sequence in Trench 2, Puntutjarpa. Did this tendency reflect a preference by the makers of these tools based on functional considerations, especially longevity of the working edge when used for scraping hard wood?

3. Do these experiments support the idea that Micro-Adzes were made and used in a manner analogous to the observed manufacture and use of ethnographic Western Desert Adzes?

EXPERIMENTAL MANUFACTURE AND USE OF MICRO-ADZES

From a random but comprehensive selection of lithic raw materials obtained in the vicinity of Puntutjarpa Rockshelter and at localities near Lake Throssell (about 160 miles southwest of the Warburton Mission, where many stones similar to the Exotics discussed in Chapter VI were found), Mt. Weld (near Laverton), and the Wingelinna Hills, we manufactured 22 Micro-Adzes (subtypes 3e and 3g). One small Endscraper (subtype 3i) was also made of quartz, and two small "retouched fragments" were fashioned of Warburton porphyry. In the case of these latter tools, several attempts to produce Micro-Adzes conforming to all of the typological specifications given in Chapter V out of these materials failed, so we settled for artifacts which possessed some but not all of the attributes of a Micro-Adze. Initially all of these tools were made by means of freehand direct percussion, but once they were hafted further resharpening was done by means of direct percussion with a hardwood percussor. Both percussion flaking techniques were carried out in exactly the manner observed in the Western Desert, although the reader should understand that replication of motor patterns, even after much practice, must remain somewhat subjective and difficult to control with precision.

The stone tools were hafted to a mulga wood club (an ethnographic specimen from the Western Desert 18 inches in length) with spinifex resin. The bulbar face of each tool was aligned with the linear axis of the club. Working on a rough but moderately green slab of mulga wood, long strokes were firmly drawn toward the worker. The club was tilted at an angle of 30 to

45 degrees in relation to the surface being worked, so the working edge of the stone tool consistently engaged the wood at angles within these limits. This technique imitates that used by contemporary Western Desert aborigines when using hafted stone adzes for working hard woods. A count was kept of the number of strokes taken between each resharpening and rehafting. The tool was resharpened when its edge was worn dull and could no longer draw off any wood shavings. During use, pressure was applied vertically downward along the center-line of the tool, leaving the worn Micro-Adze with a concave edge which had to be periodically straightened or made slightly convex before continuing work. Rehafting became necessary when the Micro-Adze had worn down to its spinifex haft. In most cases, rehafting and retouch were done at the same time. When a Micro-Adze was considered no longer useful for this task it was "discarded" and its qualitative and quantitative attributes noted and measured.

RESULTS

Qualitative attributes were the basic adze and slug shapes and patterns of retouch and step-flaking described in Chapter V for Subtypes 3a-3h. Metrical attributes of maximum width, maximum thickness, weight, and angle of working edge at midsection are summarized in table 46. All metrical and qualitative attributes except one, weight, were found to conform closely to the characteristics of Subtypes 3a-3h presented in Chapter V. The weights of the experimental specimens tended to be lower, with means well below those for Subtypes 3a-3h. Since the other measurements conform, we have concluded that we were probably getting a fuller degree of use from these tools than did the ancient inhabitants at Puntutjarpa. Aside from this discrepancy, the experimentally replicated Micro-Adzes and Slugs conform closely to those excavated from Trench 2 at Puntutjarpa, leading us to conclude that application of modern Western Desert aborigine techniques of manufacture and use as applied to Adzes can effectively replicate the Micro-Adzes and Micro-Adze Slugs found archaeologically at Puntutjarpa Rockshelter. Of course, it is conceivable that other techniques not tried in this experiment could achieve similar results, and further experiments should be tried one day to explore this possibility.

As shown in table 47, 17 of the 22 experimentally produced Micro-Adzes were used to extinction and resulted in Slugs. Thus the ratio here of slugs to unworn or lightly worn tools is much higher than was the case for excavated Micro-Adzes vs. Slugs. The results of this experiment are more in line with the results shown in

TABLE 46
Measurements of Experimentally Produced Stone Tools (After Use) Based on Subtypes Described from Trench 2, Puntutjarpa

Tool Type	N	Mean Width (cm.)	Range of Variability (cm.)	Mean Thickness (cm.)	Range of Variability (cm.)	Mean Weight (grams)	Range of Variability (grams)	Mean Working Edge Angle (degrees)	Range of Variability (degrees)
Micro-Adzes	5	2.46	1.8-3.3	0.76	0.5-1.2	3.62	1.6-7.0	58.6	45-62
Micro-Adze Slugs	17	2.05	1.4-2.5	0.71	0.4-1.1	1.70	0.4-3.6	67.76	42-114
Small End-Scraper and Retouched Fragments	3	1.93	1.4-2.8	0.83	0.7-1.1	2.70	0.7-6.2	50.66	44-58
Total Population	25	2.12	1.4-2.8	0.73	0.4-1.2	2.20	0.3-7.0	63.88	42-116

TABLE 47

Tabulation of Micro-Adzes, Slugs, and "Retouched Flakes" Produced Experimentally by Lithic Raw Material

Material	Micro-adzes that became slugs	Micro-adzes that remained adzes	Others
Local Cherts (red and white)	7	0	0
Exotic Cherts	6	2	1
Warburton Porphyry	1	1	1
Quartz	0	0	1
Quartzite	2	1	0
Opaline	0	1	0
Chrysoprase	1	0	0
Total Population	17	5	3

Table 23 for Adzes vs. Adze-Slugs. Thus the data derived from this small experiment suggest that the hypothesis which proposed small size and area of haft attachment as an explanation for the relatively large number of Micro-Adzes to Slugs in Trench 2 at Puntutjarpa is probably invalid. Further hypotheses must be proposed and tested before the questions raised by the stratigraphic analysis of these classes of stone tools can be resolved. This experiment should be viewed as a limited, trial effort to point the way to expanded and varied experiments in the future based on questions arising from these excavation results.

Table 48 presents a summary of the numbers of useful strokes of hard woodworking use obtained for Micro-Adzes and "Retouched Fragments" in terms of the lithic raw materials used. Note that red and white chert consistently led by almost 2 to 1 over the next most efficient raw material. Within the class of Exotic raw materials there was considerable variation, with Mt. Weld Chert (obtained from the vicinity of Laverton and probably never actually used at Puntutjarpa) leading with 15,911 strokes of useful wood-

TABLE 48

Comparison by Lithic Raw Material of Useful Strokes in Working Hardwood (*Acacia aneura*) with Experimentally Produced Stone Tools

Material	N	0-500 strokes	500-1000 strokes	1000-1500 strokes	1500-3000 strokes	3000-5000 strokes	5000-8000 strokes	8000-10,000 strokes	10,000-15,000+ strokes	Average of strokes
Local Cherts (red and white)	7			1			4	1	1	7555
Exotic Cherts	9		2	2	2	1		1	1	4073
Warburton Porphyry	3		1	1		1				1602
Quartz	1			1						2072
Quartzite	3		1	1			1			2659
Opaline	1	1								78
Chrysoprase	1					1				3369
Total Population	25	1	4	6	2	3	5	2	2	

TABLE 49
Summary of Resharpenings, Rehaftings, and Number of Strokes of Woodworking Use by Lithic Raw Material During Stone Tool Experiment

Material	N	Mean Number of Resharpenings	Mean Number of Rehaftings	Mean Number of Strokes Worked
Local Cherts (red and white)	7	5.4	1.8	7555
Exotic Cherts	9	4.9	3.0	4073
Warburton Porphyry	3	3.0	0.67	1602
Quartz	1	10.0	4.0	2072
Quartzite	3	3.7	2.7	2659
Opaline	1	0	0	78
Chrysoprase	1	3	2.0	3369
Total Population	25	4.28	2.02	3058

working wear. While an expanded sample of experiments along these lines would be desirable, these results do suggest that of all the lithic raw materials available in the vicinity of Puntutjarpa Rockshelter, red and white cherts were the best for efficient working of hard woods. Since white chert is more widely and abundantly available there than red chert (which is limited to a single, very small quarry exposure), this experiment helps to explain the fact that while white chert accounts for only 19.0 percent overall of the total lithic raw material assemblage in Trench 2 at Puntutjarpa (see fig. 67), it accounts for 60.3 percent overall of the lithic raw materials from which Adzes and Micro-Adzes were fashioned. Similarly, the experimental results obtained for various Exotic raw materials (aside from Wingelinna chrysoprase) suggest a similar interpretation to explain the fact that while these Exotic stones account for only 2.6 percent overall of the total lithic raw material assemblage at Puntutjarpa, they account for 26.2 percent overall of all the lithic raw materials from which Adzes and Micro-Adzes were made. In short, the results of this experiment point to an explanation of these figures based on the functional advantages of these particular lithic raw materials for hard woodworking use. Chert and chertlike materials worked best for this purpose, while Warburton porphyry, quartz, quartzite, and opaline were less effective. The chrysoprase Micro-Adze worked well, suggesting the possibility that this material may prove to have been important in the manufacture of Adzes and Micro-Adzes at archaeological sites closer to the quarry source in the Wingelinna Hills, even though no Adzes or Micro-Adzes of chrysoprase were found at Puntutjarpa.

The most obvious physical characteristic one would expect to account for these differences in

TABLE 50
Reasons for Extinction of Experimentally Produced Stone Tools During Use

Reasons for Extinction	N
1. Knocked out of haft while being retouched	12
2. Knocked out of haft by sudden rough work, such as hard knot in wood	1
3. Knocked out of haft or broken during course of normal use	3
4. Accidental: broken while attempting to repair haft, etc.	1
5. Other: general discards. Flake too thick, too small, too soft, etc. to retouch. Bad choice of flake, etc.	7
6. Not extinguished. After much use still a good adzing tool	1
Total Population	25

woodworking efficiency is hardness. As measured on the Moh's Scale of 10 degrees, quartz, quartzite, and chrysoprase have a hardness rating of 7; chert varies in hardness from 6 to 7; and opaline is relatively soft with a rating of from 5 to 6. Quartzite and porphyry, despite their greater hardness than chert, contain granular inclusions that reduce their efficiency, whereas quartz has pronounced internal planes of cleavage. These factors not only make these materials less efficient for woodworking purposes but also make it harder to do controlled flaking with them, thus making them relatively poor choices from a technological point of view for making into Adzes and Micro-Adzes. Although easy to shape by percussion flaking, opaline tends to be too soft for efficient working of hardwoods. Local and Exotic cherts thus seem to have offered the best balance or compromise between hardness on the one hand and workability arising from smoothness of texture and surface on the other.

VIII: FAUNAL REMAINS FROM THE EXCAVATION AT PUNTUTJARPA ROCKSHELTER

MICHAEL ARCHER

INTRODUCTION

Tedford (1968) reported a preliminary analysis of mammalian remains collected in 1967 from an exploratory trench at Puntutjarpa Rockshelter. He recorded a small dasyurid, probably *Dasycercus cristicauda*; *Megaleia rufa* and/or *Macropus robustus*; species of *Onychogalea* and *Bettongia*; and *Oryctolagus cuniculus*. Most of the bones were badly broken and isolated teeth and jaw fragments were rare.

Further collections made by Gould and others in 1970 provided more bone material. These additional specimens are similarly badly broken making identification difficult. Calaby (1971) has indicated the caution required when making identifications based on this type of material. The uncertainties involved in identifications given below are indicated wherever necessary.

Because of the very fragmentary nature of the material, no comprehensive attempt to calculate minimum numbers of individuals has been made. However, in the case of the rarer forms, the minimum number of specimens is given. The taxa identified in each level are shown in figure 89. Numbers given unless otherwise stated are those of the Western Australian Museum's Anthropological Collection (e.g., A20473) or the Western Australian Museum's Mammal Collection (e.g., M6166). At the time of collection of the Puntutjarpa material, Anthropological numbers were given to particular samples of bone which may include pieces representing more than one taxon. However, the numbers cited below have been chosen so that no confusion in application can arise.

