Prehistory of the Eastern Highlands of New Guinea

VIRGINIA DREW WATSON and J. DAVID COLE

Prehistory of the
Eastern Highlands of New Guinea
By VIRGINIA DREW WATSON AND
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This volume examines the prehistory of the Eastern Highlands of New Guinea through a study of its archeology. Working from artifacts collected from seventy-six sites by J. David Cole, Virginia Watson has constructed a paradigmatic classification of stone tools which has the potential of greater elaboration and wider application in New Guinea. The classification represents a distinct departure from most previous attempts to interpret stone tools and carries to a more productive conclusion a line of investigation that is similar to J. Peter White's pioneering analysis of "altered edges."

Using the data from similarity coefficients, frequency seriation, stratigraphy, and radiocarbon analysis, Watson has established a chronology of three phases which spans the period from 18,000 B.P. to the present, from hunting and gathering to a largely horticultural existence. The findings are also compared with those from five other sites excavated in the Eastern Highlands, and similarities and differences are assessed. Finally, an attempt is made to relate the archeological data, especially those from the latest phase, to groups of New Guineans currently living in the area, who have been the subject of intensive study.

J. DAVID COLE worked with the University of Washington Micro-evolution Project in the Eastern Highlands in 1966-67. VIRGINIA WATSON, affiliate curator at the Burke Memorial Washington State Museum, completed the research by analyzing the materials collected by Cole.

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James B. Watson, *Editor*

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Foreword

Commonly considered extraneous to the *research,* the history of a project is often passed on only in oral form. In the belief that research is shaped not solely by planning but also by chance, the career of the prehistory segment of the New Guinea Micro-evolution Project, its hazards and turning points, is recorded as a part of this report. First there was substantial doubt that the study would occur at all. That hurdle cleared, the next question was whether the proposal to investigate open sites would receive the required ratification. When a compromise was reached, the question then became whether the reconnaissance would justify the faith of the proponents of open sites or prove that the skepticism of the regional experts was correct after all. Once excavation was underway, available money threatened to be insufficient for the number of sites considered a minimum program.

The field work itself produced further questions. One was inherent in the very success of the open site reconnaissance. Within the designated study area the large number of open sites discovered made it clear that the actual number was considerable. With each site an unknown point in an uncharted past, moreover, which were the sites to excavate? In light of the number of sites, the limited resources made the decision to excavate a given site a decision not to excavate at least seven or eight others. As it turns out, sites in present grassland are much better represented than sites in present bush; and ridge-top sites are less well represented than those on lower slopes or bottoms. Since the only prior work done in the study area, other than surface or casual finds, has dealt with cave sites and rock shelters, the implications of this pioneering strategy cannot yet be seen.

As is often the case with turning points, the major juncture of this study was accidental. David Cole, a young archeologist with prior residence in Papua New Guinea, conducted all of the field work with determination and a good measure of success. In this he was ably assisted by his then wife Rosemary, the sometime help of Keith Weigel, and a field crew he much admired from the locality under study. Visiting the Coles in August 1967, I found their *hauskunai* field station almost completely filled with equipment, maps, files, site bags, soil samples, and artifacts. Amid all this one ate or slept as best he could. The hospitality was everything it should be, but work, not amenities, obviously came first. Only the separate *haus kuk* where Tute reigned seemed reserved to its nominal function; and even there that loyal man had at times to stand his ground against the threat of an encroaching "project." As if any doubt could survive, the clerical presence of Teku rounded out the picture of a camp wholly organized for work.

After returning to Seattle and setting up a laboratory in the Burke Memorial Washington State Museum, Cole, for reasons of health, was obliged to withdraw from the research in all but a consultative capacity. The issue then became whether one could find someone else to carry on, to collate, analyze, report, and interpret the findings. And if someone did carry on, how much could the successor realize of the original intentions and possibilities of the field phase?

Whatever the replicable truth of a library or laboratory, in field-based research, when the data are gathered and stored but still await description and analysis, a change of researchers is a serious change. The best one can hope for is the patience, imagination, and courage of the second worker, and the forebearance and cooperation of the first if he is still in some measure involved. In this the project was fortunate on all counts. Handicapped as it may be in its discontinuity, the research has been realized through the dedication and sustained enterprise of David Cole throughout nearly a year's work in the field. It has been kept alive and brought to fruition through the singular purpose and tenacity as well as the professional skill of Virginia Watson, the author of this monograph. She collated the field material and conducted the painstaking analysis which informs her detailed report. In that joint good fortune, a research in which so much hard work was invested, but which seemed at least to some forlorn, has been carried through with results that we believe are significant.

As is implied in its inclusion in the monograph series, "Anthropological Studies in the Eastern Highlands of New Guinea," this research bears on the findings of the larger micro-evolution project.[1] Dealing with the prehistoric record of a segment of the Eastern Highlands of New Guinea—the micro-evolution "study area"—it has direct value as a baseline for inter-

1. James B. Watson, "A Micro-evolution Study in New Guinea," *Journal of the Polynesian Society* 72 (no. 3): 188-92; Howard McKaughan, ed., *The Languages of the Eastern Family of the East New Guinea Highland Stock,* Anthropological Studies in the Eastern Highlands of New Guinea, vol. 1 (Seattle and London: University of Washington Press, 1973); Robert A. Littlewood, *Physical Anthropology of the Eastern Highlands of New Guinea,* Anthropological Studies in the Eastern Highlands of New Guinea, vol. 2 (Seattle and London: University of Washington Press, 1972).

preting the developments that present conditions can only suggest. The continuity of the immediate past with this present is indicated on independent grounds, principally ethnohistorical and linguistic;[2] but now archeology confirms it.

Establishing that point is less sanguine, obviously, than our further hope that we might distinguish different prehistoric traditions, despite the smallness of the area, no more than thirty miles across. If successful we hoped in turn to recognize among these differences how deep in time was the separation of the four study peoples with which the micro-evolution project has been mainly concerned. We could even conceive of relating a particular tradition to a particular modern people—that is, a contemporary ethnolinguistic tradition. Not surprisingly that hope still remains unfulfilled. One reason is the amount of excavating it would require across the study area to search for the earlier evidence of each of the several peoples of today—always assuming, moreover, that their traditions would be discriminable archeologically.

What has developed, however, is not unrelated to that hope, for it is in fact a demonstration of local variation, specifically two recognizable traditions. These putatively distinguish the study peoples, collectively the Kainantu group (Wurm's "Eastern Family"), from at least one of the peoples of the ethnolinguistic cluster immediately to their west, Wurm's "East Central Family." The evidence shows that at this fairly low level of differentiation local traditions evident at present have depth and a separateness that is palpable archeologically. The modern traditions in question here have a much lower order of difference, for example, than those which the Daulo Pass divides. If we risk the retrospective use of contemporary linguistic criteria in assessing them, the two traditions visible archeologically in the present study correspond to relatively close families.[3]

The study of the Central Highlands of New Guinea has only recently begun. Many observers have been understandably impressed by the existence of a region-wide commitment to a single major crop, sweet potatoes, and to a particular manner of producing and using it, notably in foddering numerous domestic pigs as well as for the human mainstay. Because of the probable recency of introduction of the sweet potato to the region, however, the extent of the changes it brought is a tantalizing question. How much can happen in so short a time? Was the outside world's "Central Highlands"—that of the 1930s—the same region with the same boundaries as of yore, differing only in its conversion to the new crop? Or did that

2. Cf. Howard McKaughan, "A Study of Divergence in Four New Guinea Languages, in *New Guinea: The Central Highlands,* ed. James B. Watson, pp. 98-120 (*American Anthropologist* Special Publication 66 [no. 4, pt. 2]).

3. S. A. Wurm, "Australian New Guinea Highlands Languages and the Distribution of Their Typological Features," in *New Guinea: The Central Highlands,* ed. James B. Watson, p. 95 (*American Anthropologist* Special Publication 66 [no. 4, pt. 2]).

conversion sweep across a cultural terrain quite different from, perhaps more variegated than, the one that the conversion reshaped? We now have the prospect of recognizing pre-existing differences at relatively close range, so to speak, at the taxonomic level of what may be closely related linguistic families. This is not only a technical advance but one that should eventually give us, among other things, a better measure of recent uniformizing developments associated with the intensive use of the sweet potato.

Like the other volumes of this series, the present monograph can also undoubtedly stand on its own. It will be useful in its own terms, that is, apart from the balance of the larger project within which it was first conceived. It is a pioneer study of prehistory for the area, preceded there by nothing of its kind. In establishing that open sites in the study area are abundant, many of them readily identified (which had heretofore seriously been doubted), the present study gives a clear demonstration of the time depth and cultural context that open sites provide in the Central Highlands of New Guinea. (To an ethnographer, at least, it will not seem remarkable that people in the Central Highlands did not live only in caves; but the issue raised was whether their more usual habitations in the open could be recognized or would warrant excavation.)

The study breaks ground in recognizing distinct horizons or periods within a temporal continuity that has previously been considered lacking in demonstrable transitions. Some earlier conclusions, in fact, emphasize the great continuity of prehistory both through time and throughout the Highlands, implying a past not only undifferentiated by clear transitions but also presumably a *regional* tradition with much the same boundaries, as the present "Central Highlands." The presumption of stable, hence similar, boundaries through time is obviously open to challenge on general grounds: first, because of the lack so far of prehistoric evidence of the location and character of such boundaries; and, second, because some of the chief markers of the present boundary (such as the preponderant use of sweet potato as food and pig fodder) are not likely to be more than a few centuries old. The present study obviously could not test the time-depth of regional boundaries, which would be a large undertaking. But as was noted above, bounded local traditions—intraregional differences—are recognized. The demonstration of prehistoric diversity not only challenges the presumption of regional homogeneity but underlines the question whether the boundaries of the past will prove to match those of the present.

Not only does the present study recognize, in contrast to some previous work, that local variation is demonstrable and change substantial within the span of man's presence in the Central Highlands; it does so even with the limited indices, such as tool types, accessible here to the archeologist. These findings are clear, moreover, with the survey of but a small fraction of the Central Highlands and with the excavation of but a minority of the sites discovered.

In particular the study underlines the occurrence of substantial change in the late precontact period. This locally evident transition may conceivably have a bearing on a recent cultural transformation of the wider region, posited by some observers (e.g., the writer) but strongly rejected by others.[4] But here I intrude upon the work itself when my purpose is to write the Foreword. I gratefully desist with a commendation to the reader of the more capable account that follows.

JAMES B. WATSON
Seattle

4. For example, H. C. Brookfield and J. Peter White, "Revolution or Evolution in the Prehistory of the New Guinea Highlands: A Seminar Report," *Ethnology* 7 (no. 1): 43-52.

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In an undertaking of this magnitude, the assistance and encouragement of many people are essential. I have been fortunate, indeed, to receive support from a wide circle of individuals. Several faculty members of the University of Washington have provided expertise of varying kinds and degrees. I acknowledge with sincere appreciation my debt to Professor Arthur W. Fairhall and Mr. Anthony W. Young for three radiocarbon determinations; the late Professor George Goodspeed for his petrographic analysis of rocks and pottery; Dr. John M. Rensberger for identifying the faunal material; Professor John C. Sherman for providing guidance in map preparation; Professor Fiorenzo C. Ugolini for examining soil samples; and Dr. Joseph A. Vance for determining the refractive indices of obsidian samples. From Australia, G. A. M. Taylor, Bureau of Mineral Resources, Geology and Geophysics, kindly provided samples of obsidian from New Guinea sources; Dr. Roger Bird of the Australian Atomic Energy Commission and Mr. W. R. Ambrose of the Australian National University analyzed twenty-three of our obsidian artifacts; Ronald Vanderwal of the Tasmanian Museum sent me pertinent sections of his doctoral dissertation; and Jeannette Hope, during a sojourn in Seattle, took a cursory look at the faunal material. From their posts in Papua New Guinea, Susan Bulmer, R. L. Giddings, Mary-Jane Mountain, Pamela Swadling, and Alex and Lois Vincent graciously responded to my numerous requests for information.

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I cannot be too generous in my acknowledgment of gratitude to Dr. R. J. Lampert, Australian National University, and Dr. J. P. White, University of Sydney, both of whom have read the manuscript. Many of their helpful comments and suggestions have been incorporated into the text. Professor Robert C. Dunnell, University of Washington, has read one draft of the manuscript and has given generously of his time and ideas. Although I have profited greatly from his suggestions and advice, I alone am to be held responsible for any misapplication of his ideas. Finally, to James B. Watson, University of Washington, my appreciation not only for having guided the micro-evolution project over an extended period of time, but at a more personal level for his unstinting encouragement and support.

V. D. W.

I would like to express my gratitude to all those who supported and assisted this project. Special acknowledgment is in order for James B. Watson, who supported the idea of the research with courage and insight, assisted with the initial planning, and provided continued support and guidance throughout the project's duration. I am equally indebted to Virginia Watson, whose wisdom and patience carried the project to completion in the face of many difficulties. As a collaborator and as an independent researcher exploring the materials with her own insights and methods, I could ask for nothing more.

I am also particularly grateful to Keith Weigel, who devoted six months to the survey and excavations. Mr. Weigel shared the burden of many decisions, in addition to the long hours and rugged conditions. I also thank Rosemary Cole, who spent the entire year in the field assisting daily with the project. Ron Scarlett also worked with the project for two months and deserves sincere thanks for his contributions.

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Special acknowledgment and thanks are in order for the excavation crew, for without their keen and dedicated assistance a project of this size and scope would have been impossible. Permanent crew members included: Tute (foreman, Bene Bene), Teku (clerk, Chimbu), and excavators Pia'o, Lebi, Naina, Tabe, Be'o, and Pu'ano (all from North Tairora), and Burri from Auyana. In addition, many thanks to temporary crew members and all those New Guineans who assisted with their information, food, shelter, and good cheer.

J. D. C.

Contents

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PREHISTORY OF THE EASTERN HIGHLANDS OF NEW GUINEA

I. Background

This monograph is the culmination of a twelve-month's archeological field investigation in the eastern highlands of New Guinea[1] and a much longer period of analysis of the recovered data. The undertaking is part of the University of Washington New Guinea Micro-evolution Project, directed by James B. Watson.[2] This volume is the third to emerge from the project field investigations, which spanned nearly a decade, from the initial field reconnaissance in 1959 to the conclusion of the archeological phase of the project in 1967.

The following quotation, excerpted from J. Watson 1963 (pp. 188-89), gives some perspective to the project as a whole.

> The research was to be a comparative study of the languages, cultures, psychological traits, racial characteristics, and ecological adaptations of each of the four "study peoples" [Auyana, Awa, Gadsup, and Tairora]. . . . Stated most generally, our central question asked by what means, to what degree, and in what directions the original group, or *Urstamm*, had diversified to produce the four modern peoples? This question was to be answered for each of the several orders of diversification indicated. . . . At the very least our efforts should place us in a position to describe and analyze various aspects of the languages, cultures and social orders, some of the racial features, psychological characters, and the ecologies, of each group under study. . . . Our

1. At the time of the field work, 1966-67, the political area in which the project was conducted was called Trust Territory of New Guinea (New Guinea, for short), on the island of New Guinea. The name of the political unit on the island of New Guinea has since been changed to Papua New Guinea. In this monograph the term "New Guinea" will be used unless the context requires Papua New Guinea for proper understanding. Likewise, the term "New Guinean" will be used to refer to the local residents of the area in preference to Papua New Guinean or Niuguinian.

2. The field work was financed by Grant GS 103, National Science Foundation. Grants 5951 and 6482, Penrose Fund, American Philosophical Society, helped to defray some expenses incurred in the laboratory. Gratitude to both institutions is acknowledged.

most sanguine hope was of course to establish functional relationships or co-variables among some of the features of different orders.

During the early stages of the project, no archeological enterprise was envisaged, for although archeology had been included in the original request for project support, it was not funded. Writing generally about the project, Watson recognized that "while the purpose of the research has not been explicitly historical or archaeological, it is possible that some light may incidentally be thrown by the project on the history of these Eastern Highlands peoples and perhaps on that of the Eastern Highlands generally" (J. Watson 1963: 191). He discussed the strategic position which the area occupies with respect to the lowlands as well as the observation that linguistic work by McKaughan

> strongly indicates that the present languages of the Kainantu group have diverged or evolved from the Kainantu proto-language largely if not wholly *in situ*, rather than representing one or more migrations of peoples whose speech had become diversified outside the present area. . . . The modern Kainantu peoples may be resident in the area as much as a millennium or more. If archaeological excavations were to be carried out in this area, therefore, they would have a very good chance of establishing a time-scale for the present populations and some estimate of the degree of continuity in artifacts and habitation patterns over a substantial period. [Ibid.: 191-92]

When in the mid-sixties, it became apparent that a modest archeological venture could be put into the field, a person with previous archeological experience in highland New Guinea, J. David Cole, was chosen to direct it. The main thrust of the archeological program was the establishment of a chronology for the region.

> The purpose of the field research was the development of a local sequence or a set of local sequences within the regional domain defined by the boundaries of four ethnolinguistic groups: Tairora, Auyana, Gadsup, and Awa. It was hoped that local sequences could then be integrated into a tentative regional sequence of prehistoric events . . . .[3]

A major purpose of the original survey by the Micro-evolution Project archeological field party was to determine the potential for open-site archeology by locating the widest variety of sites over a maximum segment of the study area. This approach would permit both an assessment of the archeological potential of the area and a judicious selection of sites to be excavated. The survey, discussed in more detail in appendix 2, consisted of three main transects. The first went from Aiyura to Ndumba, traversing both North and South Tairora territory. The second extended from Aiyura to Noreiaranda, thence through Auyana territory and a segment of Fore territory as the field party pursued the track to Ilakia and Mobuta in Awa territory. The third transect included the North Tairora basin from Norei-

3. Unless otherwise indicated, all quotations in this monograph are from the field notes and reports.

kora to Kainantu. No survey or excavation was conducted in Gadsup territory.

Generally, the field party followed established footpaths and roads and inquired at local villages for information on sites; many of those located are not far from the travel arteries. A large number of sites, including the oldest ones, were located visually without informant assistance: roadbeds provided a kind of test trench through the surveyed areas, and erosion channels, washes, garden ditches, freshly cultivated gardens, and house excavations also provided a view of the subsurface structure of previously occupied areas.

Within a year of his return from the field, Cole, for health reasons, disassociated himself from the project. When it became evident that the disassociation would be permanent so far as carrying the work to its conclusion, it was imperative to find someone to assume the responsibility. Because all of the funds allocated to the archeological phase of the Micro-evolution Project had been expended on the field operations, I agreed to undertake, as a volunteer, the rather formidable tasks of analyzing field data collected by other investigators and of writing a monograph. Thus, there has been a strict division of labor in bringing the project to fruition: Cole organized and executed the field work; and I, although I had no affiliation with the field program, have had full responsibility for the laboratory analysis of the material and for the production of the monograph.[4]

Basically, my work has involved four operations: (1) to read and assimilate the field notes and reports; (2) to make the decision of what methods and techniques to use in the analysis of the data; (3) to conduct the laboratory analysis; and (4) to write the monograph and prepare it for publication. Although it was obvious from the outset that earlier decisions relevant to field strategy and procedures would affect the degree of analytical flexibility available to me, I felt constrained to weigh carefully the advantages of continuing the kind of analysis originally envisaged or of proceeding with some other. I decided in favor of the latter option.

One drawback to having selected a new route is the fact that the data were not collected with this orientation in mind. To cite but one example, the main survey goal of the field party was to locate archeological sites; although they attempted to make representative surface collections, they were not concerned either with having a complete surface collection from a site or with recording precisely from what area of a site the surface ma-

4. From April to July 1973, Cole participated in the project, preparing the site location map, site maps, house plans, and profile drawings, selecting charcoal samples for dating, and illustrating stone tools. He has also been of assistance in clarifying some of the obscurities and inconsistencies in the field notes and in discussing some problems of site interpretation. Although the press of his business has not allowed him time to read the final draft of the manuscript, he has read two earlier drafts of major portions of it. He has reviewed the analysis of the material and is in agreement with the method and its application as well as with the resulting chronology.

terial was recovered—tactics essential for successful application of the scheme which I attempt.[5] Most critical, then, is my lack of control over the crucial field portion of the project, especially my inability to determine either the quantity or quality of the data collected. It will be clear in several parts of the analysis that incomplete or inadequate data make it impossible to maintain optimum standards of analytical control. A further disadvantage is that I have seen none of the sites nor am I personally familiar with much of the area in which they are located.

In being so bold as to undertake an analysis, given the parameters of control within which I operate, I will attempt to accomplish four major goals in bringing this material into the purview of the archeological profession. First, I will provide some description of the sites and the cultural material that was recovered from them. Second, I believe that the classification of stone tools which I have constructed holds some promise for greater elaboration and cultural understanding in New Guinea. It represents a distinct departure from most previous attempts to interpret stone tools and succeeds in carrying to a more productive conclusion a line of investigation that shares similarity with White's pioneering analysis of "altered edges." Third, I suggest a chronology for the eastern highlands which might be termed minimal, but which emerges from the data and, I hope, will be confirmed and elaborated with future explorations. Finally, I demonstrate a visible dimension of culture change in the interpretation of the prehistory of the area.

In this analysis I am primarily concerned with archeologically retrieved artifacts—discrete objects which are not part of the natural environment and which, in this case, were exposed by road cuts, grass cutting, garden making, ditch digging, the excavation of house foundations, and site excavations themselves. Prehistory as here understood does not mean a general overview of the activity of people in prerecorded times, a research goal not only of some archeologists but of linguists, ethnographers, and geographers as well (cf. Bulmer and Bulmer 1964; Frantz 1973; Giddings n.d. a, b, c, d; Sorenson and Kenmore 1974; Swadling 1973; J. Watson 1965a, 1965b, 1975).

My primary data are artifacts; they are not, for example, what contemporary New Guineans of the area say about those artifacts. In the rather unusual case of the New Guinea highlands where the history-prehistory interface is not only so recent but also so visible, some restraints are imposed on the prehistorian. If, for example, an informant once lived at a now abandoned site, or his father or his grandfather did, this information can be completely disregarded, although it need not be (cf. Swadling 1973). It is not a datum of prehistory, *sensu stricto*, and the archeologist must be firm in his resolve to have consistent parameters to his data field

5. For further discussion see Dancey 1973, 1974.

and in his refusal to be seduced by the often easily available, yet difficult to verify, ethnographic information projected into the past. The moot problems of how far into the past ethnographic data can be projected and to what extent it is possible to construct a coherent or accurate time-scale on the basis of informant response alone are acknowledged by ethnographers working on the island of New Guinea (R. Bulmer 1971; Heider 1967; for another aspect of the problem see DeBoer 1975). Compared to the long sweep of history that the archeologist views, in this case eighteen thousand years, the period covered by ethnographic data can be but minuscule, indeed.[6] In short, ethnographic data are in no way basic to my analysis and have been used only tangentially. (Appendix 7 contains some ethnographic information.)

PHYSICAL ENVIRONMENT

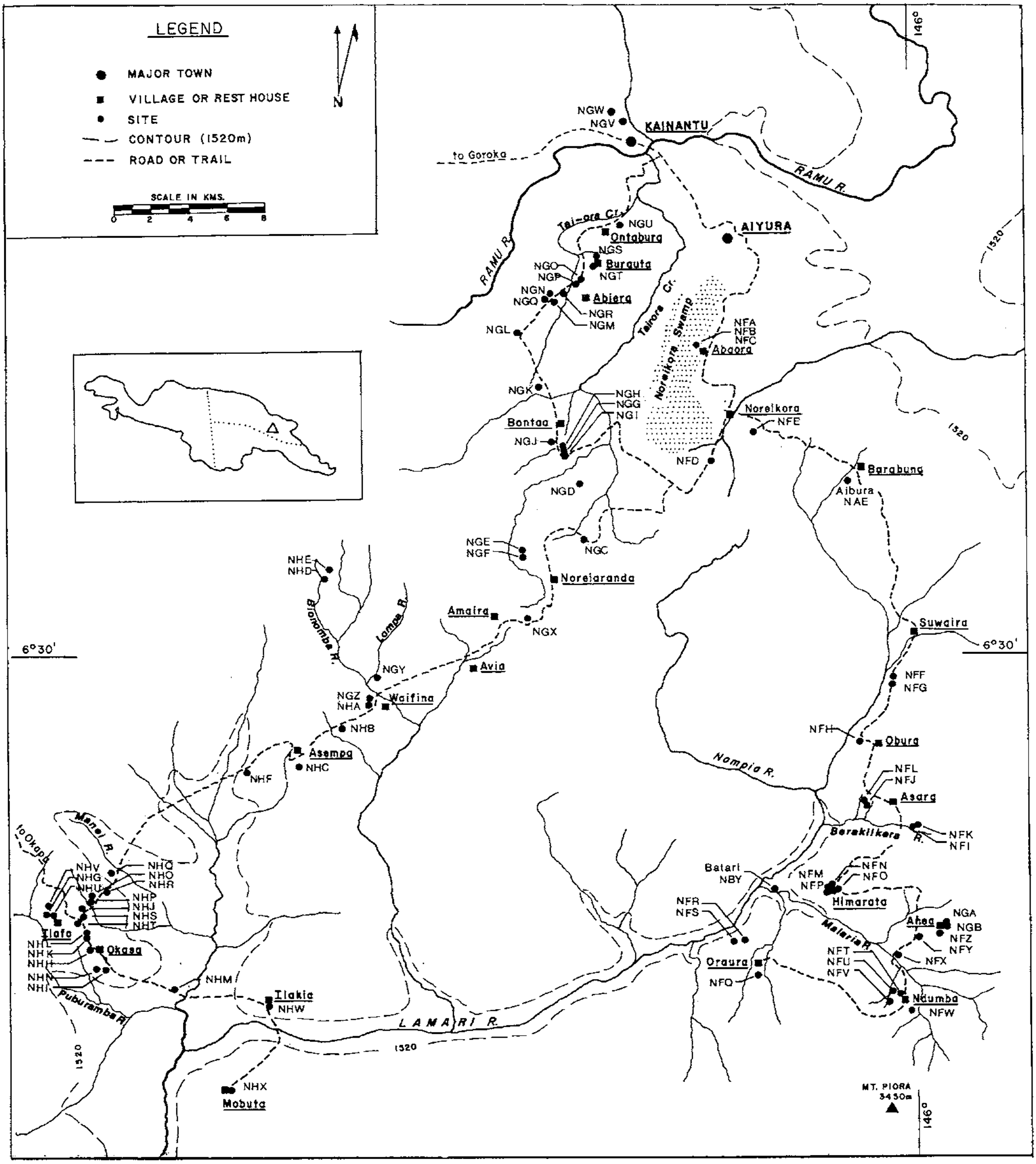
Environmental data, broadly defined—geomorphology, topography, climatology, pedology, botany, zoology—are not available in the same quality or quantity for all sections of the region in which the sites are located (hereafter called the study area).[7] The northern fringe of the study area (see map 1)[8] lies within the southernmost extension of that part of the eastern highlands of New Guinea which has been studied rather intensively by several investigators (Dow and Plane 1965; Haantjens et al. 1970; Heyliggers and McAlpine 1971; Mackay 1955; McMillan and Malone 1960; Robbins, personal communication; Schindler 1952). The following brief background account is drawn largely from these sources, as well as from Brookfield 1964, Brookfield and Hart 1971, and from personal observation. For environmentally and geologically related data of the southeastern and southwestern sections of the study area there is, to my knowledge, but one published paper (Dow and Plane 1965). My characterizations rely upon their paper; on Pataki 1965, 1968, 1977; and on observations recorded in the field notes. I acknowledge all of the foregoing sources, but in the interest of readability I make no attempt to cite specific sources for each statement.

The highlands of New Guinea have a complex geological history that dates from pre-Permian times. The basement rocks are primarily metamorphic with later formations, especially Miocene sediments (notably limestone), lying unconformably over the older rocks. The terrestrial sediments in turn are overlain by Pliocene clastics. There are both igneous and metamorphic intrusions in the predominantly sedimentary base. The

6. This is not to deny that ethnographic analogy may have some value for studies of the recent past, and I have made one suggestion of a test in chapter V, under the discussion of "The Arona Valley."

7. The study area as defined here differs from the definition of the Micro-evolution Project Study Area primarily in the exclusion of the Gadsup area and the inclusion of a small segment of Fore territory.

8. This map was drafted by Cole. It is discussed in chapter II.



Map 1. Archeological sites in the study area

major activity accountable for current topography (including the northwest-southeast trending Kratke Plateau Range, which bisects the study area, and Mount Piora, 3450 m asl,[9] the region's highest peak, which lies just south of the southeasternmost sites surveyed) apparently dates from the Plio-Pleistocene orogenesis. It was accompanied by much folding and faulting, followed by vigorous down-cutting by the streams, both of which have influenced the development of valley bottoms, where not only lacustrine deposits but alluvial and colluvial deposits have been formed. Minor volcanic activity continues in the Recent, although the region is fairly stable.

Climate varies significantly from one locale to another in the study area. Generally, there are two wind systems: the northwest monsoons, which are dominant from December to March—the wet season—and the southeast monsoons, which are dominant during the dry season, from May to October. The southeast monsoons have the least effect on the highlands because they drop much moisture on the southern flanks of the highlands ranges; internal climatic control during this period is important. Climatic differences can be traced in part to differential heating of basin floors and the slopes surrounding them. At the risk of oversimplification of what is, in fact, a complex orography, the following generalizations can be made: (1) basins in the study area are generally drier than those farther to the west; (2) in any basin, rainfall increases from the center to the periphery; and (3) seasonality is more marked in the east and more directly affected by the northwest monsoons than in regions to the west because of the lesser influence of the Bismarck Range and the greater influence of the markedly seasonal rainfall pattern in the Markham and Ramu valleys (cf. McAlpine 1970). Generally, temperatures range from the low fifties to the upper sixties on overcast days and upper eighties on sunny days (Pataki 1977). For Aiyura, average variation between night and day is 9°—56.0° F to 65.3° F; 9:00 A.M. daily temperature monthly means show a variation of 3.3°, from 65.3° F in July to 68.6° F in December (Schindler 1952: 302).

Within the study area, as defined here, three units of physiographic variation can be recognized: a northern segment and two subdivisions to the south, the southeast and southwest. The north contrasts more markedly with either the southwest or southeast than do the two subdivisions with each other.[10]

The northern part of the study area consists of large, open grassland basins, within the altitudinal range of 1625 m asl to 1880 m asl with maximum relief about 100 m. Rainfall averages 220 cm per year; there is no-

9. This elevation was determined in 1972 by Terrence Hays and Kerry Pataki.

10. Initially I had hoped that significant variation of environmental adaptation would be reflected in the archeological data. Such did not prove to be the case. Whether this indicates a bias in the selection of sites or some alternative factor(s) may be answered by future research.

ticeable wet-dry seasonality; serious drought is rare; and frost occurrences are rare or nonexistent. Dominant cover is induced stabilized grassland including *Capillipedeum, Arundinella, Themeda,* and *Imperata.* In addition, there are wet grasslands of *Ischaemum* and *Phragmites.* Tree corridors along streams and rivers are small or absent. Relatively high intermittently forested ridges consisting of remnant oak (*Castanopsis*) and mixed lower montane forest with remnant stands of *Araucaria* at lower elevations do occur. Lithologically, unconsolidated clay is most common, with colluvial, alluvial, and lacustrine gravels.

Professor Fiorenzo Ugolini, College of Forest Resources, University of Washington, briefly examined soil samples from two excavated sites, NFA and NGG. Disregarding for the moment minor differences between the two, generally there are three horizons represented. (1) A_1 is a dark (brown to black) horizon containing abundant organic matter, with roots present. There are no iron stains. (2) B horizon is a clay loam texture, well structured or aggregated, pale in color, and containing a few very small concretions. Superficially the soil appears to contain more "concretions" than it actually does; many of the "concretions" are, in fact, water-soluble peds. This horizon was subjected to fluctuation of the water table. When the soil is wet, the iron becomes mobile; upon drying, it produces the iron stain coatings that are present here. When the soil is dry, it can become extremely hard. The field notes refer to this as a lateritic crust, although the term "plinthite" is currently more precise (Sanchez and Buol 1975: 599). (3) Bg, a horizon of humic gley, varies from whitish to red-orange and often shows mottling.

Within the northern area is the region of the Noreikora Swamp, within the altitudinal range of 1625 m asl to 1700 m asl, 3 m to 12 m maximum relief. Rainfall averages 220 cm per year with well-marked seasonality; serious drought is rare, as heavy mists alleviate aridity of the dry season. There are greater concentrations of swamp grassland, more soils of alluvial origin, and deep layers of peat are commoner than elsewhere in the area. Generally the soil is richer. A recent study to determine the potential of the region for Western kinds of agriculture reported it to be moderately capable for arable crops and tree crops, highly capable for pasture. If drainage were improved, the study concluded, it would become high to very high for arable crops, high for tree crops, and very high for improved pastures (Haantjens et al. 1970, "Agricultural Land Use Capability" map, reference item 3).

In contrast to the undulating, open grassland basins of the north are the high, steeply incised ridges to the southeast and southwest. In the southeast the ridges are forest or grass-covered, and the grass-covered valleys are often long and narrow. In the southwest the ridges are predominantly forested, and the grass-covered valleys tend to be short. The altitudinal range is 1500 m asl to 2350 m asl. Rainfall averages 220 cm to 250 cm per year with less marked seasonality than in the north. Forests are remnant oak (*Castanopsis*) and mixed forest, with beech (*Nothofagus*) at higher elevations. Short grasses in the valley bottoms merge into tall grasses on valley sides with a shrub zone between tall grass and forest. Whereas forests may extend almost to the valley bottoms in some parts of the southwest, the grasslands may extend to the ridge tops in some areas of the southeast. Tall grasses such as *Miscanthus* predominate with intermittent areas of short grasses such as *Themeda* and *Imperata* and with *Phragmites* and *Saccharum* present in swampy or well-watered areas. Lithologically, limestone predominates, although mudstone, siltstone, sandstone, graywacke, volcanic agglomerates, and lava occur. Soils are tropical lithosols, generally lateritic with a predominance of compact red and brown clay and consistently acidic with low humic content. Often the pH is 6.0 or lower (Pataki 1965: 29).[11] The topsoil overlying the clay ranges from 5 cm to 25 cm in depth and is brown to black in color. Gravel and concretions also occur. Erosion is extreme on some of the grass-covered ridges of the southeastern area. Edible forest resources include trees with edible nuts (e.g., *Elaeocarpus, Castanopsis, Pandanus*) and vines with edible fruits. Some available fauna are macropods (e.g., tree kangaroo and small wallabies), rats, mice, *Dobsonia* (fruit bat), *Phalanger* (opossums), small birds and large birds (hawk to cassowary [*Casuarius*]).

11. The figure given in Pataki is .60, but this must be a typing error as such acidity would preclude life.

II. Sites and Assemblages

The seventy-six sites from which cultural material was collected are grouped in three categories: excavated sites; surface-collected sites which provided assemblages used in the quantitative analysis; and surface-collected sites inadequate for quantitative analysis. All of the sites are discussed in this chapter, but the reader may prefer not to read the complete descriptive section, especially for the third category, before proceeding with subsequent chapters.

During the analysis of the material, the term "collection area" was applied to any locale from which cultural material was obtained. This included excavated sites, areas from which objects were surface-collected, areas listed in the survey notes but whose classification as "sites" is questionable, and the areas from which small amounts of cultural material were brought in by New Guineans—locations that were not checked out by the field party. The original intent was to use the term "collection area" in the monograph; in the interest of readability, however, it has been abandoned in favor of the simpler term "site," at the same time recognizing that "site," strictly defined, might not always be applicable.[1]

Whenever possible, the site descriptions parallel one another; lack of correspondence reflects omissions or discrepancies in the field notes. Some kinds of data such as site dimensions, altitude asl, and kinds of soils and their interrelationships were not uniformly recorded and consequently are lacking for some sites. General descriptive terms used in the field notes such as "house remains," "hearths," and "latrine" were often not elaborated, so that further description is impossible. Quotations in this monograph, unless otherwise noted, are from field notes or field reports, as is the orthography used for many New Guinean terms.

1. For a discussion of "site," "cluster," "occupation," and "aggregate," see Dancey 1974.

In the field notes the term "ridge" refers not only to the very high, steep, sharp ridges in the south but also to the low, linear, rounded prominences of the north. The latter I have usually distinguished as hills or interfluves. The terms for soil types employed in the field notes have been used except in some of the excavated sites, samples from which have been examined by a pedologist. Distances of sites from rest houses, villages, rivers, or other landmarks are field estimations or measurements. The reader is reminded that these are locations in 1966-67; rivers probably have not moved appreciably in the interim, but rest houses and villages may have.

Cole drafted the site location map (map 1) on the basis of the Markham Quad, SB 55-10, New Guinea, 1:250,000, and his own knowledge of the area.[2] No new mapping was done except for the excavated sites. The scale 1:250,000 suggests the accuracy of site location that can be expected. The names of most rivers are those given to the field party by local residents and will not be found on any map; they may be of use in relocating a site. Government usage of names which appear on the Markham Quad, SB 55-10, is generally followed for the larger watercourses, including two streams south of Kainantu, Tairora Creek and Tai-ora Creek, different spellings of the same word.[3] Dow and Plane (1965) have labeled what I understand to be Tairora Creek as "Akwiranu"; they do not say on what basis they selected the name and, so far as I am aware, it occurs on their map only.[4]

At the time of the field work in 1966-67, the major vehicular road in the study area was the loop road Kainantu to Kainantu via Bontaa and Noreikora, with an extension southward from Noreikora to Obura. In the text, the "Kainantu–Obura road" refers to the eastern segment of the loop road and the extension to Obura; the "Kainantu–Noreikora road" refers to the western segment of the loop from Kainantu to Noreikora via Ontabura and Bontaa.

Site designations used in this monograph are in accordance with the official University of Papua New Guinea system, which was adopted after the period of field work. In the field, sites in an area occupied by a given ethnolinguistic group in 1966-67 were numbered sequentially, beginning with 1. Thus, sites were designated AUY (Auyana), AWA, FORE, and TAI (Tairora). A further designation, ME (Micro-evolution), was applied

2. The Markham Quad was compiled in 1964 by the U.S. Army Corps of Engineers and enlarged in 1966 by the Royal Australian Survey Conference.

3. Personal communication, J. D. Brady, A.D.C., May 11, 1973.

4. Two other names I have heard applied to the same watercourse are Urala (= Akwiranu?), used by the Tairora of Abiera (Untoa), and Vae, supplied by Alex and Lois Vincent (personal communication, July 6, 1973). New Guineans of the area do not conceive of watercourses as discrete units and call different sections of the same stream by different names, many of them being the names of the land through which the water flows or, as in the case of Vae, the name of a social unit to whom the land (and water while flowing through it) belongs.

to some of the archeological and ethnographic material brought in by New Guineans. No official designations have been assigned to the many areas from which small samples of cultural material were brought to the field party, areas not checked and to which no field catalog numbers were given.[5] The concordance between the official site designations and those assigned in the field is given in appendix 1.

Excavated Sites

Eight sites were excavated to varying degrees of completeness, ranging from nine square meters at NGJ to seventy-nine square meters at NFB. The quantity of unifacially chipped stone tools recovered at all of them, with the exceptions of NGJ and NGM, was sufficient to permit their use in the quantitative analysis of the material. The sites are described in alphabetical order, not in the order in which they were excavated. The descriptions generally contain material germane to and adequate for understanding the analysis that is to follow. I have not presented the minutiae of details of excavation, nor have I attempted a microanalysis of these sites.

During the period of field work, the lower portion of an interfluve that extends into the Noreikora Swamp, six km south of Aiyura and one and one-half km south of Aupora village, an area which lies from ten m to twenty m above the present swamp level, was either under cultivation or the locus of two hamlets, Abaora and Karamurora, approximately 150 m apart. Cultural material was spread over an area of approximately 6500 square meters. In June 1967, excavations were begun in the area, which is referred to as a "site complex" in the field notes; in the ensuing months three sections, which Cole considered to be separate sites, were partially excavated. I follow Cole's designations.

Cultural material was collected from the surface of the interfluve on several occasions prior to its selection for excavation, as well as during the excavation period. The exact location of much of this surface material relative to the three excavated sites is not recorded in the field notes and has not, therefore, been included in the three assemblages, although it was used in classificatory procedures. The bulk of the artifacts assignable to the general area only are chipped stone tools and detritus. In addition, there are pottery fragments; adzes; one perforated, thick stone disc (fig. 1); one fragment of perforated, thin stone disc (fig. 2a); one stone disc with double depression (fig. 3b); one fragment of a stone disc (whether perfor-

5. In labeling these rocks in the laboratory I did, of course, assign designations: T for Tairora (they are all from Tairora territory, most of them from North Tairora) with sequential use of lower case letters, thus Ta, Tb . . . Taa, Tab . . . Tba, Tbb. Moreover, when I applied labels to over twenty thousand pieces of rock from surface-collected and excavated sites which had not been labeled in the field (Cole labeled only those pieces of rock which he considered to be "artifacts"), in the interest of time I abbreviated TAI to T, AUY to A, AWA to AW, and FORE to F.

Fig. 1. Thick stone disc fragment, NFB/1885

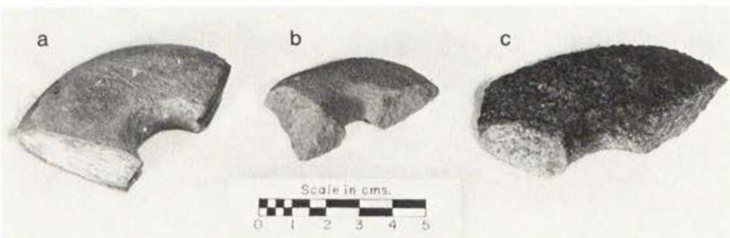


Fig. 2. Fragments of thin stone discs or rings. (a) NFA/219, 1s; (b) Tat; (c) NHN/110 (has been burned)

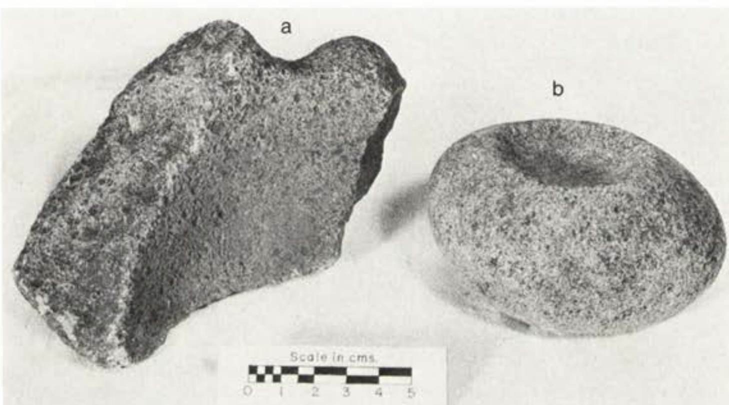


Fig. 3. (a) Fragment of stone mortar, NFB/1344; (b) stone disc with double depression, NFB/225, 1s

Fig. 4. (a) Fragment of stone disc, NFB/1880; (b) fragment of perforated club head, NFB/ME 803/b (has been burned); (c) fragment of perforated stone disc, NFD/105

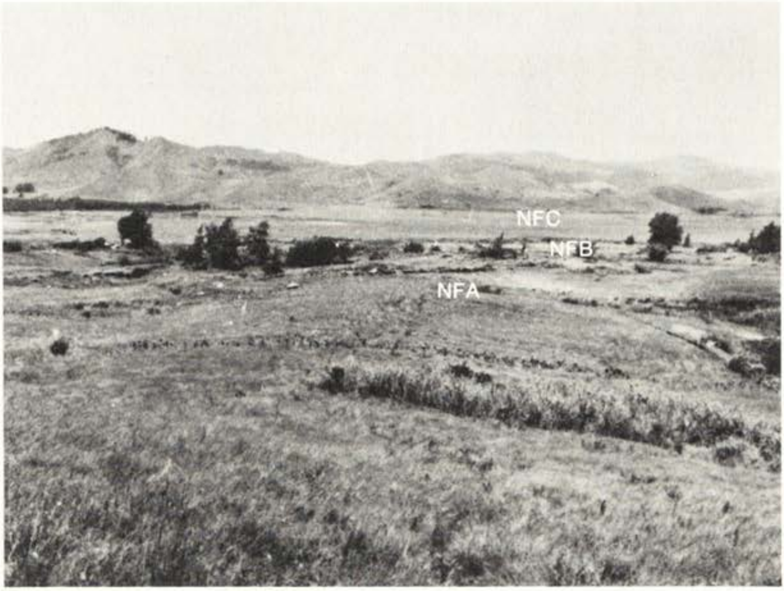


Fig. 5. View of sites NFA, NFB, and NFC (crest of hill obscures view of NFC)

ated or merely containing depressions is not determinable) (fig. 4a); and one fragment of stone, possibly of a club head (ME 817).

NFA

NFA is an open site located northeast of NFB at the western edge of the contemporary village of Abaora, 6° 24′ S, 145° 54′ E, 1650 m asl (see fig. 5). The surface of the site contained large numbers of volcanic rocks, some of them heat-fractured, which apparently had been turned up by recent excavations for garden ditches or removed from the soil during other gardening operations. Previously used garden ditches constituted further surface disturbance of the area.

Three units, each three meters square, were excavated to the culturally sterile humic gley horizon. In the clay loam, underlying a thin layer of topsoil and extending into the hard limonitic layer, were three features, three roughly circular pits.[6] Feature 1, the most complete pit, measured 88 cm by 86 cm and contained 6.5 kg of fire-cracked rock and charcoal fragments mixed with the soil (fig. 6). Feature 2, a second pit, only part of which lay in the northeast portion of excavated unit 3N18W, measured 38 cm by 16 cm and contained 14 kg of fire-cracked rocks and charcoal fragments mixed in the soil (fig. 7). There were also 1.5 kg of fire-cracked rocks scattered throughout this excavation unit at the level of the pit. Fea-

6. The term "feature" is here used to indicate nonportable artifacts.

Fig. 6. Feature 1, earth oven, type N, in unit 3N18W, NFA

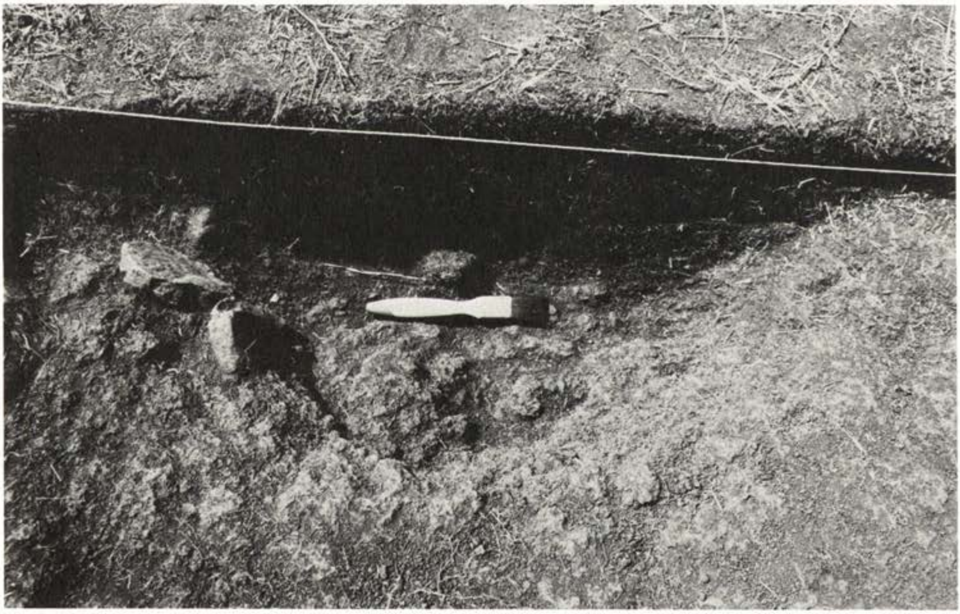


Fig. 7. Feature 2, partially excavated earth oven, type N, in unit 3N18W, NFA

ture 3, in unit 3N27W, was a similar circular depression measuring 72 cm by 60 cm and containing 500 gm of fire-cracked rock. In addition, 5 kg of fire-cracked rock were scattered around and on the outside of this feature. These three pits have been interpreted as type N earth ovens. Five pottery fragments, chipping detritus, and thirty-three stone tools (see table 1) were also recovered.

NFB

NFB is located 6°24′ S, 145°54′ E, southwest of NFA and 100 m northwest of NFC on the interfluve which projects into the Noreikora Swamp (see fig. 5). The cover is grass with gardens adjacent and heavy stands of reeds in the nearby swamp; forest is distant. At the risk of oversimplification, the soil profile generally can be characterized as consisting of a top horizon of fine soil, gray to gray-brown in color, powdery to compact, underlain by well-structured clay loam containing fine concretions, in which occur lenses of clay. This is underlain by highly limonitic soil much of which is a very hard lateritic crust, lying on humic gley (see fig. 8). Furthermore, the aggregate clay loam horizon varies rather markedly in thickness from one part of the site to another; there is often no neat demarcation between horizons but rather a thin mixed layer intervening; the configuration of the lenses of clay soil is complex; the situation in some areas of the site is exacerbated by intrusive features, particularly those resulting from fairly recent use; and in some sections of the site culture-bearing layers are very thin.[7]

Seventy-nine square meters were excavated over a period of one and one-half months (see figs. 9-11). Cultural material included chipping detritus and 480 stone tools (see table 1), as well as numerous other artifacts. The variety of artifacts and features from NFB is appreciably greater than that from any other site of the study (see table 2). I am able to recognize three components at NFB; I shall describe them, as well as the features which I am unable to relate precisely to any of the three components, with suggestions for their possible assignment.[8]

Component 1

Post-European contact occupation of the site is indicated by both features and artifacts. A fence (feature 1) at the western edge of the site

7. NFB is a complex site. I provide the best description I can with the time and resources at my disposal, but I make no pretense of having undertaken a microanalysis of the site—something which perhaps only the excavators can accomplish. I describe what I consider to be the major features of the site and attempt to relate them to each other. Although I feel that the general interpretation is reliable, I have been unable to integrate details from some very disturbed sections of the site with the whole, and some questions remain. I do not anticipate that they would substantially alter the interpretation presented here.

8. Component as used here refers to manifestations of a phase at a particular locality or site.

TABLE 1

Distribution of Stone Tools and Debitage in Assemblages Used in Quantitative Analysis

Site	Type																								Total Tools	Debitage
	IA1a	IA1b	IA1c	IA1d	IA2a	IA2b	IA2c	IA2d	IB1a	IB1c	IB1d	IB2a	IB2d	IE2d	IF1d	IIC3c	IIC3e	IIIB2a	IIIB2c	IIIB2d	IIIC3e	IIIC4e	IIIC5e	IVD6h		
NFA	12		2	7	4		1	4							1									2	33	278
NFB	147	9	35	94	99	14	2	47					1	3	1	6	7		2	2				11	480	5674
NFC	14		3	2	18			4						1	1						1			1	45	328
NFD	25		5	10	29		1	10						4	1									2	87	176
NFE	18			4	50	5	1	14	1	1		1		3						1					99	158
NFF	7	1		4	27	1		7						5	2										54	56
NFM	6			2	27	4	1	3			2			1	1										47	77
NFN	9		2	4	9	2		6						1	1									3	37	117
NFQ	5		2	3	13	1		7				1													32	19
NFT	9		2	5	20	1	3	3																	43	120
NFX	17		1	7	82	6	5	9					1	3	1						3				135	910
NGD	4		1	2	24	3		3						2											39	49
NGG	40	2	8	12	282	27	9	37		1			2	8	2						1				431	7583
NGH	2			1	29	9	1	2						3											47	58
NGI	12		2	6	40	5		2	1																68	186
NGS	5			3	21	1		6																	36	105
NGT	7		2	3	30	3		6	1		1			1											54	119
NHB	12			8	18	6		5														1		3	53	105
NHI	11			8	20	9	1	8			1		1							2				1	62	241
NHK	7		1	4	11	5	1	6			1		1												37	86
NHL	23	1	2	12	51	22	1	17	1					2						2	1	1		5	141	344
NHN	14	1	1	6	24	26		8							1						2	2	3	20	108	236
NHR	4		1	2	15	8		3						1								2	3	19	58	77
Total	410	14	70	209	943	158	27	217	4	2	5	2	6	38	12	6	7	0	2	7	8	6	6	67	2,226	17,102

TABLE 2

Distribution by Site of Cultural Material Other Than Identified Stone Tools

Site	Domestic: Pottery	House remains	Pig enclosure	Fence	Charcoal on ceiling	Hearth	Charcoal	Ash	Earth oven	Fire-cracked rock	Latrine
NFA	5						P		3	P	
NFB	304	1	1	2		2	P		7	P	
NFC	15	1				2	P		4	P	
NFD	2										
NFE											
NFH										P	
NFI					P			P			
NFJ										P	
NFL							P	P			
NFM		P						P			
NFN		P									
NFP		P									
NFQ		P				P					
NFR								P			
NFS							P	P			
NFV		1									

Site	Stone: Obsidian	Red ochre	Yellow ochre	Mica	Galena	Quartz crystal	Petrified wood	Stone with hematite	Stone bowl	Perforated stone disc	Stone club head	Stone nose plug
NFA												
NFB	22	14	2	1	1	16			2		2	
NFC												2
NFD										1		
NFE	1											
NFH												
NFI												
NFJ												
NFL												
NFM												
NFN												
NFP												
NFQ												
NFR												
NFS												
NFV												

Site	Fauna: Suid tooth	Tooth	Kapul tooth	*Rattus* bone	Suid bone	Bone
NFA						
NFB	7	2				9
NFC	11			1		115
NFD						
NFE						
NFH						
NFI			1			
NFJ	14					
NFL						
NFM						
NFN						2
NFP						
NFQ						
NFR						
NFS						
NFV						

Site	Flora: Ipomoea batatas	Cucurbit	Pandanus nut	Acorn	Unidentified nut	Kudzu vine	Reed	Bamboo	Live bamboo	Live dracaena	Bamboo tube	Organic debris	Unidentified fibre	Black palm arrow tip
NFA														
NFB		2	7			1	P							1
NFC	1													
NFD														
NFE														
NFH														
NFI												P		
NFJ														
NFL												P		
NFM									P					
NFN														
NFP									P	P				
NFQ														
NFR											P		P	
NFS												P		
NFV									P					

Site	Post-contact: Coffee	Mirror	Aluminum foil	Belt buckle	Nail	Stove bolt	Wire	Glass	Plastic	Art: Rock painting	Charcoal drawing
NFA											
NFB	3	1	1	1	1	1	2	14	2		
NFC											
NFD											
NFE											
NFH											
NFI											
NFJ											
NFL										P	P
NFM											
NFN											
NFP											
NFQ											
NFR											
NFS											
NFV											

NFX		3	1	P																					
NGG			2	P					1																
NGH			1	P						2															
NGJ				P																					
NGL							1																		
NGM		2	6	P	2					1			1		2										
NGN	1																								
NGT							1																		
NGU	4											1													
NGX		P																							
NGY														1		1	1	4	P	P	P		P		
NGZ	1	P																							
NHC		P			P		1																		
NHD																								P	P
NHE		P	P	P																					
NHG		1																							
NHI											1														
NHK								1			3														
NHL											1														
NHM		P				P																			
NHN		P	P		P	P																P			
NHP		P																							
NHR		4																							
NHS		P																							
NHU			P																						
NHW																								P	

NOTE: P = present (occurrence recorded in field notes but quantity not stipulated).

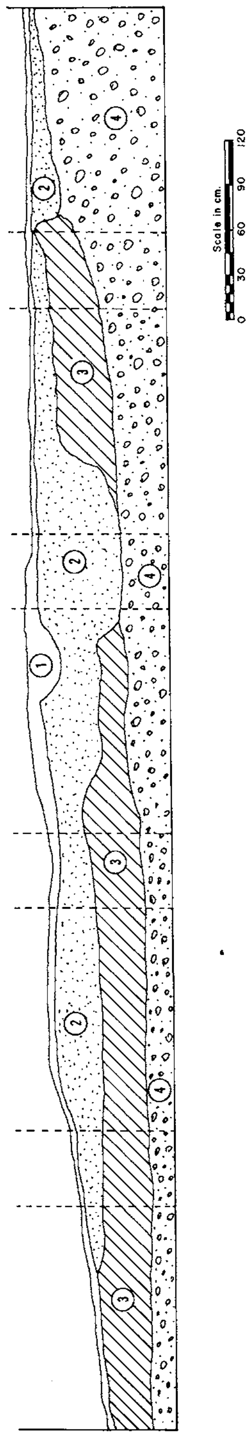


Fig. 8. Schematic diagram of soil profile at NFB. 1 = very fine topsoil; 2 = well-structured clay loam containing concretions; 3 = hard lateritic crust; 4 = humic gley

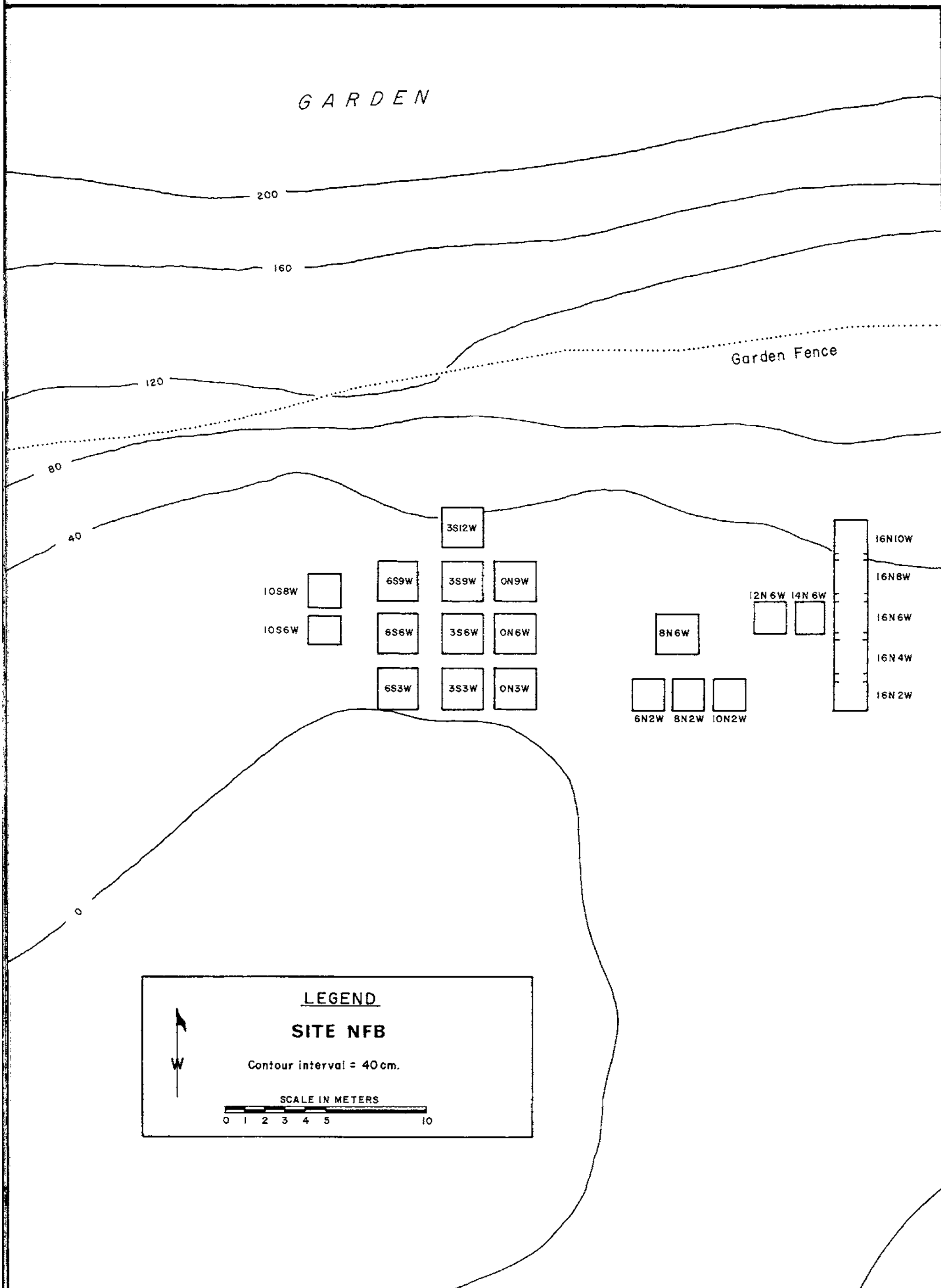


Fig. 9. Contour map showing excavated units at NFB

fringes contemporary gardens (see figs. 10, 11). At the edge of the excavated area there are surface indications of five houses (feature 2): circular, grass-covered depressions with occasional planklike posts protruding from the ground near the periphery.[9] They were not disturbed during the archeological work. Near these house indications are smaller depressions (feature 3), the walls of which have slumped and in which grass is growing. They were not excavated by the field party. In unit 10S6W, the bases of two rows of posts (feature 4) were intact, although the tops of most of them were broken off at, or disintegrated to, ground level. One row consisted of planklike posts alternating with dracaena stalks (fig. 12), the other consisted of round posts only. The two rows converged, but did not meet within the excavation unit. Each was at the same level as the other, however, suggesting their contemporaneity. A row of "post" remains (feature 5) was found oriented north-south in unit 8N6W. It consisted of from two to six reeds in each "post" hole. A row of similar groupings (feature 6) of from two to six reeds in one hole, east-west orientation, was found in unit 16N4W (fig. 13).

With one exception, all of the indubitably post-European contact artifacts (see table 2) were found on the surface of the ground or within a few centimeters of it in a "layer of tilth" which the field notes refer to as "a mixture of sweepings from the recent houses above the site and the breakdown of the [clay loam] by wind, water and pedestrian erosion." The single exception is a stove bolt found at a depth of 20.8 cm in unit 10S6W in a highly disturbed section of the site, immediately below feature 4, a fence. Chipping detritus and thirty-three stone tools (see tables 1 and 3), seventeen fragments of pottery, and one fragment each of what are inferred to be two abraded club heads (figs. 4b, 14a) complete the list of artifacts.[10]

Contemporary inhabitants of the nearby villages of Abaora and Karamurora, some of whom cultivate the gardens adjacent to the site, reported that the five houses (feature 2) were built about 1945, the grass-covered depressions near the houses (feature 3) were the remains of earth ovens used in the recent past, the post remains in unit 10S6W (feature 4) had in the fairly recent past been segments of two walls of a pig enclosure, and the reed remains in longitudinal alignments in unit 8N6W and unit 16N4W (features 5 and 6) were the remains of two sides of a single fence. One informant indicated that he had used one of the club-head fragments as a stone in an earth oven (fig. 4b) and later discarded it.

9. The "planklike posts" are rough-hewn stakes, elliptical in cross sections, which resemble "planks."

10. The stone tools include three type IVD6f tools definitely assignable to this component.

TABLE 3
DISTRIBUTION OF SOME UNIFACIALLY CHIPPED STONE TOOLS, WHETSTONES, ADZES, AND POTTERY AT NFB BY COMPONENT*

Artifacts	Component 1		Component 2		Component 3	
	No.	%	No.	%	No.	%
Stone tools						
IA1a	7	26	76	43	2	14
IA1b	1	4	2	1	0	0
IA1c	2	7	18	11	0	0
IA1d	6	22	34	19	0	0
IA2a	8	30	30	17	9	64
IA2b	0	0	6	3	0	0
IA2d	3	11	13	7	2	14
IE2d	0	0	0	0	1	7
IIC3c	0		6		0	
IIC3e	3		2		0	
IVD6f	3		8		0	
Pottery						
P	1	6	8	6	0	0
Q	11	65	98	78	0	0
R	3	18	11	9	0	0
S	2	12	9	7	0	0

* Artifacts not assignable to components are not included.

Component 2

A grouping of artifacts and features in horizontal and vertical association with each other in the site make up component 2.[11] Rows of post holes (feature 7) appearing in four adjacent (but not adjoining) excavation units suggest a circular structure, house 1 (fig. 15) (neither the eastern part of the house nor the area immediately to the east of it was excavated). The posts varied in size with a tendency to alternate posts of different sizes (figs. 16, 17). The notes indicate that a "bedding channel" was apparently first excavated in the clay loam and the posts were placed in this, penetrating the underlying lateritic crust (figs 16-18). Four single post holes, each one located approximately 50 cm to 100 cm outside of the wall line, suggest eaves supports. Inside of the house are two lines of post holes in unit 6S3W, which may indicate partitions of some sort. The soil inside of the house is darker than that outside, and there are small bits of charcoal scattered through much of it. In unit 6S6W there is evidence of a longitudinal depression (feature 8) outside of the house which may indicate a channel to catch run-off from the roof. The bulk of the cultural material, other than post indications and the ditch, was found adjacent to the house on the fairly level area to the northwest and west, between it and the slope to the swamp.

11. Only two of the eight type IVD6f tools display definitive modes of the type; the others are inferred class members because of morphological similarity.

Fig. 10. Northern part of main excavation at NFB, facing west. Feature 16, monolith, on left; units 6N2W, 8N2W, and 10N2W in foreground, left to right

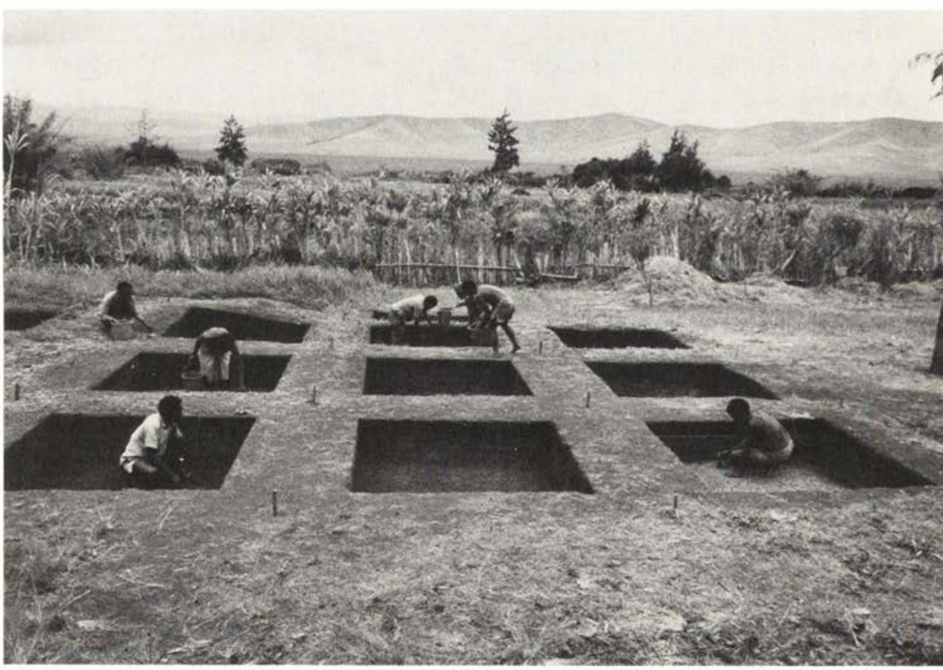


Fig. 11. Southern portion of excavation at NFB, facing west. Feature 16, monolith, on right; units 6S3W, 3S3W, and 0N3W in foreground, left to right

Fig. 12. Feature 4, partial, posts of pig fence, in unit 10S6W, NFB, facing south

Fig. 13. Feature 6, reeds and hole remains, fence, in unit 16N4W, NFB

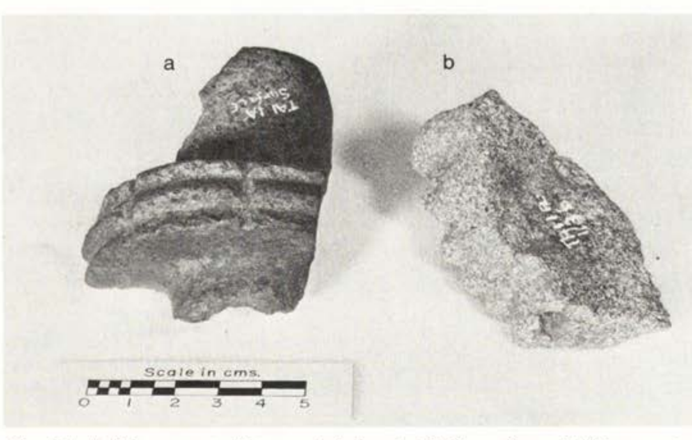


Fig. 14. (a) Fragment of stone club head, NFB, surface; (b) fragment of stone bowl (club head?), NFB/1136

Other features include a hearth of type F (feature 9) in unit 0N3W, outside the post line, measuring 44 cm by 46 cm and 13 cm deep, described as "basically a bowl-shaped depression packed with charcoal"; a feature (10) in unit 0N6W identified as a hearth of type D; and a pit (feature 11) in unit 0N9W which measured 52 cm in diameter and contained seven rocks weighing 5.09 kg, identified as an earth oven pit of type N. Three pits, less well preserved than this one, are tentatively identified as earth oven pits of type N: a second pit (feature 12) in unit 0N9W, 40 cm in diameter and containing three stones weighing 0.7 kg; a pit (feature 13) in unit 6S6W, 80 cm in diameter, containing fifty-one stones weighing 13.5 kg (fig. 18); and a pit (feature 14) in unit 6S9W, approximately 76 cm in diameter, containing eleven stones weighing 3.17 kg. Portable artifacts include chipping detritus, 215 stone tools, and 126 pottery fragments (see table 3).

Component 3

The third component recognized is represented at deep levels in the trench from unit 16N6W to unit 16N10W. There are no post-European contact materials, no structural remains, no earth oven pits, no hearths, no pottery, and no adzes. Cultural material includes two stone artifacts—one inferred to be a fragment of a mortar, the other probably a fragment of the rim of a bowl but possibly a club head (figs. 3a, 14b)—which were found within two meters of each other in similar-type soil at roughly the same depth, 71 cm to 77 cm. Sparse chipping detritus and fourteen stone tools (see table 3) complete the artifact list. In unit 6S6W, under the level of the house, is a circular hearth (feature 15). Although rocks are present, their configuration or placement is not clear from the notes; so although it is possible the hearth was stone outlined, it cannot be stated with certainty. I am tentatively identifying the hearth as type E and, on the basis of this and the radiometric determination of charcoal from within it, placing it in component 3.

Features Not Assigned to Components

Nine additional features can be described, but it is difficult for me to place them in secure relationship to the three components just discussed or to each other. A large, roughly rectangular, upright-standing piece of rock (a monolith) (feature 16) is located in unexcavated square 4N6W. Its top is approximately 1.5 m above the surface of the ground (figs. 10, 11).[12] In unit 0N9W, three features are suggested, although the notes are sketchy: a pit (feature 17) measuring 40 cm in diameter and containing three rocks weighing 0.7 kg, inferred to be a type N earth oven; a few post

12. It is not unlike monoliths which I have seen (1963) in one Tairora village, Abiera (Untoa), and on the top of a grass-covered ridge east of Abiera, 100 m from the Tairora hamlet of Araubara (in the latter case the monolith was surrounded by a small fence consisting of poles, reeds, and dracaena.)

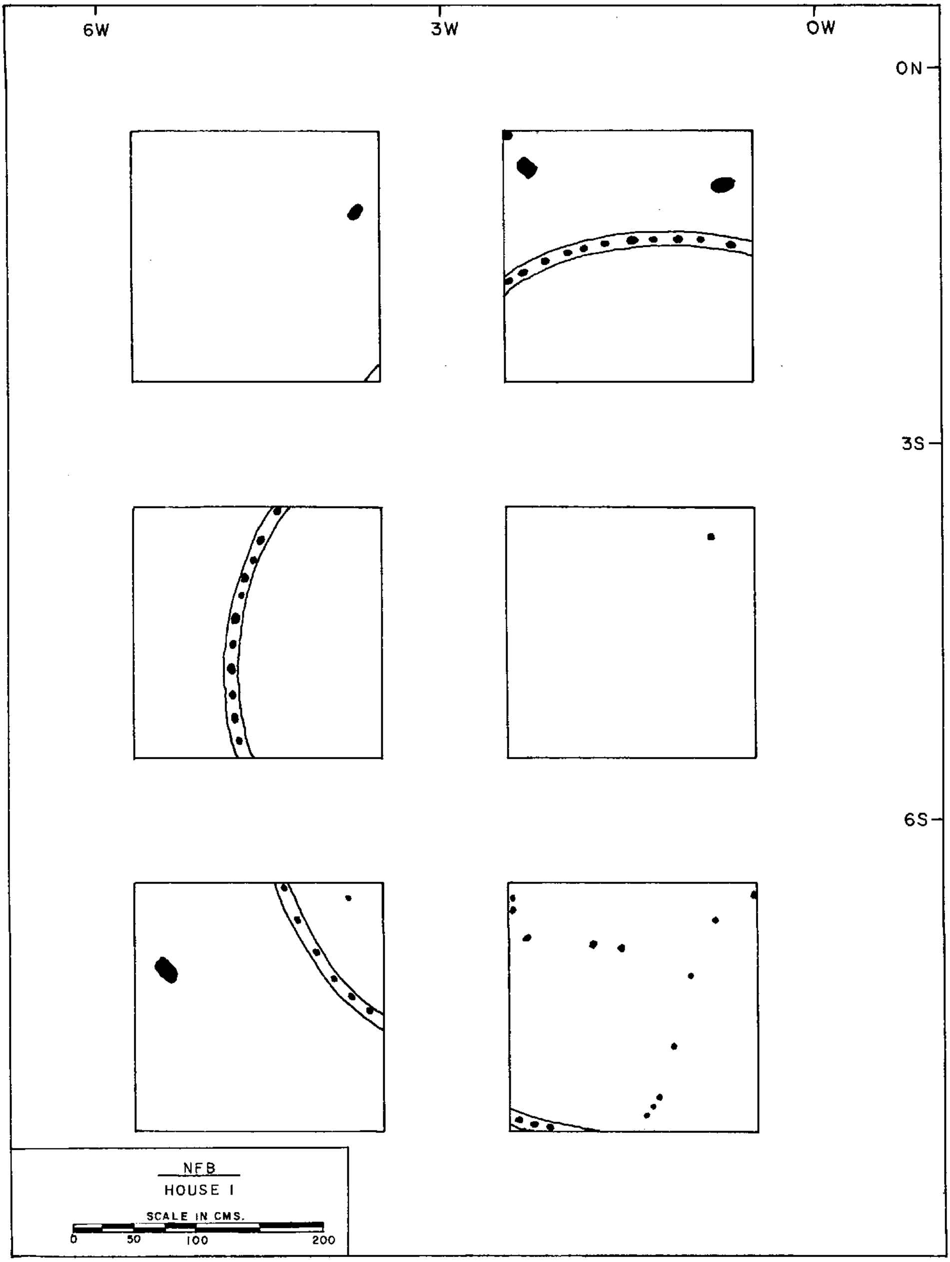


Fig. 15. Plan of excavated segments of house 1 at NFB

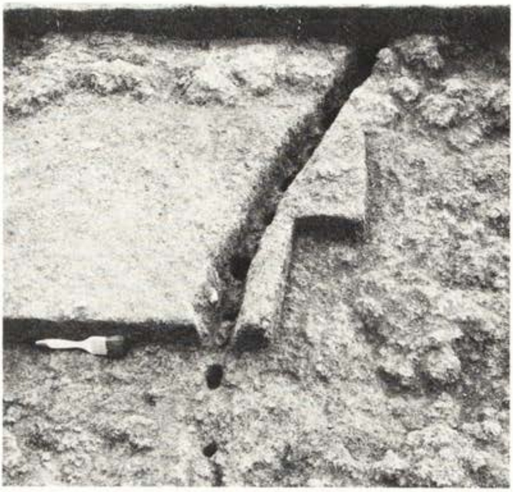


Fig. 16. Feature 7, post holes and "bedding channel," in unit 3S6W, NFB (channel removed around two holes in foreground)

Fig. 17. Feature 7, post holes and "bedding channel," in unit 0N3W, NFB. Note also hole near northwest corner of unit, possible eaves support

Fig. 18. On the right, feature 7, "bedding channel" in which post holes occur, in unit 6S6W, NFB. On the left is feature 13, a type N earth oven

Fig. 19. Cross section of feature 21, a type N earth oven, in north wall of unit 16N6W, NFB

holes (feature 18) apparently underlying the level of the earth oven pit; and a possible hearth (feature 19). On the west wall of unit 16N10W is a series of five post holes 30 cm deep with post butts still intact (feature 20), extending from the surface of the site into the lateritic crust but not completely penetrating it. Just to the west of this is an area which appears to have been intentionally leveled. No further excavations were made here. On the north wall of excavation unit 16N6W are the remains of an earth oven pit (feature 21), type N (fig. 19), which is 60 cm in diameter and 20 cm deep. It is intrusive from near the surface of the site and is filled with a mixture of topsoil and clay loam. Excavation unit 38N2W, one of two squares excavated at the far northern end of NFB, contains the possible remains of an earth oven pit (feature 22) exposed in one corner of the unit. Type N is suggested. In unit 0N3W there is evidence of a longitudinal depression aligned in a north-south direction (feature 23). Two post holes (5 and 6 from west wall of unit 0N3W) and part of a third (4 from west wall of unit) of house 1 (see fig. 15) penetrated the soil in what the notes refer to as a "ditch or drain" which measures approximately 23 cm in width at the level of the top of the post holes. The evidence suggests that the depression antedated the house, although the two are probably not widely separated. In fact, the notes I have are incomplete—either they were not completed or some are missing—and the actual excavation of the "drain" is not recorded. There is no evidence of a similar feature in adjacent excavated units to the north or south.

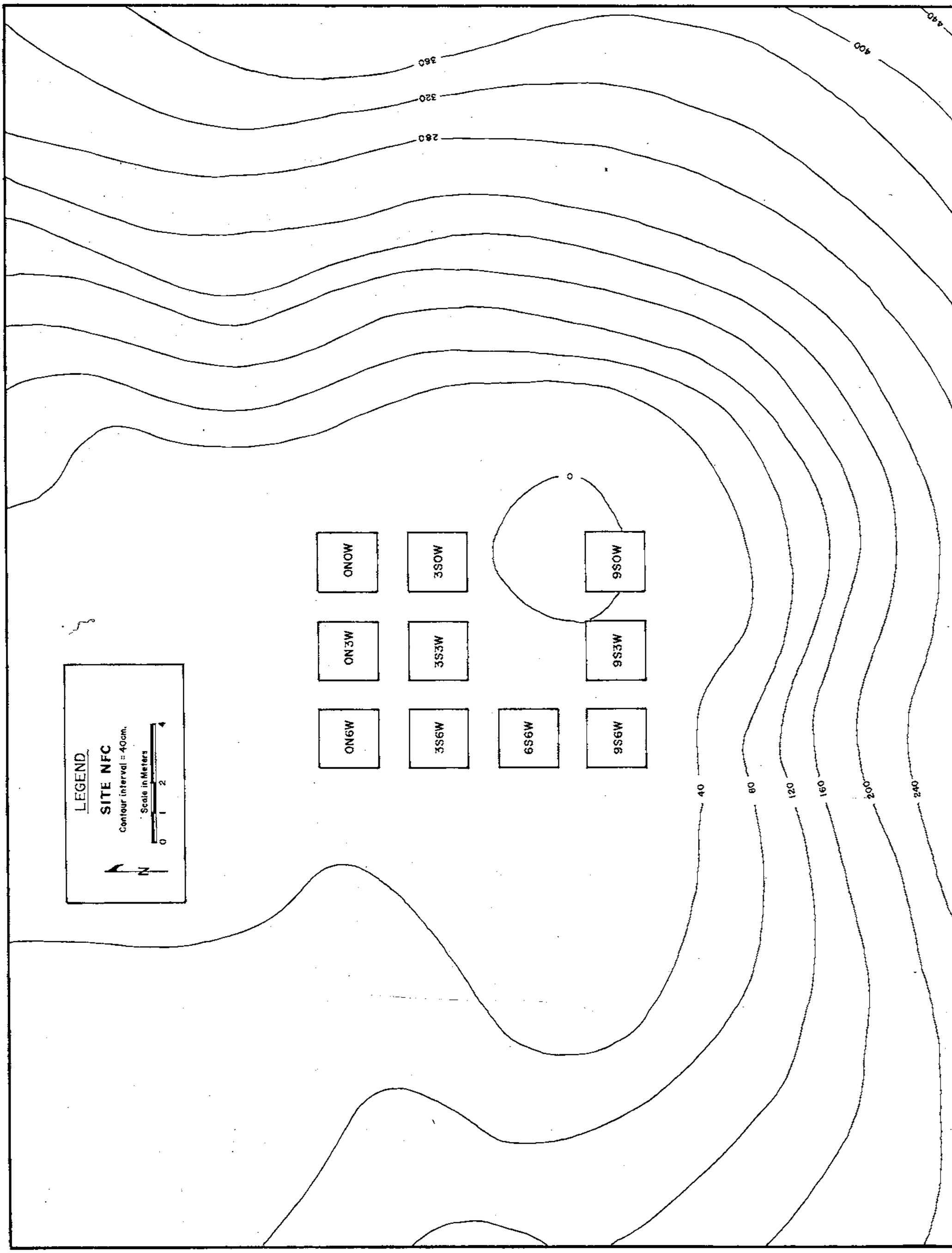


Fig. 20. Contour map showing excavated units at NFC

Although I am unable to make a definite assignment of these features to one or the other component delineated, I would suggest that: 16 may well belong to component 1, possibly also to component 2; 20 may well belong to component 1; 17, 18, 19, and 23 may well belong to component 2; and 21 and 22 probably belong to either component 1 or component 2.