Taxonomic and vernacular names are those used by Ride (1970).

MARSUPIALIA

1. Dasyuridae:

   Dasyurus cf. *D. geoffroii* (Western Native cat)

   This dasyurid is represented by at least one specimen (A20473), a small dentary fragment. Its size is consistent with *D. geoffroii* rather than *D. hallucatus*, but there are no teeth. *Dasyurus geoffroii*, although uncommon outside of southwestern Western Australia, is known from central Australia (see Ride, 1968 for a mapped distribution) and its occurrence in the Puntutjarpa area is not unexpected.

   Gould (in lett. Jan. 26, 1973) noted that he previously (Gould, 1967, p. 47) was probably in error in implying that *Satanellus hallucatus* rather than *D. geoffroii* was known from the Warburton Range area.

2. Peramelidae:
2a. Peramelinae

Perameles cf. *P. eremiana* (Desert bandicoot)

At least one specimen (A19750), a dentary fragment with P_1-M_1 (P_4 broken) and alveoli for C_1 and M_2, represents a small species of *Perameles*, possibly *P. eremiana*. Measurements in mm. are given in table 51.

M1575 (see table 50) may or may not represent *P. eremiana*. It is presumably this specimen that Glauert (1933) recorded as *P. eremiana*. It was obtained in Ghanda (lat. 27° 35′S, 125° 56′E long.), Western Australia. It may not be comparable with some of the measurements of the adult specimens (they are indicated in table 2). However, there appears to be a better match in premolar lengths between M1575 and A19750 than there is between A19750 and M6166 and 10576. On the other hand, the lengths of the M_1 and M_1-M_2 of A19750 more closely match those of M1575 and A19750 than M1575. Whatever the case, A19750 represents a small species of *Perameles*, and may tentatively be referred to as *P.* cf *P. eremiana*.

Finlayson (1961) suggested *P. eremiana* was formerly not uncommon in some areas of central Australia but Parker (1973) suggested some of the earlier identifications of this form may refer to *Isoodon auratus*. The species has not been recorded live since 1932-1935 (Finlayson 1961; Ride 1970).

Troughton (1967, p. 67) said of *P. eremiana* that it "... scoops out a shallow hole on the surface just large enough to lie in and thatches it over with grass. The natives capture it by placing one foot on the nest, pinning the animal down and then pulling it out by hand."

Perameline cf. *Isoodon auratas* (Golden bandicoot)

A single dentary fragment (A20693) may represent this arid-adapted species. The dentary fragment almost certainly represents *Isoodon* and probably *I. auratus*.

Very little is known about this species. Finlayson (1961) suggested it is not un-

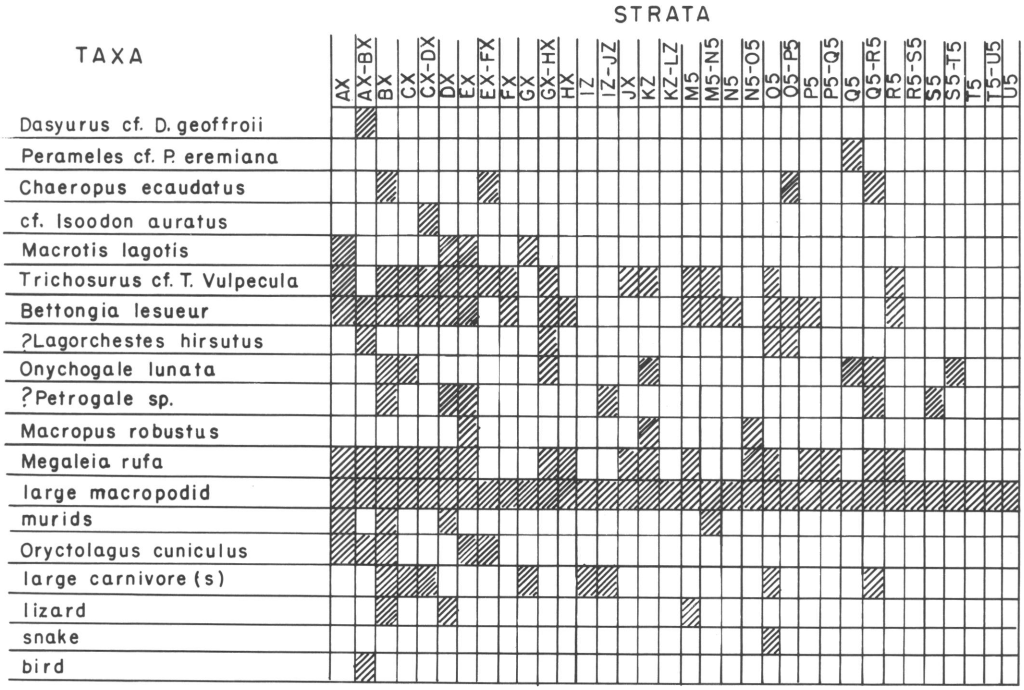


FIG. 89. Stratigraphic distribution of faunal remains in Trench 2, Puntutjarpa.

common in Central Australia but Parker (1973) recorded that the last live specimen was taken in 1952 at the Granites in the Northern Territory. It is not known to occur in the Warburton Ranges but is recorded from the Canning Stock Route and other central arid areas in Western Australia (Ride 1970 and Parker 1973).

Chaeropus ecaudatus (Pig-footed bandicoot)

This bandicoot is represented by at least four specimens (A18624 a maxillary fragment; A21175 a dentary fragment; A20575 another dentary fragment; A20810 a maxillary fragment).

Chaeropus ecaudatus is known from south central Northern Territory (Ride 1970; Parker 1973) and southwestern Western Australia but has not previously been recorded as far northwest as the Warburton Ranges. The Puntutjarpa record is therefore a range extension. The last specimen collected was taken in 1907 but Glauert (1933) reported a letter from LeSouef who claimed to have seen a skin at Rawlinna on the Hampton Tableland in 1927. There is no specimen known to support this claim.

2b. Thylacomyinae:

Macrotis lagotis (Common Rabbit-eared bandicoot)

There are at least three specimens representing the Rabbit-eared bandicoot (A19087; A18489; and A18479, all dentary fragments).

Macrotis lagotis is known from the Warburton Ranges (1970). Gould (in lett. Nov. 16, 1971) reported seeing "... Aborigines in the desert in 1967 who were wearing bandicoot-tail necklaces and hair ornaments which they said they had got recently." The film, *Desert People* (Dunlop, 1965) contained a sequence showing a Rabbit-eared bandicoot being captured by aborigines in an area about 100 miles north of the Warburton Ranges Mission.

3. Phalangeridae:

Trichosurus cf. *T. vulpecula* (Brush-tailed possum)

This species is well represented (e.g., A18443, a maxillary fragment, in the deposit. It is also recorded live from the Warburton Range by Finlayson (1961).

Troughton (1968) commented on the extensive use of the Brush-tailed possum for food by aborigines.

4. Macropodidae:

4a. Potoroinae:

Bettongia lesueur (Lesueur's Rat-kangaroo)

Bettongs are well-represented in the Puntutjarpa deposit. Some specimens with teeth (e.g., A20971) clearly represent *B. lesueur*. Toothless fragments of maxillaries and dentaries of *Bettongia* were identified as probably representing a species of this genus rather than a macropodine or phalangerid on the basis of the root-pattern of the molars. None of the fragmentary specimens is clearly small enough to represent *Caloprymnus campestris*.

A21321 includes a premaxillary with I^1 in place. This is referred to *Bettongia* sp. The I^1 appears too slight and thin to represent *B. lesueur*, but this character may be subject to considerable variation.

Finlayson (1958) noted that this species was formerly common along the "... east west axis of the Macdonnell Range system ..." even as late as 1940. Giles (1889, fide Finlayson 1958) recorded the species from lat. 24° 42′ south and 127° 44′ east long. in the Gibson Desert in 1874. Finlayson (1961) noted that this species was one of the most important of aboriginal accessory food sources. Gould (1967) noted that the Ngatatjara people from north and east of the Warburton Mission are familiar with a Rat-kangaroo ("mitika" is the aboriginal name) and believe it was actually displaced when the rabbits spread into the area.

Gould (in lett. Jan. 26, 1973) noted that he previously (Gould 1967, p. 47) was in error referring aboriginal reports of Rat-kangaroos in the Warburton Range area to *Bettongia penicillata*. He now believes the animals referred to were *Caloprymnus campestris*. However, no positive evidence of the presence of *C. campestris* in the Puntutjarpa deposit has been found in the course of the present study.

4b. Macropodinae:

?*Lagorchestes hirsutus* (Western Harewallaby)

There are five specimens (e.g.,

A19858, a maxillary fragment) which may represent *Lagorchestes hirsutus*. However, the material is too incomplete to allow positive identification. Parker (1973) recorded *L. hirsutus* from west of Warburton Creek. Finlayson (1961) recorded that the species was one of the aborigines' "... chief food supplies in 1932-35 ..." in some areas of central Australia but that it has declined in numbers since that time.

Onychogale lunata (Crescent nail-tailed wallaby)

Several specimens (including A20994, a dentary fragment with dp_4-M_1 in place and P_4 unerupted) clearly represent *O. lunata.*

Ride (1970) recorded that Harry Butler found a specimen of this species near the Warburton Range in 1964. It "... appeared to have been killed by a Fox some short time previously." Finlayson (1961) noted that this species was occasionally being collected by aborigines during 1932-1935 from this same general area of central Australia.

?*Petrogale* sp. indet. (Rock-wallaby)

There are at least six fragmentary specimens (including A21276, a proximal half of a femur and A18281, an alveolar area of bone comparable with a modern specimen (M3992) of *Petrogale penicillata*), and which probably represent a species of *Petrogale*. The only modern species recognized by Ride (1970) in this area is *P. penicillata*. Ride gave the range as "... probably all over Australia." Gould (1967) recorded that individuals of *P. penicillata* "are still fairly common and are sometimes shot..." by aboriginals in the central desert area of Western Australia.

LARGE KANGAROOS

By far the bulk of faunal remains in the Puntutjarpa deposit represents large kangaroos. Gould (1967) recorded both *Megaleia rufa* and *Macropus robustus* from the Western Desert area which includes the Warburton Range. Both species are probably represented in the excavated material from Puntutjarpa. However, except for certain molar fragments, there are few specimens large or complete enough to allow positive identification. On some of the upper molar fragments there is a pronounced forelink between the protoloph and the anterior cingulum, and this is generally present in species of *Macropus* (including *M. robustus*) but not *Megaleia rufa* (Tedford, 1967). Unfortunately there is some overlap in this character, as for example a specimen of *Megaleia rufa* (Queensland Museum J5813) also suggested that *M. robustus* exhibits a variable development of the forelink. Nevertheless, the tentative identification as *Megaleia rufa* or *Macropus robustus* given in the present report is based on either the clear presence or clear ab-

TABLE 51
Perameles sp.

	A19750	*P. bougainvillei*	*P. bougainvillei*	*P.* cf. *P. eremiana*
		(M6166)	(10576[a])	(M1575)
A	13.0	16.0	15.7	?12.4
B	10.3	13.3	13.0	–
C	2.5	2.6	2.6	2.8
D	5.6	5.6	5.4	5.9
E	16.2	18.9	18.6	?15.5
F	2.0	2.4	2.6	1.5
G	2.2	2.8	2.9	2.5
H	2.0	2.6	2.7	–

M6166 is from Bernier Island and 10576 is from Dorre Island, Western Australia. *a* = The specimen is in the Western Australian Museum modern Mammal Collection. ? = The measurements are given but because the specimen is juvenile they are probably not comparable with the corresponding measurements given for the other specimens.

sence of this forelink. In most modern specimens of both species I have examined, this character appears to be useful in differentiating the two species, although it is not absolutely diagnostic.