NFC

NFC is located approximately 100 m southeast of NFB on a small spur of ground near the base of the interfluve on which NFA and NFB are located (see fig. 5). The soil consists of a horizon of highly organic, black topsoil over a horizon of well-structured clay loam, which in turn overlies a dense, compacted clay loam, itself overlying humic gley. The field notes indicate the existence of "evidence for land slips which increased the depth of the top soil and thinned out the [clay loam]" and noted that much of the topsoil and some of the clay loam had been removed at some time prior to occupation of the area. Further disturbance on the northern edge of the area was a result of recent gardening activities. Forty-one square meters were excavated in four-meter-square units with fifty-centimeter balks between, one of which, 0N6W-3S6W, was removed (see figs. 20, 21).

Artifacts recovered include chipping detritus and forty-five stone tools (see table 1); six teeth identified as suid; two teeth, probably suid; one fragment of a suid maxilla with three teeth intact; one mandible fragment identified as *Rattus*; fifteen bone fragments (unidentifiable); fragments of charred sweet potato (*Ipomoea batatas*); fifteen pottery fragments; and two fragments of whitish stone, 9 mm and 8 mm in diameter, respectively, apparently shaped by abrading and resembling stone nose plugs worn in recent time. (See appendix 6 for petrographic analysis.)

Nine features were encountered at NFC. Four of them, numbers 1-4, have been interpreted as earth oven pits. Feature 1 was 88 cm in diameter, 74 cm in depth, and contained 168 rocks weighing 35 kg which were lying on the bottom of the pit, as well as a "large" sample of charcoal. Feature 2, 16 cm distance from the first, in the same excavation unit, was 52 cm in diameter, 61.3 cm in depth, and contained rocks which weighed 2.03 kg as well as some charcoal. Feature 3, in a different excavation unit, 0N6W, was 64 cm in diameter, 89.3 cm deep, and contained 6.9 kg of rocks, some charcoal, charred wood, and chipping detritus. Feature 4, in balk 0N6W-3S6W, was approximately 60 cm in diameter and 63 cm in depth. All four pits are identified as type M earth oven pits. They are shown in figures 21 and 22.

Features 5 and 6 were areas of fire-burned earth with charcoal through and on each one. Feature 5 measured 64 cm by 32 cm, and feature 6 measured 52 cm by 40 cm. Fragments of charred sweet potato and a piece of charred bone (unidentifiable) were found in feature 5. Two rocks

Fig. 21. Site NFC looking southeast. From left to right are features 3, 4, 2, and 1, type M earth ovens; excavation unit 0N6W is in foreground

Fig. 22. Feature 3, earth oven, type M, in unit 0N6W, NFC

weighing 1.5 kg lay at one edge of the smaller feature 6. Features 5 and 6 are identified as type C hearths.

Feature 7, an accumulation of ash "in a heap," in the southeastern quadrant of unit 9S6W, was accompanied by dense chipping detritus and two fragments of unidentifiable bone.

Feature 8 consisted of seven post holes in excavation unit 9S3W. The cross sections of four of them suggest planklike posts, elliptical in cross section, the tapered butt end being represented by the hole; cross sections of the other three post holes are circular. The disposition of the holes in the unit suggests a circular structure. A single circular post hole, 40 cm from the projected row of house post holes, is placed in a position which might have served as support for an overhanging roof. Feature 9 is "the clearly defined embankment, which extends around the lower end of the site and continues as a high embankment on the upper side." This embankment suggests the configuration that results from leveling a sloping surface. These last two features together imply a structure of considerable size. If the row of what is inferred to be indications of house posts is extended, the squares which include the earth oven pits and the bulk of the cultural material all lie immediately outside of the structure to the west and northwest; only two stone tools were found inside the house.

NFX

NFX is an open site on the lower of two steplike spurs at the foot of a steep lateral ridge, located at 6°39′ S, 146°00′ E, 1550 m asl (300 m below contemporary villages in the area), in the valley of the Malaria River, a tributary of the Lamari River (see fig. 23). The site is approximately 200 m north of the river and 25 m above it. The total site area is approximately 225 square meters. The cover is grass; the nearest forest is approximately 5 km from the site. The soil profile includes a black organic horizon from 15 cm to 35 cm thick, overlying a zone of clay loam aggregate with concretions, which in turn overlies humic gley (see fig. 24). It is similar to soil profiles at sites NGG, NGH, and NGJ, except that the black organic horizon is less organic, the clay loam aggregate is sometimes absent, and when it does occur, the texture, nodule size, color, and degree of weathering of the clay loam display more varied composition than at the three northern sites.

During a period of one month, fifty-five square meters were excavated in both one-meter-square units and four-meter-square units (see fig. 25). Portable cultural material was concentrated in one level, 1 to 2 cm in thickness, usually lying on, or slightly within, the clay loam aggregate. Chipping detritus and 135 stone tools (see table 1) were collected mainly from the excavations, some from the surface of the road which crossed the site. Feature 1 is a type E hearth containing charcoal fragments (fig. 26).

Three features composed of numerous small post holes are interpreted

Fig. 23. View of NFX looking south

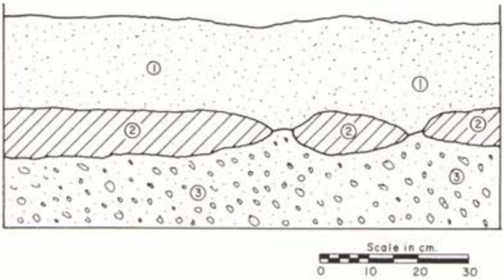


Fig. 24. Schematic diagram of soil profile at NFX. 1 = humus; 2 = well-structured clay loam; 3 = humic gley

in the field notes and reports as representing house remains. With incomplete data and my not having seen the excavations, it is difficult for me to confirm that interpretation, although it seems reasonable. I am thus accepting these as house remains even though I realize that future work may prove this to be in error. (I shall not always repeat this qualification in future discussion.) Generally, a house outline is indicated by roughly parallel rows (often three to four) of post holes that measure approximately 50 cm to 65 cm from inner to outer row. The spacing of the holes is uneven, and it is often difficult (for me, at least) to determine the exact alignments of the holes in a row. This problem occurs, for example, in figure 27, the schematic diagram which Cole prepared of feature 2, house 1 (post holes

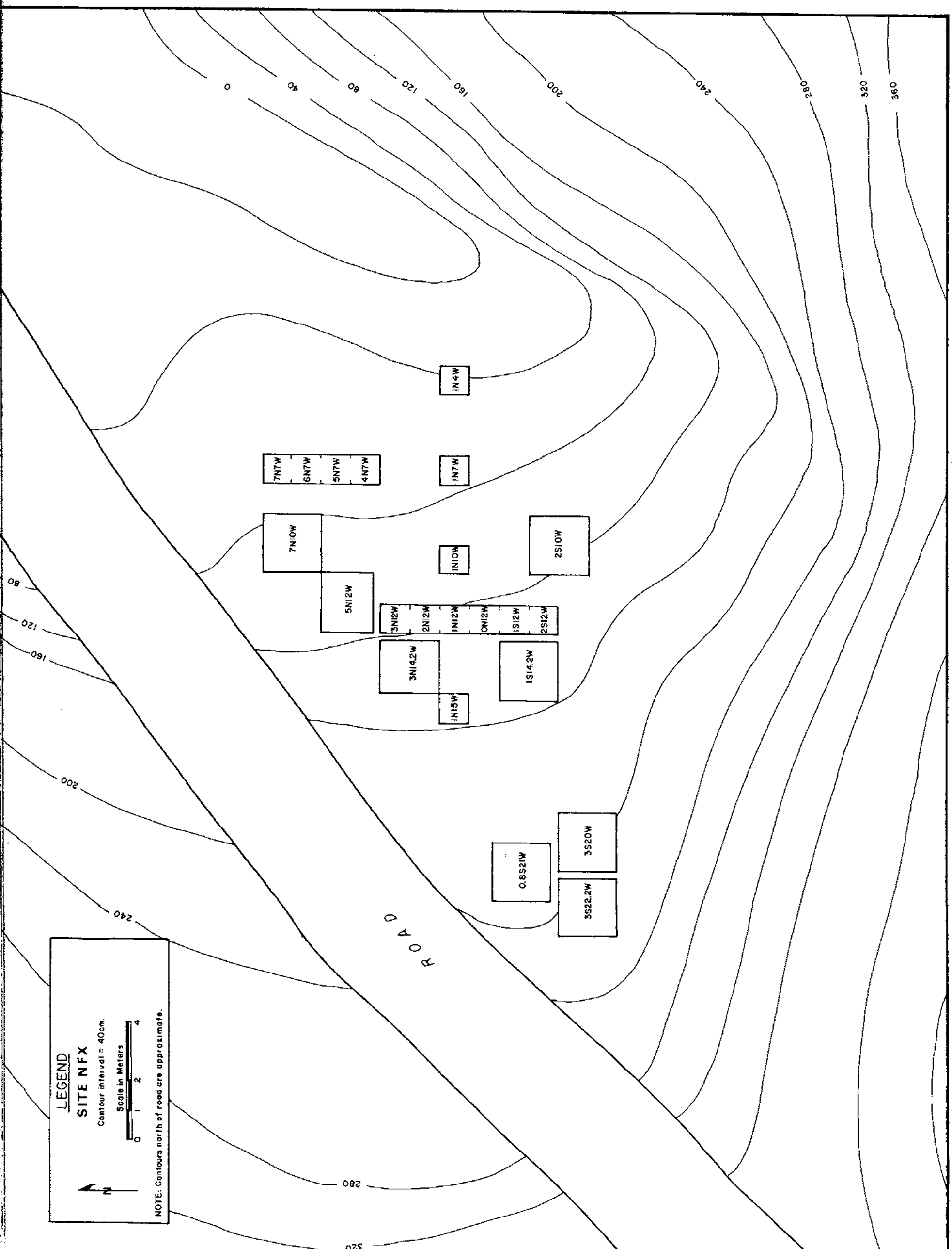


Fig. 25. Contour map showing excavated units at NFX

Fig. 26. Feature 1, type E hearth, in unit 1N12W, NFX

are not to scale). If one draws lines through certain holes, an oval configuration is generally evident. From the photograph of house 3, in figures 28 and 29 (before and after excavation), the indication of parallel rows of post holes is also present. Some holes are roughly circular in plan, others tend to be triangular or elliptical (figures 29, 30). The holes range in diameter from 3 to 5 cm and extend from the occupation level, the level at which the majority of the artifacts were recovered, into the clay loam to a depth ranging from 6 to 8 cm. Mineralized charcoal fragments were found in some of the holes, and in all of the holes the texture and color of the soil within them was distinctly different from that surrounding them. In "more than one instance" there was a "pinching out" of the clay loam which "coincides with the placement of the holes as if the [clay loam] had been removed before implanting the posts." Interpretation is made more difficult by the fact that none of the structures was completely excavated.

On the premise that these are houses, further description can be given. House 1 is oval in configuration and measures roughly 4 m by 7 m. A break in the northeast wall is suggested by the lack of post holes in sections of unit 2N12W and unit 3N12W (see fig. 27). A hearth (feature 1) is located near the area devoid of post holes (figs. 26, 27). An oval configuration is also indicated for house 2 (portions excavated in units 5N12W and 7N10W), although it may have been somewhat smaller than house 1—less of it was excavated in any event. House 3 (portions excavated in units

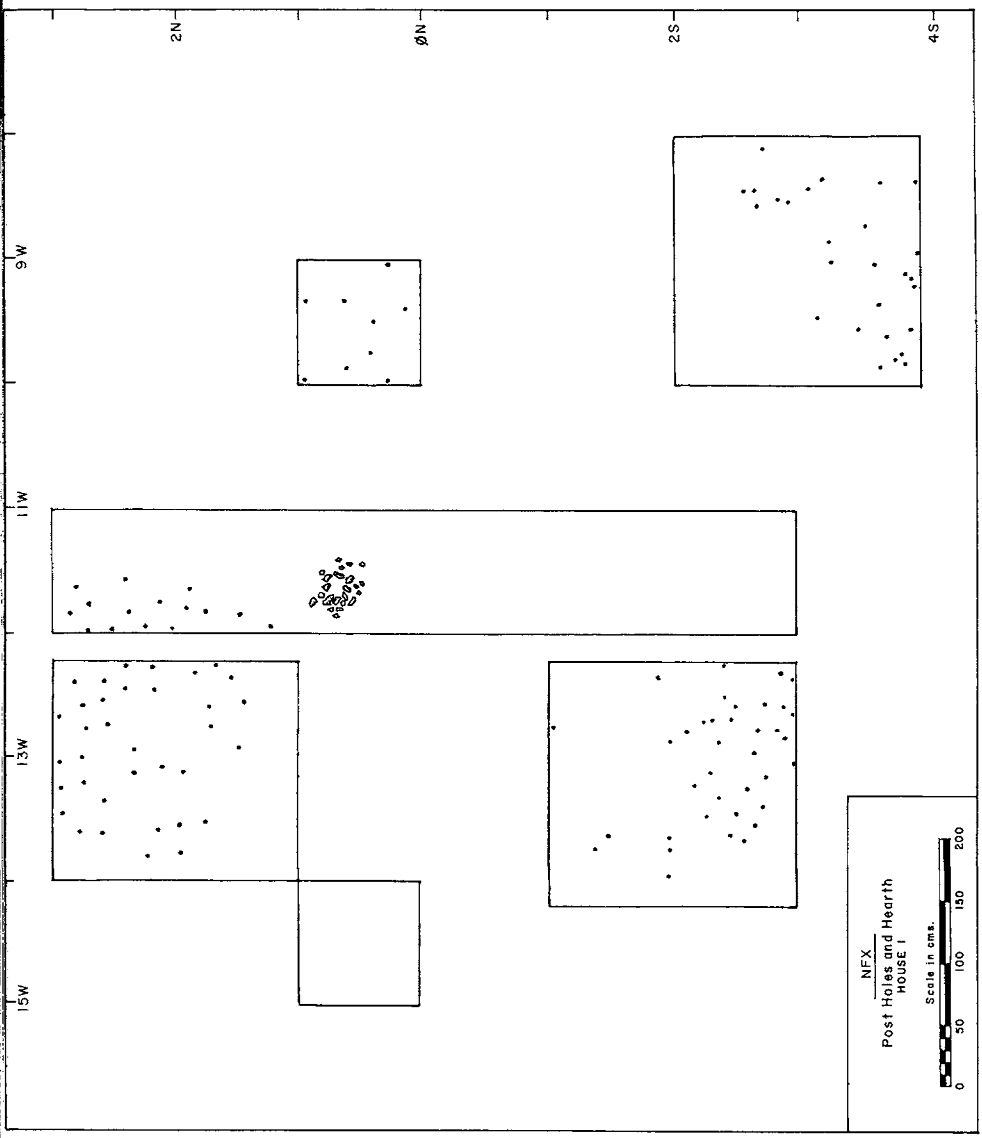


Fig. 27. Post hole pattern and hearth (type E) of house 1 (type L), at NFX (post holes not to scale)

3S22.2W and 3S20W) also may have been oval, and I am tentatively accepting it as such, although the amount excavated and the larger number of supernumerary holes make assessment of its shape difficult. All three houses have been identified as type I.[13] Figure 28 shows the contrasting appearance of the hole indications in unit 3S20W before excavation. The excavated holes in units 3S20W and 7N10W are shown in figures 29 and 30.

Interpreting this site from the field notes is rather difficult. Seventy-five percent of the excavated stone tools were retrieved from the three excavation units in the southwestern section of the site, the majority in a fairly narrow horizontal stratum. Twenty-five percent of the excavated stone tools were scattered in the eastern section of the site, the majority in the units at longitude 12W. NFX is apparently a site in which it was generally difficult to determine the full depth of the post holes and to discriminate soil differences. The supernumerary post holes found in all excavated sections of the site and the distribution of artifacts suggest that the site was occupied more than once, although it is impossible for me to clearly delineate this from the notes. Indeterminate circumstances such as possibly the practice of clearing the ground to more or less the same level before an occupation may be extenuating factors in a proper interpretation of the stratigraphy.[14] The radiocarbon dates confirm multiple use of the site (see table 16).

NGG

NGG is an open site located at 6° 25′ S, 145° 50′ E, 1680 m asl, 2 km southeast of Bontaa at a locale the Tairora call Baritabara. The site is located on an interfluve about 40 m above a tributary of Tairora Creek, a minor tributary of the Ramu River. The Kainantu–Noreikora road bisects the site, which is estimated to cover an area of 360 square meters. The cover of the site is grass; forest is several kilometers distant (see fig. 31). The soil profile (fig. 32) consists primarily of a heavy, black organic horizon which varies from 15 to 40 cm in depth, below which is a zone of well-structured clay loam containing small concretions (the water-soluble peds diminish in size with greater depth), under which is a basal stratum of bluish white clay or humic gley. In some portions of the site the clay loam lies in thick lenses, the upper surfaces of which are regular and well defined, while the lower surfaces are very uneven, revealing in plan small patches of clay loam and in profile distinct pockets often extending more than 10 cm below the main body of the lens itself (fig. 33). In other sec-

13. In no way do these houses conform to the other house types present in the study area.

14. Bulmer (1973: 12), quite independently, has suggested for JAO that a "single soil formation may be associated with long term and even interrupted occupation."

Fig. 28. Stone tools and debitage, unit 3S20W, NFX. Note also spots of soil discoloration indicating more or less parallel rows of post holes (house 3)

Fig. 29. Unit 3S20W, NFX, after excavation of post holes, house 3

Fig. 30. Roughly parallel rows of post holes, house 2, in unit 7N10W, NFX

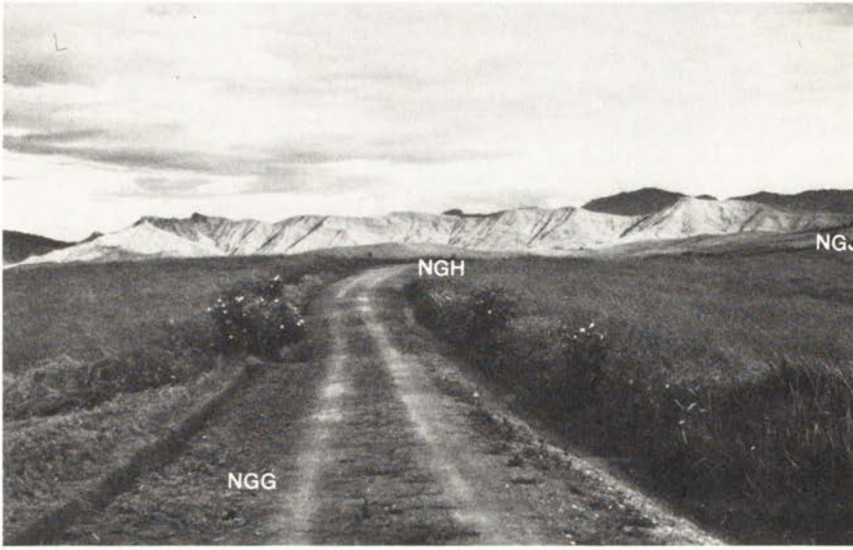


Fig. 31. View of NGG, NGH, and NGJ, looking northwest. Photo courtesy of Keith Weigel

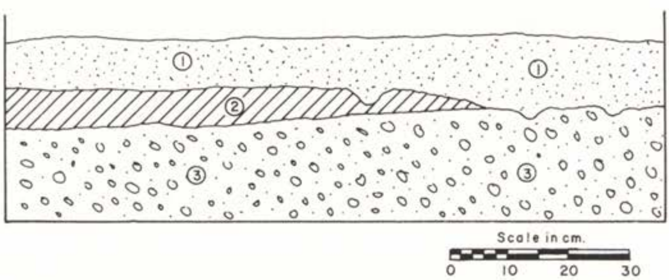


Fig. 32. Schematic diagram of soil profile at NGG. 1 = humus; 2 = well-structured clay loam with concretions; 3 = humic gley

tions of the site the clay loam occurs in these pockets only. In still other instances, pockets of humic gley interrupt the clay loam.

Forty-six square meters were excavated over a period of one month. The site was excavated during the rainy season, and a compromise between drainage and area to be covered resulted in a series of trenches excavated by one-meter increments (see figs. 34, 35). In addition, in an attempt to locate structural remains, an exploratory trench, 50 cm wide and 100 m long, was dug on a slope adjoining the site; no cultural material was found in this trench.

Chipping detritus and 431 stone tools (see table 1) were collected, most of them from the excavations, a few from the road cut and from the surface of the site. Excavated cultural material, especially stone tools, chipping detritus, and charcoal, were concentrated in one occupation level from 1 to 2 cm in thickness, which usually lay upon or within the clay loam de-

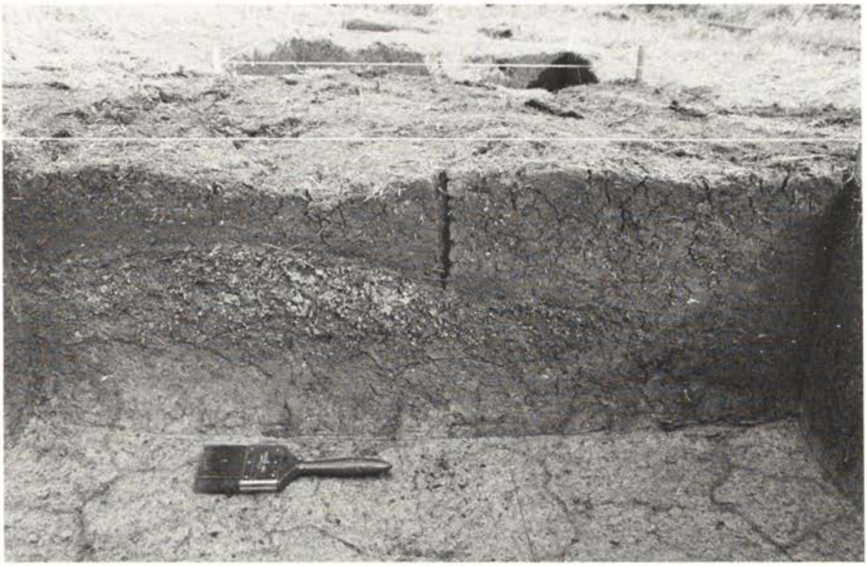


Fig. 33. Unit 0N20W, NGG. Note thick lens of well-structured aggregate, center left

scribed above or, rarely, lodged in the humic gley (see figs. 36, 37). The only other artifact is a piece of yellow ocher. Features include one hearth of type E in unit 1S2W (fig. 38) and another hearth, probably type E, in unit 6S13W. One set of features includes five piles of rocks, usually limonite or chert, none of which has charcoal or ash associated with it, three of which have artifacts or chipping detritus associated with them (fig. 38).[15] There is no sign of wear on the rocks to suggest possible activities in which they were involved. Around two of the piles there occurred both stone tools and chipping detritus, and in one of the piles the stones were resting on one another with chipping detritus wedged in between them and scattered around and under them. There were no indications of a cache. Judgment is deferred as to the use, purpose, or significance of these accumulations of rocks.[16]

15. The late Professor George W. Goodspeed reported that the limonite contains bits of quartz and that the rocks "look as if they had been moved while still fresh and less hard than at present" (personal communication).

16. Although there is no evidence in the notes to suggest cultural relevance, the occurrence of holes in one portion of the site should perhaps be mentioned. The largest of the holes measures 45 cm in diameter, although most of them are smaller; the range of depth is from 10 cm to 15 cm. The bottom of one of the holes was close to the clay loam horizon corresponding to the occupation level in those portions of the site where occupational evidence occurred. Cole interpreted these as natural bog holes associated with poor drainage. They are apparently common in the general area in which the site is located and seem to be most prevalent in areas containing whitish humic gley. Cole suggests comparing Haantjens 1965.

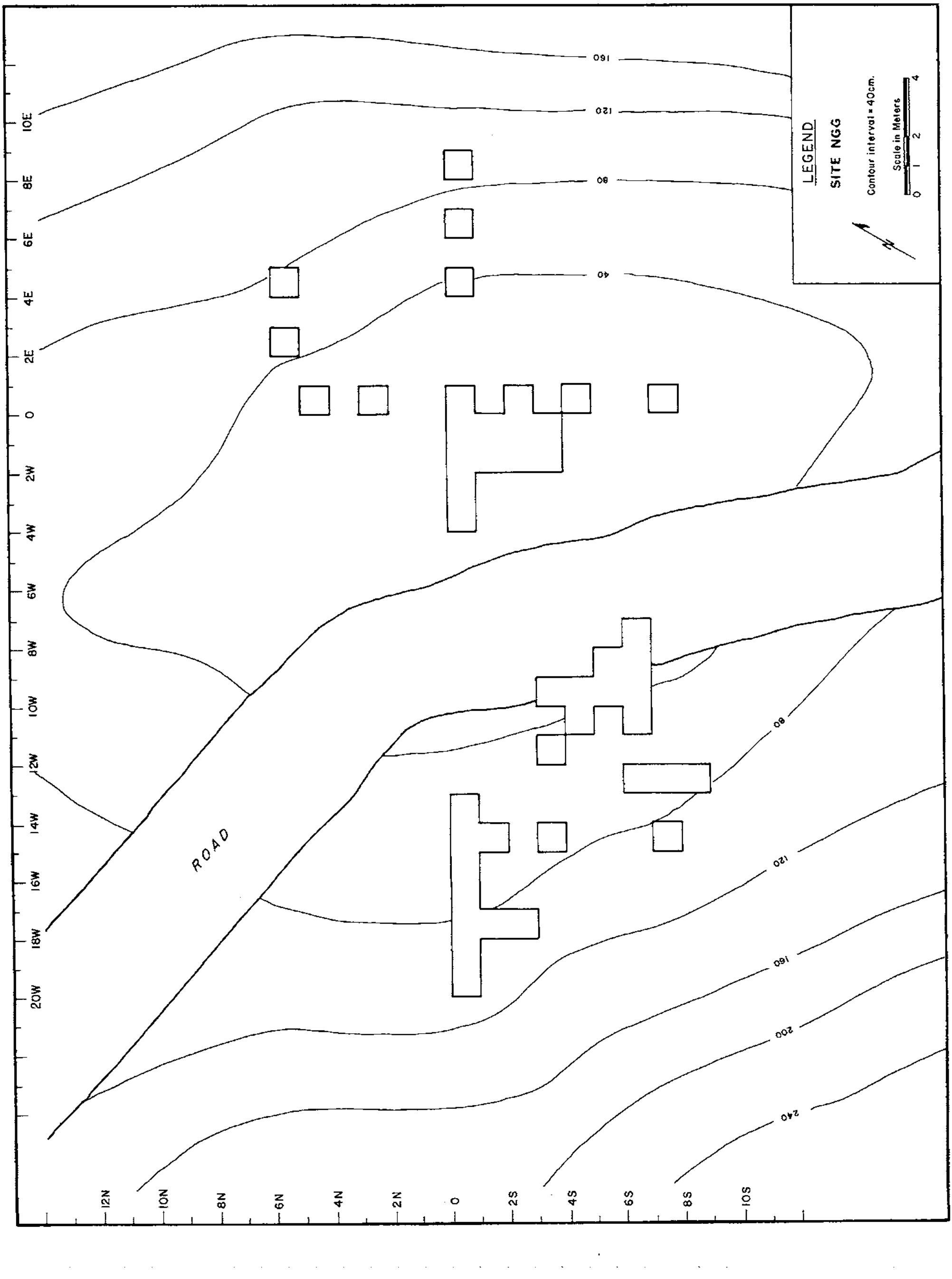


Fig. 34. Contour map showing excavated units at NGG

Fig. 35. Site NGG, facing southeast. Trench in foreground includes units 0N14W to 0N21W, left to right

Fig. 36. Stone tools and debitage on habitation surface of unit 6S11W, NGG

Fig. 37. Stone tools and debitage on habitation surface of unit 6S13W, NGG

Fig. 38. Units 1S1W and 1S2W, NGG. Note hearth identified as type E, in background; two of the enigmatic piles of stones are in foreground

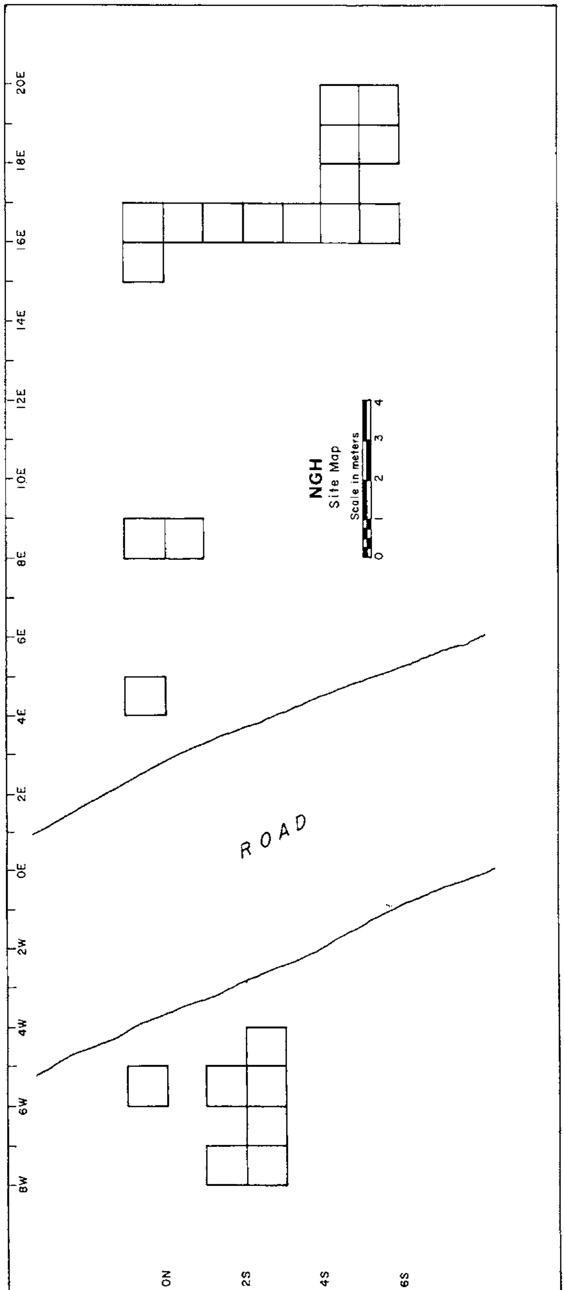


Fig. 39. Contour map showing excavated units at NGH

NGH

NGH is an open site on the same interfluve as NGG, located 6° 25′ S, 145° 50′ E, 1700 m asl, 2 km southeast of Bontaa, 50 m above a tributary of Tairora Creek, which in turn is a tributary of the Ramu River (see fig. 31). The Kainantu–Noreikora road bisects the site. The cover of the site is grass; forest is quite distant. The soil profile is similar to that at site NGG, with a heavy, black organic horizon varying in depth from 15 to 40 cm, underlain by a zone of well-structured clay loam containing small concretions, under which is a basal stratum of humic gley. The clay loam horizon at NGH appears to be unbroken, in contrast to that at NGG. Twenty-three square meters were excavated (fig. 39). Chipping detritus and 47 stone tools (see table 1) were collected from the road cut, the surface of the site, and the excavations. In the excavated squares, cultural material (fire-cracked rock, two pieces of quartz, chipping detritus, stone tools, and charcoal) were found lying on the clay loam horizon. A single feature, a hearth of type E with 80 gm of associated charcoal, was found in units 2S5W and 2S6W (figs. 40, 41). Stone tools and chipping detritus occurred most frequently in units 5S18E and 5S19E.

In addition to the charcoal associated with the hearth and artifacts, there occurred a rather heavy concentration of highly mineralized charcoal in several excavation units. It was quite intact in the form of twigs, branches, and logs, the largest of which, 60 cm in diameter, lay 1 m to 1.5 m north of the hearth. (See fig. 42 for a similar occurrence at NGJ.) These charcoal concentrations lay on the clay loam horizon sometimes within a few meters of cultural material but never associated with it.

NGJ

NGJ is an open site located at 6° 25′ S, 145° 50′ E, 1680 m asl, just west of the Kainantu–Noreikora road, on an interfluve 1.5 km southeast of Bontaa (see fig. 31). The cover is grass. A horizon of black organic soil is underlain by a well-structured clay loam horizon with small concretions, which in turn is underlain by humic gley. The latter two horizons were not always clearly separated at this site, a partially gleyed band intervening. Nine one-meter-square units were excavated. The surface collection and excavated material included chipping detritus and 17 stone tools (see table 4). An excavated feature was heavily ferric-coated charcoal, often still in the configuration of parts of trees (fig. 42); the largest piece was 7 cm long and 4 to 5 cm in diameter. NGJ lies in close proximity to NGG, NGH, and NGI. The stratigraphy and location of cultural material were similar to those at NGG and NGH, and the presence of charcoal was similar to that at NGH.

Fig. 40. Hearth, type E, in units 2S5W and 2S6W, NGH

Fig. 41. hearth, type E, in units 2S5W and 2S6W, NGH

Fig. 42. Charcoal in unit 2.2N8E at NGJ. Note articulation in limblike structures

NGM

NGM is an open site at 6° 22′ S, 145° 50′ E, 1725 m asl, 1.2 km southwest of Abiera (Untoa) on the east side of the Kainantu–Noreikora road about 30 m from water in an area the Tairora call Hobiera. It lies on the crest of a gentle hill in the midst of vast, open grassland; reeds and coarse grasses grow along the streams in the valley bottom; there is no forest in the vicinity (see fig. 43). The soil profile consists of a thin horizon of turf and organic humus 1 to 2 cm thick, overlying a horizon of well-structured clay loam with small concretions, which in turn overlies sterile, heavy red clay. The site covers roughly 1400 square meters, of which eighty-one square meters were excavated during a period of one month (see fig. 44).

In the major excavations, sixty-seven contiguous square meters were level-stripped to an occupation level including scattered fragments of fire-cracked rock, hearths, charcoal, post remains, and small amounts of chipping detritus, which lay on and in a thin layer of clay loam with concretions. Remains of two houses were exposed (fig. 45). House 1 consisted of a row of more or less round posts, interpreted as external house posts (see figs. 46, 47). In house 1 there were remains of five hearths: one identified as type A, completely intact (fig. 48); one, type B; and three whose type

Fig. 43. View of NGM, looking south. Photo courtesy of Keith Weigel

cannot be determined, for while all contained charcoal and/or fire-cracked rocks, the rocks that may have outlined them were in some disarray. House 2 was indicated by a center post; an external wall post; one unidentifiable hearth; six charred post butts which are interpreted as the remains of an internal partition or supports (fig. 49); and indications of a shallow longitudinal depression or ditch surrounding and slightly below the occupation level. Two features lying outside of the houses are interpreted as the remains of earth oven pits, both of type N. In unit 2N0E, a very heavily charred area 5 cm deep, roughly circular in plan, and resting on basal clay contained only a few rocks, but the concentration of charcoal was high. In unit 2N4W a concentration of charcoal and fire-cracked rock 2 m in diameter underlay house 1, and thus its use predates the building of house 1. The remains of an unexcavated earth oven pit lay to the northeast of house 1.

Artifacts include chipping detritus, eight stone tools (see table 4), one pig tooth, one quartz crystal, one proximal end of a tibia, and one patella.[17]

Because the major excavations produced so few artifacts, fourteen one-meter-square units were excavated to sterile clay on the slopes below the

17. Both bones are considered unidentifiable by Dr. John Rensberger. Jeannette Hope, however, after a cursory examination of the tibia, "guessed" that it is macropod. Both bones are from the surface of unit 3S5W.

TABLE 4
DISTRIBUTION OF STONE TOOLS AND DEBITAGE IN
ASSEMBLAGES NOT USED IN QUANTITATIVE ANALYSIS

	Tool Types																									
Site	IA1a	IA1b	IA1c	IA1d	IA2a	IA2b	IA2c	IA2d	IB1a	IB1c	IB1d	IB2a	IB2d	IE2d	IF1d	IIC3c	IIC3e	IIIB2a	IIIB2c	IIIB2d	IIIC3e	IIIC4e	IIIC5e	IVD6f	Total Tools	Debitage
NFG					1																				1	3
NFH	3			1	10	1	1	2						3							1				22	63
NFI																									0	0
NFJ	4		1	3	12	2		5																	27	15
NFK		1																							1	0
NFL																									0	0
NFO					8			3						1											12	19
NFP																									0	0
NFR																									0	0
NFS																									0	0
NFU								1																	1	5
NFV																									0	0
NFW	15		3	8	35	7	1	11					1	1	1										83	140
NFY	3		1		5			1											1						11	131
NFZ	5			7	13	1	1	1						1					1	1					31	294
NGA	4			4	8			1						2					1						20	60
NGB	6			2	5	1															1				15	78
NGC	1		1		3		1							1											7	55
NGE					4	3				1															8	2
NGF																									0	0
NGJ	1	1			9	2		3				1													17	487
NGK	5				4	2																			11	17
NGL	2	1			14	1	2	2						1											23	105
NGM	1			1	3											1	2								8	148

NGN																								0	0
NGO					2																			2	31
NGP																								0	0
NGQ					5			1																6	6
NGR	1				3			1												1				6	11
NGU		1			1	1																		3	7
NGV	1	1		1	10																			13	10
NGW	3	1	1	1	3			2																11	20
NGX																								0	0
NGY	6			1	9	2	1	1																20	1
NGZ			1		2	2																		5	7
NHA	1			1	3	1																		6	7
NHC	5			1	8	2	2	1	2										1				1	23	121
NHD					1																			1	11
NHE	3			2	6	1	2	2												1			1	18	73
NHF																								0	4
NHG						2												2						4	2
NHH				1	1																			2	9
NHJ	1			2	5	2	1	1														1	1	14	33
NHM																								0	0
NHO	1			2	1							1												6	9
NHP	1				4			1																6	9
NHQ	3			3	8	9					1			1		9	3				1		5	43	77
NHS						1																	1	2	3
NHT					3	1		1																5	9
NHU	1			3	6	6		2						1				2			1		4	26	48
NHV				2	15	10		2		1			1									1	1	33	35
NHW																								0	0
NHX	1				3																			4	3
Total	78	6	8	46	233	60	12	45	2	2	1	2	2	12	1	10	5	7	2	4	2	2	15	557	2168

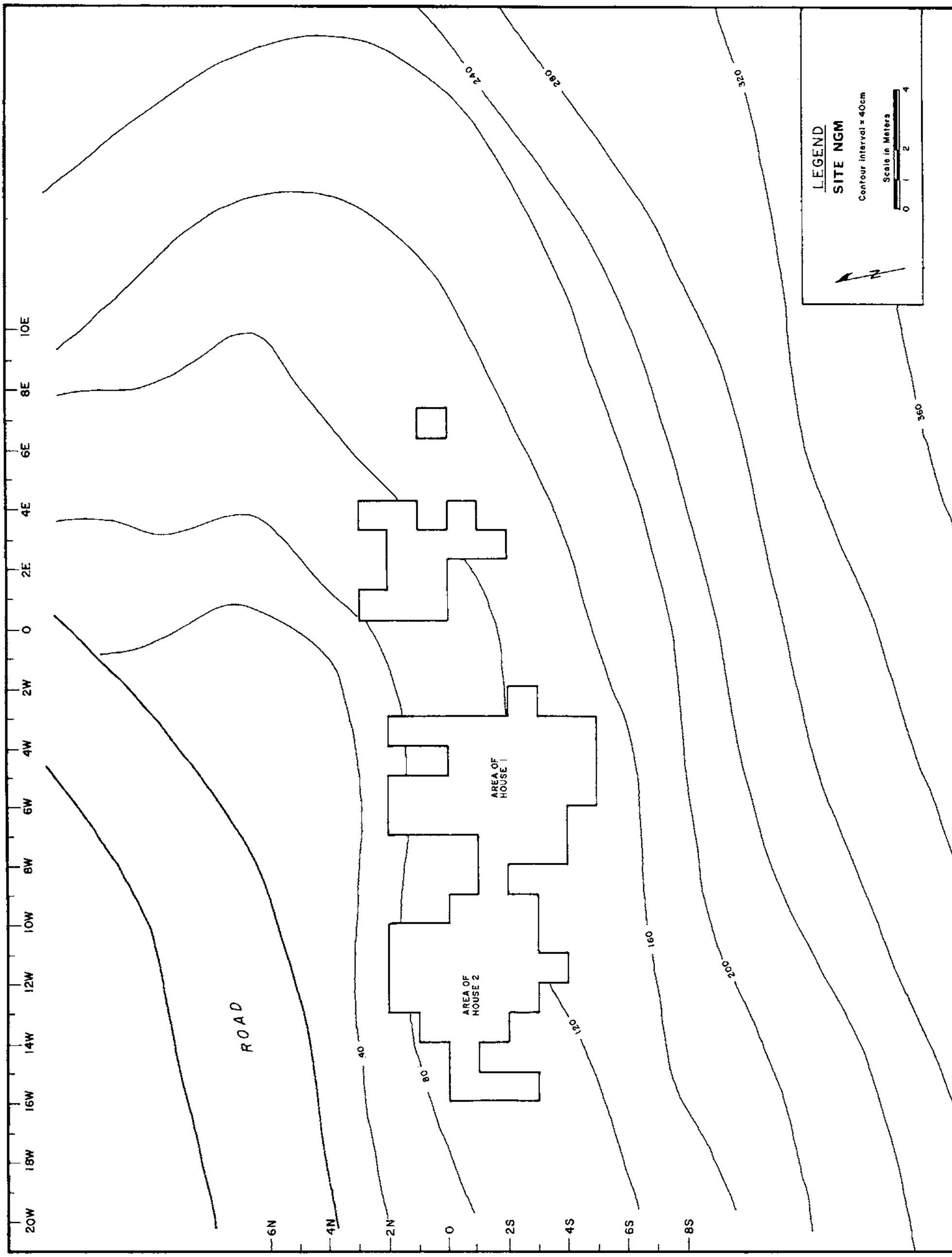


Fig. 44. Contour map showing excavated units at NGM

Fig. 45. Excavations at NGM, looking north. House 1 is on the right, house 2 on the left. Tent and piles of sifted soil in background. Note road in upper left

major excavation; no artifacts were found. The area contained, however, complex lenses of a mixture of black topsoil, clay loam with concretions, and red clay, quite distinct from the soil profiles of the previously excavated area. In the field notes this is interpreted as material that had been thrown out during leveling of the ground preparatory to constructing the houses in the area above it, the site of the major excavations. This seems a reasonable interpretation and thus can be accepted as cultural and part of the site.

Surface-collected Sites: Assemblages Used in Quantitative Analysis

Assemblages from eighteen sites that were surface collected but not excavated (except for test pits in some of them) were considered adequate to incorporate them in the quantitative analysis of the data. The assemblages contain thirty or more unifacially chipped stone tools. The sites are described here.

NFD is an open site at 6°25′ S, 145°55′ E, south southwest of Noreikora village, not far from the edge of the Noreikora Swamp. The cover is grass; the soil, black humus over pebbly red clay. The surface collection contains two pottery sherds, chipping detritus, eighty-seven stone tools (see table 1), and one fragment perforated stone disc.

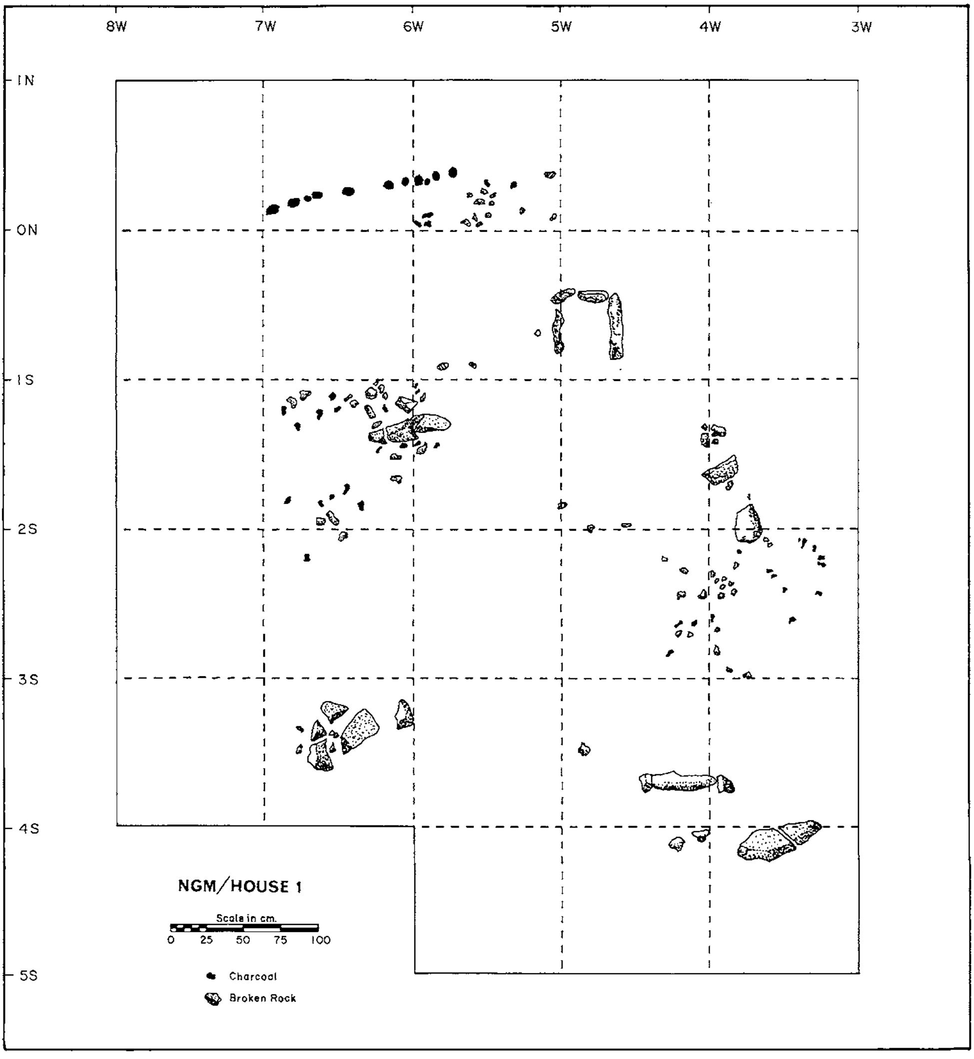


Fig. 46. Map of house 1 at NGM. Post remains and indications, upper left; type A hearth, upper right; type B hearth, lower right; and three unidentified hearths

Fig. 47. Units 1N6W and 1N7W, NGM. Note post holes in outer wall of house 1

Fig. 48. Hearth, type A, in unit 0N5W, NGM

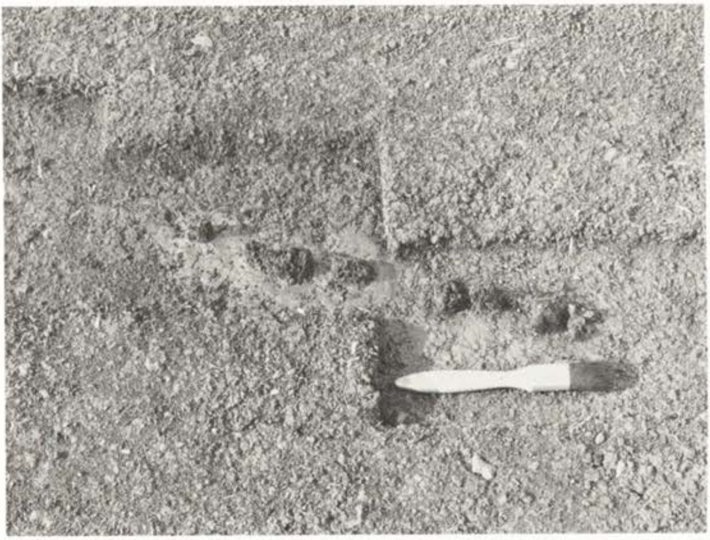


Fig. 49. Post remains in house 2, unit 1S12W, NGM. Possible remains of interior partition (excavation around posts of no significance other than to show posts more clearly)

NFE is an open site on an interfluve surrounded on two sides by swampy area, approximate location at 6°26′ S, 145°55′ E, southeast of Noreikora village. The cover is grass. The surface collection contains chipping detritus, including one piece of obsidian, and ninety-nine stone tools (see table 1). (The material from this site was not collected by the field party but brought to them by a New Guinean.)

NFF is an open site on a sharp spur off a low ridge at 6°30′ S, 145°59′ E, 5 km north of Obura, 400 m east of the Lamari River, 200 m north of a small tributary of the Lamari River. The cover is grass; primary forest is 1.5 km distant. Soil is black clay. Cultural material was collected from an area 5 to 7 m north to south and 10 m east to west, and in some places in the road cut, to a depth of 10 to 20 cm. It consisted of chipping detritus and fifty-four stone tools (see table 1).

NFM is an open site at 6°37′ S, 145°57′ E, 2400 m asl, on top of the high western ridge 200 m from the Himarata Resthouse and 200 m south of the Upper Barindouna River. The cover is short grass and bamboo, but primary forest exists not far from the site. Soil is red clay and black blocky clay, both of which are badly eroded. Artifacts and chipping detritus were most abundant near the edges of a wide path which runs the length of the ridge. A surface collection produced ash, chipping detritus, and forty-seven stone tools (see table 1). Features were old house platforms and bamboo.

NFN is an open site at 6°37′ S, 145°57′ E, 2440 m asl, on the southern branch of the ridge west of Himarata Resthouse, 400 m from the Upper Barindouna River. The cover is gardens; the soil is dark brown clay. The surface collection contains two bone fragments (unidentifiable), chipping detritus, and thirty-six stone tools (see table 1). Features revealed in a small test pit were two well-preserved posts in a water-soaked matrix, 10 cm below the surface.

NFQ is an open site on a low ridge at 6°40′ S, 145°56′ E, 2200 m asl. There is an ample water supply to the east and west. Cover is grass and contemporary gardens; the soil is black clay. Features include old house cuts and hearths near the Oraura Resthouse and, 600 m distance up the ridge, to the south, the remains of an old men's house which is located near the forest. Cole treated this long strip as if it were one site and I have no choice but to retain it as such, although more than one site may be represented. The surface collection includes chipping detritus and thirty-two stone tools (see table 1), which were most abundant around the house remains and the men's house although they were scattered along the entire area in between.

NFT is an open site on a gentle broad ridge located at 6°40′ S, 145°59′ E, 2375 m asl, 20 m west of the parade grounds at the Ndumba Resthouse, 400 m east of the Yapitaina River. The site measures approximately 200 m north to south and 50 m east to west. Erosion of the area is pronounced, and cultural materials may be distributed more widely than when originally deposited. The cover is short grass; forest is about 1.5 km distant. Soil is clay with a light, dry A horizon. Several small test pits 20 cm square and 20 cm deep were dug to the bottom of the A horizon. Chipping detritus and forty-three stone tools (see table 1) were collected from the surface.

NGD is an open site on a long, gentle hilltop located at 6° 26′ S, 145° 51′ E, 1800 m asl, 3 km north of Baiera (Noreiaranda), 400 m south of a tributary of the Norinduna River. The cover is short grass; the site lies in the midst of a vast grassland, presently uninhabited, 6.5 km from primary forest. The soil is pebbly, black, blocky clay with a thick horizon of black organic soil overlying it. Cultural material was found over an area of 300 m east to west and 10 to 50 m north to south. The hilltop is not badly weathered. One concentration of cultural material came from the floor of a contemporary uncompleted house excavation at a depth of from 10 to 15 cm from the surface, between the clay loam and humic gley horizons. Chipping detritus and thirty-nine stone tools (see table 1) constitute the cultural material retrieved from NGD.

NGI is an open site on a low, gentle interfluve located at 6° 25′ S, 145° 50′ E. Bisected by the Kainantu–Noreikora road, it lies in the midst of a vast expanse of grassland, distant from forest. Cultural material collected from the surface and from the road cut included chipping detritus and sixty-eight stone tools (see table 1). The field notes indicate that the site, which is located approximately 25 m from NGG, "seemed to have been almost wiped out by the road. It was on the side of a fairly steep little hillock. Stratigraphy is similar to NGG; the soil profiles are fairly similar."

NGS is an open site in the contemporary village of Burauta (established 1956), located on a gently sloping hill at 6° 21′ S, 145° 51′ E. The cover is grass; soil is black humus on pebbly red clay. Cultural material was collected from the surface, but much of it doubtless was uncovered when the ground was cleared and leveled for recent house construction. It consists of chipping detritus and thirty-six stone tools (see table 1).

NGT is an open site whose exact location cannot be described although it is up the hill from NGS at Baiora, generally in the vicinity of 6° 21′ S, 145° 52′ E. The cover is grass; soil is black humus over pebbly red clay. The surface collection consists of chipping detritus, including one piece of obsidian, and fifty-four stone tools (see table 1).

NHB is an open site located on a high limestone ridgetop at 6° 32′ S, 145° 45′ E, 2 km southwest of Asempa near the Kuatinou River. Cover is tall grass and reeds; the soil is red clay. Surface collection produced chipping detritus and fifty-three stone tools (see table 1).

NHI is an open site in the modern village of Yaunomuti, located at 6° 35′ S, 145° 40′ E, 100 m north of the Opindi River (see fig. 50). The area

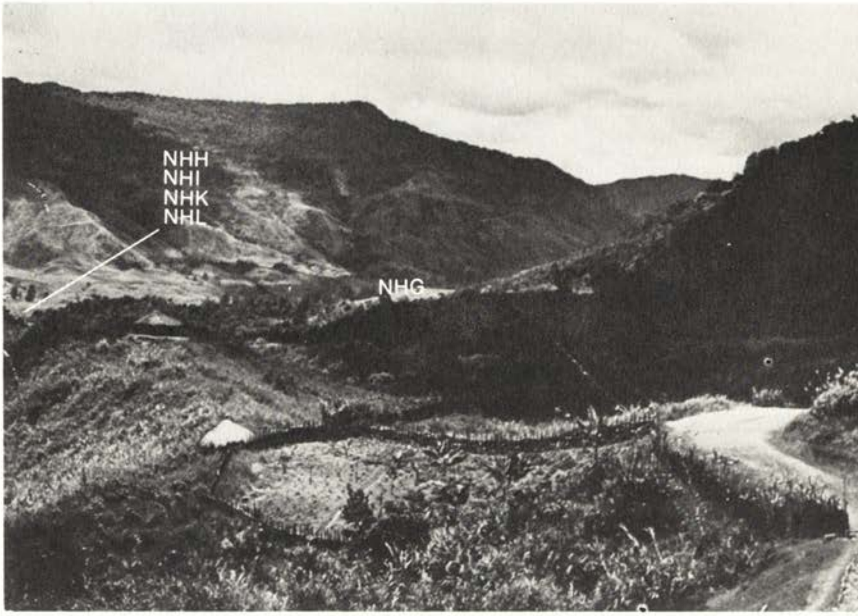


Fig. 50. View of NHG, NHH, NHI, NHK, and NHL

is cleared and the soil includes a thin, brown horizon overlying pebbly brown-orange clay. The size of the site is 95 m north to south and 30 m east to west. The surface collection contains chipping detritus, including one piece of petrified wood, and sixty-two stone tools (see table 1).

NHK is an open site on a low ridge located at 6°34′ S, 145°40′ E, 560 m east of the Manivinti River. The cover is grass (see fig. 50). Cultural material is scattered along the road; in the soil profile humus overlies red-brown clay. The size of the site is 40 m north to south and 20 m east to west. The surface collection includes chipping detritus, one piece of red ocher, three pieces of petrified wood, and thirty-seven stone tools (see table 1).

NHL is an open site on a low, gentle ridge, located at 6°34′ S, 145°40′ E, 1600 m asl, 560 m from the Manivinti River. The cover is grass and gardens (fig. 50), the soil includes humus overlying red-brown clay. The size of the site is 100 m north to south and 100 m east to west. The surface collection includes one piece of petrified wood, chipping detritus, and 141 stone tools (see table 1).

NHN is an open site on a ridge top located at 6°35′ S, 145°40′ E, 1460 m asl, 185 m from the nearest river, 1.5 km south of the Okasa Resthouse at the junction of the trail to Noreiaranda and the road to Yakia. The cover is sparse grass and some shrubs, not far from primary forest. Soil is light brown to brown clay. The size of the site is 100 m north to south and 20 m east to west. Surface indications include hearthstones, fire hearths, and earth oven pits. A large circular depression near the north end of the ridge was interpreted as the remains of a men's house; another men's house is indicated by a center post, pig bones, and the charred stumps of dracaena. A few feet away from that is a heap of white earth which Cole thought might be sweepings from the men's house, but which an informant said were the remains of a latrine. To the south are what Cole interpreted to be women's houses, with rectangular hearths and a few center posts projecting from the orange clay to a height of a few centimeters. Wall posts can be discerned if a thin film of soil is brushed away from their tops. The surface collection includes a fragment of a burned, perforated stone; chipping detritus; and 108 stone tools (see table 1).

NHR is an open site on the level part of a steep ridge located at 6°33′ S, 145° 41′ E, 1620 m asl, 165 m west of the Wanindonti River. Cover is grass and includes three casuarina trees and one large broad-leafed tree and secondary forest; primary forest is 400 m away. Soil is red clay. Surface features are remnants of two square houses and two round houses. Surface collection includes chipping detritus and fifty-eight stone tools (see table 1).

Surface-collected Sites: Assemblages Inadequate for Quantitative Analysis

Fifty sites with samples of fewer than thirty unifacially chipped stone tools were, by definition, inadequate for inclusion in the quantitative operations. Twelve of the assemblages, those with ten or more stone tools, have been identified in the classification (table 15) in an attempt to suggest their cultural affiliation, although it is recognized that the assignments are based on minimal data.

NFG is an open site in the middle of a long, broad ridge at 6°30′ S, 145° 59′ E, 400 m east of the Lamari River, 100 m south of a tributary of the Lamari River. The cover is grass; the soil, black clay. Chipping detritus and one stone tool (see table 4) were collected from the surface.

NFH is an open site located at 6° 32′ S, 145° 58′ E, 800 m west of Obura Government Station. It is the site of a contemporary village, occupants of which allege that their ancestors earlier resided at the same location. Grass is the surrounding cover; a thin layer of dark brown soil overlies reddish clay. The surface collection includes chipping detritus, twenty-two stone tools (see table 4), and fire-cracked rocks.

NFI is a rock shelter located at 6° 35′ S, 145° 59′ E, 2175 m asl, 1.2 km southeast of Wymiti (Asara), 60 m north of the Berakilkera River. There are two chambers into which a very small amount of light is admitted. A test pit was dug through ash and a "silty pebbly clay" to a depth of 12 cm. Surface collection produced one kapul tooth, twigs and branches, but no stone tools or chipping detritus. A feature, carbon on the ceiling, is inferred to be the result of human use of the site.

NFJ is an open site on a steep, narrow ridge at 6°35′ S, 145°58′ E, 1650 m asl, 1000 m west of the Asara Resthouse and 75 m west of the Doeala River, a tributary of the Berakilkera River. The contemporary village of Monichoulola is located on the same ridge. The surrounding cover is grass; topsoil is dark brown to black, overlying orange clay. The site measures 150 m north to south and 4 to 15 m east to west. A test pit, 80 cm square, was excavated near the center of the site, and a surface collection was made of the entire area. Maximum depth of the deposit was 18 cm, where artifacts and detritus lay on orange clay. Surface-collected artifacts and detritus, apparently eroded out of the deposit, were littered around the edges and bottom of a gulley. Cultural material includes chipping detritus, twenty-seven tools (see table 4), and fire-cracked rocks.

NFK is an open site on a low ridge located at 6°35′ S, 145°59′ E, 2200 m asl, 800 m southeast of the Asara Resthouse, 800 m north of the Berakilkera River. Cover is grass and casuarina; the soil is black clay. Surface collection produced one stone tool (see table 4).

NFL is a rock shelter formed by the undercut surface of a huge limestone boulder located at 6° 35′ S, 145° 58′ E, 2000 m asl, 1.2 km west of the Asara Resthouse and 10 m west of Taeara stream, a minor tributary of the Berakilkera River. The boulder is surrounded by a cover of grass and shrubs. The size of the site is 9.2 m wall to wall at drip line; 6.6 m, drip line to back wall; and the ceiling height varies from 0 to 4 m. A small test pit was dug to 55 cm: a 2-cm to 3-cm layer of charcoal, ash, and organic debris overlay orange-brown clay. No stone artifacts or detritus were found. Features consist of tricolored (black, white, orange) paintings on the back wall of the shelter and black line drawings of stick figures overlying them (figs. 51-54).

NFO is an open site located at 6°37′ S, 145°58′E, on a very steep ridge 800 m northeast of the Himarata Resthouse. Apparently the occupation area was once on the crest of the ridge, but it has been literally washed down the hill, where artifacts litter the eroded surface. The surface collection includes chipping detritus and twelve stone tools (see table 4).

NFP is an open site located on a high ridge top at 6°37′ S, 145°57′ E, 2400 m asl. It is 1.2 km south of the Himarata Resthouse overlooking the Himarata land bridge, 400 m northwest of the Babera River, its closest source of water. Furthermore, it is on the southerly extension of the ridge west of Himarata Resthouse on which NFM is located. The cover is grass and contemporary gardens; the topsoil has washed away and red clay is exposed. Evidence of human use of the area is the presence of house remains, bamboo, and dracaena. Adz blades are mentioned on the site survey form but these were either not collected or lost in transit.

NFR is a rock shelter located at 6°39′ S, 145°56′ E, 1900 m asl. It is 2.5

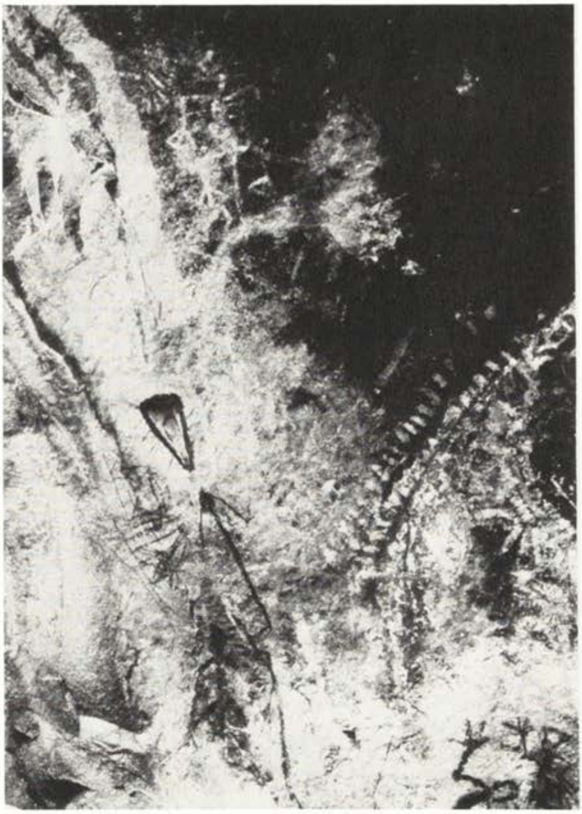


Fig. 51. Section of rock painting at NFL. Position is just to left of fig. 52. (Figs. 51-54 are not at same scale.)

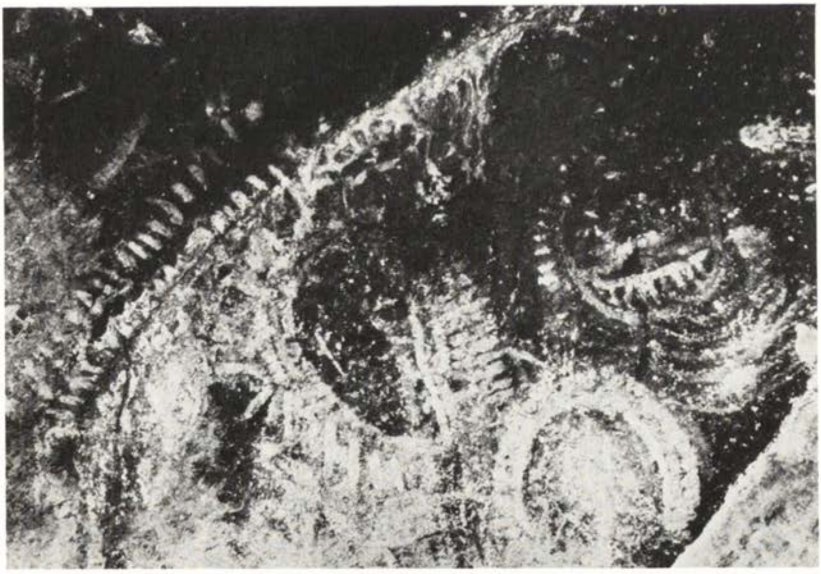


Fig. 52. Section of rock painting at NFL, positioned between figs. 51 and 53

Fig. 53. Section of rock painting at NFL, to the right of and somewhat lower than fig. 52

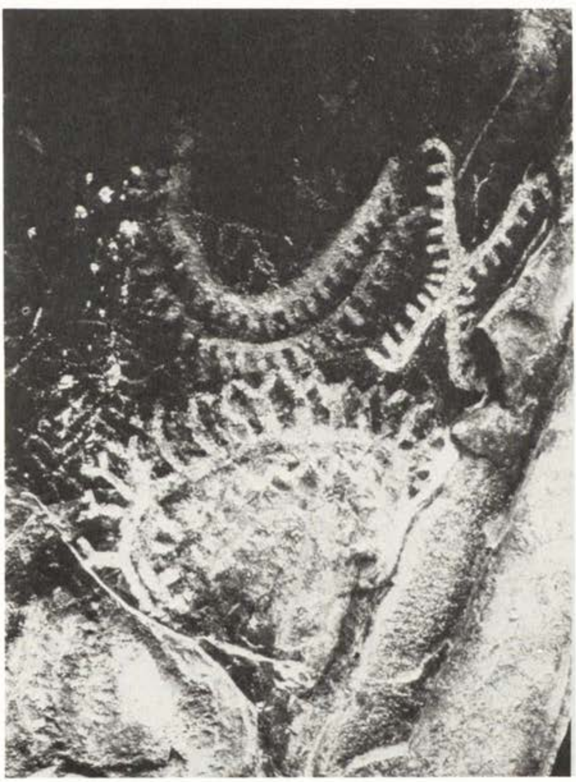


Fig. 54. Section of rock painting at NFL, to the right of and somewhat above fig. 53 (and on the same plane as fig. 51)

km northeast of Tuzana (Oraura), 20 m east of a tributary of the Soara River. Cover includes grass and a secondary growth of trees including bamboo and broadleaf trees. It is 3 km to 4 km from primary forest, which lies to the south and southeast. The soil is brown clay. The dimensions of the shelter are: width at drip line, 7.2 m; maximum depth, 3 m; ceiling height, 1 to 3 m; drip line to front, 2.5 m. No cultural material was found in a small pit dug to 16 cm. A surface collection was made which includes bamboo tubes, ash, decomposed bamboo leaves, and organic fiber (unidentified). There were no stone tools or chipping detritus.

NFS is a rock shelter located at 6° 39′ S, 145° 55′ E, 1800 m asl. It is 5 km northwest of Oraura and 200 m north of the Soara River, 5 to 6 km north-northwest of primary forest. The cover is heavy streamside brush. Soil is brown clay. The size of the shelter is: width at drip line, 2.5 m; ceiling height, 2 to 2.5 m; drip line to back wall, 2 m; drip line to front, 0.5 m. Charcoal, ash, and organic debris occurred on the surface, but there were no stone tools or chipping detritus.

NFU is an open site located at 6° 40′ S, 145° 59′ E, 800 m west-northwest of the Ndumba Resthouse, east of the Yapitaina River. Surface collection includes chipping detritus and one stone tool (see table 4).

NFV is an open site located at 6° 40′ S, 145° 59′ E, 50 to 75 m east of the Yapitaina River, 600 m southwest of the Ndumba Resthouse. The cover is reeds and old gardens with bamboo growing to the west. Soil is orange-brown clay. A feature is a still-visible level depression in the ground measuring 10 to 15 m north to south, 10 to 15 m east to west, which Cole interpreted as a house floor. No chipping detritus or stone tools were found.

NFW is a site near or at the garden at a locale near Ndumba called Qaisora; exact location was not recorded.[18] Chipping detritus and artifacts were brought to the field party on two separate occasions by Taopanau of Dandura (Ndumba), who found them while making a garden at a location where, he reported, his ancestors once lived. The surface-collected material includes chipping detritus and eighty-three stone tools (see table 1).

NFY is an open site on a ridge at 6° 38′ S, 146° 01′ E, 3 km north of and at a higher elevation than NFX. The excavation of a three-meter-square pit produced what Cole interpreted as evidence of an old trail running up the ridge. The band of hard-packed clay which spanned the pit was 2 to 3 cm deep and about 15 to 20 cm wide. "It was defined by following a hard-packed surface which was easy to recognize. Generally the trail followed the ridge top or ran parallel to it and was within a meter or so of the ridge crest only a meter north of the present trail." Chipping detritus and eleven stone tools (see table 4) were found.

18. NFW is excluded from quantitative analysis, although the sample size is adequate, because of the questions surrounding its provenience.

NFZ is an open site on a ridge top on or near the garden called Yay-akoru. The exact location of the site was not recorded. Chipping detritus and artifacts were brought to the field party by Nauokaba and Kaiba of Bauora (Ahea), who had found them. The site, near the village of Ahea, is "up a steep ridge, off main track roughly north of NFX. The turn-off is not far from NFY." The cover is grass and contemporary gardens. Cultural material collected from the surface includes chipping detritus and thirty-one stone tools (see table 4).

NGA is an open site located at 6°38′ S, 146°01′ E, east of Ahea. The cover is grass. The surface collection includes chipping detritus and twenty stone tools (see table 4).

NGB is an open site located at 6°38′ S, 146°01′ E, east of Ahea. The cover is grass. A surface collection was made of chipping detritus and fifteen stone tools (see table 4).

NGC is an open site located at 6°28′ S, 145°51′ E, 1735 m asl, north of the Noreiaranda Resthouse, on a badly weathered hilltop near the contemporary hamlet of Markiya. The site is in the midst of a vast expanse of grassland and quite distant from forest. A surface collection consists of chipping detritus and seven stone tools (see table 4).

NGE is an open site on a steep, badly weathered ridge at 6°28′ S, 145° 50′ E. The cover is grass and dense reeds. The soil is humus over clay. The site lies between Baiera and primary forest. Surface collection includes chipping detritus and eight stone tools (see table 4).

NGF is an open site located at 6°28′ S, 145°50′ E, near a small stream southwest of Baiera. The cover is grass and reeds. Soil is black organic humus over clay. Neither stone tools nor chipping detritus was recovered.

NGK is an open site located at 6°24′ S, 145°50′ E, 1800 m asl, 500 m from the nearest river and 200 m from one of its tributary streams, 90 m northwest of Bontaa on the Kainantu–Noreikora road. The site lies in the midst of a vast grassland distant from forest. The surface collection includes chipping detritus and eleven stone tools (see table 4).

NGL is an open site located on a gentle hilltop at 6°23′ S, 145°49′ E, northwest of Bontaa on the Kainantu–Noreikora road. The site is located in a broad expanse of grassland very distant from forest. A test trench was excavated. Chipping detritus, including one piece of obsidian, and twenty-three stone tools (see table 4) were recovered from the trench and surface.

NGN is an open site on a gentle hill at 6°22′ S, 145°48′ E, 10 m west of the Kainantu–Noreikora road, just 25 m above NGM. The cover is vast open grassland, distant from forest. Soil is thin black humus over red clay. The site covers approximately 1200 square meters. The following description is from Cole's notes:

> Two contiguous circular embankments connected by a broad path. The smaller of the two circles is eighteen m by sixteen m while the larger meas-

> ures approximately 35.5 m by thirty m. The height of the embankment ranges from fifty cm in the smaller to one m in the larger. The banks, which have probably slumped, were apparently built up with earth scooped from inside and outside the enclosure. There is a pronounced break in the peripheral embankment of the larger circle at a point directly opposite the pathway between the two circles. This gap suggests an exit. In addition, there is a low mound in the center of the large circle, approximately seventy five cm in height and 1.5 m in diameter. A line projected from the center of the smaller circle, bisecting the mound, also bisects the external and internal pathways and defines an axis of symmetry for the entire earthwork [fig. 55].

Three pits, one square meter each, were excavated within the smaller of the two circles, but no cultural material was found.[19] One pottery sherd was found on the surface of the site.

NGO is an open site on a small knoll at 6° 21′ S, 145° 51′ E, 200 m east of Abiera stream. It is in the middle of vast grassland, distant from forest. Soil is thick black humus with reddish clay beneath. Chipping detritus and two stone tools (see table 4) were collected from the surface.

NGP is an open site on a low hill located at 6° 21′ S, 145° 51′ E, 100 m from Abiera stream near NGO. It is in the middle of vast grassland, distant from forest. Soil is thick black humus overlying reddish clay. It consists of two adjacent circular embankments of raised earth similar to NGN and NGQ. No artifacts were retrieved and there were no excavations.

NGQ is an open site on a gentle hill at 6° 22′ S, 145° 50′ E, 1700 m asl. It is intersected by the Kainantu–Noreikora road and consists of two contiguous circular embankments. The smaller circle is 16 m by 15 m; the measurable part of the larger circle, which has been cut through by the road, is 35 m by 18 m. (It would be approximately 28 m if not partially obliterated.) The site lies approximately 50 m west of NGM. The surface collection includes chipping detritus and six stone tools (see table 4).

NGR is an open site on the spur of a low hill, east of the Kainantu–Noreikora road, at 6° 22′ S, 145° 50′ E, 200 m west of Boida stream. It is located in open grassland, distant from forest. The soil is black organic humus over reddish clay loam with small concretions. The site is "small." Cultural materials consist of chipping detritus and six stone tools (see table 4).

NGU is an open site located on a gentle hilltop at 6° 20′ S, 145° 52′ E, 1800 m asl, 400 m from the nearest river and 100 m from one of its tributary streams, south of Haparira, east of the Kainantu–Noreikora road. Cover is short grass; small patches of bush line some streams, but gener-

19. Although it is not recorded in the notes, in conversation Cole has said that at the bottom of one of the pits, he encountered damp, matted, vegetable fiber which resembled kunai grass. Time did not permit an adequate investigation of the fiber. On the basis of informant statements that a men's house had once stood at the site, Cole interpreted it to be remains of a house roof. On the basis of the data at my disposal I am not now including this as cultural material.

Fig. 55. Two contiguous circular embankments with raised section in center of the larger one, at NGN. Sketch by Keith Weigel

ally the forest is far distant. A surface collection consists of four pottery sherds; chipping detritus; three chipped stone tools (see table 4); and a piece of water-worn volcanic rock, 135 mm by 47 mm maximum dimensions, on one end of which is an irregular band of powdered hematite, 67 mm in length and varying in width, but never more than 10 mm (and this is at either end of the band).

NGV is an open site located at 6° 17′ S, 145° 51′ E, north of Kainantu, outside of the study area, in territory currently occupied by Agarabi ethnolinguistic groups. Cultural material includes chipping detritus and thirteen stone tools (see table 4).

NGW is an open site located at 6° 16′ S, 145° 51′ E, north of Kainantu, outside the study area, in territory currently occupied by Agarabi ethnolinguistic groups. Cultural material includes chipping detritus and eleven stone tools (see table 4).

NGX is an open site on a ridge located at 6° 29′ S, 145° 49′ E, 2000 m asl, approximately 3 km north of the contemporary village of Amaira. It is just south of the drainage divide, 2200 m asl, which separates the northern from the southwestern part of the study area. The valley bottom lies at approximately 1950 m asl, and the sides of the valley are grass-covered to 2100 m asl. The site was not visited, but surface indications, consistent with informant reports of an abandoned village, could be seen from a distance (see fig. 56).

NGY is a rock shelter, high on a steep ridge overlooking a gorge located at 6° 31′ S, 145° 46′ E, 1650 m asl, 22 m west of Loampa stream, 1.2 km northwest of Waifina. The cover is secondary forest. The size of the shelter, which has three entrances, is: wall to wall at drip line, 5.2 m wide; ceiling height, 2.5 m. The floor was littered with angular pieces of chert. A one-square-meter pit was excavated 40 cm to sterile clay. Surface material included one husk of *Pandanus* nut, one acorn, four unidentified nuts, bamboo fragments, reed fragments, fragments of small sticks and twigs (unidentified), one kapul tooth, chipping detritus, and twenty stone tools (see table 4).

NGZ is an open site on a low ridge, located at 6° 31′ S, 145° 46′ E, on the bank of a large river which flows past Waifina, 2 km to the southeast. Cover is tall grasses and dense reeds. Soil is damp black clay. Surface collection was difficult but produced one piece of pottery (figs. 94 f, 95), chipping detritus, and five stone tools (see table 4). Features consisted of house outlines.

NHA is an open site located at 6° 31′ S, 145° 46′ E. The site is badly eroded in some places; in others the cover is tall grasses and dense reeds. The surface collection includes chipping detritus and six stone tools (see table 4).

NHC is an open site on a long ridge located at 6° 33′ S, 145° 44′ E, 1950 m asl, near the Kuatinou River. The area has been cleared of grass and

Fig. 56. View of NGX

topsoil; the soil is red clay. The site measures 500 m north to south and 30 m east to west. Surface indications include the features posts and what the field notes refer to as the remains of earth oven pits. The surface collection includes chipping detritus, including one piece of obsidian, and twenty-three stone tools (see table 4).

NHD is a rock shelter, the major shelter of a series of smaller shelters under a large limestone outcrop, 6°30′ S, 145°45′ E, 1750 m asl, 95 m below NHE, 18 m from Bionamba Creek. The cover surrounding the outcrop is secondary growth and gardens; inside, loose soil and dust overlie limestone. The deposit was tested to 50 cm. A surface collection produced chipping detritus and one stone tool (see table 4). Features are charcoal drawings and geometric designs.[20]

NHE is an open site on a sloping ridge located at 6°30′ S, 145°45′ E, 1850 m asl, 45 m from the Tuanombope River, below Okapala. Cover is grass with secondary forest not far away. Soil is very dark and loose with organic debris. Surface material included chipping detritus and eighteen stone tools (see table 4), as well as features of charred timbers, hearth remains, charcoal, and house depressions.

20. In the field notes, it is suggested that the charcoal drawings are of lizards and that they and the geometric designs are of some age. Cole attributes the colored paintings to small children working quite recently.

NHF is an open site located at 6° 32′ S, 145° 43′ E, at a place the Auyana call Opoimpimpa. The cover is grass; secondary forest is nearby. Soil is red clay. Chipping detritus was collected from the surface (see table 4).

NHG is an open site on a high ridge top located at 6° 34′ S, 145° 39′ E, 1700 m asl, 200 m east of the Yarawini River (see fig. 50). Soil is red clay. The site measures 200 m north to south, 30 m east to west. Surface indications include men's house remains, chipping detritus, and four stone tools (see table 4).

NHH is an open site on a long, low, gentle ridge located at 6° 34′ S, 145° 39′ E, 560 m east of Manivinti River, across the road from the Okasa Resthouse (see fig. 50). The cover is grass, the soil, red clay. The site measures 30 m north to south and 30 m east to west. The surface collection includes chipping detritus and two stone tools (see table 4).

NHJ is an open site on a round-topped ridge which ends in a southern steep slope, located at 6° 33′ S, 145° 40′ E, 100 m southwest of the Baratina River, 1.5 km north of the Okasa Resthouse. The cover is grasses and large trees with secondary and primary forest to the northeast. The soil consists of a thick black humus overlying red clay. The surface collection includes chipping detritus and fourteen stone tools (see table 4).