A19076 (a bone sample) consists in part of molar fragments one of which represents an upper molar of *Macropus robustus* on the basis of the presence of a clear forelink. A18055 includes macropodid molar fragments, at least one of which represents *Megaleia rufa* on the basis of the absence of a clear forelink.

Gould (1967) pointed out that both these species have been used for food by aboriginals in the Western Desert area.

PLACENTALIA

Muridae:

Pseudomyinae (Native mice)

At least two specimens (A21293 and A21345, both fragments of maxillae) represent pseudomyine murids. There are many genera of pseudomyine murids known from the general area of central Australia. In this study, no attempt has been made to identify the species of murids involved, although from the size of the specimens it is clear that there is more than one species represented.

Placental or Marsupial Large Carnivore

(Dingo, Thylacine or Tasmanian Devil)

There are several maxillary (e.g., A20551) and dentary (e.g., A20535) fragments that represent a large carnivore. The fragments are so incomplete that no identification has been made.

Dingos are widespread in Australia. Thylacines and Tasmanian Devils are presumed extinct on the Australian mainland but had a continentally peripheral distribution in prehistoric times (e.g., Ride 1964, Gill 1953, Calaby and White 1967, Brandl 1972).

Leporidae:

Oryctolagus cuniculus (European rabbit)

Many specimens (including A18061), an astragalus; A18038, a scapular fragment; A18985, a dentary fragment with a broken tooth) represent the introduced rabbit.

Finlayson (1961) reported that in ". . . 1901 Maurice and Murrary recorded it as already plentiful in the Musgrave Range area and in 1902, enroute to the Cambridge Gulf, they found it as far north as Lake Amadeus." Gould (1967) gave evidence for believing that the rabbit had arrived in the Warburton Range area probably between the 1920s and 1930s. Local aborigines told Gould that within their lifetime "at a site called Mitika about seventy miles north of Warburton, they saw rabbits replacing the *mitika* [(*Caloprymnus campestris*) fide Gould in lett. Jan. 26, 1973] by actually moving into the burrows used by these marsupials . . ." Gould added that "rabbits continue to be abundant there and comprise an important food source for the natives." (1967, p. 47).

REPTILIA

Lacertilia (Lizards)

?Varanidae:

? *Varanus* sp. (Monitor lizard)

Several specimens (including A20736, a burned vertebra, and A18624, a vertebra) appear to represent a large lizard. It is probable that these represent a species of *Varanus*. Gould (1967, p. 48) stated that in the Western Desert area the "*kurkati* (*Varanus gouldii*) is the most commonly hunted species . . . though *ngintaka* (*Varanus gigantus*) are sometimes captured too."

OPHIDIA

Snakes

A20051 (a vertebra) represents a snake.

No attempt has been made to identify the type of snake because of lack of available comparative material.

?AVES

Birds

Remains clearly representing the birds are not at all abundant in the Puntutjarpa deposit. Some specimens however (e.g., A20946, a bone fragment), do appear to represent bird remains.

FAUNAL DEVELOPMENT

There is an overall superficial increase in taxonomic diversity from the base to the top of the Trench 2 deposit. This may be the result of sampling errors.

None of the species represented in the deposit is known to be extinct. However, *Chaeropus ecaudatus* and *Perameles* cf. *P. eremiana* are rare (Ride, 1970) and may be extinct. *Perameles* cf.

eremiana occurs with certainty only once and in the deeper part of the deposit (see figure 89). The species may have become regionally extinct since that time. On the other hand, it may be so uncommon that its absence in the higher parts of the deposit is merely the result of low probability of sampling. *Chaeropus ecaudatus* is represented in the upper parts of the deposit, and if it is regionally extinct now, this extinction postdates the age of these levels.

Rabbit remains occur as deep in the Trench 2 deposit as level EX-FX. As noted above, the rabbit probably arrived in the Warburton Range area in the first half of the twentieth century, possibly around the 1930s to 1940s. As a result, everything occurring in and above EX-FX presumably postdates this period. Taxonomically, all identifiable forms occur above this level except snakes and *Perameles* cf. *P. eremiana*.

Above the level at which rabbit remains first appear, only *Perameles* cf. *P. eremiana* and the snake(s) are not represented in the Trench 2 deposit. On the other hand *Chaeropus ecaudatus* and cf. *Petrogale* sp. are not represented at the top of the deposit. With the possible exception of these forms, there is no species represented in the deposit whose apparent absence from the upper parts of the Trench 2 deposit could be correlated with the appearance of rabbits.

The Trench 3 deposit (table 52) is in some respects similar to the Trench 2 deposit except that the samples and taxonomic diversity are smaller. There are however proportionally more murid remains and this may indicate a somewhat different source for the bone material in the Trench 3 area. It is possible the murid remains are the result of owl activity in the shelter near the Trench 3 area.

There is not enough material nor is the Trench 3 deposit deep enough to demonstrate clear faunal evolution during the period of accumulation.

THE CONDITION OF THE BONE

Virtually all bones recovered from the Puntutjarpa deposit are broken, most into square centimeter and smaller size. Commonly even the molars of large kangaroos are broken in half. Examples of other broken bones are: A18085–a fragment of a tympanic ring; A2122–fragment at proximal end of a radius; A18302–fragment of a vertebra; A18452–a fragment of a femur; A18111–a fragment of a fourth metatarsal; A18462–a tibial surface of a broken astragalus; and A19071–a fragment of a cuboid. This condition may in part be due to rock falls. However, much of the deposit is not covered by rockfall

TABLE 52

Trench 3 Fauna and Levels.

TAXA	LEVELS				
	F.39	6-12"	12-18"	18-24"	24-30"
Onychogalea lunata				X	
?Petrogale sp.	X				
large macropodid	X	X	X	X	X
murid	X	X		X	
Oryctolagus cuniculus	X				
bird	X				

(see description of stratigraphy in Chapter III). It is possible that many of these breaks are the result of deliberate or accidental smashing of bones by aborigines. It is not clear why or for what purpose these bones would have been so thoroughly broken. Arguments that this was done to procure marrow are reasonable but do not explain why molars, calcanea, astragali, and even cuboids are broken. Accidental breaks such as might occur through human activity on a bone-strewn living surface seem unlikely to account for broken cuboids and astragali which are very solid bones.

Dogs are another likely cause for broken bones. Gould (in lett. March 5, 1973) informed me that "not only do dogs scatter discarded animal bones, but they grind them into exceedingly small bits. Dogs are an ever present factor in ethnographic Aborigine camps in the desert, and, since they are not fed with any regularity, this is one of their most important ways of finding food."

Bones may also of course be broken in the act of catching an animal. For example Grey (1841) recorded that among some Western Australian aborigines the "smaller species of animals are either caught by surprising them in their seats, or by burning them in the bush. A native hunting for food has his eyes in constant motion, and nothing escapes them; he sees a kangaroo rat sitting in a bush, and he walks toward it, as if about to pass it carelessly, but suddenly when on one side of it, he stamps on the bush with all his force, and crushes the little animal to death. . . ." This might explain how bones of some of the smaller animals were broken but would certainly not explain how bones of large kangaroos were smashed. Gould (in lett. March 5, 1973) however, noted that dogs may be "powerful and can reduce even large bones to small bits." Dogs may at least in part account for the damage done to large kangaroo bones.

Gould (1967, p. 50) noted that in the case of *Varanus gouldii*, some aborigines he observed "take roasted goanna from the coals and prepare to eat them by placing the pieces of the animal (especially the back and ribs as well as the head and neck) on a small, flat rock and pounding them with another rock until the meat and bone are pulverized into a single shredded mass. This pulpy mass of meat and bone is eaten in its entirety, without waste!" The perentie (*Varanus giganteus*) lizard has bones which shatter into splinters, and the desert people, after cooking and eating these animals, place the bones high in the crotch of a tree specifically to keep the dogs from eating them (Gould, in lett. March 5, 1973). Gould did not know of other animals being prepared for eating in this way. Large kangaroos (*Megaleia rufa* and *Macropus robustus*) according to Gould (1967, pp. 53-54) are not normally pulverized by modern aborigines. However, Gould (in lett. March 5, 1973) noted that this sort of pounding of kangaroo bones and meat into a pulpy mass does sometimes occur but that the technique is applied only to the tail. This is "done mainly for the benefit of certain old people who found it hard to chew the meat otherwise." Gould also noted that this method is used in the preparation of feral cats but in this case it is only the vertebrae that are treated in this manner.

BURNING

There are many burned bones among those recovered from the Puntutjarpa deposit. These include examples of nearly every type of bone of the large kangaroos. For example, A18217 includes a burned fragment of a maxilla; A18003 includes a burned fragment of the angle of a dentary; A20419 includes a burned fragment of an occipital bone; A18222 includes a burned fragment of a periotic bone; A18266 includes a burned half of a molar; A18867 includes a burned fragment of the proximal end of a humerus; A20951 includes a burned fragment of the distal end of a humerus; A19084 includes a burned fragment of the proximal end of a rib; A18771 includes a burned fragment of a fibula; A18015 includes a burned fragment of what appears to be a proximal end of the diaphysis of a tibia; A18406 includes a fragment of a phalanx which appears to be burned; A18855 includes a burned fragment of a fourth metatarsal; and A18079 includes a burned fragment of an astragalus.

If, as Gould (1967) described from observations of modern aboriginal behavior, large kangaroos were cooked whole, in the skin, it is difficult to see how this ubiquitous burning could occur. It is possible however, that the bones were burned after the carcasses had been eaten. This could happen in at least two ways. The aborigines might have tossed meatless bones onto an open fire, or alternatively fires might have been built on a living surface where bones had accumulated. Either practice would produce burned bone. Gould (in lett. March 5, 1973) said that "from time to time I have seen aborigines, both adults and children, toss animal bones into the fire. This is pretty much a random behavior and does not suggest any sort of cultural patterning, but it certainly results in a small amount of charred as well as broken bone."

Burning was not restricted to the bones of large kangaroos. A18410 represents a burned fragment of a maxilla of a Brush-tailed possum (*Trichosurus* sp.) and A18074 includes a fragment of a maxilla of a Rat-kangaroo (*Bettongia* sp.) that appears to have been burned.

Among the bones examined from the Puntutjarpa deposit there was no clear evidence for man-made grooving. Gould (1967, p.53) observed that among modern aborigines carcasses are dismembered after roasting. He suggested that the real reason for roasting the carcasses was that it "stiffens the whole carcass and makes the skin weak and easy to cut." This might mean that the carcass would come apart more easily, resulting in less need to smash or cut bones.

ACKNOWLEDGMENTS

The author was supported alternately during the research of this project by a Fulbright scholarship from the American-Australian Educational Foundation, a grant in aid from the Explorers Club of New York, and a Research Assistantship grant to Dr. W. D. L. Ride from the Australian Research Grants Committee.

IX: FOSSIL-POLLEN ANALYSIS AND pH-TESTING RESULTS

Although collections of soil were made under controlled conditions in Trench 2 at Puntutjarpa for purposes of extracting fossil pollen and pH-testing, the results so far in both cases are incomplete and await further analysis. Thus this chapter is intended as a brief progress report to describe the circumstances of collection and the results so far.

FOSSIL POLLEN

Small soil samples of 10 to 20 grams were taken at 3-inch intervals from the entire vertical profile from the surface to a depth of 61 inches in the center of the north wall of Square 6 in Trench 2. These samples were taken to Dr. Basil Balme, Department of Geology, University of Western Australia, in February, 1970, for initial examination to determine how much, if any, pollen grains could be identified in these desert soils. Balme's findings were not encouraging, although he detected numerous small pieces of carbonized seeds and plant stems of the sort we had already encountered as a result of our efforts in the field at flotation. Balme suggested, however, that better techniques of identification might be available at the University of New South Wales, where fossil pollen facilities are established. Accordingly, the samples were split, and half the soil (from each 3-inch level) was sent to Dr. Helene A. Martin, School of Botany, University of New South Wales. What follows is Dr. Martin's Interim Report on the Palynology of the Puntutjarpa Rockshelter which was included in a letter dated October 10, 1973.