NHM is an open site on a small ridge located at 6° 36′ S, 145° 41′ E, 50 m from a stream south of Koneti. The cover is primary and secondary forest. Surface features include two house clearings and an abandoned latrine. There were no other artifacts.

NHO is an open site on a broad gentle slope, located at 6° 33′ S, 145° 40′ E, 1600 m asl, 375 m from the nearest river. The cover is grass; primary forest is nearby. The soil is red clay. The surface collection includes chipping detritus and six stone tools (see table 4).

NHP is an open site on a level ridge top, located at 6° 33′ S, 145° 40′ E, 90 m southeast of the Waipama River. The cover is grass and gardens, 125 m from primary forest. The soil is red clay. The site measures 50 m north to south by 50 m east to west. Surface features are charred "boards" and posts; the surface collection includes chipping detritus and six stone tools (see table 4).

NHQ is an open site on a ridge top located at 6° 32′ S, 145° 41′ E, 1690 m asl, 400 m west of the Manei River. The site is bare, having no cover; it is 800 m from primary forest. The site measures 100 m north to south and 30 m east to west. The surface collection includes chipping detritus and forty-three stone tools (see table 4).

NHS is an open site on a level area of a gently sloping ridge located at 6° 34′ S, 145° 40′ E, 235 m from a river. The cover is grass and secondary forest; it is 200 m to primary forest. The soil is brown-reddish clay. The surface collection includes chipping detritus and two stone tools (see table 4); the field notes refer to "vegetational changes which are apparently house remains."

Fig. 57. Painting on rock wall at NHW

NHT is an open site on a gentle, rounded ridge located at 6°34′ S, 145°40′ E, 50 m south of the Kumtapma River. The cover is grass; primary forest is nearby. Soil is humus and reddish clay. The surface collection consists of chipping detritus and five stone tools (see table 4).

NHU is an open site on a low, sloping ridge located at 6°34′ S, 145°39′ E, 190 m northwest of Isindonti Creek. The cover is grass and reeds; soil is brown, heavy clay. The size of the site is 400 m north to south and 40 m east to west. Surface features are hearthstones; the surface collection includes chipping detritus and twenty-six stone tools (see table 4).

NHV is an open site on a ridge top located at 6°34′ S, 145°39′ E, 1625 m asl, 190 m northeast of the Miendavoratna River. The cover is grass, gardens, and secondary growth. Soil is reddish clay. The size of the site is approximately 100 m north to south and 30 m east to west. The collection from the surface includes chipping detritus and thirty-three stone tools (see table 4).

NHW is a rock shelter on a small limestone ledge located on a high razor-backed ridge at 6°37′ S, 145°43′ E, 475 m from the contemporary village of Ilakia. The site is 1.6 km north of the Lamari River. The single feature is a rock painting (fig. 57).

NHX is an open site located at 6°41′ S, 145°43′ E, at the current village of Mobuta. The surface collection contains chipping detritus and four stone tools (see table 4).

III. Artifacts

Debitage

The largest category of artifacts recovered during the field work is chipping detritus or debitage, which comprises approximately 83 percent of the assemblages.[1] The occurrence of detritus, by site, is shown in table 1, and the ratio of detritus to stone tools in twenty-five assemblages with samples of thirty or more unifacially chipped stone tools, expressed in percentages, is presented in figure 58. Debitage has not been subjected to detailed study in the present analysis, although it may well be warranted in future.

Stone Tools

Excepting debitage, stone tools are the most frequently occurring artifacts in our collection and are found throughout the prehistoric sequence. Thus, it seems essential that they be understood and manipulated. An elemental operation is their classification. Spaulding has noted that "proper classification is . . . paradigmatic classification . . . in which attributes are properly organized into dimensions (sets of mutually exclusive attributes) and the result of the classification properly reported" (Spaulding 1974: 515).

I am not aware of any previous attempts at the present kind of classification of stone tools in New Guinea or the larger areas of which it is a part —Melanesia, Oceania, and Australasia. The approach to classification has been stimulated by the ideas of Robert C. Dunnell (1971a, 1971b), which in turn were influenced by Conklin (1964) and Rouse (1939). Dunnell's work, which he and his students have been elaborating and refining over a period of years, is concerned with the development of a rigorous, nonin-

1. In this study "artifact" is identified as any object which has been culturally modified, that is, modified through human activity.

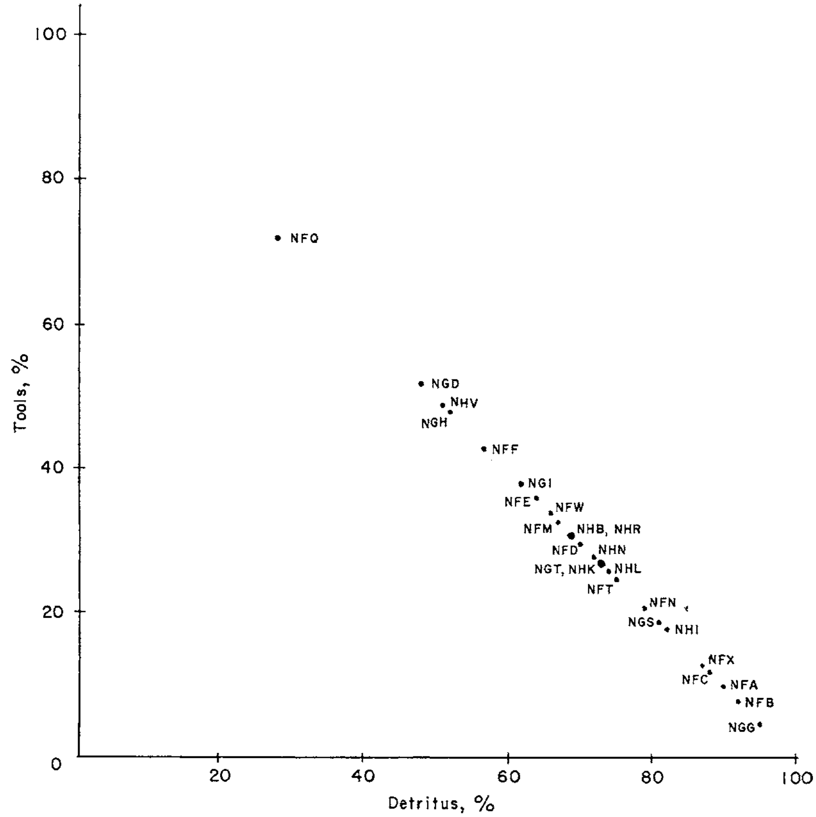


Fig. 58. Ratio of stone tools to detritus in twenty-five assemblages with samples of thirty or more stone tools

tuitive approach to the study of artifacts, one that permits, *inter alia,* a scientific definition of the units with which the prehistorian is concerned. This particular contribution, classification, is of immediate concern to this monograph.

Although much of the analysis represents a new departure, some facets of it are certainly not without historical precedent in Oceania. I note but two cases in point. Over a decade ago, Shawcross, working with New Zealand assemblages, recognized that "edges" had a significance not shared by "repetitive shapes" (Shawcross 1964: 23) and that the angle of an edge on a rock was of greater importance than the shape of the rock itself (ibid.: 17). Subsequently, White, apparently stimulated both by his prior attempts to group New Guinea stone artifacts on the basis of shape and by his ethnographic observations of stone technology in the highlands of New Guinea (White 1967), directed his analysis to the "altered edges" of implements (White 1969: 23). One of White's important contributions to archeology is his acceptance of "edge" as a viable unit of analysis, a precursor to Dunnell's concept of "tool," used here. The concept of "tool" not only arose from a different formal context than did "edge" (Dunnell 1971b) but it is more inclusive, being able to accommodate all kinds of stone tools including those in which edges are not involved, such as hammerstones and whetstones. My analysis, in fact, has much in common with White's, both of them differing in a similar direction from traditional schemes of stone tool analysis. At the same time, it will become clear in the ensuing discussion that the analysis employed here departs from White's in several respects, including an independence from ethnographic analogy and the devising of a classification based on empirically recognizable attributes, which not only accommodates *all* stone tools but has some power for solving problems of New Guinea prehistory.

The classification here reported is based on attributes of objects, classes of which are called "modes."[2] An attribute is a unique occurrence that can be combined with other similar occurrences as members of a class of attributes or mode. For example, the attribute "chipping" on a single object taken in conjunction with the same attribute on a number of objects belongs to the mode "chipping."

Modes, in turn, are organized into mutually exclusive sets referred to as "dimensions."[3] For example, the modes "chipping" and "abrading" belong to the dimension "kind of wear," the modes "unifacial edge" and "bifacial edge" belong to the dimension "location of wear." Classes (commonly referred to as "types") are produced by the intersection of modes, one from each dimension. Thus, the modes *chipping* (dimension: kind of wear) on a *unifacial edge* (dimension: location of wear) which is *symmetric* (dimension: profile of wear) and *concave* (dimension: plan of wear) define one particular type of stone tool, the componential definition of which, in the classification here explicated, is IA1a. All objects exhibiting definitive modes of a class—in other words, the necessary and sufficient conditions for membership in the class—have equal status with each other as class members or denotata.[4]

The kinds of attributes selected as bases for a classification depend, in part, on the use or uses for which the classification is intended. Classes based on attributes of style[5] (historical classes are generally of this kind)

2. The term "mode" refers only to classes of attributes. For example, no "psychological" or "mental" connotations are intended. (Cf. Rouse 1939: 19, "habits," "visual patterns.")

3. Modes and dimensions are defined below, under "Classification."

4. In a paradigmatic classification there is no "ideal type," no "more" or no "less" representative tools of a given type.

5. "Style," as understood here, is not synonymous with "shape," although shape can vary stylistically. Style "is present by and large only in artifacts that are the products of relatively complex manufacturing processes which afford the artisan opportunities for arbitrary choice" (Dunnell and Lewarch 1974: 12-13). Tools do have shape, as is reflected, for example, in my classification in the two dimensions, plan of wear and profile of wear, two attributes associated with wear.

theoretically can provide an adequate basis for chronological studies because styles tend to change through time, often with some rapidity.

Classes based on functional attributes permit activity-related descriptions (for example, the association of stone tools with pottery, earth ovens, and structures), the description of the spatial organization of a site, comparison of assemblages in functional terms, and the delineation of the relationship of environmental and cultural differentiation. Functional attributes can vary through time, although usually with less rapidity and predictability than features of style. When a regional sequence is characterized by significant functional change (as recent archeological studies such as White 1972, as well as the present study, suggest for New Guinea), functional attributes can have chronological significance. In view of the foregoing considerations, I have chosen to produce a classification of stone tools based on functional attributes.

In proposing the method used here, Dunnell has defined the concepts of function and use in specifically prehistoric terms to insure "empirical, identifiable referents in the phenomenological world" (Dunnell 1971b: 34). He defines prehistoric function, a special subset of function, as "the artificial (i.e. cultural) relationship that obtains between an object at whatever scale conceived and its environment, both natural and artificial" (ibid.: 15). Prehistoric use is defined as "the special case of prehistoric function in which the artificial relationship is motion" (ibid.). Because archeologists observe attributes of artifacts, not motion, it is necessary to indicate attributes that are the result of motion. To accomplish this, Dunnell refers to a principle from physics: "When an object moves in a medium, friction occurs which alters the object and the medium through heat and or breakage, among others" (ibid.: 11). He then redefines prehistoric use of an object as wear, or "that set of attributes which results from [an object's] artificial motion through its environment" (ibid.: 17).[6]

The archeological unit meaningful for functional analysis is a *tool*, defined as "the maximal set of co-occurrent functional attributes associated within the boundaries of a single object" (ibid.: 21). This definition permits the identification of tools solely on the basis of empirically recognizable attributes and obviates the necessity to infer function through ethnographic analogy. Moreover, it also allows for the potential multiple use of an object.

In the archeological literature, a "tool" is often regarded as a unique, discrete object. Following White's observation that wear patterns on different parts of the same object are independent instances of use (White 1967: 412), it now seems commonplace that among New Guinea artifacts a single object or rock may include more than one tool, as defined here, re-

6. The definition of wear is ideational and logical, but its recognition in the phenomenological world is problematic and testable. For a set of hypotheses used to test for the correct identification of wear, see Rice 1975: 178-79.

flecting both concurrent use and sequential re-use.[7] In the following discussion the term "tool" is used as defined above while the object on which one or more tools occur will be referred to most often as a "tool-bearing rock," sometimes shortened to "rock" or "object."[8] More explicitly, each tool consists of the co-occurrence of attributes of wear proper, such as chipping or abrading, and attributes associated with wear, such as shape or location of the worn area. For example, a rock surface that has been smoothed through abrading, in a longitudinal, depressed configuration, is one type of tool (i.e., one kind of whetstone; see figure 80b for multiple examples).

In conclusion, it is sufficient to recognize the classes which are based on dimensions related to wear in order to know in what assemblages class members or denotata occur and in what proportions.[9] It is not necessary to distinguish other than broad categories of wear (see below, under "Identification") to infer the use to which a tool was put nor to attempt to know or understand the ideas about the tools which were held by the people who made or used them.

CLASSIFICATION

Four dimensions that have been shown to have functional significance (Hewitt 1973; Rice 1975) have been chosen as the bases for classification: kind of wear, location of wear, profile of wear, and plan of wear. These four by no means exhaust functional attributes of recognized utility; other examples are the relation of wear to an axis of a rock, shape of rock, breakage, hardness of rock, and various measurements. The four dimensions here used consist, respectively, of four, six, six, and six mutually exclusive, exhaustive modes. The intersection of these four dimensions, represented by twenty-two modes, produces 864 classes, twenty-four of which have denotata.

The resulting classification provides categories whose members are individual artifacts. Classes have no empirical existence; they are the artifice of the analyst, enabling her to deal with such problems as distribution which unique artifacts do not permit, since it is the classes, not the individual artifacts, that have distributions.

7. For example, "1,598 edges [i.e., tools] were observed on the 615 stone implements [i.e., objects]" at NBY (Batari) (White 1969: 33).

8. White has recognized the utility of making this distinction. He uses the term "implement . . . to describe the stone *as a whole*," the term "altered edges" to indicate the basic unit of analysis (White 1969: 23). The inadequacy of "altered edge" for our purpose has been indicated above. Because "implement" and "tool" are so often used synonymously in the literature, the former term has not been adopted here.

9. As Dunnell has pointed out, the particular classificatory format followed here has the added descriptive advantage of "creating a large number of classes and tabulating a large number of physical attributes so that as our knowledge of New Guinea increases and with it an appreciation of significant variation," the data presented here can be incorporated in new schemes by "regrouping without extensive restudy" (personal communication).

The major concern in this section is class definition, or the stipulation of attributes which a tool assigned to any class *must* display. Once classes have been defined, nondefinitive attributes are used to describe the members of any class. Descriptions of class members—that is, attributes a tool *may* display—appear in appendix 3.

DIMENSIONS AND MODES USED IN DEFINING STONE TOOL CLASSES[10]

Dimension: Kind of wear (in what manner object has been altered as a result of active contact with its environment through use)

Mode I. Chipping: exhibiting scars resulting from detachment of chips

Mode II. Abrading: exhibiting smoothing and/or striations resulting from rubbing

Mode III. Crushing: exhibiting loss of granular particles of which the rock is composed

Mode IV. Abrading and crushing: exhibiting striations resulting from rubbing in combination with mode III

Dimension: Location of wear (the spatial relationship of wear to an object's structural features)

Mode A. Unifacial edge: a length of two intersecting planes, one of which shows wear

Mode B. Bifacial edge: a length of two intersecting planes, both of which show wear

Mode C. Surface: an external plane showing wear

Mode D. Surface and edge: co-occurrence of wear on one or two external planes and at the intersection of two planes

Mode E. Point and unifacial edge: wear occurring on a point and a contiguous unifacial edge

Mode F. Point and bifacial edge: wear occurring on a point and a contiguous bifacial edge

Dimension: Profile of wear (the shape of the cross section where wear occurs. For objects exhibiting modes A, B, E, and F, cross section is determined on a plane perpendicular to the edge; for objects exhibiting

10. Technically, the model has been violated in that some criteria are not strictly dimensions. Modes IV, D, 6, f, and the infrequently occurring modes E and F, comprise an unanalyzed residue which I have accepted for convenience' sake. Mode D, for example, refers to two locations that bear different kinds of wear. This is to be distinguished from mode A, where one kind of wear, chipping, occurs.

mode C, cross section is determined on a plane perpendicular to the surface)

Mode 1. Symmetric edge: having a correspondence in shape on either side of the axis formed by the intersection of two planes

Mode 2. Asymmetric edge: absence of a correspondence in shape on either side of the axis formed by the intersection of two planes

Mode 3. Concave surface: curving inward

Mode 4. Flat surface: having no concavity or angularity

Mode 5. Convex surface: curving outward

Mode 6. Asymmetric and convex: combination of modes 2 and 5

Dimension: Plan of wear (the shape of the worn area when viewed perpendicular to cross section)[11]

Mode a. Concave: incurvate from the chord[12]

Mode b. Wavy: undulating

Mode c. Straight: extending uniformly without bend or curve

Mode d. Convex: excurvate from the chord

Mode e. Irregular: having no regular shape

Mode f. Convex and irregular: combination of modes d and e

The definition of each class, the number of its members, and the percentage of the total stone tool sample which this represents are presented in table 5. The relative frequency of occurrence of each of the modes in the whole collection of stone tools is shown in figure 92. The relative frequency of occurrence of two modes among the unifacially chipped tools is shown in figure 93.

IDENTIFICATION

Some brief remarks about policy decisions in the process of identification may be useful. All of the rocks collected by the project field party from archeological contexts in the study area have been examined and all that display wear have been included. This is essentially a macroscopic study: no greater magnification than a 2 × magnifying glass has been

11. If unifacially and bifacially chipped tools were the only ones being identified, the term "plan of worn edge" could be substituted.

12. The reader should not be confused by the duplication of terms in the definition of modes of the two dimensions, "profile of wear" and "plan of wear." For example, mode 3 would refer to the concave *surface* of a whetstone, whereas mode a refers to the concave configuration of a unifacially or bifacially chipped *edge*.

TABLE 5

STONE TOOL CLASS DEFINITIONS

Tool Type	Definitive Modes: Kind of Wear	Location of Wear	Profile of Wear	Plan of Wear	No. of Tools	% of Total (3,674)
IA1a	chipping	unifacial edge	symmetric	concave	603	16.2
IA1b	chipping	unifacial edge	symmetric	wavy	21	0.6
IA1c	chipping	unifacial edge	symmetric	straight	104	2.8
IA1d	chipping	unifacial edge	symmetric	convex	323	8.8
IA2a	chipping	unifacial edge	asymmetric	concave	1544	42.0
IA2b	chipping	unifacial edge	asymmetric	wavy	292	8.0
IA2c	chipping	unifacial edge	asymmetric	straight	68	1.9
IA2d	chipping	unifacial edge	asymmetric	convex	367	10.0
IB1a	chipping	bifacial edge	symmetric	concave	19	0.5
IB1c	chipping	bifacial edge	symmetric	straight	10	0.3
IB1d	chipping	bifacial edge	symmetric	convex	9	0.2
IB2a	chipping	bifacial edge	asymmetric	concave	7	0.2
IB2d	chipping	bifacial edge	asymmetric	convex	16	0.4
IE2d	chipping	point/unifacial edge	asymmetric	convex	78	2.0
IF1d	chipping	point/bifacial edge	symmetric	convex	15	0.4
IIC3c	abrading	surface	concave	longitudinal	16	0.4
IIC3e	abrading	surface	concave	irregular	12	0.3
IIIB2a	crushing	bifacial edge	asymmetric	concave	10	0.3
IIIB2c	crushing	bifacial edge	asymmetric	straight	18	0.5
IIIB2d	crushing	bifacial edge	asymmetric	convex	9	0.2
IIIC3e	crushing	surface	concave	irregular	17	0.5
IIIC4e	crushing	surface	flat	irregular	9	0.2
IIIC5e	crushing	surface	convex	irregular	8	0.2
IVD6f	abrading/ crushing	surface/ edge	asymmetric/ convex	convex/ irregular	99*	2.7

NOTE: Illustrations of tool types are found in the following figures: IA1a, figs. 59a, 59b, 60-64; IA1c, figs. 59c, 59d, 65; IA1d, figs. 66a, 66b, 67; IA2a, figs. 68-73; IA2b, figs. 74c, 75; IA2d, figs. 74d, 76; IB1a, figs. 77a, 77b; IB1c, figs. 77c, 77d, 78; IE2d, fig. 79a; IIC3c, figs. 80b, 81, 82; IIC3e, figs. 80a, 83, 84; IIIB2a, fig. 85; IIIB2c, fig. 79b; IIIC3e, fig. 86; IIIC4e, fig. 79c; IVD6f, figs. 87a, 87b, 87c, 88a, 88b, 89, 90, 91.

*Of the ninety-nine tools identified as type IVD6f, seventy-two have a complete or fragmentary worn edge and surface. Crushing on the edge is visible on sixty-nine of these; evidence of abrading wear is visible on thirty tools, is faint, but indicated, on thirty-two tools, and is not visible on ten tools. For those tools which show no evidence of surface abrading but have crushing wear on edge, as well as those tools which exhibit no wear, membership in class IVD6f is inferred if they are morphologically similar to members of the class because only one defined class has such a form.

used in observing wear patterns. I do not mean to gainsay the potential which microscopic study may hold; my procedure merely reflects a practical tactical decision.

Some biases were introduced in the identification of wear, including fatigue and eyestrain. Also, it was sometimes necessary to make arbitrary decisions to include, or not, cases of minimal wear. In the analysis I have been conservative: if I have erred in the decisions concerning doubtful cases, it is in the direction of excluding rocks which may have tools on them, rather than in the opposite direction of including rocks which do not bear tools. Breakage was not accounted for: what may be broken or incomplete worn edges, for example, were classified according to the wear observed. Because the procedure was followed consistently, the bias is probably minimal. In future analysis, however, it might be worthwhile to note the occurrence of broken tools and examine the distributions including and excluding them, to test the hypothesis that wear correlates with patterns of breakage. It should be emphasized that to the extent that it is possible I have made a consistent application of the definitions to all of the rocks in the collection.

My assessment of wear should also be qualified.[13] With respect to chipping wear, no distinction is made among sizes and shapes of chip or flake scars.[14] In other words, no discrimination has been made between "step flaking," "nibbling," "chattering," "snap fracture," or other well- or ill-defined kinds of chipping. All nonrandom chipping that occurs regularly on a rock is accepted as evidence of chipping wear. (Figures 60-63, 65, 69-72, and 78 show examples of chipping wear.) A single chip or two is not accepted as wear, for such chipping could have resulted from breakage by natural action or during transport.

The size of the particles of rock removed from the tools by crushing wear is irrelevant in this classification.[15] (Figures 86 and 87 show crushing wear.) No distinction is made between crushing and battering (the latter term sometimes applied to wear evidence in which large particles have been dislodged from the rock). Another distinction wherein "crushing" is applied to this particular kind of wear evidence occurring on edges and "battering" is applied to the same kind of wear on surfaces, is not made.

Abrading wear, depending upon the abrading medium, may have different results. Truncation of irregularities on a rock results in smoothing. If a hard particle is introduced between the rock and the medium, however, abrading wear may result in gouging, with striations being cut into the rock. On whetstones, for example, smoothing is the definitive feature (figs. 81-84), while on adzes, striations are the definitive feature (fig. 85).[16] Excessive abrading may produce high gloss, to be distinguished from polish, which is here accepted as evidence of the result of chemical change in the rock. Although high gloss has been observed on two bifacially chipped tools (fig. 78) and on the horizontal arrises on a few rocks on which unifacially chipped tools with asymmetric profiles occur, this attribute has not been utilized in the present analysis.

13. No inferential discrimination has been made between wear and "retouch," nor between the results of use and manufacture (but see note 18, this chapter).

14. The term "flaking" might be substituted for "chipping." In some archeological contexts and in common parlance "chip" and "flake" are synonymous (e.g., *American Heritage Dictionary,* 1975, p. 498). Because "flake" also has a special definition in archeology, "chipping" is here used to include the removal of both "chips" and "flakes" as technically defined.

15. Crushing wear is sometimes referred to as "pecking."

16. An alternative procedure would be to convert abrading into two separate modes.

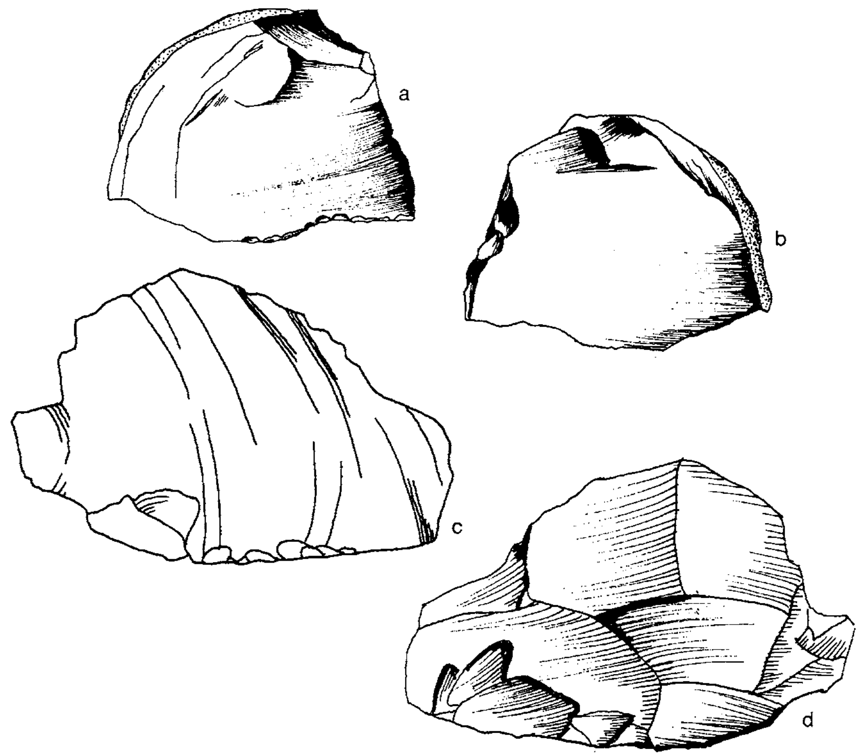


Fig. 59. Tool sketches. a: type IA1a, top view, 2X actual size, NFB/1735; b: type IA1a, bottom view, 2X actual size, NFB/1735; c: type IA1c, top view, 2X actual size, NFX/113; d: type IA1c, bottom view, 2X actual size, NFX/113

Crushing wear and abrading wear occur in combination on the members of one tool type (see note 10, above): crushing wear occurs on an edge, and abrading wear, in the form of striations on the rock rather than smoothing, occurs on the surface(s).[17]

Since this particular classificatory format is being applied for the first time to New Guinea stone tools, it is important to be precise in labeling tool types. Because there are no morphological terms that can embrace all of the tool types, nor are discrete functional terms adequate, the componential definition of each class is used as name or label.[18] This may seem

17. The crushing wear on the edge of these tools is often present and easy to detect. Abrading wear on the surface of the rock resulting in striations is often less easy to detect. Smoothing results of abrading are part of the manufacturing process of type IVD6f tools but usually can be distinguished from abrading through use.

18. This position differs from that taken by some investigators. Lampert, for one example, uses the term "scraper" as the label for "all implements usually classified by archeologists as scrapers, whatever their actual use might have been" (Lampert 1971: 16).

Fig. 60. Chipping wear on type IA1a tool, 1.4X actual size, NFQ/14

Fig. 61. Chipping wear on type IA1a tool, 1.2X actual size, NFW/12

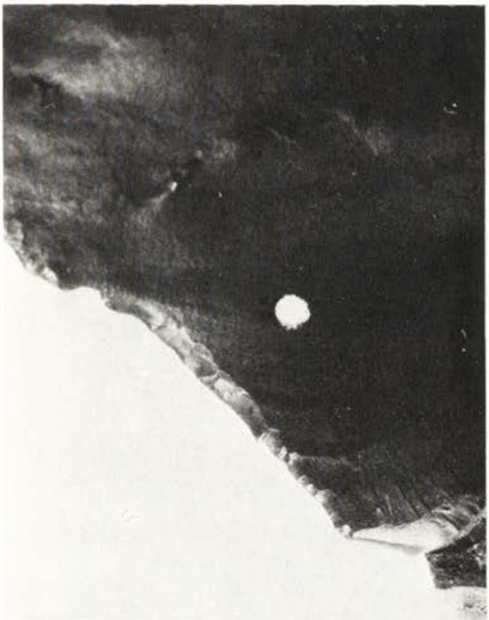


Fig. 62. Chipping wear on type IA1a tool, 4.3X actual size, NFB/1621

Fig. 63. Chipping wear on type IA1a tool (below dot), 3.4X actual size, NFB/1713

Fig. 64. Sample of rocks bearing type IA1a tools. Left to right, top to bottom: NFN/8, NFX/215, NGG/81; NFI/2, NHN/20, NGT/17; NFD/13, NFB/1457, NGG/2, NFX/157; NHI/76, NFM/23, NFB/1483, NGG/44; NFB/1196, NFT/15, NGG/646, NFD/68; NFF/33, NFD/26, NFB/1499, NFB/1694; NFB/1348, NFB/1214, NFC/6, NFB/1546

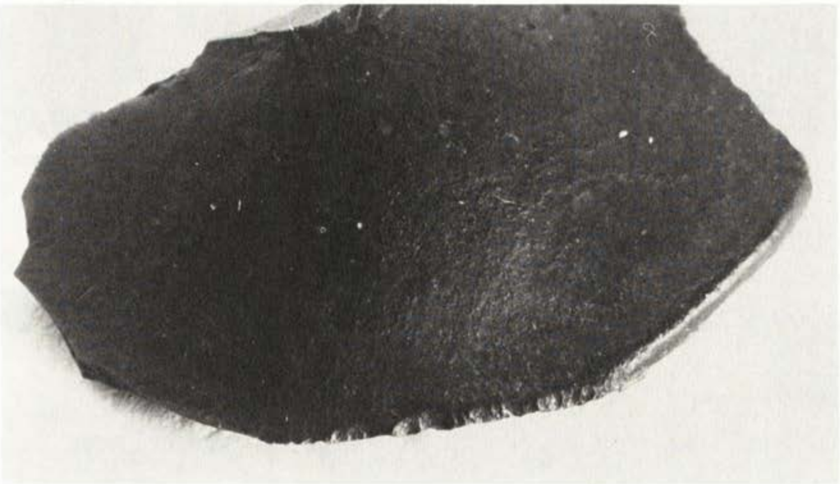


Fig. 65. Chipping wear on type IA1c tool, 5.6X actual size, Tab 1

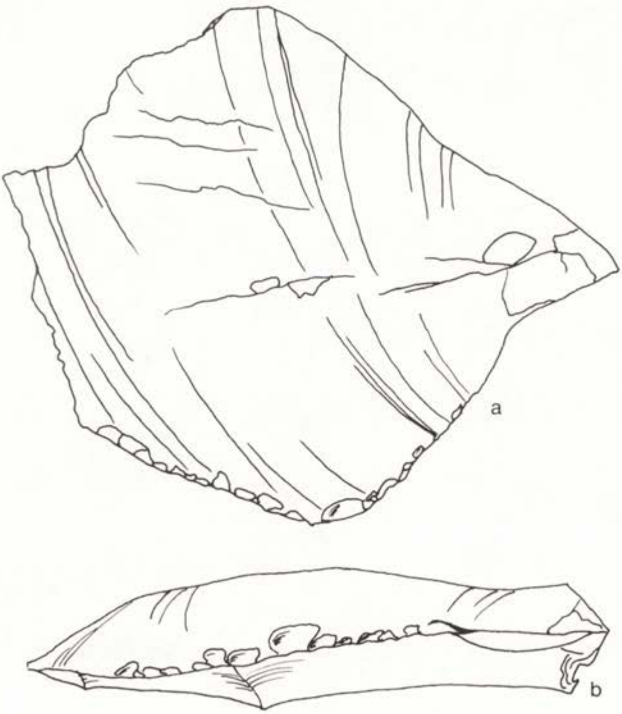


Fig. 66. Tool sketches. a: type IA1d, top view, 1.75X actual size, NFQ/11; b: type IA1d, side view, 1.75X actual size, NFQ/11

Fig. 67. Sample of rocks bearing type IA1d tools. Left to right, top to bottom: NGG/66, ME 608/3, NFM/28; NFZ/6, NHE/31, ME 597/8; ME 608/6, NFZ/18, NFW/4; NGG/8, ME 588/11, NHQ/16, NFF/5; NGA/12, NFZ/102, Th/4, NFD/23, NGI/9; NFT/38, NFA/5, NFB/1179, NFN/41, Tt/8

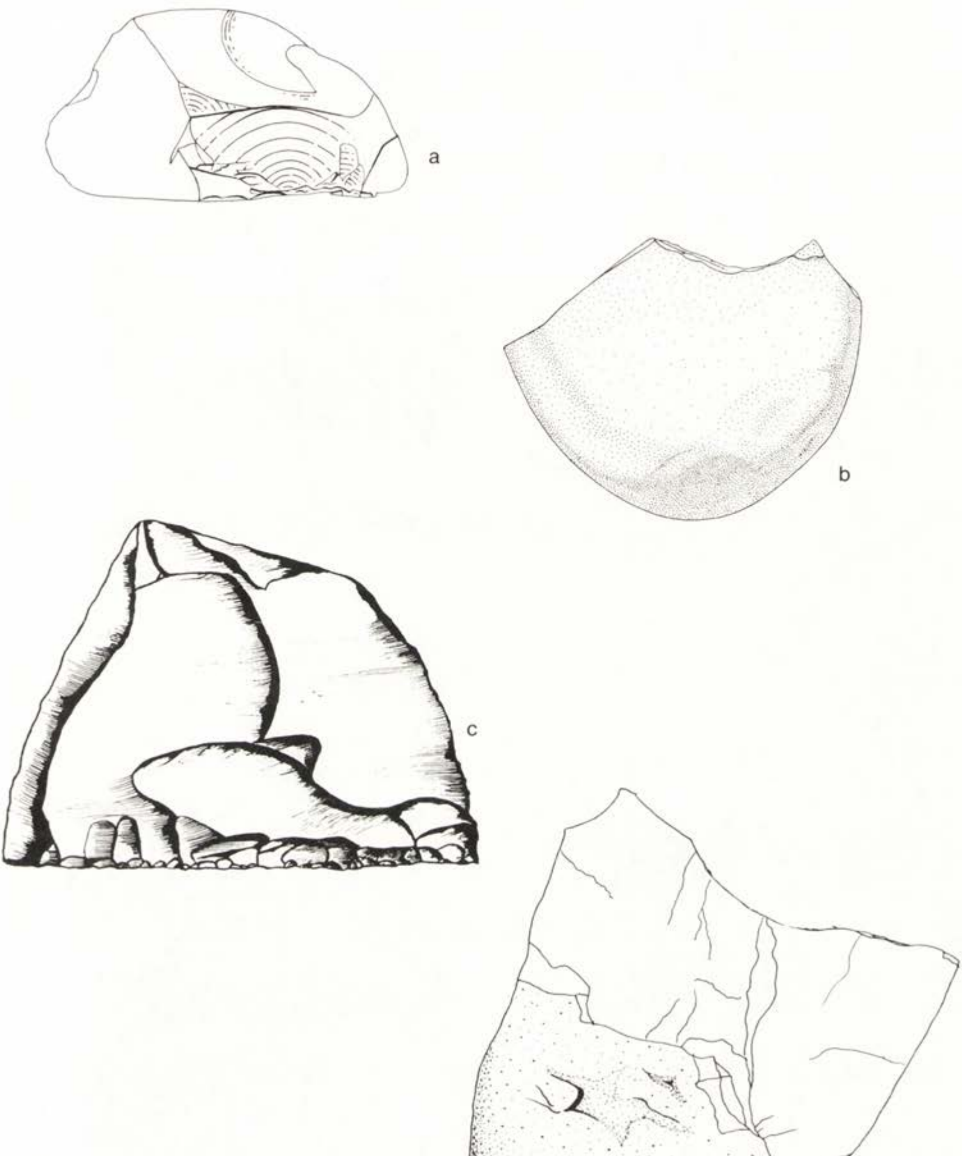


Fig. 68. Tool sketches. a: type IA2a, side view, 1.2X actual size, NGG/275; b: type IA2a, bottom view, 1.2X actual size, NGG/275; c: type IA2a, side view (concave plan not evident), 1.2X actual size, NGG/312; d: type IA2a, bottom view, 1.2X actual size, NGG/312

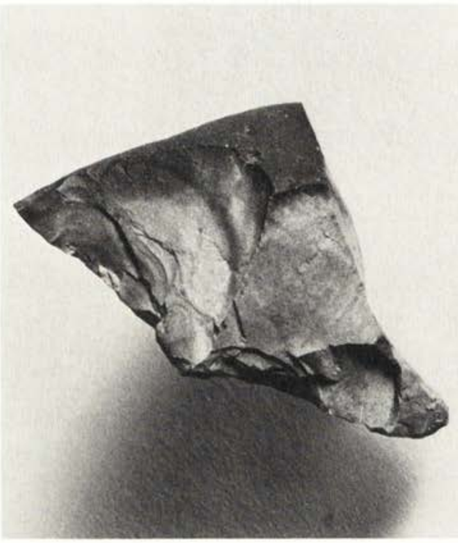


Fig 69. Chipping wear on type IA2a tool, approx. actual size, NGG/1

Fig. 70. Chipping wear on type IA2a tool, approx. actual size, NFX/122

Fig. 71. Chipping wear on type IA2a tool, 1.4X actual size, NGI/7

Fig. 72. Chipping wear on type IA2a tool, approx. actual size, NGG/4

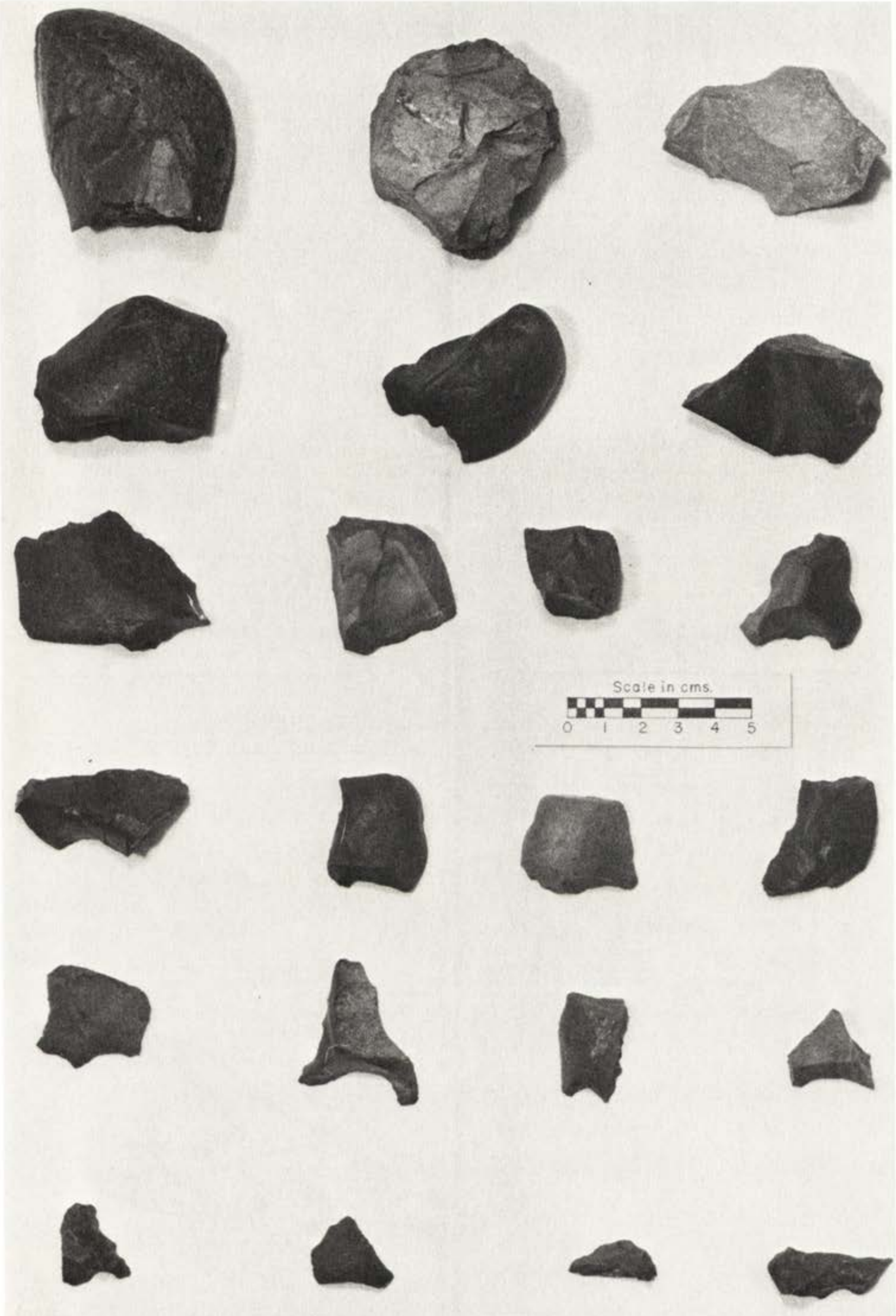


Fig. 73. Sample of rocks bearing type IA2a tools. Left to right, top to bottom: NGG/80, NHL/23, NFX/154; NGG/318, NGG/299, NGG/287; NGG/303, NFX/12, NGH/24, NFT/2; NFQ/23, NGG/254, NHL/11, NGG/340; NGG/462, NGG/4, NFC/95, NGG/278; ME 594/25, NFC/43, NFB/1810, NGG/509

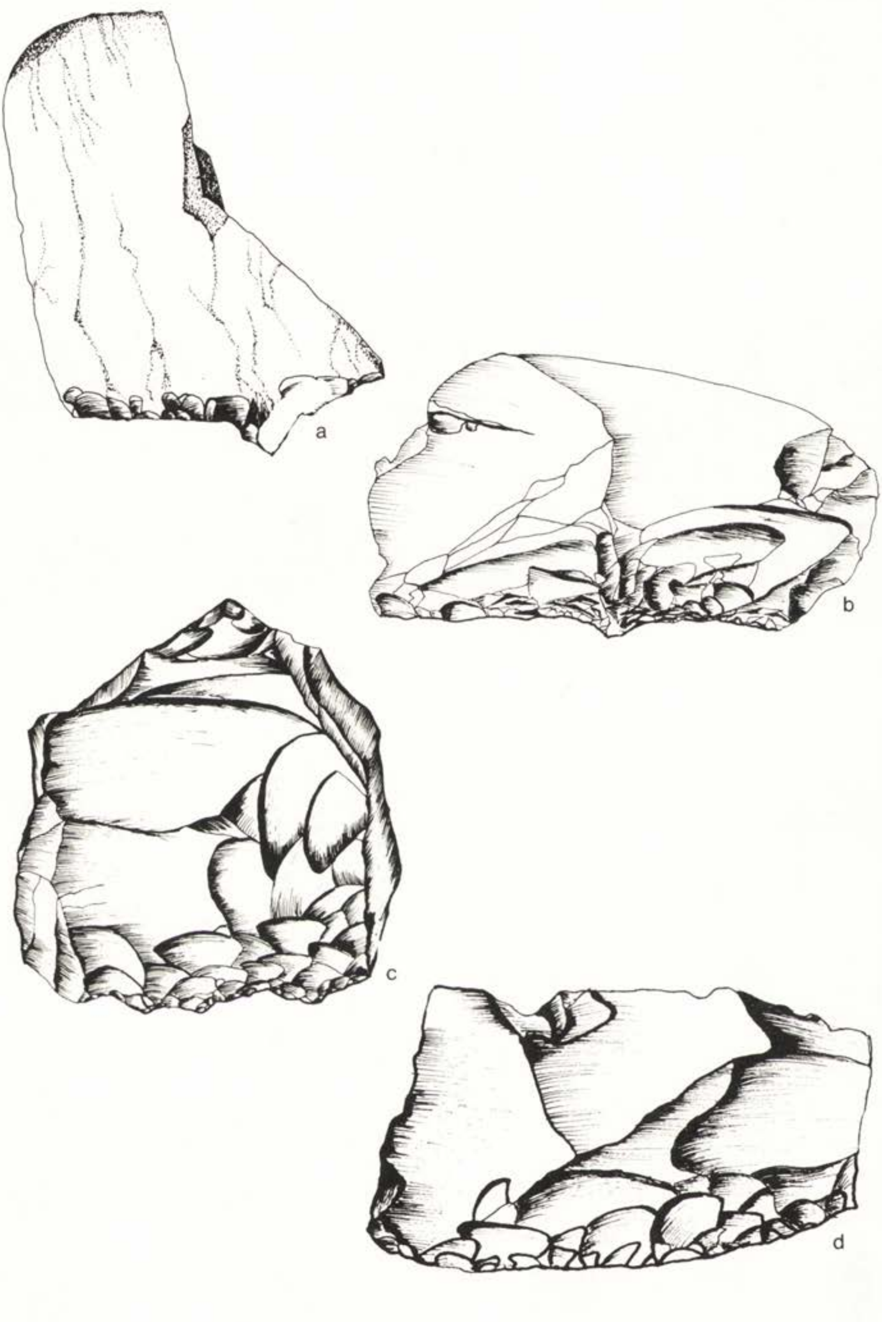


Fig. 74. Tool sketches. a: type IA2a, top view, 1.3X actual size, NGL/5; b: type IA2a, 1.3X actual size (two tools), NFX/122; c: type IA2b, 1.3X actual size, NHR/18; d: IA2d, side view, 2X actual size, NGS/5

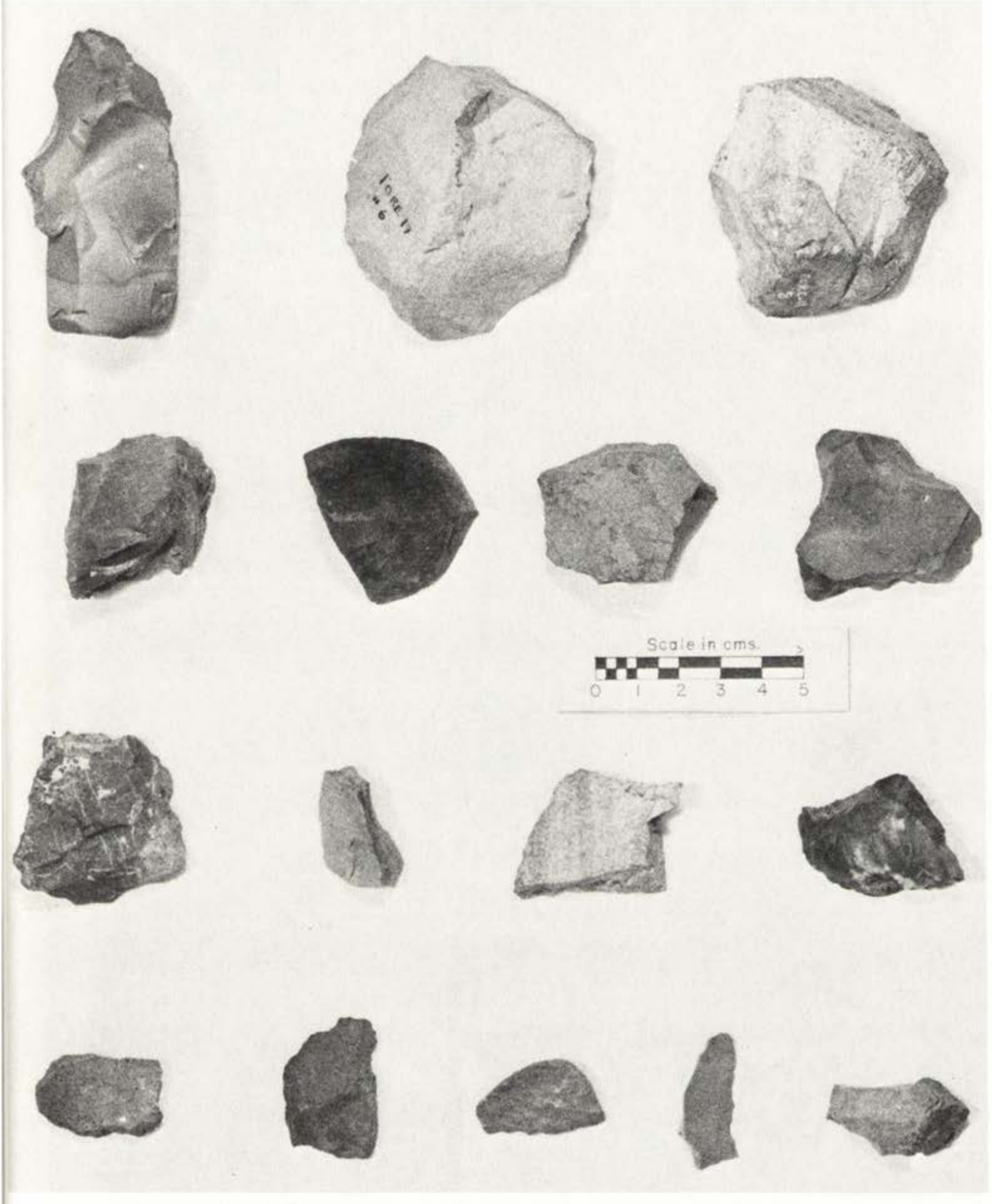


Fig. 75. Sample of rocks bearing type IA2b tools. Left to right, top to bottom: NHG/4, NHV/6, NHQ/8; NHN/102, NHN/23, NHN/68, NHS/1; NHN/80, NHL/107, NHQ/11, NHL/108; NHN/43, NHL/63, NHQ/5, NHL/55, NHK/28

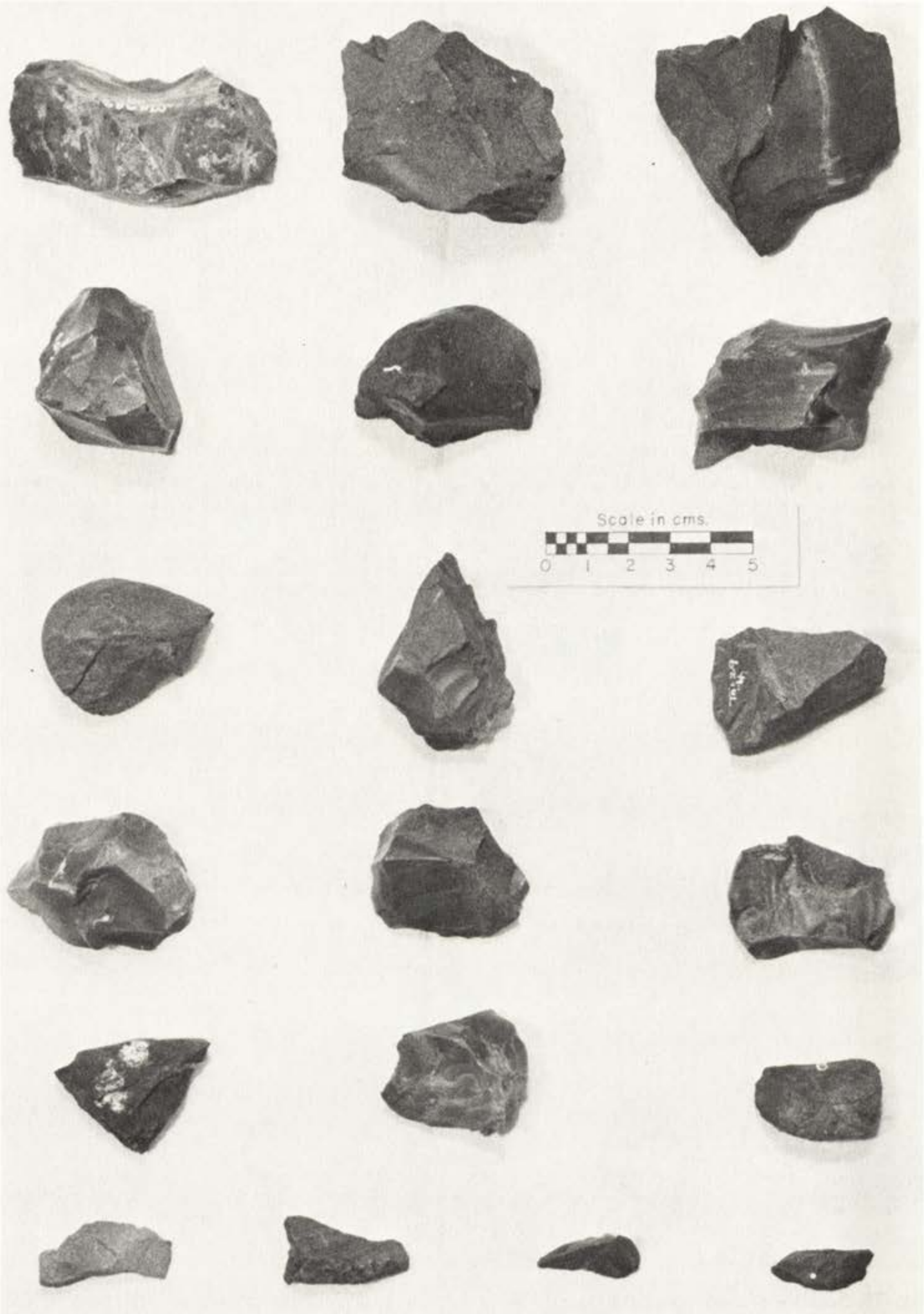


Fig. 76. Sample of rocks bearing type IA2d tools. Left to right, top to bottom: ME 588/10, ME 567/8, NHB/6; ME 600/3, NGJ/24, ME 608/1; NGG/488, NFZ/3, NGH/4; NFX/218, NFF/47, NFZ/41; NHB/47, NFN/50, ME 594/8; NFQ/8, Taz/5, ME 597/1, NFB/1473

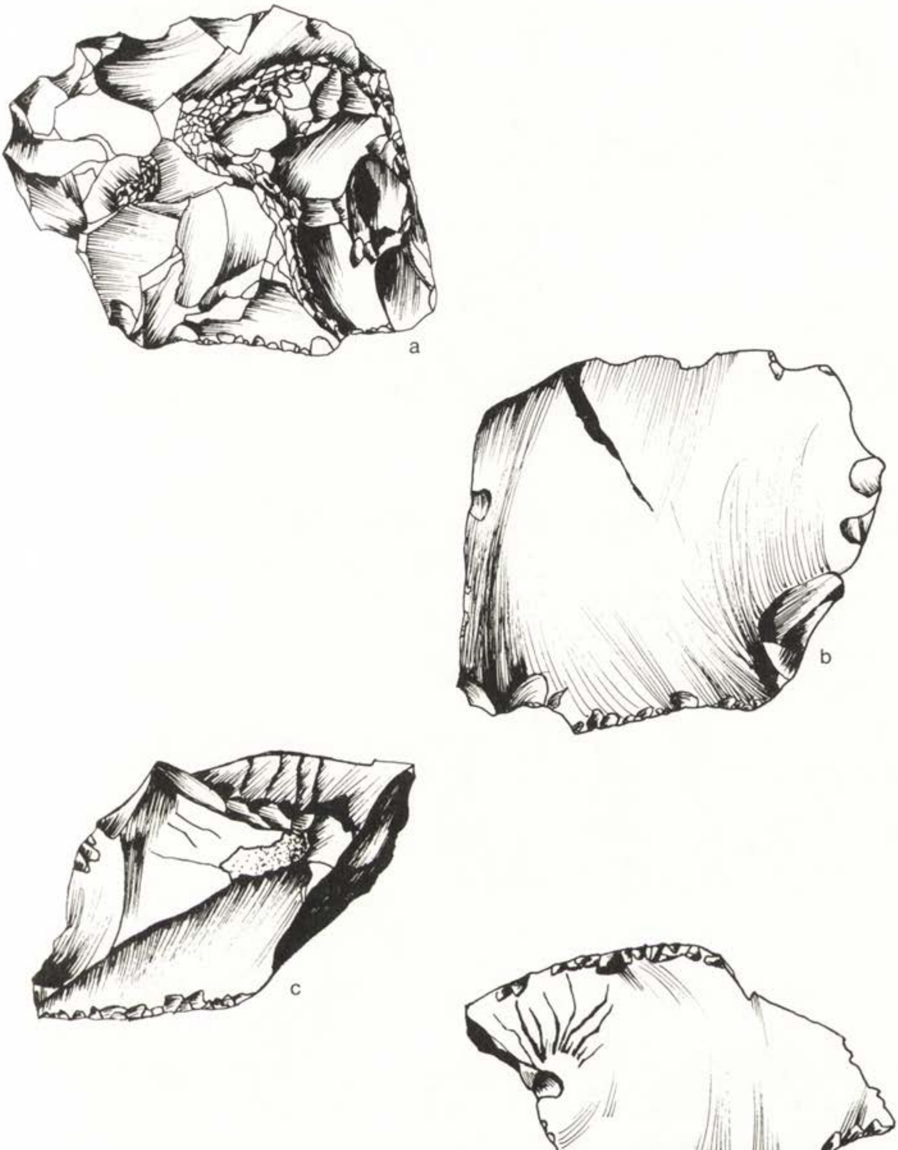


Fig. 77. Tool sketches. a: type IB1a, top view, .75X actual size, ME 597/5; b: type IB1a, bottom view, .75X actual size, ME 597/5; c: type IB1c, top view, actual size, ME 598/5; d: type IB1c, bottom view, actual size, ME 598/5

Fig. 78. Chipping wear with high gloss on type IB1c tool, 2X actual size, ME 591/2

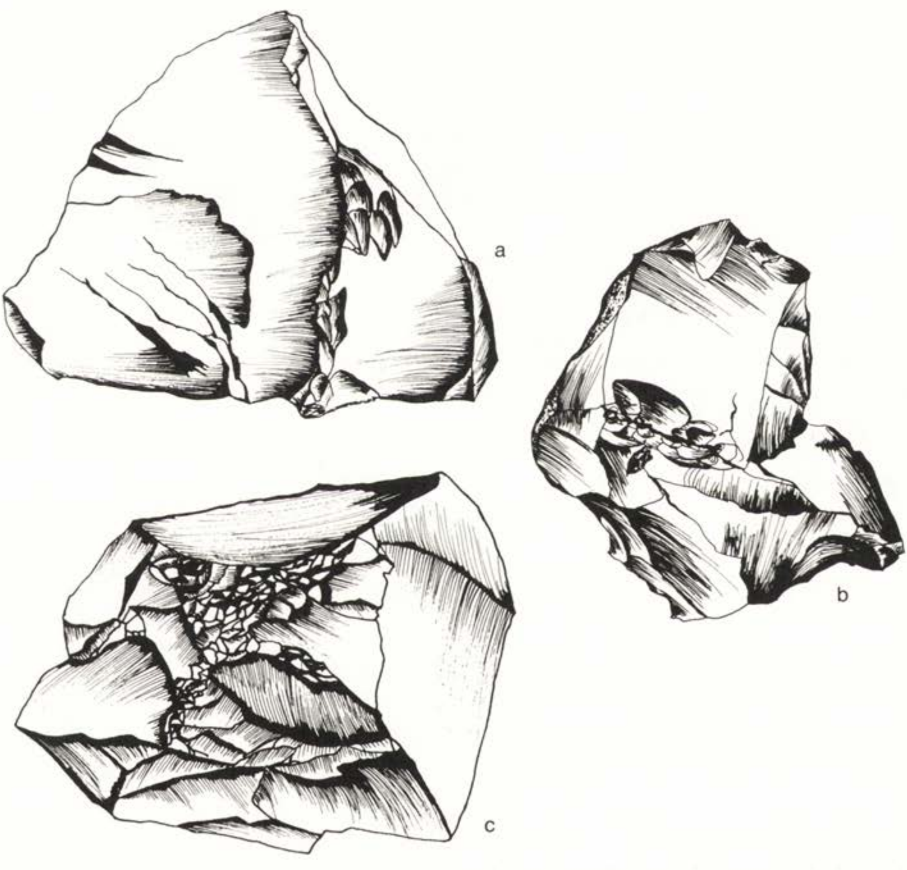


Fig. 79. Tool sketches. a: type IE2d, 1.3X actual size, NFF/27; b: type IIIB2c, top view, 1.3X actual size, NFZ/15; c: type IIIC4e, 1.3X actual size, NHL/105

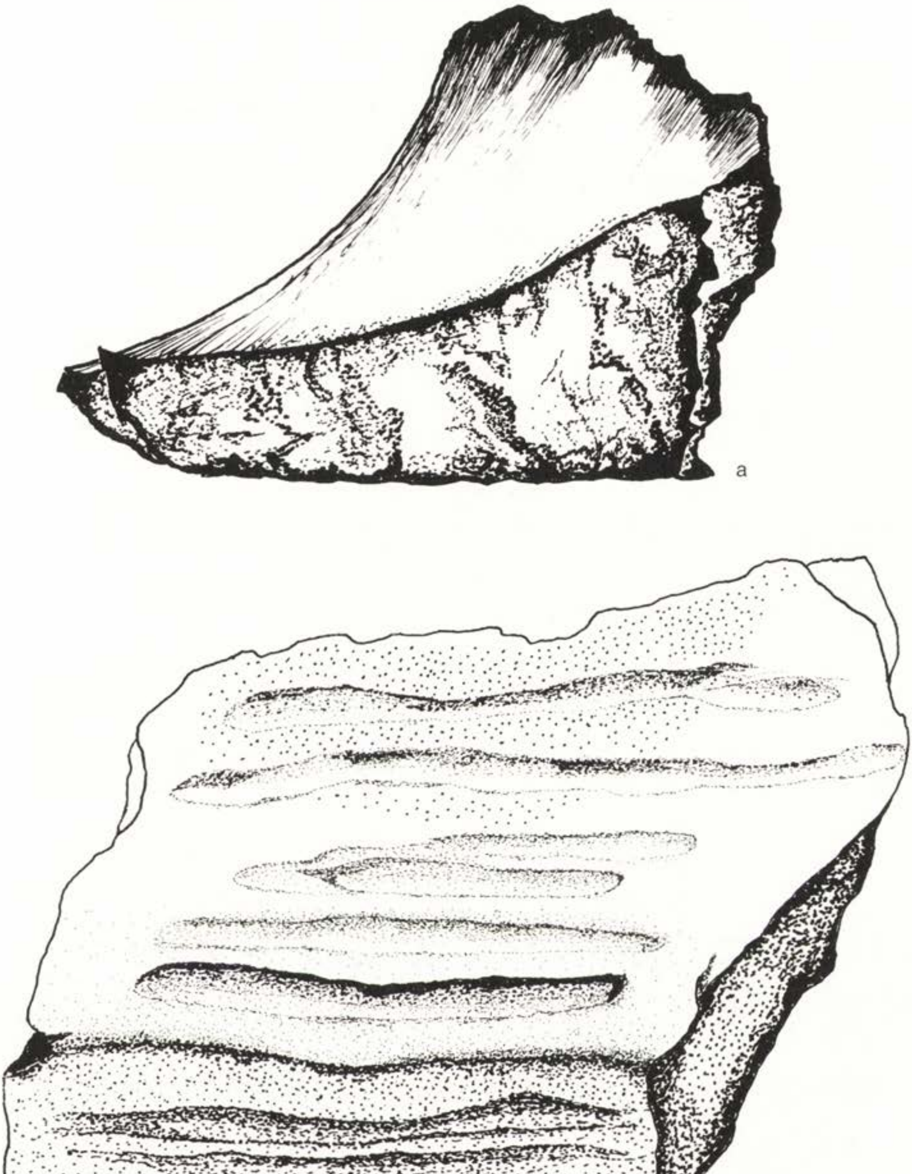


Fig. 80. Tool sketches. a: type IIC3e, 1.3X actual size, NGM/119; b: type IIC3c, .88X actual size (9 tools), NHQ/25

Fig. 81. Abrading wear on type IIC3c tool, NHQ/25

Fig. 82. Abrading wear on type IIC3c tool, NFB/1771

Fig. 83. Left: abrading wear on type IIC3e tool, NGM/119; right: abrading wear on type IIC3e tool, NFB/3000.

Fig. 84. Abrading wear on type IIC3e tool, ME 824.

Fig. 85. Abrading wear on surface (note striations perpendicular to cutting edge), chipping wear on edge, type IVD6f tool, NFN/2

Fig. 86. Crushing wear on type IIIB2a tool, 2.1X actual size, ME 506/1

Fig. 87. Crushing wear on type IIIC3e tool, 2.1X actual size, NFC/1

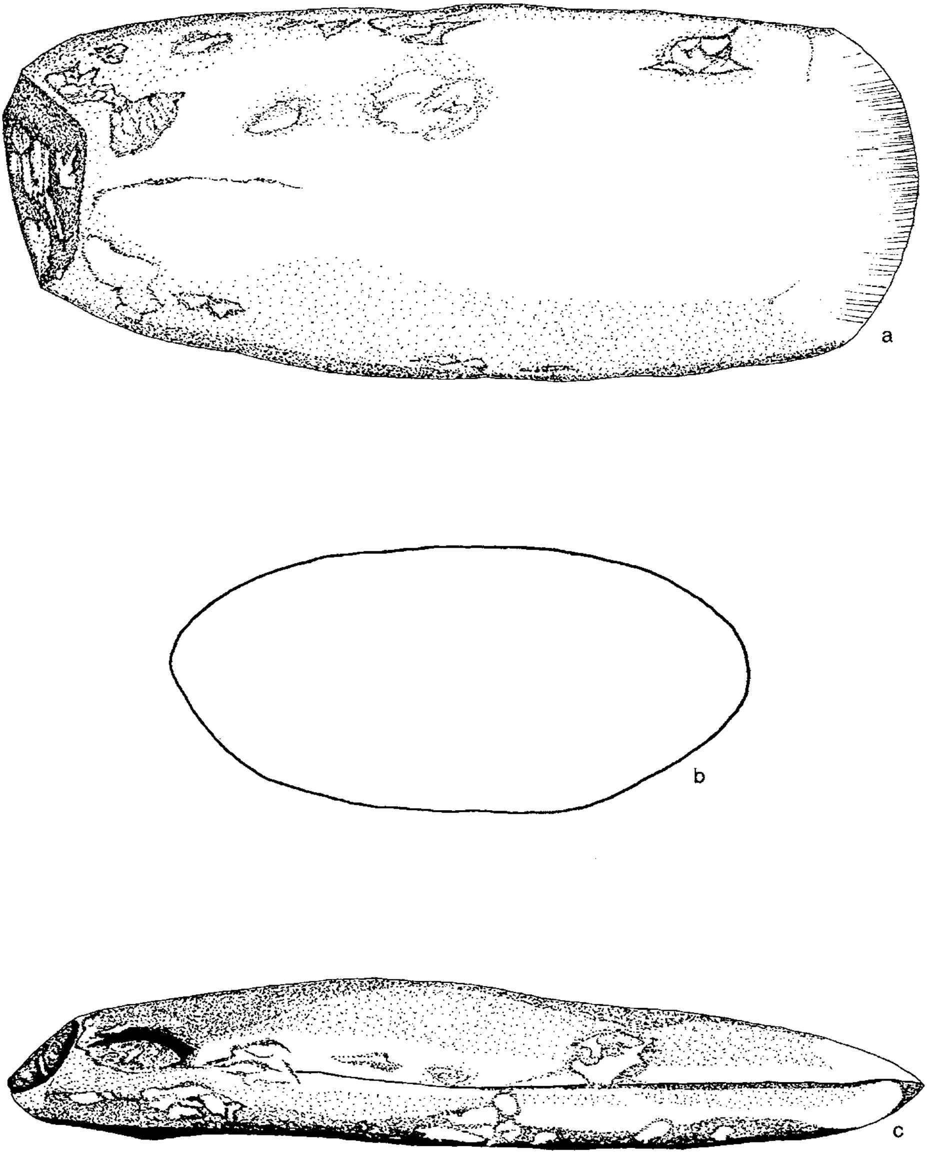


Fig. 88. Tool sketches. a: type IVD6f, .64X actual size (note striations perpendicular to cutting edge), NFA/22; b: type IVD6f, actual size, cross section at mid-section, NFA/22; c: type IVD6f, side view, .64X actual size, NFA/22

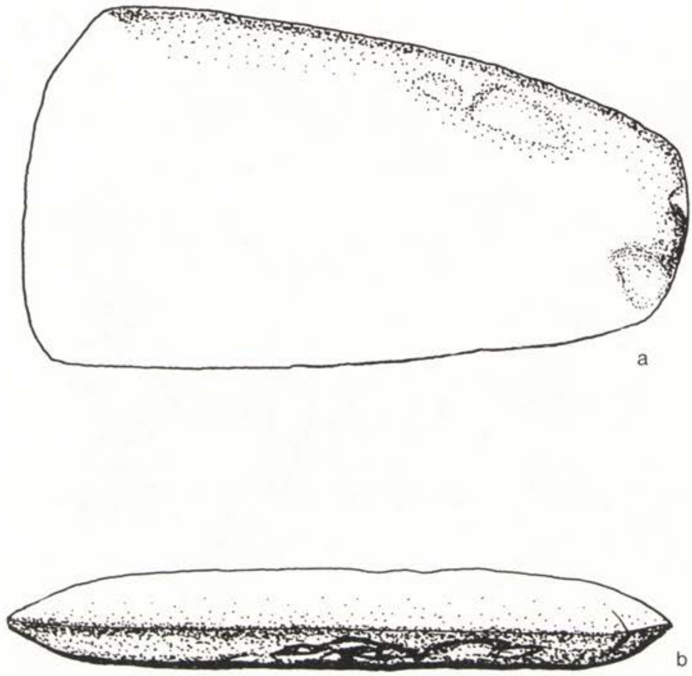


Fig. 89. Tool sketches. a: type IVD6f, top view, actual size, no wear marks, very weathered, NFB/823; b: type IVD6f, side view, actual size, NFB/823

Fig. 90. Examples of type IVD6f tools. Tools in top row are very weathered; tool on right, middle row, also bears one type IA2a tool. Left to right, top to bottom: NFA/ME 821, ME 816, NFD/100, NFB/823; NHR/4, NHN/2, NHQ/24; NHR/2

Fig. 91. Examples of type IVD6f tools. Left to right, top to bottom: NHB/21, NHL/14, NHR/8; NHB/19, NFB/4, NFA/ME 813; NFN/3

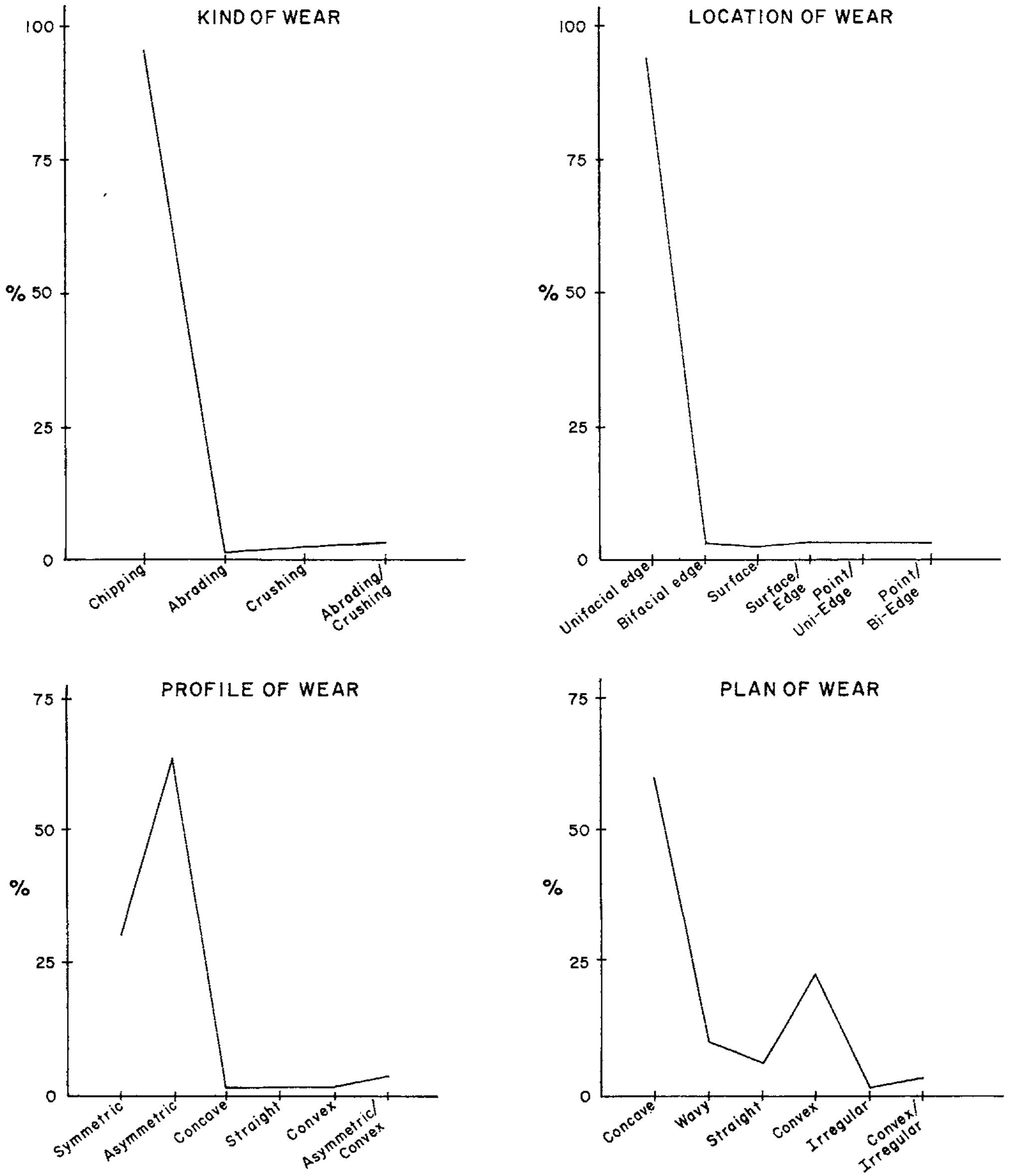


Fig. 92. Definitive modes as percentage of total tool inventory (total = 3,674)

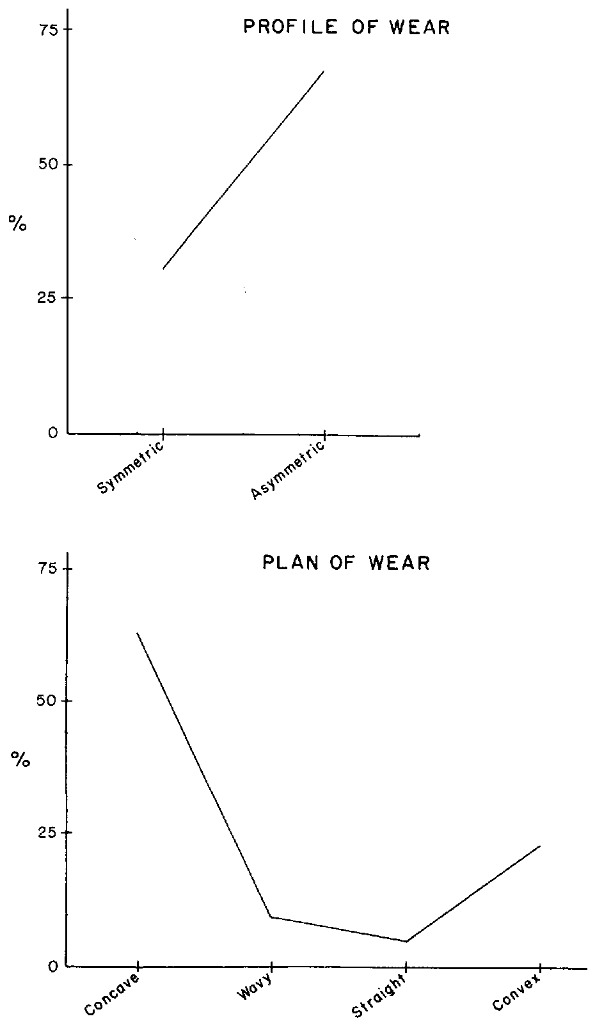


Fig. 93. Definitive modes as percentage of unifacially chipped stone tools (total = 3,400)

cumbersome, yet it is the most accurate descriptive device available and it provides a high degree of consistency. The reader is urged, therefore, to have forebearance and to accept these designations.

It is not essential to this study to infer the uses of the different types of tools; rather, it is sufficient to recognize the classes in order to know in what assemblages class members occur and in what proportions. In the interest of conforming with traditional practice, however, I make some inferences and often use the resulting terms in the discussion, even though the componential definition has priority. Types IE2d and IF1d are inferred to be "points." Types IIC3c and IIC3e are inferred to be "whetstones." Types IIIC3e, IIIC4e, and IIIC5e are inferred to be "hammerstones." Type IVD6f is inferred to be an "adz" on the basis that the visible wear striations on the surface are perpendicular to the working edge of the tool (see figs. 85, 88a) (Born 1971; Semenov 1964; Sonnenfeld 1962).[19] At two sites, NFB and NFC, fragments of rock which some archeologists might term ax or adz flakes or chips occur. They are not included here because they do not display definitive wear nor is enough rock present to infer their membership in class IVD6f on the basis of form. No inference is made about the uses of bifacially chipped tools (types IB1a, IB1c, IB1d, IB2a, and IB2d) or of bifacially crushed tools (types IIIB2a, IIIB2c, and IIIB2d). No attempt is made to differentiate among the unifacially chipped stone tools (types IA1a, IA1b, IA1c, IA1d, IA2a, IA2b, IA2c, and IA2d). Different types doubtless served different purposes, including what may loosely be termed "scraping" activity, as well as more specific woodworking tasks (Bartlett 1964; Frison 1968; Gould, Koster, and Sontz 1971; Hester, Gilbow, and Albee 1973; Newcomer 1974; Nissen and Dittemore 1974; Strathern 1969; White 1968; Wilmsen 1968, 1970).

That the terms used here differ from those commonly employed in the literature in no way implies that the tools being analyzed differ from some kinds that have been found in quantity in New Guinea and related areas. To my knowledge there is, however, no extant terminology adequate to distinguish all of the types here defined. Of perhaps greater significance is the fact that the identifying attributes used in some common terms are not definitive attributes in this classification, although they may be used as descriptive attributes. One example is "steep-edge scraper": size of edge angle is a descriptive, not a definitive, attribute in the scheme presented here. Admitting my reluctance to have the defined tool types categorized with or locked in existing terminology, in deference to the reader some general concordances are indicated. It is strongly urged that these be used merely as guides to initial orientation and not as an indication of equivalence.

19. The occurrence of axes cannot be ruled out in view of the absence of abrading wear marks on some tools (see note 13). No visible wear suggests axes, however, so there is no class whose members are inferred to be axes.

Generally, many of our unifacially chipped stone tools would be included in the term "miscellaneous scrapers" (White 1969: 19). Furthermore, there is some concordance between "unretouched edge" (ibid.: 40), "used edges," "utilised tools" (White 1972: 8), and type IA1 (a, b[?], c, d) tools. There is also some concordance between "retouched edge" (ibid.: 8), "steep-edge scraper" (Jones 1973: 280), and some type IA2 (a, b[?], c, d) tools. Although it seems apparent from the literature that steep-edge scrapers are type IA2 (a, c[?], d[?]) tools, not all type IA2 (a, c, d) tools are steep-edge scrapers. (All of the type IA2– tools do have asymmetric profiles, however.) In other words, "asymmetric" and "steep" are not synonymous. The distribution of edge-angle size (steepness) is indicated in figure 117, appendix 3. "Double-concave scrapers," which occur infrequently in our collection, are identified as two occurrences of type IA2a tools (there is no wear on the protruberance of rock between the two occurrences of chipping wear, thus permitting the identification of two tools).

Although this classification has proved to be applicable in the present work, I would be the first to acknowledge that it is not the only viable one or that it can be improved. For example, in the selection of *definitive* modes it might be productive to distinguish between manufactured and nonmanufactured artifacts, or to distinguish among structural characteristics of the tool-bearing rock, such as flake, core, chunk, or pebble. It might be useful to include artifacts with no wear (e.g., debitage); or, at the other extreme, because unifacially chipped stone tools are so much commoner than other stone tools, it might be efficient to limit a classification to them (V. Watson 1976). Different kinds of classifications may be devised for different kinds of problems. Regardless of which modes are selected for class definition, it is essential that all of the definitive modes be applied to all of the objects being identified.