INTERIM REPORT ON THE PALYNOLOGY OF THE PUNTUTJARPA ROCKSHELTER

HELENE A. MARTIN

Some preliminary observations and tentative comments on work in progress on the palynology of Puntutjarpa Rockshelter excavation are presented in this report.

Eighteen samples taken between the surface and a depth of 61 inches, from the north wall of square 6, Trench 2, have been treated and their pollen content extracted. A preliminary examination has shown that all samples contain enough pollen, sufficiently preserved, to be workable. About half of the samples have been counted, but identifications are hampered by lack of a reference pollen collection from the Puntutjarpa region. The pollen spectra from the excavation can only be interpreted in terms of present vegetation cover by reference to the pollen content of surface soil samples, taken from beneath known vegetation types. The lack of a surface soil sample collection prevents all but the most superficial interpretation of the pollen spectra from the excavation.

Although all samples from the entire profile contain much the same suite of pollen, there are changes in the relative abundance of the different types. The most striking feature is a variation in total pollen content, as judged by qualitative examination (see table 53). The top and bottom sections have roughly the same pollen content, whereas the middle section contains much less. The changes in relative abundance of the different pollen types appear to be linked with the variation in total pollen content. If the final counts confirm these preliminary observations, it appears likely that the middle section represents a reduced vegetation cover, with fewer trees and large shrubs, e.g., eucalypts, and possibly mulga.

TABLE 53
Pollen Content, Trench 2, Square 6, Puntutjarpa Rockshelter

Depth (inches)	Pollen content[a]
0-1	+++
3-4	+++
6-7	+++
9-10	+++
12-13	++
17-18	++
21-22	++
24-25	++
27-28	+
30-31	+
36-37	+
39-40	+
42-43	++
45-46	++
48-49	++
54-55	+++
57-58	+++
60-61	+++

[a]Subjective estimation of pollen content.
+++ good
++ less
+ least

In other research I have found that most of the pollen accumulated in rock shelters derives from plants in the immediate vicinity, while vegetation growing at a distance, e.g., 1 or 2 miles, is unlikely to contribute much pollen to the deposits. Consequently, if the period of reduced vegetation cover is confirmed, it would only apply to the immediate locality of the rock shelter. Any one or more of a number of possibilities may produce such changes as for example:

1. Shifting sand dunes may, in effect, bring the plant communities normally found in this habitat closer to, or farther from, the rock shelter.
2. The position of water courses may change and effectively move the stream-side plants (e.g., the eucalypts) farther from, or closer to, the rock shelter.
3. There may have been a regional climatic fluctuation but evidence from one rock shelter is not sufficient proof of such an hypothesis.

Plans are in hand to visit the Puntutjarpa Rock Shelter to collect the present plant species, survey the vegetation and obtain a representative suite of surface soil samples. The evidence obtained from the visit will serve to confirm or modify the suggestions presented above.

pH-TESTING

Simple pH-testing was carried out in each excavated square by 3-inch and natural levels. Approximately two gallons of sifted soil was taken from each excavation unit for flotation purposes (see Chapter III), and a small portion from each

TABLE 54
Stratigraphic Summary of pH Values of Soils in Trench 2, Puntutjarpa, by Natural Levels

Natural Levels (Soil Features)	Extremes in pH values	Mean pH values
F.3	6.5-7.5	6.9
F.4	4.0-7.5	6.4
F.31	6.0-7.0	6.3

of these samples was pH-tested with a soil pH-meter of a type commonly used for agricultural purposes and regarded as accurate to a value within 0.5 of a pH-number. Values obtained ranged from pH 4.0 to 7.5, with a mean value of pH 6.4, indicating that the soils in Trench 2 at Puntutjarpa tended in general to be slightly acidic.

As tables 54 and 55 show, the stratigraphic variation in pH values in Trench 2 was not great. In terms of natural levels (soil features) there was a mild tendency toward lower values, indicating slightly greater acidity in Feature 4 and Feature 31 soils. This same tendency is reflected in terms of arbitrary 3-inch levels (strata), with values ranging downward generally from means of pH 7.0 in Stratum AX to pH 5.5 in Stratum X5. Some interesting reversals in this pattern occur in Strata DX-FX, with pH values as low as 4.0 occurring in a few squares, but this dip in values cannot at present be correlated with any observable cultural or natural features in Trench 2. There is a fairly marked shift in pH values between Zone B (Mean pH value 6.5) and Zone C (Mean pH value 5.9), and the Upper Rockfall layer stands out with a slightly higher pH value than Zone B or the rest of Zone A. However, this possible correlation of pH values and stratigraphy must be viewed with caution because some of the mean values lie within the range (pH 0.5) of accuracy postulated for the original pH measurements, and no clear basis for such a correlation can be offered at this time. Perhaps further geomorphological analysis of the soils in and around Puntutjarpa Rockshelter will one day provide some explanations for these patterns.

TABLE 55
Stratigraphic Summary of pH Values of Soils in Trench 2, Puntutjarpa, by Arbitrary Levels (Strata)

Stratum	Extremes in pH values	Mean pH values	Zone
AX	6.5-7.5	7.0	–
BX	6.5-7.5	6.9	–
CX	5.0-7.0	6.3	–
DX	4.5-7.5	6.1	–
EX	4.0-7.5	6.2	A
FX	4.0-7.0	6.2	(Mean pH value 6.5)
GX	5.0-7.0	6.4	–
HX	5.5-7.0	6.7	–
IZ	6.0-7.0	6.8	–
JZ	6.5-7.0	6.8	Upper Rockfall
KZ	6.5-7.0	6.8	(Mean pH value 6.5)
LZ	6.0-6.5	6.2	–
M5	5.5-7.0	6.7	–
N5	5.5-7.0	6.6	–
O5	5.5-7.0	6.6	B
P5	6.0-7.0	6.5	(Mean pH value 6.5)
Q5	5.0-7.0	6.3	–
R5	5.5-7.0	6.4	–
S5	5.0-6.5	6.1	–
T5	5.5-6.5	6.1	–
U5	5.5-6.5	5.9	C
V5	5.0-6.5	5.8	(Mean pH value 5.9)
X5	5.5	5.5	–
	Overall Mean pH Value	6.4	

X: PUNTUTJARPA ROCKSHELTER AND THE AUSTRALIAN DESERT CULTURE CONCEPT

In 1971 I first proposed the hypothesis that during all or most of the post-Pleistocene period in the Western Desert there existed a stable hunting and gathering way of life, the model for which exists among historic and present-day Western Desert aborigines (i.e., the Nagatatjara and their neighbors; Gould, 1971, pp. 174-175). This concept drew freely upon the interpretation proposed by Jennings (1957) at Danger Cave, Utah, where a culture sequence extended continuously from about 11,000 years ago to the historic Gosiute and Paiute Indians. The evidence at Danger Cave led Jennings to propose the concept of the desert culture to emphasize elements of historical continuity and cultural stability from the ancient to the modern hunter-gatherers in the Great Basin region of North America. In the case of the Western Desert of Australia, this is seen as an adaptive rather than a typological concept. I am suggesting, in other words, that prehistoric as well as historic aboriginal cultures may be understood in terms of their economic and ecological adaptations rather than in terms of the presence-and-absence or relative frequencies of different tool types. The earlier chapters in this monograph have provided general descriptions of what appear to be the significant behavioral and ecological variables that impinge upon and in many cases co-determine the nature of this adaptation. As Bennett (1969, pp. 9-19) pointed out, there have evolved in anthropology two basic ways to view human culture in adaptive terms; 1. the study of "cultural ecology" following the pattern set by Julian Steward and others in which one examines the relationships between institutions, environmental data, and human social groups, and 2. the approach referred to by Bennett as "adaptive behavior," by which he means, "coping mechanisms or ways of dealing with people and resources in order to attain goals and solve problems" (Bennett, 1969, p. 11). These two approaches, of course, are not mutually exclusive, and the Australian desert culture concept proposed here partakes of both. The general question this report addresses is: How have people coped with and solved the problems of living in a nonseasonal and impoverished desert environment during the post-Pleistocene period in Australia?

It was assumed from the beginning that archaeology, in the limited sense of conventional techniques of site survey and excavation, would be necessary but not fully adequate for the task of answering—or at least beginning to answer—this question. Hypotheses about adaptive behavior (in the sense intended by Bennett) would be required, and these would have to be tested against the archaeological data. Such hypotheses do not simply happen; they must ultimately issue from ethnographic and/or historic observations of living human societies where such adaptive behavior takes place. The more empirical and long-term these observations are, the more useful they can be for establishing models of adaptive behavior. A model in this case is seen as a general statement of the interrelated regularities of behavior involved in a society's efforts to solve the problems of locating and managing resources in the context of particular environmental variables. Such a model may take a descriptive-ethnographic form (as is the case in this report) or may be presented in a more rigorous, systems-analysis form as a computer simulation (Thomas, 1973, pp. 155-176) or as a flow model (Schiffer, 1972, pp. 156-165). Whichever format is used, the validity of the model as a source of hypotheses for archaeological testing rests ultimately upon the accuracy and empirical detail of the original ethnographic observations, which is why I found it necessary to begin this project with an 18-month field period devoted entirely to ethnographic studies of Western Desert aborigines.

THE CONTEMPORARY AUSTRALIAN DESERT CULTURE AS A "RISK-MINIMIZING" SYSTEM

The data presented in Chapter II indicate that historic and present-day Western Desert aborigines were faced with the overriding problem of finding food and water in an almost completely nonseasonal desert environment. Rain, when it falls, tends to come during the hottest time of the year (December-February), but its occurrence every year or in the same localities from one year to the next is highly unpredictable. It is hard to speak of seasons at all in the Western Desert. Temperature varies on a seasonal basis, but water is unquestionably the primary variable. All water supplies for native man and for native flora and fauna depend directly upon rainfall, and it can truly be said of the Western Desert aborigines that they "chase rain" in the sense that a primary determinant in planning any move is the observed occurrence of falls of rain, correlated with known occurrences of water catchments, and the further correlation of these catchments with known occurrences of plant staples nearby. Thus the Western Desert aborigines have an opportunistic subsistence strategy based upon the actual occurrence of rain combined with traditional geographic knowledge (mainly in terms of localities of totemic or sacred significance) of the exact location of water catchments in order to minimize uncertainties.

A move into an area where rain has been seen falling and where staple food plants are known to abound but where few good rain catchments exist is always a tempting but high-risk proposition. Cases of families becoming trapped and perishing in such areas, where there may be plenty of food but no water, are known. On the whole, aborigines tend to avoid such areas except when the rains are so extensive that even the smallest and most widely scattered catchments can be expected to be full. To avoid the situation of arriving at a key water-source after several days' travel only to find that the rains—seen at a distance—just missed the catchment and failed to fill it, members of the group sometimes fan out while on the move and plan to approach the water source by different routes, visiting other potential water sources on the way. In such cases, whoever finds water lets the others know by means of a prearranged smoke signal, and they come across to join him. They will generally avoid moving directly to the most reliable water source, preferring instead to collect food in the vicinity of smaller waterholes first, since these are likely to dry out first, and reserving the food near the better waterholes for later when these other options are closed.

Given the essentially nonseasonal nature of rainfall (along with the plant and animal resources following from it) in the Western Desert along with the generally low number of edible plant and animal species when compared with other deserts of the world where people live or have lived directly off the land as hunter-gatherers, I would argue that the contemporary aboriginal adaptation to this region is best understood as a successful "risk-minimizing" cultural system. In making a living, the Western Desert aborigines have adapted by combining their traditional knowledge of the local geography (much of it sacred knowledge, an area of extreme conservatism within aboriginal culture) with their observations of actual falls of rain and occurrences of edible staples, an essentially random matter requiring an opportunistic response. All subsistence decisions made within this framework tend to minimize uncertainty, even at the possible expense of increased yields of food in certain areas where reliable waterholes do not exist. Movement by groups is frequent and far-reaching and is basically random with respect to areas which do contain usable waterholes. Groups also fluctuate in size in direct response to the local availability of rainwater. As long as one knows the location of key water and food resources in the desert and can correlate this knowledge with the actual occurrence of rains and act accordingly, life there is fairly comfortable. But virtually no other options exist, and a hunting-and-gathering life based on any other approach, including a seasonal one, would surely fail. In a subsistence strategy like this there is little margin for error. The essential components of this particular "risk-minimizing" subsistence strategy may be summarized:

1. The diet is primarily vegetarian. Women forage for seven staple species (defined in Chapter II) and thus provide the bulk of the diet. Although longer-term observations are needed before precise figures can be given, it seems safe to say at this time that about 90 percent of the time women furnish at least 80 percent of the food available to the group as a whole.

2. There are times when the same staple may become available at widely different times of the year. This is because of localized conditions of rainfall or drought that can result in staples ripening at different localities. There is no regular seasonal pattern of food-collecting, since there

are no annually predictable seasons in the desert when plants may be expected to ripen.

3. Although the number of edible plant species is reduced during drought years, the actual quantities of these drought-staples are generally greater than is the case for the same plants during wet years. In the case of quandong this is the result of natural preservation of the desiccated fruits while the weather remains dry, but for the other drought-staples it seems to be a case of larger yields stimulated by the prolonged dry weather. Thus foraging in drought years may not be as hard as one might at first suppose.

4. Men hunt constantly but generally with poor success. Men and women collect small game, which provides the only animal protein available most of the time. Only on relatively rare occasions of sustained and heavy localized rainfall in areas of predominantly acacia-scrub cover does game become abundant enough for the men's hunting efforts to provide the bulk of the diet, and these instances are of short duration. The dependable efforts of the women in gathering free the men for more chancy hunting activities.

5. The largest groups, usually between 100 and 150 individuals, come together on the rare occasions when hunting is good. This is when ceremonies are most likely to occur. Such groupings are the result of natural rather than man-made food surpluses, even though the aborigines do have the ability to prepare and store some vegetable foods. There is some evidence to indicate that these food-storage practices may be oriented primarily toward emergency situations such as times of extremely prolonged drought.

6. As drought conditions worsen and hunting becomes more difficult, groups tend to fragment and move to areas where they can base their activities close to one or more relatively dependable water sources. Although no water sources are 100 percent reliable or permanent, some are better than others; and it is these that one finds in use by minimal groups of from 10 to 30 individuals during drought periods.

7. The food-quest does not require more than a maximum of four to five hours of work for each woman each day, and generally it requires less. Even in times of drought, two or three hours' collecting by the women can provide sufficient food for the group for that day. In terms of man hours, much more time is expended by the men in their hunting, for much poorer returns. On most occasions there is ample leisure time for people to use in resting, gossiping, making tools, and other activities.

8. Aborigines must move frequently and travel long distances in order to maintain themselves. Journeys of as much as 250 to 350 miles are not unusual, particularly in times of drought. Groups observed in this study sometimes moved as many as nine times in a period of three months, living in a different camp each time and foraging over an area of roughly 1000 square miles during that period. This is perhaps the greatest amount of nomadism reported for any known hunting-and-gathering society in the world. Along with this, there is evidence for extremely low population densities, on the order of one person per 35 to 40 square miles. Of course, actual concentrations of population were much greater than this figure would indicate.

9. A single habitation campsite may be reoccupied more than once in the course of a single year as different staples are exploited in the same area; or, conversely, a camp may not be revisited for several years in succession if no rains happen to fill nearby waterholes during that period.

THE AUSTRALIAN DESERT CULTURE AS SEEN THROUGH ARCHAEOLOGY

To what extent does the archaeological evidence at Puntutjarpa Rockshelter reflect the adaptive pattern observed among the Western Desert aborigines? It is a truism to say that archaeology always provides an incomplete picture of a total cultural system, owing to limitations brought about by poor physical preservation of organic materials, difficulties with respect to archaeological visibility (see Chapter II), and the fact in this case that most of the stone artifacts found in the excavations do not relate directly to the procurement of food and other resources. Given such limitations, perhaps the question can be rephrased to ask: Is there specific evidence in the Puntutjarpa data that is most economically explainable in terms of the descriptive ethnographic model of Western Desert aborigine adaptation presented in this report?

To answer this question we must consider the evidence in terms of two related problems; 1. the evidence for or against historic continuity throughout the Puntutjarpa sequence, and 2. the evidence for similarity (or lack of it) between the total ethnographic model on the one hand and the rather incomplete picture of the cultural system afforded by archaeology at different periods during the occupation of the site. Does the evidence from Puntutjarpa lead one inescapably to conclude that the nonseasonal kind of adaptation described above was operating throughout the sequence, or could it be that a different model (for example, a seasonal one) would fit the archaeological facts equally well or better?

Continuity and Cultural Conservatism at Puntutjarpa. Though one might suggest the possible existence of a gap or interruption in the stratigraphic sequence in Trench 2 at Puntutjarpa in the levels immediately prior to the occurrence of the Upper Rockfall on the grounds that this segment of the stratigraphic sequence lacks consistent, sequential radiocarbon dates, there is no unambiguous evidence in the physical stratigraphy or in the sequence of cultural remains to support this view. Basically, the stratigraphic sequence in Trench 2 is continuous and uninterrupted. The artifact-distribution, t-test, and lithic raw material tables accompanying Chapter VI demonstrate the uninterrupted, continuous nature of artifact type-frequency distributions, the essential uniformity of metrical attributes for different stone tool types, and the almost unvarying pattern of selection of lithic raw materials by the prehistoric inhabitants of the site, respectively. This is not to suggest that absolutely no changes occurred during the occupation of Puntutjarpa Rockshelter. Backed blades appeared, probably around 4000 years ago, and then went out of use shortly before the historic period. Micro-Adzes, although continuously present from the beginning of human habitation at Puntutjarpa, increased noticeably in popularity after the Upper Rockfall occurred, as did Adzes which appeared later than Micro-Adzes but eventually came to dominate the Type 3 tool category—a condition which persisted into the ethnographic situation. So changes did occur, although these changes appear to be restricted to "maintenance tools" which cannot be linked directly to the food quest or other aspects of resource procurement.

In general, the Puntutjarpa sequence presents us with a broad correlation of an unchanging fauna with a virtually unchanging stone tool assemblage, with both fauna and lithic technology culminating directly in the modern Western Desert with the present-day fauna and the contemporary Aborigines. The problem here is that any connection between these two aspects of the archaeological evidence must, for reasons presented earlier, be viewed as indirect, with perhaps one or two exceptions. Thus an explanation of this basic, overall correlation will rest upon the ethnographic model of the Western Desert Aborigine mode of adaptation and the way in which this model relates these two lines of evidence.

The adaptive model proposed for the Western Desert is nonseasonal and is based on opportunistic procurement of a limited variety of plant foods with hunting become important in terms of food intake only when particular circumstances of heavy localized rainfall and/or surface catchments of water provide a locally concentrated availability of game (mainly macropods). Looked at in terms of this model, Puntutjarpa Rockshelter appears throughout most of its history to have been a habitation campsite and base occupied when people came together into maximal groupings in order to exploit localized natural surpluses of game in the mulga-covered area between the Warburton and Brown ranges. Puntutjarpa gives every appearance of having been an ideal base camp, with its excellent shade, abundant water, and slightly elevated position offering a fine view of any game movements between the Brown Range and the Warburtons. While the West Cave water hole continued to retain moisture, Puntutjarpa could also have served as a locality to which minimal groups could have retired during periods of drought, when, of course, their subsistence would have been based on collecting edible plants. With the drying out of the West Cave water hole some time around or before 1900 B.C. this site would have been habitable on a large scale only after heavy rains occurring in the summer (though not necessarily every summer), but this kind of habitation apparently did occur, since stone tools, debitage, faunal remains, and features like hearths and the Feature 7 living surface occurred abundantly in the upper levels of Trench 2 until about within the last 100-200 years. In these uppermost levels the amounts of stone tools and debitage fall off rapidly, suggesting either a decline in the frequency or density of human occupation or an increase in the accumulation of wind-blown sand. Either or both of these alternative explanations may be correct, but it should be noted that after the establishment of the Mission, which gradually assumed the role of a "base camp" in its own right, Puntutjarpa was visited only at irregular intervals by small groups of aborigines (representing only a limited range of the total population) for specific purposes; namely, collection of wild fig and quandong by women, communal hunting of macropods and rabbits by men (with roasting and butchering occurring nearby), and visits by men to the nearby Ngintaka dreaming-site (along with occasional additions to the paintings in and around the site). Thus there is some reason for thinking that in the final phase of occupation Puntutjarpa may have changed from its original role as a habitation base camp to that of a task-specific locality. It is possible, in other words, that the pattern observed at Puntutjarpa following the founding of the Warburton Ranges Mission was already established before the first missionaries arrived. One small piece of evidence to support this interpretation comes from Trench 1, where an elongated hearth was found just below the surface in Square 6, which closely resembled a contemporary aborigine roasting pit or earth-oven. Charcoal from this hearth yielded a radiocarbon date of <185 years. Thus there is at least some confirmation for the idea that within the last 200 years Puntutjarpa Rockshelter served as a task-specific site, in this case related to the task of roasting and butchering game.

In attempting to relate an ethnographic model of Western Desert aborigine adaptation to the archaeological patterns observed at Puntutjarpa Rockshelter, one should remember that Western Desert aborigines have never been observed to live in caves. This statement should be qualified by pointing out that while overnight habitation in caves has never been observed, there are numerous cases known of Western and Central desert aborigines visiting caves and rockshelters for sacred and ritual purposes, for taking shelter from torrential rains, or to relax in the shade for a while during hunting or foraging expeditions. Aborigines show no reluctance in entering caves and rockshelters, but it should be noted that there are relatively few caves found in resistant rock in the Western Desert generally and none that have been found so far that are currently close to a reliable water catchment. Without a water catchment nearby no cave will make a suitable habitation campsite.

Thus at some time after 1500 A.D. (that is, following the abandonment of the latest recognizable living-surface at Puntutjarpa) cave habitation at Puntutjarpa ceased, with habitation campsites then occurring in the open, presumably closer to good water catchments. Was this shift limited to Puntutjarpa, or did it include other rockshelters and caves in the Western Desert as well? No clear answer can be given at this time, since most of the Western Desert (and indeed arid Australia generally) has not seen much yet in the way of stratigraphic archaeology; but in the Warburton area there are at least some indications that this same shift occurred at other sites besides Puntutjarpa. For example, the rockshelter site of Nyawar, situated in a formation of Townshend Quartzite near Ranford Hill, about 30 miles east of the Warburton Mission, was test excavated in 1970 and showed an occupation layer at a depth of 30 to 36 inches dated by radiocarbon to 240 B.C. This was a limited test, but the fill at this site shows much the same concentration of stone artifacts, debitage, and faunal remains as was seen in the habitational layers at Puntutjarpa. Thus Nyawaṛ might be a good site for archaeologists to excavate when examining the problem of rockshelter abandonment in this region.