As the dimensions and modes used for definition proliferate, so do the classes and attendant unwieldiness of the classification. It is possible to test various choices. Hewitt, for example, working with data from three sites in West Virginia, initially chose eight dimensions, combinations of the modes of which produced 120,000 possible classes. He then conducted tests to reduce the number of distinctions to those that were most useful in minimizing the apparent overdifferentiation of attributes (Hewitt 1973: 67). Furthermore, he determined which dimensions and modes were most significant for functional analysis, using, among others, the method of dimensional withdrawal and statistical evaluation of modes within a dimension (e.g., chi-square test and phi coefficient or prime). His work indicates that the dimensions and modes used in the present analysis are among the more significant (ibid.: 90), which is not to gainsay the prudence of conducting similar tests on New Guinea data.

Other Artifacts

Stone tools and debitage constitute by far the greatest proportion, approximately 99 percent, of all assemblages. Other artifacts occur in some assemblages, although in very small numbers. Because of their infrequency and the small degree of variability demonstrated by many of them, organization similar to that used for stone tools is neither possible nor useful; they are itemized by site in table 2. Four broadly functional categories—pottery, structures, hearths, and earth ovens—would seem to warrant more detailed treatment. They occur in sufficient numbers and include enough variability for an attempt at preliminary or provisional classification which may help with the interpretation of our data as well as to serve as stimulus to future refinement or elaboration.[20]

Pottery

Three hundred thirty-two fragments of pottery, 247 of them with a maximum diameter of less than 2 cm, were recovered from eight sites. The pottery is too fragmentary for stylistic analysis, the traditional archeological method for treating pottery. There are, for example, no whole vessels, and decoration and rim sherds are too rare to be of significant value for definitive purposes, although they are used in the descriptions. Thus, an attempt to choose attributes to be used in definition and description is severely hampered; the choice of modes, unlike that in the case of stone tools, has been influenced more by the modes that are present than by the use that is to be made of the classification.

I have selected two dimensions which attend coarseness as the basis for classification of pottery fragments: thickness, or the maximum measurement of the sherd at right angles to the length/breadth, and size of inclusions or the maximum diameter of nonclay particles. Cursory inspection suggests a difference between thin and thick sherds; and as the former measure under 5 mm and the latter, over 6 mm, two modes have been

TABLE 6
Pottery Types

Class	Definition	Population
P	IA	23 members, comprising 6.93% of sherds
Q	IB	269 members, comprising 81.02% of sherds
R	IIA	29 members, comprising 8.73% of sherds
S	IIB	11 members, comprising 3.31% of sherds

20. In the interest of consistency and to demonstrate the potential of the method in studying the other kinds of artifacts, I have adhered to the format used in the definitions of stone tools. Some definitions may seem to emphasize the obvious, but at this stage of investigation it is essential to be explicit to insure that the modes are, indeed, understood by all readers in the same way.

chosen for this dimension: I. greater than 5 mm; II. 5 mm or less.[21] The discrimination of inclusion size is likewise arbitrary, and two modes have been selected for particle diameter: mode A, less than 2 mm; mode B, 2 mm or more. The intersection of these modes produces four classes, all of which are represented in the pottery fragments found in archeological contexts.[22]

The distribution of class members by site is given in table 7. Type Q is the only type found at all sites, though its occurrence is unique at every site except one, NFB; conversely, types P, R, and S are found only at NFB.

TABLE 7

Distribution of Pottery by Site

Site	Class							
	P		Q		R		S	
	No.	%	No.	%	No.	%	No.	%
NFA			5	100				
NFB*	23	7.59	241	79.27	29	9.57	11	3.63
NFC			15	100				
NFD			2	100				
NGN			1	100				
NGU			4	100				
NGZ			1	100				

*Includes all pottery sherds from the site even though not assignable to components.

Table 8 shows the percentage of each site assemblage that pottery constitutes, as well as the percentage of the total sherd sample represented at any site.[23]

TABLE 8

Pottery Sample by Site as Percentage of Total and of Site Assemblage

Site	No. of Sherds	% of Total Sherds	% of Site Assemblage
NFA	5	1.51	1.57
NFB*	304	91.56	4.6
NFC	15	4.52	3.71
NFD	2	.60	.75
NGN	1	.30	100.00
NGU	4	1.20	2.66
NGZ	1	.30	7.69

*Includes all pottery sherds from the site even though not assignable to components.

21. Apparently some sherds have been so modified during their interment that original surfaces are not present. In the instances where these fragments have a thickness greater than 5 mm, they are identified; if they measure 5 mm or less, they are considered unidentifiable.

22. Although the componential definitions have been used as the names for stone tool types, an arbitrary letter designation has been employed for classes of other artifacts.

23. Assemblages as used in this calculation include debitage and other portable artifacts; features such as structures and hearths are excluded.

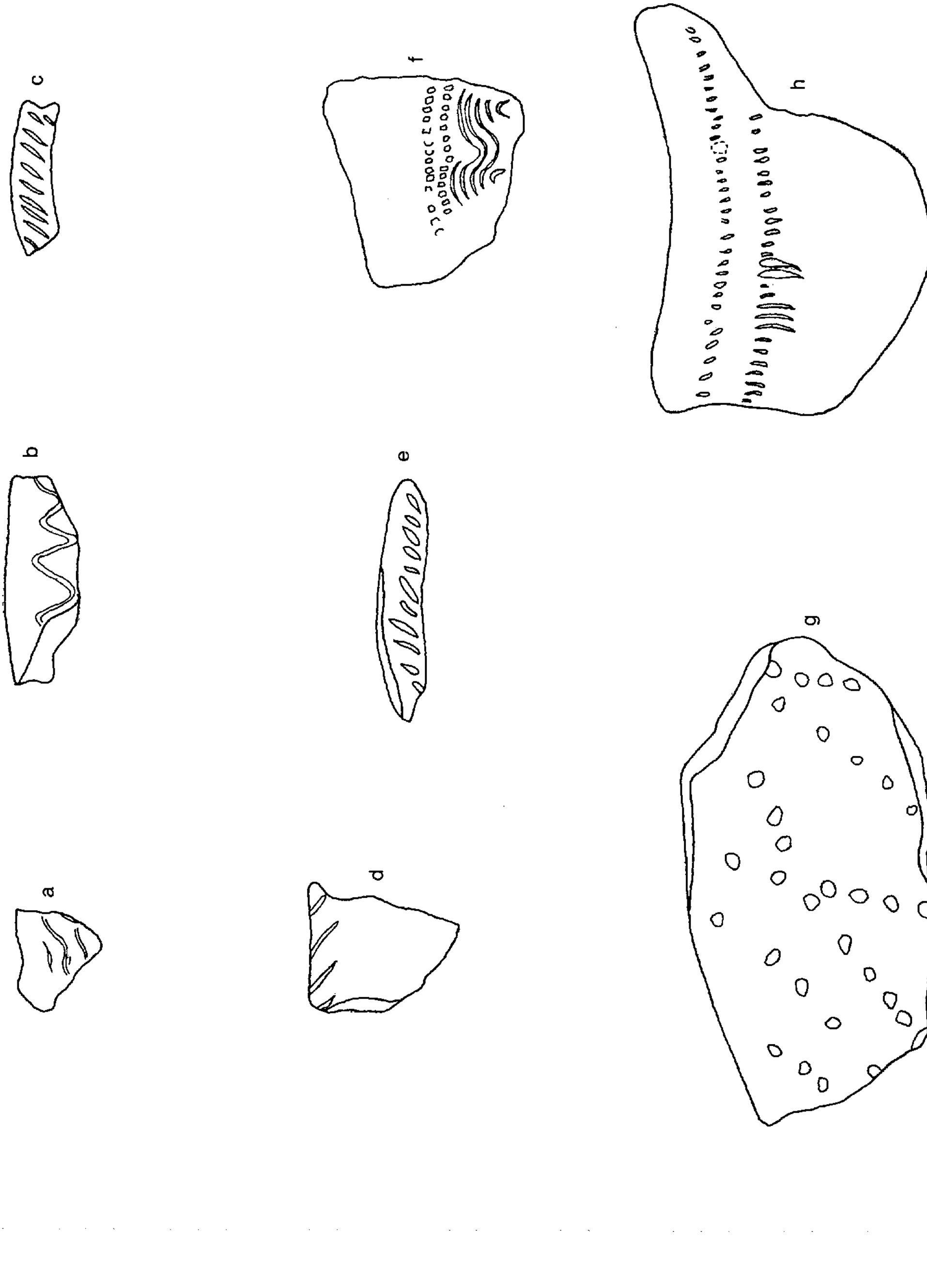


Fig. 94. Decorated pottery fragments. (a) NFD/40; (b) NFB/1630; (c) NFC/58; (d) NFB/158; (e) NFC/1; (f) NGZ/6;

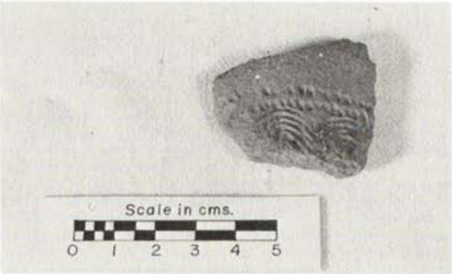


Fig. 95. Pottery, type Q, decorated, NGZ/6

Fig. 96. Pottery, type Q, decorated, NFB/1630

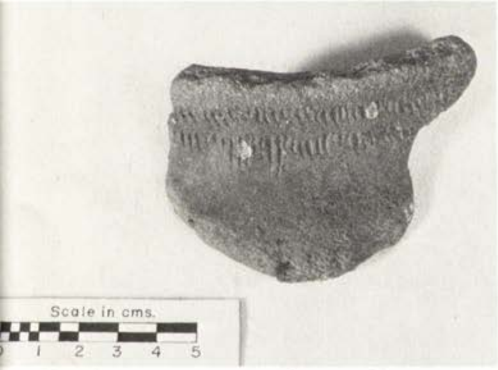


Fig. 97. Pottery, type Q, decorated, Tau

Fig. 98 Pottery, type Q, decorated, NFA/20A

Fig. 99. Pottery, type Q, decorated, NFB/1513

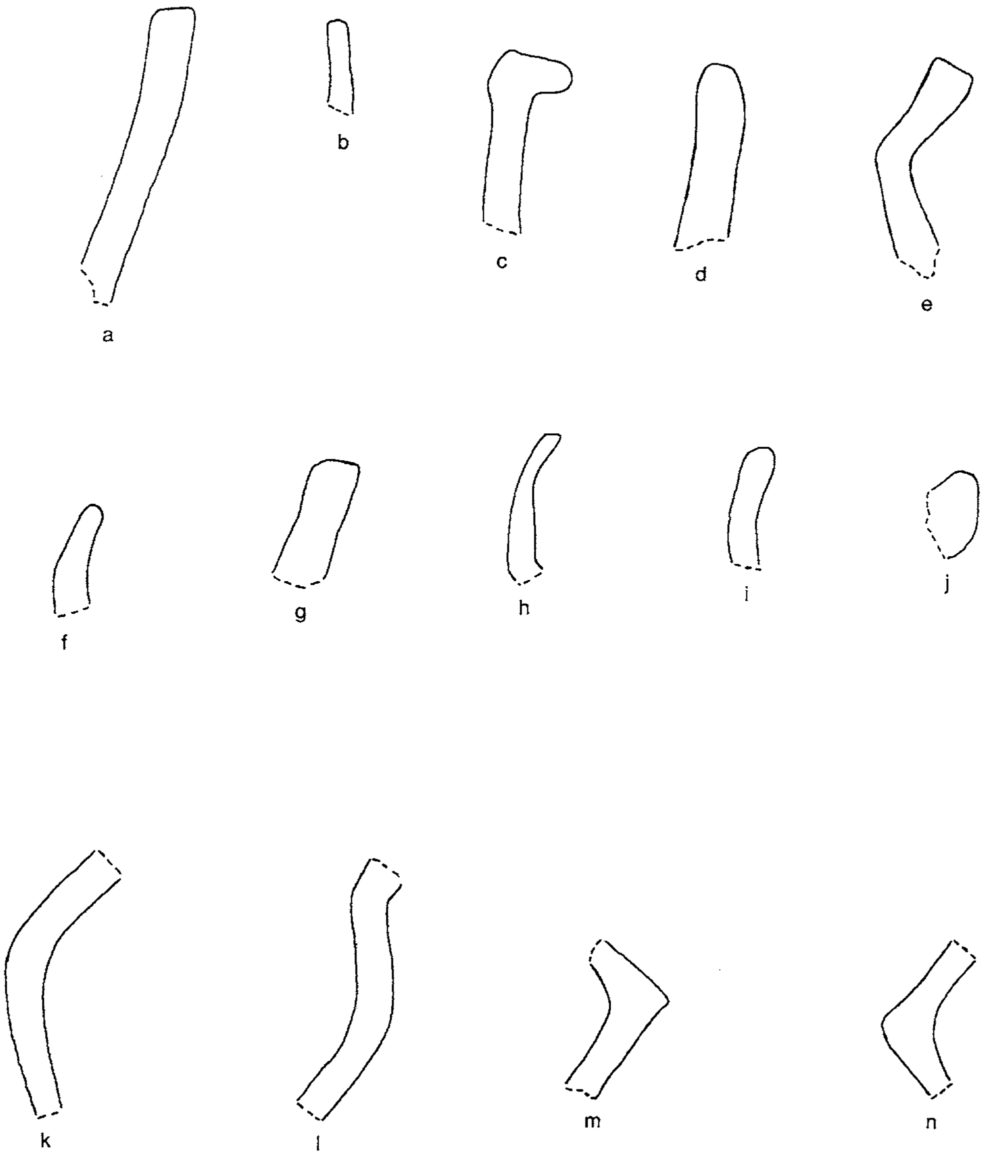


Fig. 100. Cross section of pottery fragments: a through j are rim sherds, k through n are body sherds (interior is to the left), (a) NFC/58; (b) NFB/1086; (c) NFB/1594; (d) NFB/158; (e) NFB/1038; (f) NFB/1019; (g) NFC/1; (h) NFB/1606; (i) NFB/1554; (j) NFB/1360; (k) Tau; (1) NFA/222; (m) NFB/1630; (n) NFB/1535

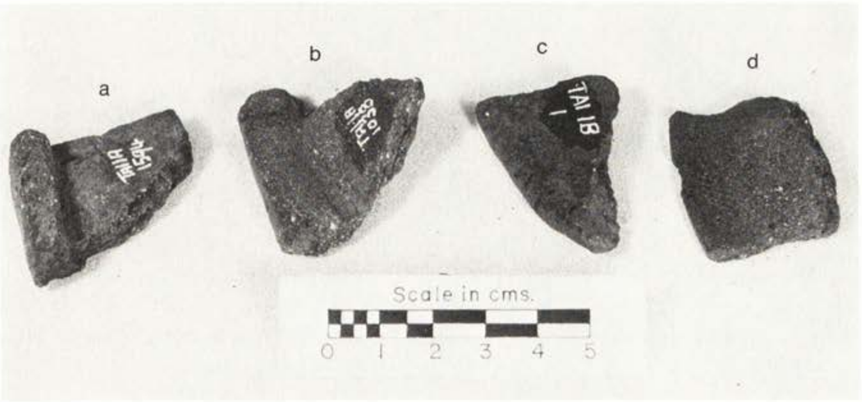


Fig. 101. Pottery rim sherds, all type Q. (a) **NFB/1594**; (b) **NFB/1038**; (c) **NFC/1**; (d) **NFB/1606**

Five modes that are more traditionally used in pottery classification can be included in the descriptions. Decoration occurs on eight sherds (2.4 percent of total) including three rim sherds (for motifs see fig. 94, also figs. 95-99). There are twelve rim sherds (3.61 percent of total), ten of which are shown in profile in figure 100 (see also figs. 99 and 101). Color of paste varies from tan to reddish brown to black. Core paste color is sometimes darker than that on either surface, but this factor is not noted in type descriptions. Inclusions are primarily sand and angular particles of rock, which may vary greatly in size in a single fragment or may be fairly uniform. Mica occurs infrequently, shell and limestone not at all. The range of variation of the thickness of the fragments is indicated. Consult appendix 6 for the results of a petrographic analysis of six potsherds.

Type P

The paste varies from tan to reddish brown to black. Sand and angular nonclay particles do not vary greatly in size. Thickness of the sherds of this type range from 6 to 10 mm, and both decoration and rim fragments are present. Members of type P occur only at NFB, where they make up 8 percent of the sherds found at the site.

Type Q

The paste varies from tan to reddish brown to black; sand and angular nonclay particles vary greatly in size. Thickness of the sherds ranges from 7 to 15 mm. Both decorated sherds (fig. 94) and rim fragments (fig. 100) are present. Members of type Q occur at all pottery-bearing sites; they are the only sherds at these sites with the exception of NFB, where they constitute 79 percent of sherds.

Type R

The paste ranges from dark brown to black, and the sand and angular nonclay particles are fairly uniform in size. Sherds of this type range in thickness from 3 to 5 mm. Neither rim fragments nor decorated sherds occur. Type R occurs only at NFB, where it comprises 10 percent of the sherd sample.

Type S

Paste varies from brown to black, and sand and angular nonclay particles tend to be uniform. The range of thickness of the sherds is 4 to 5 mm. Neither decorated sherds nor rim sherds occur. Type S sherds occur only at NFB, where they represent 4 percent of the sherd sample.

HOUSES

Patterns of holes inferred to be the remains of supports which once were part of a structure (herein called "house") can be classified in terms of three dimensions. Most of these features were discovered only through excavations, and they are limited to a small number of sites, as indicated in table 10.

Dimension: Plan of house

Mode I. Round

Mode II. Oval

Dimension: Kind of supports (often inferred from shape of post holes)

Mode A. Small poles: variable in cross section, small diameter

Mode B. Posts: roughly circular in cross section, large diameter

Mode C. "Planks" and posts: posts circular in cross section, large in diameter, "planks" roughly elliptical in cross section

Dimension: Number of post rows

Mode 1. Single

Mode 2. Multiple

The intersection of these modes produces twelve classes, of which three are represented in the sample of seven houses (table 9).

In addition to the remains of the basic structures, post holes inferred to be the remains of partitions inside of a house have been found in two type J houses, and posts outside of the structure, inferred to be the remains of posts serving as eaves supports, occur in one member of type J and the single member of type K. Unidentifiable houses were observed, and either

TABLE 9

HOUSE TYPES

Class	Definition	Population
J	IB1	3 members, constituting 42.86% of houses
K	IC1	1 member, constituting 14.29% of houses
L	IIA2	3 members, constituting 42.86% of houses

TABLE 10

DISTRIBUTION OF HOUSES BY SITE

Site	Class		
	J	K	L
NFB (component II)	1		
NFC		1	
NFX			3
NGM	2		

the number of them at a site or their mere presence, whichever was recorded in the field notes, is given in table 2.

HEARTHS

What were inferred to be hearths—agglomerations of charcoal and ash containing dirt, sometimes surrounded by rocks—have been classified by three dimensions of two, four, and three modes, respectively. These features were discovered only through excavations and are limited to relatively few sites.

Dimension: Plan of hearth

Mode I. Rectangular or square: having definite corners and generally parallel sides

Mode II. Round: forming a circle

Dimension: Outlining material

Mode A. Rectangular rocks

Mode B. Round and angular rocks

Mode C. Irregular rocks

Mode D. None

Dimension: Manufacture

Mode 1. Rocks set in ground: firmly implanted in ground

Mode 2. Rocks not set in ground: resting on ground

Mode 3. No rocks

The intersection of these modes produces twenty-four classes, of which six have members (table 11).[24] The distribution of hearth types by site is given in table 12.

TABLE 11

HEARTH TYPES

Class	Definition	Population
A	IA1	1 member, constituting 7.14% of all hearths
B	IC2	1 member, constituting 7.14% of all hearths
C	ID3	2 members, constituting 14.28% of all hearths
D	IIB1	1 member, constituting 7.14% of all hearths
E	IIB2	4 members, constituting 28.57% of all hearths
F	IID3	1 member, constituting, 7.14% of all hearths

TABLE 12

DISTRIBUTION OF HEARTHS BY SITE

Site	Class						
	A	B	C	D	E	F	Unidentified
NFB (component II)				1		1	
NFC			2				
NFX					1		
NGG					2		
NGH					1		
NGM	1	1					4

EARTH OVENS

Pits, roughly circular in plan at the top, are inferred to be the remains of earth ovens. They were observed only at excavated sites, and most of them were exposed by excavation. All contained rocks, charcoal fragments, and heavily carbonized soil, the amount of which varies from pit to pit. Two dimensions of two modes each were selected to define types of earth ovens.

Dimension: Profile of side

Mode I. Straight: perpendicular to surface for most of depth

Mode II. Curved: curving inward from top to bottom

Dimension: Depth of pit

Mode A. Shallow: having little depth

Mode B. Deep: having substantial depth

24. Bayard's argument against disregarding archeological data that may be inadequate for precise analysis is well taken (1973: 42). Nonetheless, it is inadmissible to treat such data as if they were adequate, to throw caution to the wind as it were, and accept them for more than they are. For example, some of the features at NGM are inferred hearths; they are not complete enough, however, to be identified according to the classification used here and are so indicated in table 12. (Cf. Flannery 1973: 271-72, for comment on a related point.)

The interesection of these modes produces four classes, two of which are represented in the sample of sixteen earth ovens (table 13). The distribution of earth oven classes by site is given in table 14.

TABLE 13
EARTH OVEN TYPES

Class	Definition	Population
M	IB	4 members, constituting 25% of all earth ovens
N	IIA	12 members, constituting 75% of all earth ovens

TABLE 14
DISTRIBUTION OF EARTH OVENS BY SITE

Site	Class	
	M	N
NFA		3
NFB		7*
NFC	4	
NGM		2

*Four of these belong to component II; three are unassigned, but probably belong to component II (they do not belong to either component I or component III).

IV. Analysis

The results of analytic operations on the data will be presented in this chapter, along with a provisional reconstruction of the prehistory of the eastern highlands based on this analysis. The degree of success attained with the techniques used is, of course, influenced by the quality of the basic data (cf. Brainerd 1951: 311; Renfrew and Sterud 1969: 266). For the analytic techniques employed, it is essential that the samples of artifacts be comparable—in this case, that they represent a total surface collection or at least a similarly defined representative sample from all sites (Dancey 1973, 1974). The data at our disposal are not completely adequate: the field party collected as many artifacts from each site as time and circumstance permitted; they made no deliberate effort at either systematic sampling or stratified random sampling. Given samples that represent varying degrees of adequacy to the purpose, deficiencies in the analytic results must be expected. In a study in which the field design envisaged the present analytic operations, a greater degree of precision could be anticipated.

In view of data quality and numerical constraints, a simple assessment of assemblage similarity offers the most reasonable initial analytic strategy. This will be followed by the classification of assemblages and the description of the resulting classes. The significance of assemblage similarity will then be assessed. Finally, phases and traditions will be discussed. The quantitative operations are based on types of unifacially chipped stone tools, for a number of reasons: with the exception of chipping detritus, these are the most numerous artifacts in our collection (3,400 of 3,674 stone tools); they are the most widely distributed artifacts (64 of 76 sites); and in some of the assemblages they are the only artifacts (excepting debitage). Moreover, there are no other artifacts that are sufficient in either number or distribution to be used in basic quantitative analysis.

Comparison

Two devices commonly used in archeology for the measurement of comparison are frequency seriation and the Brainerd-Robinson coefficient of similarity, both of them essentially applications of unidimensional scaling.[1] The coefficient of similarity is calculated by determining the difference of percentage occurrence of a selected number of types in two assemblages, where the selected types equal 100 percent, and subtracting the sum of the differences from 200. An ordered matrix of similarity coefficients is then constructed, with the difference in magnitude between adjacent scores ideally decreasing from the diagonal to the edge. In the absence of the ideal, the best order is that which contains the fewest negatively signed changes, a negative sign indicating an increase rather than a decrease in score.

Initially, coefficients of similarity have been calculated for twenty-three assemblages which contain thirty or more unifacially chipped stone tools. The number thirty is an arbitrary choice which is intended to satisfy two rather disparate goals: a tool sample of sufficient size to make comparisons meaningful, and the inclusion of as large a number of assemblages as possible. To assure a reasonable degree of reliability, the initial calculations are based on the eight types of unifacially chipped stone tools that constitute 91 percent of the total stone tool inventory (fig. 102).[2] The resulting matrix is shown in figure 103.

The absence of a monotonically decreasing order from a given assemblage in a straight line, indicated by the occurrence of negative signing with some frequency, suggests that "error" has occurred. Although it is impossible to isolate the error in the similarity coefficient, where so much information is compressed into a single number, a graphic model (not shown) suggests that some of the error, at least, lies in the inclusion of assemblages that are noncomparable. Figure 104 is the matrix which remains after ten assemblages are removed from figure 103.[3]

A second technique for lineal or unidimensional scaling, frequency seriation, has been used to evaluate the ordering of assemblages by the similarity model. The frequency of occurrence of each class is plotted, and the

1. The literature on seriation is extensive, including Rowe 1961, Ford 1962, Rouse 1967, Johnson 1968, Dunnell 1970, Cowgill 1972, and LeBlanc 1975, all of which contain additional references. Both the merits and the deficiencies of frequency seriation, as method and as technique, are discussed in some of the references.

For additional explication and discussion of the Brainerd-Robinson coefficient see Brainerd 1951, Robinson 1951, and Dunnell 1971a.

2. In all quantitative operations, all assemblages, both surface-collected and excavated, are treated the same.

3. The reasons for the noncomparability of these assemblages are not germane to the present discussion. A variety of reasons may be involved, including that a sample is not representative of an assemblage, or that a sample represents a mixed assemblage (e.g., contains material from more than one site), or that an assemblage may belong to a different cultural tradition.

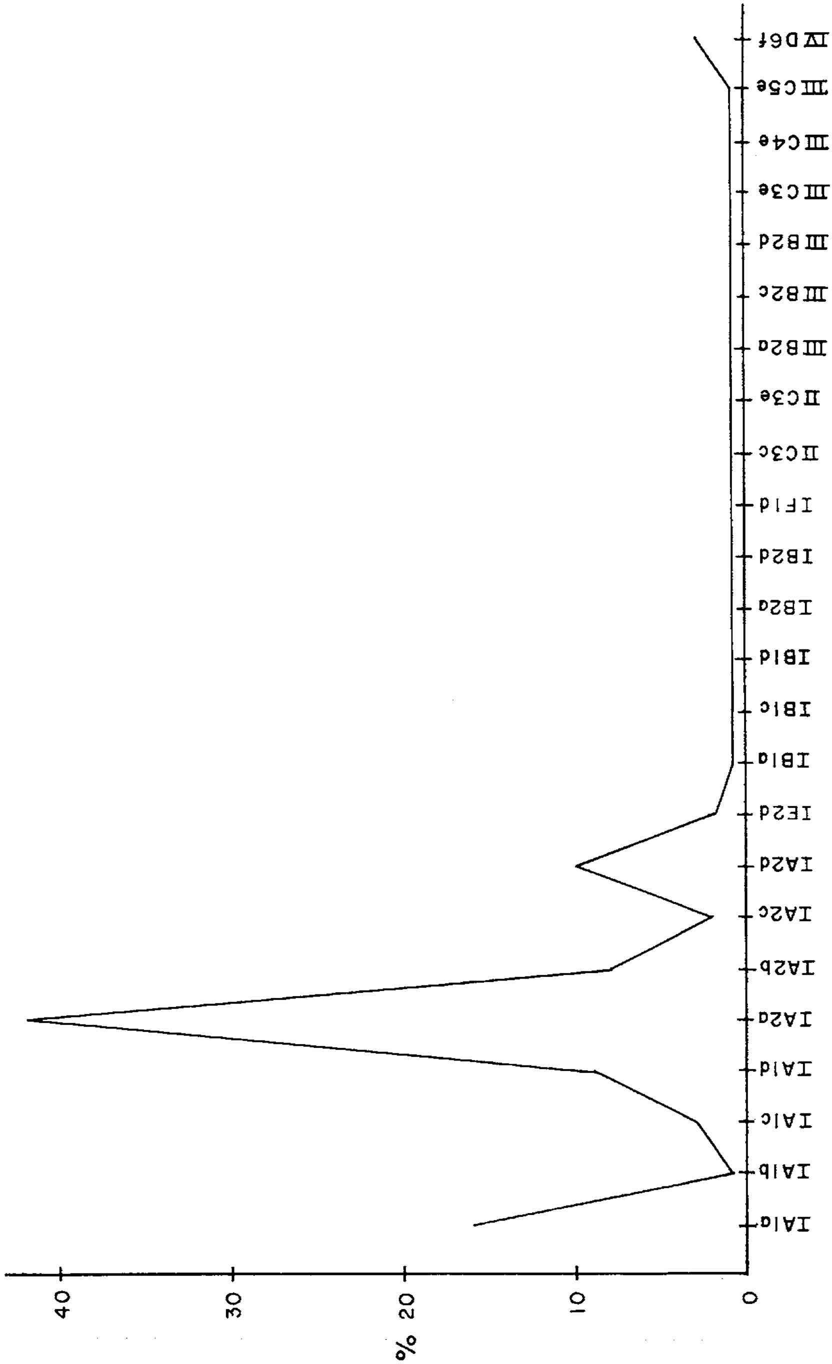


Fig. 102. Percentage distribution of stone tool types (total = 3,674)

	NGH	NGG	NGD	NFX	NFM	NGT	NGI	NGS	NFF	NFE	NFT	NHR	NHL	NFQ	NHB	NHI	NFC	NHK	NFD	NHN	NFN	NFB	NFA
NGH		172	170	167	172	153	154	141	142	145	125	155	139	114	123	130	112	119	98	123	92	82	57
NGG	172		188	185	182	177	168	166	162	165	145	151	141	138	131	130	136	127	122	117	116	98	81
NGD	170	188		187	188	183	178	170	166	165	149	158	147	144	139	134	142	133	126	125	122	104	87
NFX	167	185	187		189	180	175	173	169	168	158	152	144	143	146	135	139	132	127	122	119	103	86
NFM	172	182	188	189		181	178	174	170	171	153	132	157	142	145	144	140	137	126	122	120	102	85
NGT	153	177	183	180	181		181	185	181	178	158	162	158	161	146	145	152	144	143	132	139	119	104
NGI	154	168	178	175	178	181		172	172	169	163	153	157	152	149	144	149	143	138	133	134	116	99
NGS	141	166	170	173	174	185	172		192	181	155	151	155	168	145	148	145	147	142	129	140	116	103
NFF	142	162	166	169	170	181	172	192		181	159	149	159	166	147	171	148	145	146	129	145	127	110
NFE	145	165	165	168	171	178	169	181	181		162	152	162	161	154	157	165	154	155	134	153	121	108
NFT	125	145	149	158	153	158	163	155	159	162		150	156	163	158	153	163	154	163	130	149	137	120
NHR	155	151	158	152	132	162	153	151	149	152	150		172	151	162	154	146	152	131	164	129	121	94
NHL	139	141	147	144	157	158	157	155	159	162	156	172		159	172	183	149	176	157	168	151	131	116
NFQ	114	138	144	143	142	161	152	168	166	161	163	151	159		153	150	158	145	162	135	164	136	123
NHB	123	131	139	146	145	146	149	145	147	154	158	162	172	153		181	153	170	167	156	163	151	134
NHI	130	130	134	135	144	145	144	148	171	157	153	154	183	150	181		138	183	163	163	160	138	125
NFC	112	136	142	139	140	152	149	145	148	165	163	146	149	158	153	138		139	176	156	154	154	139
NHK	119	127	133	132	137	144	143	147	145	154	154	152	176	145	170	183	139		159	139	170	141	129
NFD	98	122	126	127	126	143	138	142	146	155	163	131	157	162	167	163	176	159		176	162	166	153
NHN	123	117	125	122	122	132	133	129	129	134	130	164	168	135	156	163	156	139	176		141	125	106
NFN	92	116	122	119	120	139	134	140	145	153	149	129	151	164	163	160	154	170	162	141		166	153
NFB	82	98	104	103	102	119	116	116	127	121	137	121	131	136	151	138	154	141	166	125	166		177
NFA	57	81	87	86	85	100	99	103	110	108	120	94	116	123	134	125	139	129	153	106	153	177	

Fig. 103. Ordered matrix of Brainerd-Robinson Coefficients of Similarity for assemblages with thirty or more unifacially chipped stone tools, based on proportions of eight types of unifacially chipped stone tools

assemblages are then arranged in sequence so there is decreasing similarity as one moves in either direction from any point in the sequence. "Error" can be said to occur when the distribution of a class does not conform to the model. In constructing this graphic display of uniscalar orders, instead of using eight classes I have followed Meighan's precedent (Meighan 1959) and selected a set of three most common tool types in calculating the percentages that appear in the bar graph in figure 105. Although in some situations this might not be justifiable, in the present instance, where the three most common tool types constitute such a large percentage of the total, the procedure seems warranted. Types IA1a, IA1d, and IA2a tools represent 73 percent of unifacially chipped stone tools (fig. 106), 67 percent of all stone tools (fig. 102).[4] The order of assemblages in the graphic and similarity models are identical with the exception of one, NGI, an assemblage which was collected from a partially disturbed site (see discussion of NGI in chap. II) and may not be representative. Finally, the graphic model permits the separation of the series of assemblages into two groups, NGH through NGI and NFD through NFA.

Tests made with the assemblages that were extracted from figure 103 as being noncomparable suggest that one set of four sites can be isolated when similarity is determined on the basis of the three types of stone tools most common to the four, types IA1a, IA2a, and IA2b. The similarity matrix is shown in figure 107 and the graphic representation in figure 108. This constitutes a group of assemblages distinct from those in figure 105.

Classification

Similarity studies indicate that three separate groups of assemblages can be recognized. The final operation on the data consists in identifying classes of assemblages, units which can be translated into phases and traditions. The classification is based on the frequency of occurrence of members of three classes of unifacially chipped stone tools; IA1a, IA2a, and IA2b are not only frequently occurring tool types, but it is apparent from the bar graphs that their distribution is significant.[5]

Definitive Types of Assemblage Classes

Type IA1a tools constitute:

I 20 percent or more of unifacially chipped stone tools in an assemblage.

4. There are 603 type IA1a tools or 18 percent; 323 type IA1d tools or 10 percent and 1,544 type IA2a tools or 45 percent. In fact, I made many seriations using all of the classes of unifacially chipped tools as well as various combinations of them in an attempt to identify the set(s) of types which would produce the most significant results.

5. Together they number 2,439 tools, which is 66 percent of all tools (fig. 102), 72 percent of unifacially chipped stone tools (fig. 106). There are 603 type IA1a tools or 18 percent, 1,544 type IA2a tools or 45 percent, and 292 type IA2b tools or 9 percent of unifacially chipped stone tools. These figures are used in the calculations.

	NGH	NGG	NGD	NFX	NFM	NGT	NGI	NGS	NFF	NFD	NFN	NFB	NFA
NGH		172	170	167	172	153	154	141	142	98	92	82	57
NGG	172		188	185	182	177	168	166	162	122	116	98	81
NGD	170	188		187	188	183	178	170	166	126	122	104	87
NFX	167	185	187		189	180	175	173	169	127	119	103	86
NFM	172	182	188	189		181	178	174	170	126	120	102	85
NGT	153	177	183	180	181		181	185	181	143	139	119	104
NGI	154	168	178	175	178	181		172	172	138	134	116	99
NGS	141	166	170	173	174	185	172		192	142	140	116	103
NFF	142	162	166	169	170	181	172	192		146	138	122	105
NFD	98	122	126	127	126	143	138	142	146		176	166	153
NFN	92	116	122	119	120	139	134	140	138	176		166	153
NFB	82	98	104	103	102	119	116	116	122	166	166		177
NFA	57	81	87	86	85	104	99	103	105	153	153	177	

Fig. 104. Ordered matrix of Brainerd-Robinson Coefficients of Similarity for thirteen assemblages based on proportions of eight types of unifacially chipped stone tools

II less than 20 percent of unifacially chipped stone tools in an assemblage.

Type IA2a tools constitute:

A 50 percent or more of unifacially chipped stone tools in an assemblage.

B less than 50 percent of unifacially chipped stone tools in an assemblage.

Type IA2b tools constitute:

1 14 percent or more of unifacially chipped stone tools in an assemblage.

2 less than 14 percent of unifacially chipped stone tools in an assemblage.

The intersection of these types produces eight classes, three of which have members: IB2, IIA2, and IIB1. These will be referred to as class X, class Y, and class Z, respectively.

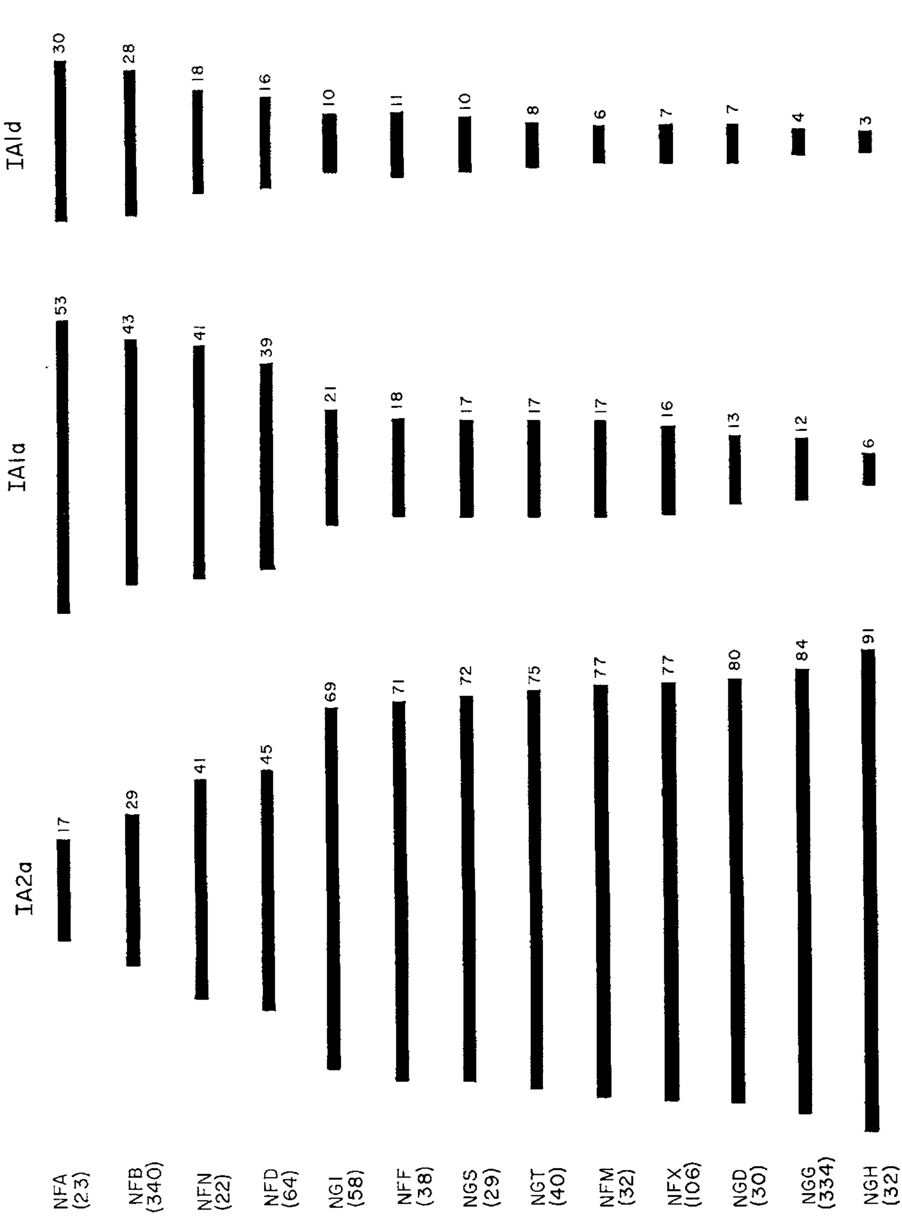


Fig. 105. Frequency seriation I (sample sizes in parentheses)

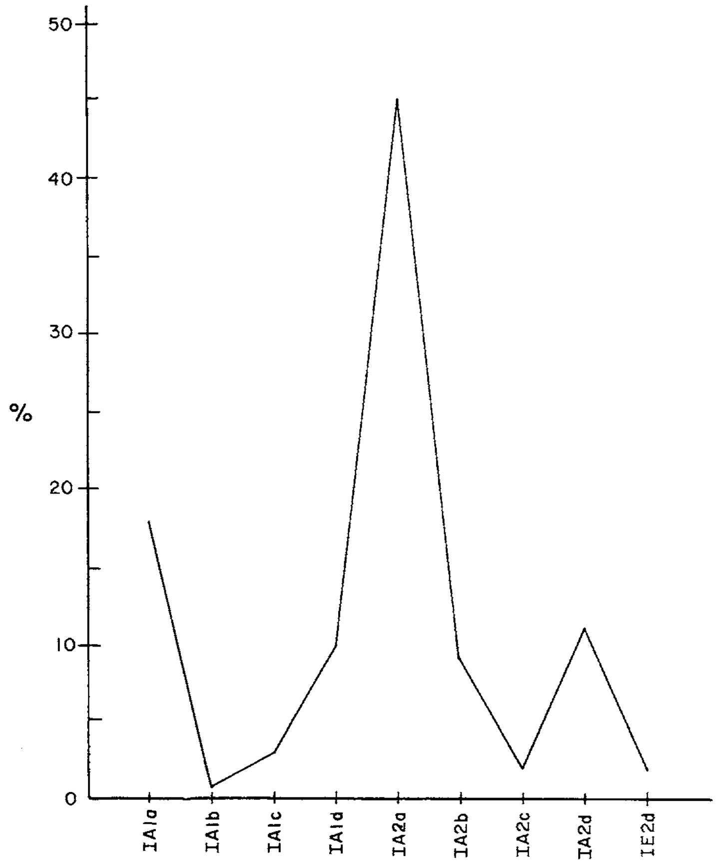


Fig. 106. Percentage distribution of unifacially chipped tools (total=3,400), by class

Definitions of Assemblage Classes

Class X: includes assemblages containing more than 20 percent type IA1a tools, less than 50 percent type IA2a tools, and less than 14 percent type IA2b tools.