Although the faunal sequence from Trench 2, along with the faunal remains recovered earlier from Trench 1 (Tedford, in Gould, 1968, pp. 184-185), indicate only modern species, nearly all of which existed in the Warburton area at the time of European contact, it must be remembered that most of these species are adapted to a broad range of arid and semi-arid habitats and are found widely over large areas of Australia. Large macropods, like the red kangaroo (*Megaleia rufa*), are particularly widespread and are by no means unique to nonseasonal arid regions of Australia like the Western Desert. The stratigraphic continuity of these species in the Trench 2 sequence and the absence of extinct varieties there support the interpretation that there has been little, if any, climatic change in the Warburton area during the last 10,000 years. However, this support is probabilistic, meaning that additional studies, such as the identification of the fossil pollens (as planned by Martin) and carbonized plant remains from flotation samples, will ultimately be needed to test and give detail to these findings. We are still a long way from understanding paleo-climates in the Australian desert.

The only stone artifacts at Puntutjarpa that can be regarded as "extractive" tools are Seed-Grinders and Grinding-Slabs, and, as shown in table 56, these were not so common as most classes of chipped stone tools and totaled 37 specimens in all. The present-day aborigines tend to leave Seed-Grinders and Grinding-Slabs as "appliances" at habitation campsites, where they are re-used during successive visits. Thus the ethnographic model suggests that; 1. the occurrence of Seed-Grinders and Grinding-Slabs indicates the presence of a habitation campsite (although these may be found at both large and small campsites), 2. relatively few of these implements can be expected to occur in habitation campsites, since they are kept for re-use and wear out slowly, and 3. the low number of seed-grinding implements could also be interpreted as evidence of a low level of this activity, suggesting in turn that plant

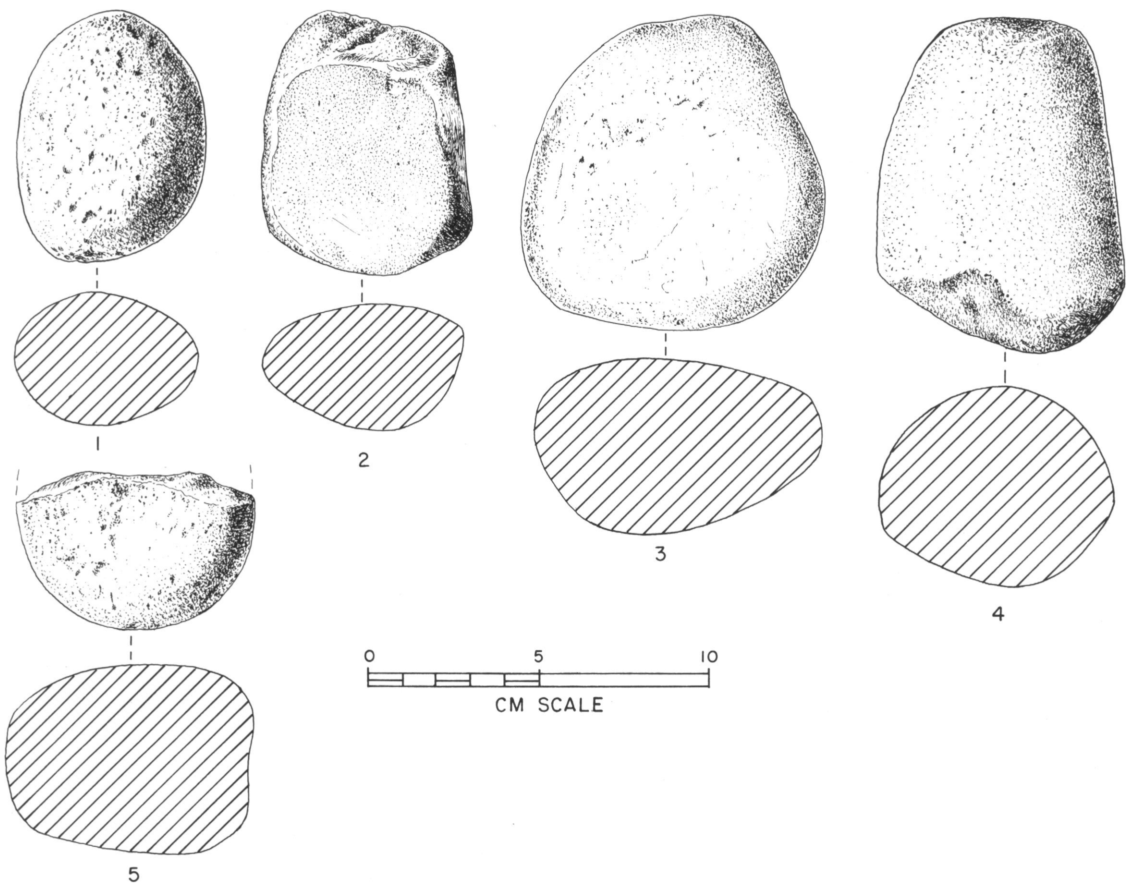


FIG. 90. Type 6, Seed-grinders, excavated at Puntutjarpa Rockshelter, 1969-1970.

TABLE 56
Stratigraphic Occurrence of Stone Seed-Grinders (Type 6) and Grinding-Slabs (Type 7), Trench 2, Puntutjarpa

Stratum	Seed-Grinders	Grinding-Slabs
AX	1	–
BX	1	–
CX	–	–
DX	3	–
EX	2	1
FX	3	1
GX	3	3
HX	2	1
IZ	–	–
JZ	–	–
KZ	–	1
LZ	–	–
M5	1	1
N5	2	1
O5	–	4
P5	–	–
Q5	–	–
R5	1	2
S5	2	–
T5	–	1
U5	–	–
V5	–	–
X5	–	–
Totals	21	16

foods were of minor importance. This, in fact, can be the case when maximal groupings occur under localized conditions of good hunting, as shown by the situation at Waṉampi Well on December 13, 1966, where only one Seed-Grinder was present (although this was a special case where, given time, the site would have been reoccupied by smaller groups who could be expected to bring more seed-grinding implements with them and leave them there). When hunting is good among the Western Desert aborigines little, if any, plant food-collecting takes place, although this condition rarely prevails for long. Thus the occurrence of seed-grinding implements at Puntutjarpa is somewhat ambiguous when it comes to inferring the relative importance of plant vs. animal foods being used by the ancient inhabitants of the site. The presence of such Seed-Grinders attests in a general way to the fact that edible plants and seeds were being collected by the ancient inhabitants, but beyond that it is hard to say much more. Seed-grinding implements need not have been in use during times when hunting was of primary importance, and it is still hard to derive any kind of overall quantitative picture of the relative importance of edible plant-collection during the occupation at Puntutjarpa. All one can say now is that the archaeological Seed-Grinders and Grinding-Slabs are identical to those in use at present in the Western Desert, and that nothing about their occurrence or associations departs from the observed patterns of use for these artifacts. At Puntutjarpa, the earliest seed-grinding implements appear in Strata T5 and S5, in contexts at or near the 10,000-year-old radiocarbon dated hearth underneath the Lower Rockfall, with seven others occurring in Zone B in stratigraphic contexts below the roughly 7000-year-old radiocarbon dated hearths. Thus 18 seed-grinding implements or almost half the total from the site were recovered from levels dating between 10,000 and 7000 years ago, indicating that preparation of plant foods went on here from almost the earliest period of human habitation at Puntutjarpa and continued throughout the entire sequence of occupation right up to the present.

In making ethnographic observations of the Western Desert aborigines' toolkit, one can see general principles concerning their use of stone, wood, and fibrous materials; 1. the use of *multipurpose tools* that are lightweight and easy to carry (for example, the Western Desert spear-thrower, which serves for throwing spears, for fire-making, as a percussion instrument at ceremonies, as a mixing tray for pigments and tobacco, and, of course, as a woodworking instrument using the hafted stone adze), 2. use of tools (*appliances*) that can be left where they are needed and re-used whenever that particular place is visited, and 3. the knowledge of toolmaking is used whenever the need arises to make the necessary implements from raw materials immediately at hand (I have elsewhere referred to these last items as *instant tools* [Gould, 1968b, p. 48]). In looking at the archaeological evidence, it is clear that instant tools will not be readily recognizable, because they are often used and discarded in areas distant from a habitation campsite and because they are rarely, if ever, trimmed or worn into a distinctive recognizable shape. Microscopic use-wear and edge-damage studies offer some possibilities for the archaeologist to be able to recognize such minimal implements, but this is still a future rather than a present prospect. However, the archaeological evidence from Puntutjarpa abounds with examples of portable stone implements (Flake-scrapers, Backed Blades, Adzes and Micro-Adzes), some of which, like the ethnographic Adze, were probably hafted to multipurpose wooden tools like clubs and spearthrowers. And the excavated evidence from Trench 2 also contains numerous stone seed-grinding implements, which are identical to those treated as appliances by the present-day Western Desert aborigines.

In terms of the entire sequence at Trench 2, the average rate of deposition for chipped stone tools and waste flakes at Puntutjarpa was extremely low, despite the large samples of material obtained. Gross calculations indicate an average annual deposition rate of 0.139 chipped stone tools and cores and 7.480 waste flakes in Trench 2. These figures suggest that chipped stone tools and debitage were not produced in large amounts in this habitation site to begin with, and that there were probably periods during which the site was abandoned or reoccupied only by small groups that produced little in the way of chipped stone refuse. The ethnographic situation observed at Waṉampi Well on December 13, 1966, supports this view, since at that time a total surface collection yielded only 13 recognizable chipped stone tools and cores and 55 waste flakes on a site then inhabited by 107 aborigines and which was known to have been in use only since 1964 (Gould, 1968, pp. 109-111). Of course, this was a post-European contact situation in which metal tools were coming into use, as was the situation described in Chapter III where five chipped stone tools and 20 waste flakes were found on the surface of Puntutjarpa during the 28 months that had elapsed between the test excavations in 1967 and the beginning of the final excavations in 1969, so one must be cautious and avoid a too-literal interpretation of these figures. Note, too, that the concentrations of stone tools and debitage from the excavated living surfaces in Trench 2 are much higher than any observed ethnographically in the Western Desert. In the case of Features 32 and 40 this could be explained by the stratigraphic evidence for accumulation due to reoccupation of these campsites over a period of several thousand years, but this explanation cannot be applied as easily to the Feature 7 living surface, where stratigraphic evidence argues for a brief period of occupation and reoccupation of up to perhaps 100 years. The total of 35 chipped stone tools and cores and 886 waste flakes found within the confines of this single living surface is far in excess of any ethnographically observed concentration; a fact that is particularly troublesome in light of the further fact that in all other respects the Feature 7 living surface conforms closely to the model of ethnographically studied Western Desert campsites (as do the Feature 32 and Feature 40 living surfaces).

Thus while the general "fit" of the archaeological patterning at Puntutjarpa with the ethnographic observations of Western Desert aborigine culture is indeed close, there are some anomalies that cannot be explained in terms of present knowledge of the contemporary aborigines. This unusually high concentration of stone tools and debitage in the Feature 7 living surface is one of the most obvious as is the fact that caves are no longer used as habitation campsites, but other, lesser discrepancies that still await explanation have been mentioned in Chapter VI. These anomalies aside, we appear to have a general picture of a continuous post-Pleistocene sequence of human occupation that conforms both in general and in terms of most details with key portions of the adaptive model of contemporary Western Desert culture—that is, those portions that are most likely to remain archaeologically visible over the passage of thousands of years.

A SUMMARY OF PAST HUMAN BEHAVIOR AT PUNTUTJARPA ROCKSHELTER

At the time Puntutjarpa Rockshelter was first visited by the aborigines around 10,000 years ago, the Main Cave was free of any rockfall and had a floor consisting of a rock ledge with a thin (probably 2- or 3-inch thick) covering of sterile desert sand. The climate, vegetation, and fauna were generally much as they are today, although many important details are still unknown and await further research. The West Cave contained approximately 20 inches of sterile, sandy fill, some of which was moist from a soakage of fresh water at the rear of the cave. This cave was too small to live in comfortably, but offered a convenient and fairly reliable source of water close to the Main Cave, which was roomy and comfortable in terms of shade and protection from winds and offered the further advantage of a good view and easy access to good hunting.

The early occupants of this site brought with them a stone technology not too different from that used by the present-day Western Desert aborigines, including both hafted and unhafted scrapers for shaping artifacts of hard wood as well as an array of cores (some of which are presumed to have seen secondary use as choppers and scraper planes, although this cannot be demonstrated) and sharp flakes used for cutting meat, sinew, and fibrous materials generally. These stone tools were made primarily of lithic materials obtained locally from several specific quarry sites and generally from the gibber plains, claypan surfaces, and creekbeds near the rockshelter. Once established, the preferences for these different lithic raw materials and their relative application to making certain types of tools remained at least as constant and unchanging as the stone tool types themselves. Stone toolmaking became an important activity at the site. Not long after the cave was first visited and lived in, stone seed-grinding implements were brought in and used for processing plant foods. At the same time large amounts of butchered and burned animal bones appeared, indicating use of Puntutjarpa as a hunting base where meat was roasted and consumed. Although no wooden tools have survived, we can assume that the manufacture and repair of wooden hunting equipment like spears and spearthrowers, clubs and throwing-sticks was carried out whenever people were there, as suggested by the presence of chipped stone tools which are virtually identical and historically continuous with the "maintenance" tools in the present-day Western Desert aborigine toolkit.

Some time between 10,000 and 7000 years ago a single rockfall event covered roughly half of the interior floor surface of the Main Cave, probably during the occupants' absence. Eventually the inhabitants returned and reestablished campsites at the rear of the cave, where the best shade was available, by clearing two oval-shaped areas of rockfall and camping within these rock-free areas (the Feature 32 and Feature 40 living surfaces) and perhaps in other parts of the cave or on the sand talus outside as well. If amounts of faunal remains, hearths, stone tools and debitage are any indication of intensity and/or frequency of occupation, it would appear that the depositional phase represented by stratigraphic Zone B was one in which the site was visited and used often by large numbers of people, in the manner of a modern habitation campsite of maximal size based on hunting as the primary economic activity. All indications are that Puntutjarpa was revisited often by groups as large as would ever be found in this region throughout the period between the reoccupation after the Lower Rockfall event and the occurrence of the first Upper Rockfall event around 4000 years ago. As suggested in Chapter III and also in this chapter, there is some possibility of wind scouring or some other natural factor that could have eroded away the surface of Zone B prior to the first phase of the Upper Rockfall. The interface between Zone B and the Upper Rockfall poses a stratigraphic and dating problem that is not easily resolved, since there is no apparent change in soil color and texture. At the moment I still favor a view of this as a continuous, although not necessarily regular or even, deposition of both soils and cultural remains until the first phase of the Upper Rockfall, at which point the enormous bulk of the rockfall itself created certain irregularities in the deposition of soils and cultural remains.

The Upper Rockfall was without question the most cataclysmic depositional event to occur at Puntutjarpa, and, again, it appears the occupants were away at the time. The first phase covered virtually the whole interior surface of the cave. Most of these rocks were too large to remove by hand as was done in the Lower Rockfall, so the presence of these boulders may have inhibited resettlement for a while. Nevertheless, stone artifacts and butchered bones were found in the gaps and interstices around and among the rocks, indicating continuous efforts to reoccupy the cave. This eventually became easier as sand covered the rocks, but then a second and probably even a later, third rockfall event occurred, each creating a kind of soil "sandwich" with butchered bones and stone artifacts and debitage contained within. This final phase of the Upper Rockfall occurred over what appears to be a limited area of the cave interior and covered an oval-shaped living surface (Feature 7) containing hearths dated at about 435 years ago, thus suggesting that the Upper Rockfall, in all its phases, spanned a period of around 3600 years.

Some time by around 1900 B.C. the native well in the West Cave dried up, although I cannot point to any direct connection between the Upper Rockfall in the Main Cave and this phenomenon. Certainly during this period some readjustment must have been made by the occupants in their pattern of use of the cave. The cave was still visited and lived in, with abundant quantities of faunal and cultural remains being left as before, but the ancient occupants now would have had to depend upon external sources of water, probably following heavy rains in the local area. Before this happened, Puntutjarpa combined the ideal features of both extreme types of habitation campsites in the ethnographic Western Desert model; that is, it possessed reliable or near-permanent water supplies in the form of the native well (a requirement for a habitation campsite used by minimal groups under drought conditions) and good hunting nearby when heavy rains fell locally (a requirement for a habitation campsite used by a maximal group). Until the native well dried up Puntutjarpa could and may have been occupied by groups under conditions representing both extremes at different times. After the drying of the native well, however, only one option remained open, namely that of maximal groups coming together to hunt following heavy, localized rains, although no direct archaeological evidence exists to support this interpretation. However, this may well have been the option that persisted at Puntutjarpa until shortly prior to European contact, when the site appears no longer to have been used for habitation but only as a task-specific locality for sacred purposes, gathering plant foods, and some roasting and butchering of game hunted nearby.

Immediately prior to the first phase of the Upper Rockfall, Backed Blades made their first appearance at the site, and they increased in popularity and then went out of use shortly before historic times. It is supposed (admittedly without adequate proof) that these items were hafted when in use, perhaps inset in rows in a wooden handle in a manner analogous to the *taap* knife of the historic aborigines of southwestern Australia. It is also supposed, here on slightly better evidence, that this toolmaking tradition was introduced from somewhere outside the Western Desert, although the artifacts themselves were probably produced locally. The presence of these implements and the continuous presence of exotic lithic materials indicates that the ancient aborigine inhabitants were not completely isolated from outside contacts and influences. These contacts may have taken the form of long-distance exchange networks of the kind reported for wide areas of Australia by McCarthy (1939) and Thomson (1949), or they may reflect intralineage relationships similar to the modern Western Desert aborigines' practice of transporting lithic materials associated with particular sacred sites over long distances to patri-kin of the same totemic clan (Gould, 1968a, p. 107)—or some other cultural mechanism not known ethnographically in Australia. At this time the archaeological evidence is too generalized to allow one to choose among these alternatives. Whatever the particular mechanisms, the presence of these exotic raw materials is *prima facie* evidence of widely ramified social networks throughout the history of Puntutjarpa.

Some 4000 to 6000 years ago the aboriginal inhabitants at Puntutjarpa began to paint designs on the roof of the cave and perhaps along the rear wall as well. Unfortunately, the evidence from Feature 25 (the ochre-stained rock) and stains of red and yellow ochre seen on the undersides of rocks in the Upper Rockfall cannot tell us about the actual designs themselves—only that this activity occurred and, like so many other aspects of human behavior at Puntutjarpa, has continued there up to today. Photographs of modern aboriginal rock paintings at Puntutjarpa appear in figures 92-94. It is impossible to say anything significant about ritual and ceremonial life among the prehistoric aborigines at Puntutjarpa, since no distinctively sacred artifacts (like incised *churinga* stones of the sort widely known throughout the Central Desert of Australia, especially among Aranda and Warramunga aborigines, or items of decorated pearl shell, such as are widely known among various Kimberley District aborigines) were found in the excavations. Plain and incised *churinga* stones and pieces of decorated pearlshell are traded throughout the Western Desert at the present time, and many of these items were observed in caches held by aborigines at Warburton during 1966-1967 and in 1969-1970 and at Laverton as well. However, present-day attitudes toward these items require that they be hidden in the bush well away from any habitation campsites. Thus present-day aborigine behavior toward such objects might adequately explain their total absence in past habitational contexts, but negative evidence of this kind is risky and cannot be carried too far. One could just as easily argue that the use of *churinga* stones and imported pearlshells by desert aborigines is a recent development—a logical possibility, of course, although not a likely one. Similar arguments can be applied to aboriginal burial practices in the Western Desert, which currently involve flexed inhumation in the sandhills several miles from any habitation campsite (to avoid later infestation by ghostlike spirits called mamu) and reburial. Here, too, current practices would lead us not to expect human burials in early habitation contexts, although there is no necessary reason why the present practice should be viewed as ancient. However, the excavations in Trench 2 yielded 75 pieces of red ochre and

TABLE 57
Stratigraphic Occurrence of Ochre, Tektites, Quartz Crystals, and Unusual Stones, Trench 2, Puntutjarpa

Stratum	Pieces of Red Ochre	Pieces of Yellow Ochre	Tektites	Quartz Crystals	Unusual Stones	Ground Slate
AX	–	–	1	–	2	–
BX	1	–	–	–	–	–
CX	1	–	–	1	–	–
DX	1	–	2	–	–	–
EX	6	1	1	–	–	–
FX	–	–	1	–	1	–
GX	11	1	–	–	–	1
HX	5	–	–	–	3	–
IZ	5	1	–	–	–	–
JZ	–	4	–	–	1	–
KZ	2	–	–	–	1	–
LZ	–	–	–	1	2	–
M5	6	1	–	–	–	–
N5	7	1	–	1	–	–
O5	15	7	–	–	1	–
P5	6	1	–	–	–	–
Q5	1	–	–	1	–	–
R5	1	–	–	–	3	–
S5	2	1	1	–	–	–
T5	5	–	1	1	1	–
U5	–	–	1	–	–	–
V5	–	–	–	–	–	–
X5	–	–	–	–	–	–
Totals	75	18	8	5	15	1

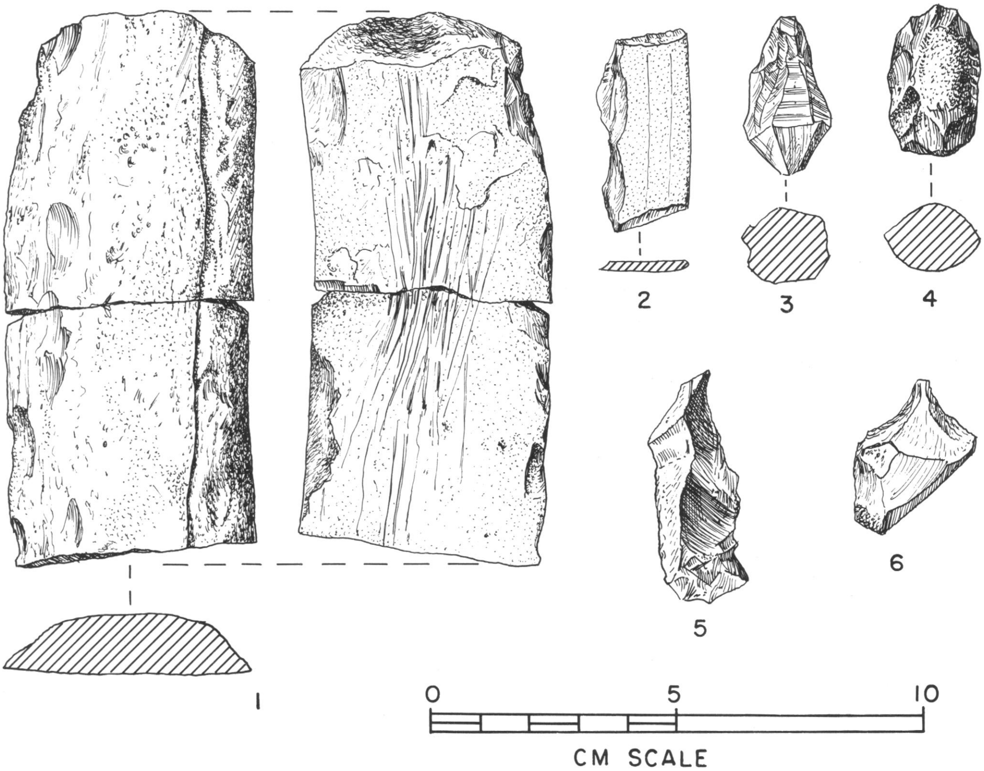


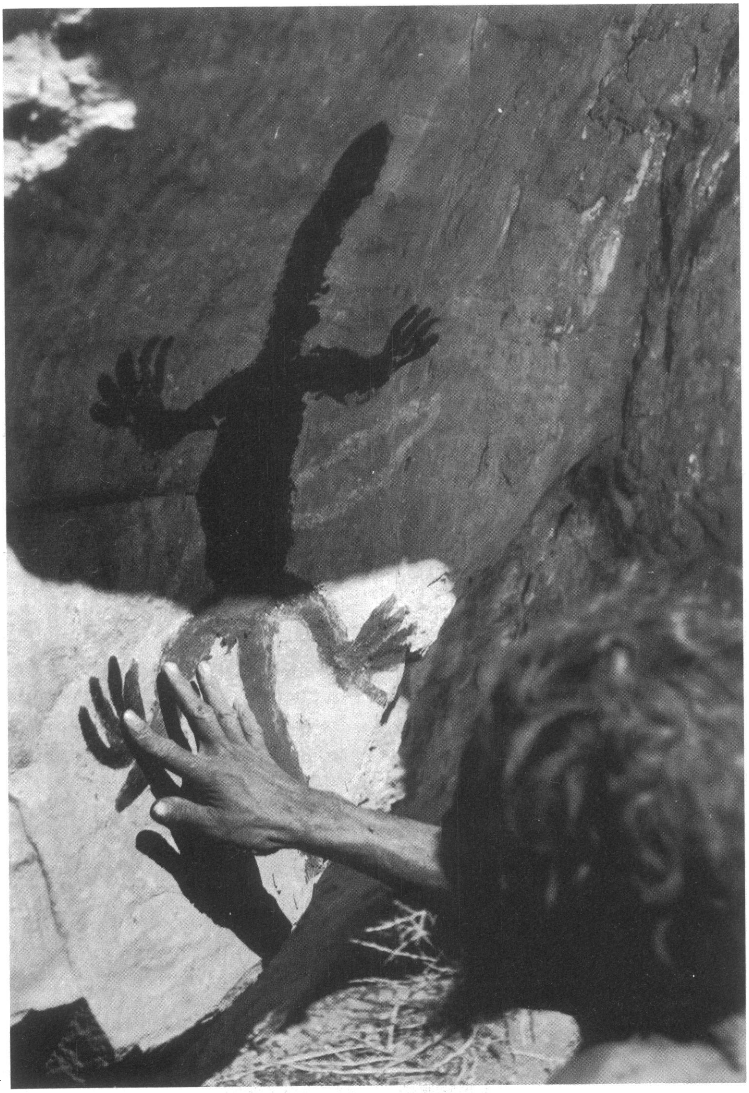
FIG. 91. Unusual stones and stone artifacts excavated at Puntutjarpa Rockshelter, 1969-1970.

18 pieces of yellow ochre, most of which showed striated facets due to grinding, occurring continuously throughout the sequence (see table 57). Red and yellow ochres today are widely used by the Western Desert aborigines in preparing body decorations and painting sacred paraphernalia for dances as well as for rock and cave paintings of both a sacred and nonsacred character. Summarized in table 57 also are stratigraphic occurrences of tektites, pieces of quartz crystal, slate, and a category of "unusual stones" among which are included large polished pebbles (usually of a stone of fairly bright color or distinctive mottling), pieces of hand- or water-polished agate, and lumps of specular hematite, to name a few—all stones that do not occur naturally at the site and must have been brought there by the ancient inhabitants. These items are all typical of the contents of aboriginal sorcerers' kits and are referred to collectively by the Western Desert people as mapaṇpa. Accounts of their use by sorcerers in effecting cures and projecting illness are presented elsewhere (Gould, 1969d, pp. 129-134). The occurrence of these rather distinctive items throughout the stratigraphic sequence in Trench 2 suggests that similar practices have been carried on at Puntutjarpa since the site was first visited by aborigines.

CONCLUSIONS

The Australian desert culture is an adaptive model based on a combination of ethnographic observations and archaeological patterns pertaining to the post-Pleistocene period in arid Australia. It applies to the Western Desert of Australia, where conditions of extreme paucity and unpredictability of food and water resources prevail and apparently have prevailed throughout for at least the last 10,000 years. Both ethnographic and archaeological evidence present a picture of hunters-and-gatherers who adopted and maintained patterns of extreme nomadic mobility and fluidity of group structure in order to make the most of their limited opportunities. From an archaeological point of view, many of the details of this mode of adaptation are not visible and can be reconstructed only with difficulty, if at all; but those aspects of this adaptive model that do possess reasonable degrees of archaeological visibility tend to fit well with what is known about the ethnographic situation. A model of this kind is intended to provide hypotheses that may be tested archaeologically through further surveys and excavations, and plans are in hand for such testing now.

The argument here is that aborigines have adapted in similar ways to extreme desert conditions of the kind described in Chapter I, and that we may look for evidence of these same sorts of



FIGS. 92-94. Rock paintings at Main Cave (on consecutive pages), Puntutjarpa Rockshelter, 1969-1970.

adaptive behavior in other areas like the Central Desert of Australia and other deserts that possess the same basic nonseasonal and impoverished plant and animal resources. In the future I shall refer to such areas as the "core deserts" of Australia, in contrast to other arid regions of Australia where one may encounter more marked annual periodicity of seasonal resources of food and water, occasional permanent springs or watercourses, and/or unique resources like fish and shellfish (for example, along the Eighty-Mile Beach region of northwestern Australia, where true desert conditions occur along the shore). From a deterministic viewpoint, the core desert can be seen as a great leveler of human behavior in the sense that it limits the optional responses by anyone with a hunting-and-gathering mode of subsistence who tries to live there. In fact, there appear to be no options except the unique kind of risk-minimizing opportunism described earlier for the present-day Western Desert aborigines, and anyone attempting to follow a seasonal round or adapt in any other way would undoubtedly perish. The irony here is that once adopted, this pattern of organized opportunism is extremely effective in making the most of the available resources and has enabled the contemporary aborigines of this region to live fairly comfortable lives without the constant feelings of insecurity over basic resources so often attributed by popular writers to desert hunters-and-gatherers. The cultural sequence at Puntutjarpa Rockshelter thus provides evidence for the success of this ancient desert culture adaptation throughout the post-Pleistocene of the Western Desert, culminating in the ethnographic desert culture of that region, in what must surely stand as one of the most dramatic cases of cultural conservatism on record. It is also a tribute to the aborigines whose resourcefulness led to the establishment and maintenance of this dignified and rewarding way of life under what were perhaps the most rigorous environmental conditions ever encountered by any historic or prehistoric hunters and gatherers.

GLOSSARY OF ABORIGINAL AND COLLOQUIAL AUSTRALIAN TERMS

The following words are used in text and tables.

Gnamma, colloquial, referring to water catchments occurring in small rock crevices or natural rockholes.

Goanna, colloquial, referring to several varieties of edible lizard commonly found in the Australian desert.

Kalpaṛi, *Chenopodium rhadinostachyum*, a Western Desert plant that produces edible seeds that are a staple food of the aborigines.

Kampuṛarpa, *Solanum centrale*, a Western Desert shrub that produces a green, tomato-like fruit that is a staple food of the aborigines. It is eaten either fresh or sun dried.

Kuka, a Western Desert aborigine term for meat and fleshy foods.

Kurkaṭi, *Varanus gouldii*, an edible species of lizard found commonly in the sandhill and sandplains country of the Western Desert. It is an important source of protein for the aborigines.

Kurrajong, *Brachychiton* sp., called *ngalta* by the Western Desert aborigines, this tree is found in places throughout the desert. Its edible seeds and water-bearing roots make it an important resource for the aborigines.

Mallee, colloquial, referring to stands of small, mixed eucalypts occurring in semi-arid country in and around the Western Desert and other Australian deserts.

Mapaṇpa, Western Desert aborigine term for objects, generally of some unusual substance such as quartz crystal or pearl shell, that a sorcerer keeps in his "kit" to use in curing, or against, ghosts.

Mirka, a Western Desert aborigine term for plant foods and other food items that are not classified as meat or fleshy foods (kuka).

Mulga, colloquial, referring both to the tree, *Acacia aneura*, and to thornscrub-like woodlands in semi-arid country dominated by this species. The hard wood of the tree is extensively used by the desert aborigines for firewood and for making tools.

Ngaṛu, *Solanum chippendalei*, a Western Desert shrub that produces a fruit with an edible husk; it is a staple food of the aborigines, eaten either fresh or sun dried.

Ngatatjara, a dialect group of Pitjantjatjara-speaking aborigines living in the Western Desert in a region centering on the Warburton Range.

Ngintaka, *Varanus gigantus*, an edible species of lizard growing up to six feet in length and found mainly in the rockier portions of the Western Desert.

Ngura, a Western Desert aborigine term for a habitation camp.

Nyatunyatjara, a dialect group of Pitjantjatjara-speaking aborigines living in the Western Desert in a region centering on the Clutterbuck Hills.

Pangara, a flat, oval shaped stick used by the Western Desert aborigines to open ngaṛu fruit and to separate the edible husk from the seeds.

Perentie, colloquial Australian, referring to the lizard *Varanus gigantus*.

Pitjantjatjara, a term referring both to the Western Desert aborigine language in general and to a dialect of the Western Desert language spoken in a region centering on northwestern South Australia. In the text of this monograph this word refers exclusively to the more general usage.

Ṛiṛa, aborigine term denoting a topography of broad, undulating knolls of gravel weathered in some places to form low escarpments. Large areas of the Western Desert contain this type of terrain.

Spinifex, colloquial Australian, referring to various species of a spiny grass (*Triodia* sp.) that grows in clumps throughout the sandhill and sandplains country of the Australian desert.

Taap knife, a distinctive type of knife produced and used by aborigines in southwestern Australia, consisting of a wooden handle with a row of small quartz flakes hafted with resin to form a cutting edge.

Tawara ngura, literally, a "dug camp." This type of aborigine camp consists of a row of scooped-out sleeping areas with a hearth between each one. Men traveling together on hunts or attending rituals generally organize their camp in this fashion.

Tjiwa, Western Desert aborigine term for the flat rock slab that is used as a seed grinding base, in combination with a hand-held stone that is rubbed or pounded across the upper surface of the slab.

Wanguṇu, *Eragrostis eriopoda*, a Western Desert plant that produces edible seeds that are a staple food of the aborigines.

Wayaṇu, *Santalum acuminatum*, a Western Desert tree that bears a bright red fruit that is a staple food of the aborigines. The outer husk of the fruit is edible and is eaten either fresh or sun-dried. Called quandong by white Australians.

Wiltja, type of bough-shelter constructed by the Western Desert aborigines during the hottest periods of the year. This word also has a more general meaning of "shade" in the Western Desert language, but in the text of this monograph the term refers only to artificially constructed shade-shelters.

Yalta ngura, literally, "cold-weather camp." Usually this is simply a scooped-out clearing with one or more hearths and a brush windbreak, used by desert aborigines during the cool parts of the year.

Yawalyuru, *Canthium latifolium*, a Western Desert plant that produces edible berries that are a staple food of the aborigines.

Yiḷi, *Ficus* sp., trees that produce edible figs that Western Desert aborigines collect as a staple food.

NOTES ON SOUNDS WITH NO ENGLISH EQUIVALENTS

a: extended a (twice normal length used in English).
i: extended i (twice normal length used in English).
u: extended u (twice normal length used in English).
ṭ: t spoken with tip of tongue turned up.
ṇ: n spoken with tip of tongue turned up.
ḷ: l spoken with tip of tongue turned up.
ny: a single sound spoken with tongue tip touching teeth.
tj: a single sound spoken with tongue tip touching teeth.
ly: a single sound spoken with tongue tip touching teeth.

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