Class Y: includes assemblages that contain less than 20 percent type IA1a tools, more than 50 percent type IA2a tools, and less than 14 percent type IA2b tools.

Class Z: includes assemblages containing more than 14 percent type IA2b tools, less than 20 percent type IA1a tools, and less than 50 percent type IA2a tools.

Assemblages that contain thirty or more unifacially chipped stone tools have been identified according to this classification; in addition, assemblages containing samples of unifacially chipped stone tools ranging from ten to thirty have been included to increase the number of assemblages identified over those used in the similarity analysis. The classes, class definitions, class members, class populations, and percentage of identifiable assemblages that they represent are shown in table 15.

TABLE 15
CLASSES OF ASSEMBLAGES

Class	Definition	Members	Population	% of Classifiable Assemblages
X	IB2	NFA, NFB (components I and II), NFC, NFD, NFN, NFT, NFZ, NGA*, NGB*, NGK*, NGM†, NGY*, NHB, NHC*,	14	39
Y	IIA2	NFB (component III)*, NFE, NFF, NFM, NFO*, NFX, NGD, NGG, NGH, NGI, NGJ*, NGL*, NGS, NGT	14	39
Z	IIB1	NHI, NHJ*, NHK, NHL, NHN, NHQ*, NHR, NHU*,	8	22

* Indicates assemblages with fewer than thirty but more than nine unifacially chipped stone tools.
† See under "Description of Assemblage Classes" for the rationale for including NGM, which has only five unifacially chipped stone tools.

DESCRIPTION OF ASSEMBLAGE CLASSES

CLASS X ASSEMBLAGES

Chipping detritus is the commonest kind of artifact in class X assemblages. Second in frequency are stone tools, especially unifacially chipped tools with relatively high percentages of types with symmetrical profiles and concave and convex plans. The majority of the chipped stone tools give the impression of occurring on lighter, smaller rocks than is the case with the majority of tools in class Y assemblages. Moreover, the rocks on which many tools with, for example, asymmetrical profiles and concave and convex plans occur tend to be smaller in class X assemblages than in those of class Y. Other stone tools occurring in class X assemblages are points, hammerstones, whetstones, adzes, and tools bearing both bifacial crushing and chipping. The presence of pottery and pig remains is recorded for some sites. Features associated with class X assemblages include all hearth types except type E; circular structures with substantial posts or planklike posts for supports, with additional supports for eaves located outside the wall proper and in some cases with a ditch surrounding the structure (houses types K and J); earth ovens; pig fences and enclosures; monoliths; and possibly earthworks. It is on the basis of descrip-

	NHK	NHI	NHL	NHR
NHK		196	188	169
NHI	196		192	173
NHL	188	192		181
NHR	169	173	181	

Fig. 107. Ordered matrix of Brainerd-Robinson Coefficients of Similarity for four class Z assemblages based on proportions of three most common types of unifacially chipped stone tools

tive features such as whetstones, pig, earth ovens, hearth types, and house types that assemblage NGM, which includes only five unifacially chipped stone tools and thus cannot be definitively identified, is assigned to assemblage class X in table 15.

Sites of class X assemblages are located in the northern grassland basins of the study area at some distance from forests, on the high ridges of the southeastern part of the study area (many of them in close proximity to forests), and in grass-covered narrow valleys fairly near forests in the northeastern part of the southwestern segment of the study area.

CLASS Y ASSEMBLAGES

Chipping detritus is also the most frequently occurring kind of artifact in class Y assemblages, followed by stone tools, of which unifacially chipped stone tools are the most numerous. Although the same types of unifacially chipped stone tools occur in class Y as in class X assemblages, the proportions differ, and those with asymmetrical profile and concave plan are commoner. In general, many of the unifacially chipped stone tools in class Y assemblages are on larger, "chunkier" rocks than those in class X assemblages. Other tools occurring in class Y assemblages are hammerstones, points, and tools bearing both bifacial crushing and chipping, although none of these types is common; no tools exhibit abrading wear. Compared to class X assemblages, features are few. They include oval structures the supports for which consist of small posts or saplings sometimes, but not always, arranged in parallel rows (type L, NFX);[6] hearths roughly circular in configuration with irregularly shaped rocks around the perimeter (type E); groupings of rocks for which no attempt is made to infer use (NGG); stone mortar and stone bowl or club head (NFB).

6. Reservations about this assessment are discussed in chapter II under "NFX."

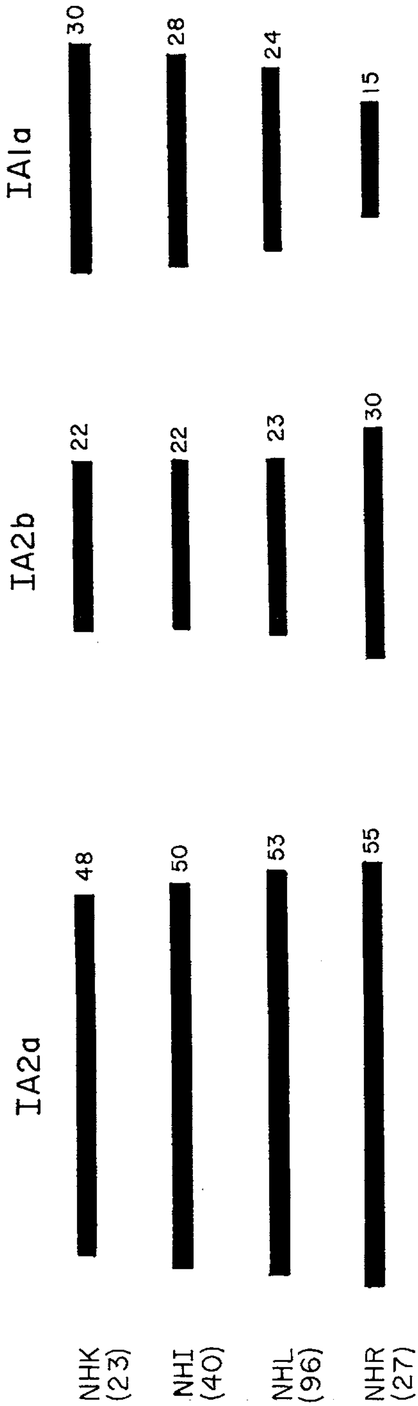


Fig. 108. Frequency seriation II (sample sizes in parentheses)

Most of the class Y assemblages are from sites located in the broad, open grassland basins of the northern part of the study area in close proximity to large or small streams, some of which are tree-lined, roughly three to six km from forests at the present time. Three sites from which class Y assemblages were collected are located in the southeastern part of the study area in relatively narrow grass-covered valleys surrounded by ridges, some of which are now grass-covered. These sites are approximately three to five km from ample forest resources at the present time, although some bush intermittently lines the nearby rivers. The presumption of closer location relative to forest resources at the time of occupation seems reasonable. Two sites of class Y assemblages are located on a high ridge not far from forests in the southeastern part of the study area. They may in fact represent exploitation of such an environmental niche, but the possibility should remain tentative because the sample from each site is quite possibly inadequate: both sites are badly eroded and, in addition, one sample is very small (NFO) and the second is from a site with a second occupation (NFM). It is reasonable to conclude that class Y assemblages are well represented at sites now located in grasslands; exploitation of ridge-top locations is a possibility, but is subject to confirmation or denial through future explorations.

CLASS Z ASSEMBLAGES

Chipping detritus is the commonest kind of artifact in class Z assemblages. Second are stone tools, especially unifacially chipped stone tools of types similar to those of both class X and class Y assemblages but with a significantly higher proportion of asymmetrically profiled tools with wavy plan. Hammerstones, whetstones, adzes, points, and bifacially crushed and chipped tools complete the stone tool inventory. Earth ovens, houses, and hearths occur, although we do not know their configuration except that both "round" and "square or rectangular" houses are indicated in the field notes. Other artifacts, such as a perforated stone disc, petrified wood, and probably latrine remains, are also part of the assemblages of this class. The consistently high Brainerd-Robinson similarity coefficients of four class Z members is shown in figure 107. The sites from which class Z assemblages come are in the southwesternmost portion of the study area generally located on low, gentle rises in narrow, grass-covered valleys surrounded by forest.

SIGNIFICANCE OF THE SIMILARITY DATA

The matrix of figure 104, if contoured in intervals of ten, would show no clustering of assemblages. Because the types are based on functional attributes, we might infer that but one functional category of assemblages is represented. All of the sites in figures 104 and 105 are located in the northern or southeastern sections of the study area, but there is no clear demarcation between the two areas. The occurrence of sites from both geographic segments in both similarity groupings suggests the absence of a culturally significant locational or spatial dimension. The possibility of a temporal dimension must also be considered. Although frequency seriations are often accepted as indicating temporal variation, in the absence of any but unidimensional scaling, other evidence must be adduced to insure that time is, in fact, being represented (Dunnell 1970).

Four kinds of data are relevant to establishing that the frequency seriation of figure 105 is a chronology and indicating its direction: (1) stratigraphy, (2) distribution of other artifacts, (3) ethnographic data, and (4) radiochemical determinations.

STRATIGRAPHY

In figure 105, assemblages of class X and class Y are at separate ends of the sequence. At two stratified sites that Cole has excavated in the eastern highlands of New Guinea, the relative position of members of class Y are stratigraphically subordinate to members of assemblage class X. At NFB, described in chapter II, component III, a member of class Y, underlies both components I and II, members of class X.

In 1964, supported by funds from the University of Washington, Cole excavated at NBZ (Kafiavana), a stratified sheltered site later excavated by J. Peter White (White 1972). Cole excavated 27 square feet: a trench consisting of three adjacent 3-by-3-foot squares, K1A, K1B, and K1C. K1C was excavated to the greatest depth, 2.1 m, with a continuation in a segment of the square to a depth of 2.49 m (98 inches). Cole's material from NBZ has not been analyzed. To test the applicability of my classification to other assemblages, I analyzed, with Cole's permission, the unifacially chipped stone tools that he recovered from unit K1C at NBZ. I then used these classes to construct the frequency paragon shown in figure 109. Because the samples from some of the fourteen levels Cole excavated are small, I have combined adjacent pairs of levels to secure more adequate samples (i.e., thirty or more unifacially chipped stone tools) and I have treated each pair as a single item. Levels 3 and 4 are omitted because the combined samples of unifacially chipped stone tools from these two levels, fifteen, is inadequate. If the assemblages from the combined levels at NBZ are identified according to our assemblage classification, 1-2 belongs to class X, 5-6 through 13-14 belong to class Y. Thus, the members of class Y are in a subordinate position to the member of class X.

DISTRIBUTION OF OTHER ARTIFACTS

Ideally the results of a frequency seriation of one kind of artifact—in this instance, unifacially chipped stone tools—should be evaluated in terms of other kinds of data. Since in our collections only the number of unifacially chipped stone tools is adequate to serve as the basis for frequency

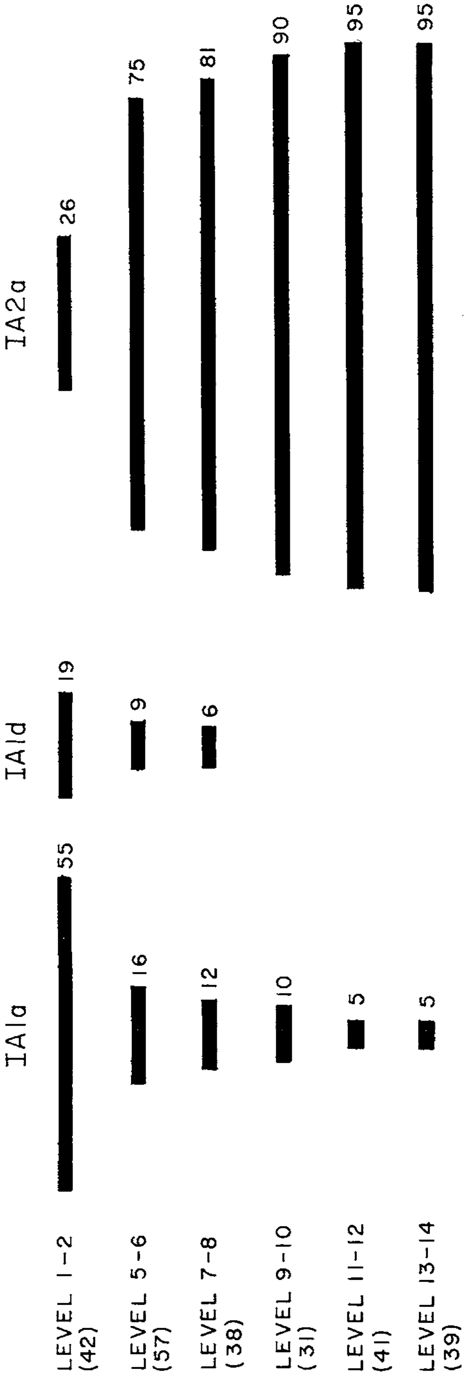


Fig. 109. Frequency seriation of unit K1C at NBZ (Kañavana) (sample sizes in parentheses)

seriation, occurrence seriations of two other kinds of artifacts, adzes and pottery, constitute supportive data. Adzes occur in the four assemblages at the top of the bar graph in figure 105; they are absent in the others. Pottery is present in the top first, second, and fourth assemblages of figure 105, absent in the others. The distribution of both adzes and pottery is limited to class X assemblages.

ETHNOGRAPHIC DATA

The ethnographic responses elicited by Cole can be used as corroborative data in a general way. Contemporary New Guineans who were interviewed had no knowledge of the existence of any of the sites from which the assemblages of class Y were collected.[7] On the other hand, some of the sites from which members of class X were collected are indicated to have been inhabited in the past and they are noted in ethnohistoric accounts (cf. appendix 7). Thus, ethnographic inquiry elicits data about some sites of class X assemblages but no data about any sites of class Y assemblages.

RADIOCHEMICAL DETERMINATIONS

Finally, the chronometric scale of radiochemical determinations also confirms that the frequency seriation of figure 105 is a chronology and that the temporal direction is one of decreasing age from bottom to top (table 16).

TABLE 16

RADIOCARBON DATES*

Class	Site	C_{14} B.P.	Laboratory Identification†
X	NFB (C II)	185 ± 80	I 7286
	NGM	290 ± 90	RL 408
	NFB (C ?)	2060 – 85‡	I 7285
Y	NFB (C III)	3070 ± 95	UW 261
	NGG	3300 ± 120	UW 107
	NFB (C III)	3530 ± 130	UW 260
	NGH	3780 ± 120	UW 108
	NFB (C III)	3960 ± 170	RL 407
	NFX	11,510 ± 140	UW 262
	NFX	12,620 ± 280	I 7284
	NFX	13,210 ± 270	I 7284-C
	NFX	18,050 ± 750	RL 370

* See Appendix 4 for more data on the radiocarbon dates and for a discussion of the radiometric scale.
†I = Teledyne Isotopes, Inc.; RL = Radiocarbon Ltd.;
UW = University of Washington Radiocarbon Laboratory.
‡ This date cannot be accepted as completely reliable. See Appendix 4.

7. A technical exception is the multi-component site, NFB; but informant knowledge pertained to class X assemblages at the site, not to class Y.

Extant evidence would support the interpretation of the frequency seriation in figure 105 as a chronology. It is fortuitous, of course—not necessary—that a classification based on functional criteria yields data of temporal utility. In this instance it indicates that there has been change in function through time.

The frequency seriation of figure 108, unlike that of figure 105, would seem not to be a chronology. Only one set of types has been used in the ordering, so it is not reasonable to call it a chronology without the support of other kinds of data which, for the present, are lacking. All assemblages are members of a single class, Z; stratigraphy is impossible to adduce, as no excavations were conducted at sites of class Z assemblages, nor are these assemblages present, apparently, in known stratified rock shelter contexts; and there are no radiocarbon dates. Ethnographic data and the occurrence of other kinds of artifacts than unifacially chipped stone tools are insufficient to indicate a chronology. What seems to be represented is an unordered group of sites located in a fairly restricted geographic area (see map 1), in a relatively short, probably late, period of time,[8] a situation which would also necessitate more rigid controls to demonstrate temporal variation in the seriation.

Phases and Traditions

Classes at the assemblage level are often called "phases"—a term which, along with "tradition," we shall use in translating the classes of assemblages into more conventional parlance (Dunnell 1971a, Willey and Phillips 1958). Three phases, corresponding to the three classes of assemblages that have been defined, are distributed in two traditions. Two phases corresponding to class X and class Y assemblages are placed in the Nanoway Tradition. The similarity data, in suggesting that these two constitute a single order of units, thus provide evidence that all units belong to a single tradition (Dunnell 1970: 313). One phase, corresponding to class Z assemblages, is assigned to the Yofee Tradition.[9]

MAMU PHASE

The Mamu Phase, the earliest known phase in the Nanoway Tradition, is represented at fourteen sites, six of which have been excavated. Assemblages from these sites are members of class Y (this excludes components I and II at NFB). Radiometric determinations indicate that the phase covers a span of time from at least 18,050 ± 750 B.P. to 3,070 ± 95 B.P.[10]

8. In the field notes, NHI, for example, is estimated to have been occupied in 1925, NHR to have been occupied in 1945, and the father of one young informant is said to have once lived at NHV.

9. Names for phases and traditions are typewriter orthography for Agarabi kinship terms. They are New Guinean terms, yet they have no relationship to the units other than artificial.

10. For the present, I am including the total range of cultural material at NFX in one

It represents a period of cultural development during which changes in material culture were slow but perceptible. The bulk of the recovered artifacts from sites of the Mamu Phase are chipping detritus and unifacially chipped stone tools, but hammerstones and tools bearing bifacial chipping and crushing also occur. Features include type L structures,[11] type J hearths, stone mortar and club head or bowl, as well as some enigmatic clusters of rocks. Change in the adaptive system during the Mamu Phase can be best indicated by the changes through time of the four commonest types of tools present at all sites of the phase. Unifacially chipped stone tools with asymmetric profiles and concave plans (type IA2a) diminish in frequency from oldest to most recent site, those with asymmetric profiles and convex plans (type IA2d) and those with symmetric profiles and both concave and convex plans (types IA1a and IA1d) increase in frequency through time.

Mamu Phase sites are well represented in today's open grasslands in the north and the more restricted ones in the southeast. The exploitation of ridge-top environments during the phase is a possibility but must be confirmed through future research (see above under "Class Y Assemblages"). At present there is no evidence for the occupation of the southwestern part of the study area during the Mamu Phase.

There is little in the data which permits inference of the subsistence economy prevalent in the Mamu Phase, except that the changes through time of the frequency of four types of unifacially chipped stone tools suggest that there were changes in the adaptive system during the period. There is nothing to suggest precipitate changes. If the inference that type IA2a tools could have been used as woodworking tools of some kind is accepted (see under "Identification" in chap. III), an exploitation of some forest resources, wood at least, is suggested. In the absence of conclusive evidence for or against the possibility, I will suggest, largely on the basis of comparative data to be discussed in the succeeding chapter, that the exploitative system during the Mamu Phase was one of hunting and collecting. The relative importance of either activity at any point in time in the phase is unknown.

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phase, although I acknowledge that future research may suggest a modification of this procedure. The hearth, charcoal from which is dated 12,620 ± 280 B.P., is of the same type as other Mamu Phase hearths, type E. There are few stone tools associated with the dated charcoal samples from the site, charcoal which underlay the greatest concentration of stone tools; there are so few tools, in fact, that it is impossible to identify the early component(s). The majority of the stone tools from NFX are from one or more later occupations than the dated features (fig. 105). Culture change in the Mamu Phase, then, is best demonstrated from the later part of the phase, that is, approximately 4,000 B.P. to 3,000 B.P. Because of the absence of positive evidence to the contrary, however, I am tentatively including the early component(s) at NFX in the Mamu Phase and will treat it so in the discussion without reiterating the foregoing qualification.

11. See note 6, above.

TENTIKA PHASE

The second phase of the Nanoway Tradition, the Tentika Phase, is represented at eighteen sites, four of which have been excavated. Assemblages from these sites, with the exception of component III at NFB, are members of class X. As with Mamu Phase assemblages, the most common artifacts are debitage and unifacially chipped stone tools. Moreover, the changing proportions of three commonest types of unifacially chipped stone tools continue in the same direction as in the Mamu Phase: unifacially chipped stone tools with asymmetric profiles and concave plans (type IA2a) diminish in frequency at the same time that those with symmetric profiles and both concave and convex plans (types IA1a and IA1d) become increasingly common. Multiple cultural innovations include adzes, whetstones, rectangular hearths, circular structures with substantial posts or planklike posts for supports with additional supports for eaves outside the wall proper and in some cases a ditch surrounding the structure, earth ovens, pottery, suid, pig enclosures, monoliths, and probably earthworks.[12] In most instances, on the basis of our data, the mechanics of innovation cannot be determined, nor is it possible to place the innovations in chronological order.

Four exceptions are changes in the cultural inventory which occur apparently late in the phase: the diminution in frequency of occurrence of chipped stone tools and of pottery; the occurrence of artifacts of Western derivation; and the use of planklike supports in the still-circular structures. Accordingly, an early and a late segment of the Tentika Phase can be recognized, with the later one possibly dating from approximtately A.D. 1920 (or earlier?), the general time at which Western influences intruded into eastern highlands cultures primarily through New Guinean catechists at first, followed by an increasingly rapid rate of influence with the advent of Australians in approximately 1930.

Known sites of the Tentika Phase are located in the open grassland basins of the north, including the margins of the Noreikora Swamp (NFA, NFB, NFC, NFD, NGK, and NGM), in narrow valleys as well as on, or near the top of, high ridges in the southeastern part of the study area, many of them close to forests (NFN, NFT, NGA, NGB, NFZ) or in the grass-covered, narrow valleys fairly near forests in the southwestern segment of the study area (NGY, NHB, NHC). Two assemblages from the north, NFC and component I at NFB, can be identified with the later part of the Tentika Phase, but unidentified sites in the southeastern and southwestern parts of the study area, and to a lesser extent in the northern

12. The earthworks NGN, NGP, and NGQ comprise functionally distinct kinds of sites which cannot be accommodated in our classification because of the absence of stone tools. On the basis of their location, however (in close proximity to Tentika Phase sites), and also on the basis of ethnographic information, they are provisionally grouped with Tentika Phase sites. They are not included in table 16.

section of the study area, have house remains that would suggest their inclusion in the late segment of the Tentika Phase.

For the Tentika Phase as a whole, the occurrence of cultural items of some permanence such as earth ovens, substantial dwellings, monoliths, and earthworks (?), as well as portable artifacts such as pottery, adzes, whetstones, and pig, suggest a degree of sedentarism. Although no indisputably horticultural artifacts have been recovered from our sites, an inference of a horticultural base for the sedentarism would not be inconsistent with what is known of the adaptive systems in the area in the late prehistoric and historic periods. At the same time, because of the close proximity of Tentika Phase sites to forest in the southeastern and southwestern parts of the study area, we can infer some dependence on a forest environment, probably with decreasing intensity and/or differential use. In sum, the co-existence of horticulture and hunting-collecting is suggested for the Tentika Phase.

The Tentika Phase succeeds the Mamu Phase in time. Although a precise assessment of its inception cannot now be made, it extends to the historic period. The latest date obtained from a Mamu Phase site is 3,070 ± 95 B.P., although the phase could have continued after that at sites not discovered or dated. The earliest certain date from a Tentika Phase site is 290 ± 90 B.P.[13] Comparative data from the eastern highlands, to be discussed in the next chapter, do suggest that its inception is somewhat earlier than this, although how much earlier is moot. Despite its intriguing association with pottery, the questionable date 2,060 ± 85 B.P. cannot provide confirmation of Tentika Phase without corroboration (see appendix 4).

YOFEE TRADITION

The eight class Z assemblages, none of them from excavated sites, have been placed in the Tesanee Phase of the Yofee Tradition. Available data suggest that it is highly localized and spans a relatively short period of time. Recent occupation of the sites is indicated by abundant ethnographic data and the remains of highly perishable features such as house posts at some sites. Although no Western artifacts were retrieved, Western influence is evident at some sites in square and rectangular houses (and latrine remains, if these have been interpreted correctly), suggesting that the occupation of some sites extends into the historic period.

13. I have not made corrections for the Stuiver-Seuss effect. I record, however, that Charles S. Tucek of Radiocarbon, Ltd., says "*perhaps* a better calendar date for RL-408 [290 ± 90 B.P.], based on tree ring dating, would be the range A.D. 1470 to A.D. 1650 with the ± 90 years uncertainty included in this range" (correspondence, 10 June 1974; italics mine). On the other hand, James Buckley of Teledyne Isotopes says: "I have not attempted corrections of very recent dates [e.g., I-7286] to make allowance for the Stuiver-Seuss effect because such effects vary considerably with locality and to date no one has proposed an adequate correction formula" (correspondence, 7 August 1974).

The Yofee Tradition differs from the Nanoway in having among its three most common tool types unifacially chipped tools, asymmetric in profile and wavy in plan (IA2b); these are not as significant in Nanoway Tradition assemblages. The Tesanee Phase sites are generally located on low, gentle rises in narrow, grass-covered valleys surrounded by forest in the extreme southwestern portion of the study area.[14] The close proximity of several sites to the forest suggests that some sites represent occupations of people moving into the area, settling it, and clearing forest, an inference confirmed by Cole's ethnographic data.[15] Inference of both horticulture and hunting-collecting based on the archeological data are also confirmed by the ethnographic data.

SUMMARY

This outline of cultural development and change in the eastern highlands of New Guinea derived from an analysis of the archeological material recovered by the Micro-evolution Project field party suggests that there was a long, continuous period of growth and development from 18,000 B.P. to at least 3,000 B.P., with slow, but perceptible changes in the frequencies of types of the ubiquitous unifacially chipped stone tools. An adaptive system based primarily on hunting and collecting is suggested for this period, during which human occupancy seems to have been confined largely to low basins and river valleys in the northern and southeastern parts of the study area. At present there is no evidence for occupation of the southwestern part of the study area during this period.

Subsequent to 3,000 B.P., changes in frequency of unifacially chipped stone tool types continue, and at some time(s) cultural innovations, as well as a significant ecological shift, occur. Many established cultural patterns continue into the historic period, some to be modified by the introduction and influence of Western artifacts subsequent to A.D. 1920 (or earlier?). Although hunting and collecting continue to be practiced, a dependence on horticulture is inferred. In the northern part of the study area, the grassland basins continue to be occupied, while in the southeast, movement up the ridges is evident as well, and in the southwest, occupation of the region becomes a reality. Figure 110 is a tentative chronology for the area.

Although it is similar in many ways to the only other archeologically based outline of cultural development in the eastern highlands, that of J. Peter White, this outline does display some differences—some of them the result, no doubt, of archeological accident; some the result of functionally different kinds of sites explored; and some, possibly, the result of differences in definition and interpretation. These problems are addressed in the succeeding chapter.

14. In fact, they are just outside of the Micro-evolution Project study area.
15. Cf. also Sorenson 1972.

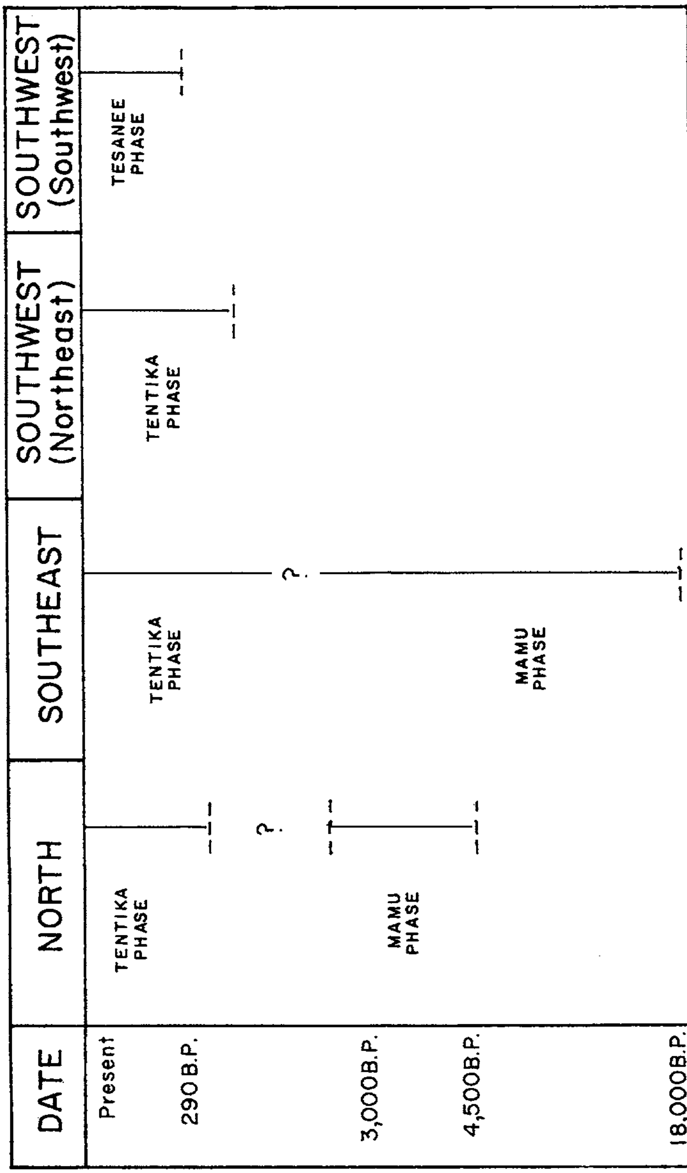


Fig. 110. Suggested chronology for four segments of the study area. Mamu Phase and Tentika Phase belong to the Nanoway Tradition, Tesanee Phase to the Yofee Tradition. Broken line and question mark indicate exact date unknown (dates not to scale)

V. Comparison

In comparing the material that has been defined, described, and placed in chronological perspective, relevant data from the eastern highlands, the region east of the Asaro-Watabung divide, are examined: Swadling's investigations in the Arona Valley northeast of the study area, and White's excavations at NAE (Aibura) and NBY (Batari) both within the study area, and at NBZ (Kafiavana), approximately forty km northwest (map 2).

Enticing as it may be, comparisons to archeological material external to the eastern highlands will not be discussed. This decision is influenced by several factors, including the belief that effort is more wisely expended in attempting a solid regional synthesis as well as artifact definitions and descriptions, on which to base interareal comparisons. Equally compelling considerations are that (1) the kind of archeological data recovered in some areas is apparently so different from data so far recovered in the eastern highlands as to preclude comparability (e.g., ditching systems in in the Wahgi Valley [Golson n.d.]); (2) some archeological data are presented in preliminary reports which understandably lack the precision of explication necessary for other than very general comparative purposes (e.g., JAO [Wanlek] [Bulmer 1973]); and (3) the methods and techniques employed in the analysis of some of the data make comparison from the literature difficult (e.g., the chipped stone tools at ADL [Kukuba Cave] [Vanderwal 1973]; NAZ[1] [Niobe, Nombi] [White 1972]; NAW [Kiowa] and MAH [Yuku] [Bulmer 1964]; and the Upper Kaugel Valley [Allen 1970]). It is apparent from both prose and sketches that some of the types of unifacially chipped stone tools which have been treated in this monograph occur in these assemblages as well as many others, not only in New Guinea but in the larger areas of which it is a part.

1. This is also duplicated in the Papua New Guinea Archaeological Survey File as NCA and NDR (Swadling 1975: 59).

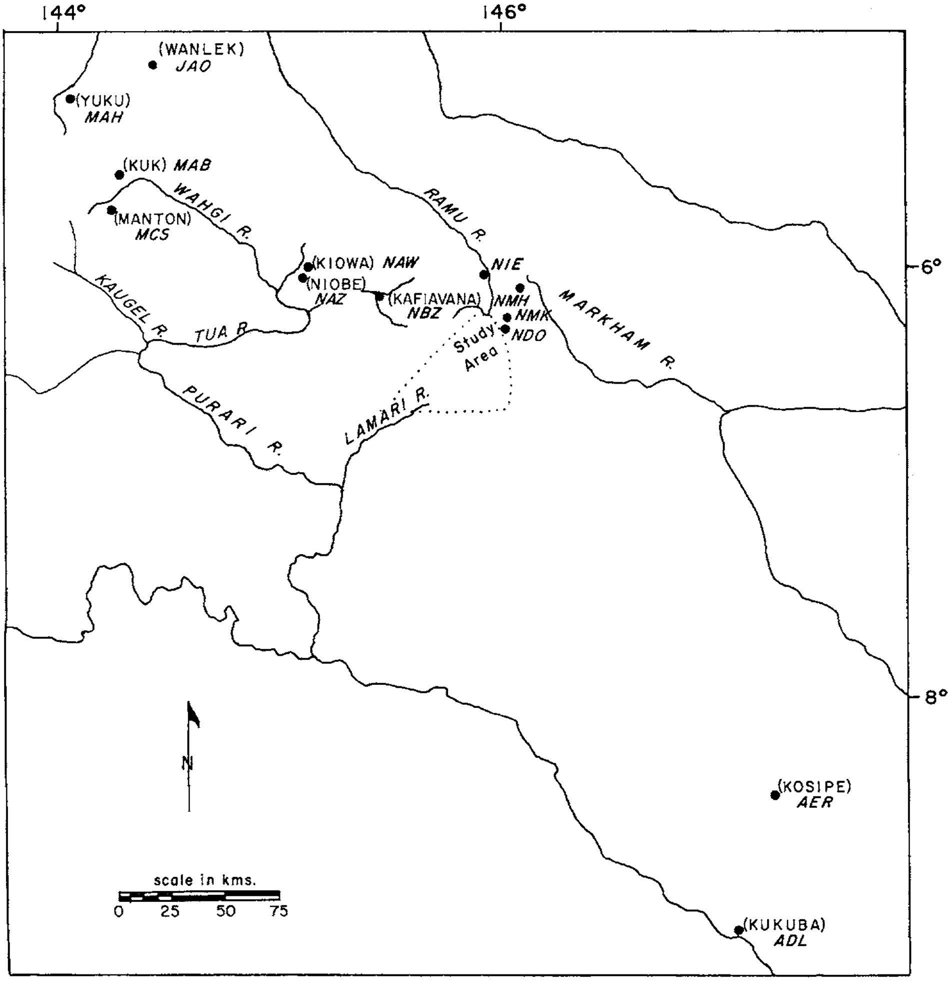
THE ARONA VALLEY: NIE, NMH, AND NMK

One corpus of archeological data from the eastern highlands of New Guinea which I discuss in comparative perspective is Pamela Swadling's valuable report of what was to be, essentially, a project in salvage archeology, with its attendant restrictions (Swadling 1973). Her specific directive was to locate archeological sites in that part of the Arona Valley which was to be inundated at the conclusion of the Ramu Hydroelectric Project of the Papua New Guinea Electricity Commission. Susan Bulmer, after a brief reconnaissance of the area in 1971, had recommended a more intensive exploration of the archeological potential of the Arona Valley, judging it to be a "very distinctive geographical and cultural region within which a heavy population has lived in the prehistoric past. Oral tradition from many villages now sited on the slopes of the valley indicates that their ancestors formerly lived down in the valley itself" (Heyligers and McAlpine 1971: 28). "In some cases former village sites are remembered that were occupied so long ago that they are beyond genealogical reckoning. Mr. Giddings estimated that some of the sites that were remembered in genealogies can be placed in the early 18th century, so the sites beyond the genealogies are almost certainly earlier than this. The sites I learned of are mostly located on ridges down in the valley" (Bulmer 1971: 41-42).

Although several of Bulmer's preliminary suggestions have not been substantiated, Swadling was able to study the area and to arrive at some significant conclusions. As a matter of fact, Swadling found no archeological evidence in the area to be flooded by the Ramu Hydro-electric Project. She then surveyed the area surrounding it and "in the absence of any earlier sites" she engaged in "the examination of . . . ancestral settlement sites" (Swadling 1973: 16). Exceptions are two sites that were "marginally beyond the traditional realm" while "their similarity to known traditional sites probably suggests that they lack any great antiquity" (ibid.: 17). One of these sites, NMK, is discussed below.

The large number of relatively recent sites discovered during Swadling's survey and the artifacts retrieved from them are discussed in her monograph. She found, for example, used flakes, waste flakes, used cores, waste cores, and edge-trimmed cores; but her listing of them makes further identification and, consequently, useful comparison impossible. Although many "axe-adzes" may well be adzes,[2] apparently she made no attempt to infer function; moreover, she does not always distinguish between specimens ethnographically collected and those actually retrieved from archeological sites. Swadling recovered quantities of pottery sherds,

2. Swadling reports that striations perpendicular to the bevel (cutting edge?) are visible on twelve of a sample of forty-five specimens from site NDO (correspondence, 24 November 1975).



Map. 2. Study area and archeological sites discussed in the text

but in this case our very small sample makes useful comparison impossible other than to indicate its relatively recent occurrence.

Swadling reports one artifact as a "tanged artefact" of slate or slatelike material, collected by Dr. A. J. Radford in 1971, at NDO. Although Swadling refers to the cultural material from NDO as a surface collection, the large number of ax-adzes, to cite but one example, raises the question of whether some of the artifacts might not have been ethnographically retrieved—that is, obtained directly from residents of the area rather than recovered from an archeological site. This is especially true of ax-adzes alleged to have originated at Ontenu, kilometers distant from NDO.[3] It would be useful to know in which context, archeological or ethnographic, the tanged artifact was retrieved. No artifact of this kind was recovered from the eastern highlands by the Micro-evolution Project archeological field party, or, so far as I am aware, by Peter White. Bulmer (1973: 17) mentions two similar artifacts from "near Kainantu" (in the eastern highlands). One of these artifacts was purchased by R. J. Giddings, at Kurangka Village, approximately twenty-five km east of Kainantu (and the study area) from a woman who had used it until fairly recently (Giddings, correspondence, 10 January 1975); in other words, it was obtained in an ethnographic, not archeologic context.[4] Swadling's sketch of the tanged artifact (Swadling 1973: 10, fig. 8) indicates that the working edge of the object is broken, as is that on the Giddings artifact, obviating functional inference.

In the category of feature (i.e., nonportable artifacts), some useful observations may be made of Swadling's discoveries. I confine comparative remarks to the two excavated sites, NIE and NMH, and one observed site, NMK, mentioned above (see map 2). NIE, located in Agarabi territory northwest of the Arona Valley, was reported once to have consisted of three men's houses, one of which was partially excavated. Swadling uncovered post remains that "formed a circular structure around a central post and hearths. Stone flakes, some of them obsidian, had been left on the floor" (Swadling 1973: 23). It is apparent from Swadling's figure 15 that the house measured approximately 6.5 m in diameter and that the circular hearths "consisted of burnt flecks of clay dark stained soil and flecks of charcoal" (ibid.: 25). Artifacts include bone fragments found in the hearths, pottery, cores, lumps of red-orange clay, ax-adz fragments, polished stone, and stone (ibid.: 77-78). From genealogical data, Giddings

3. The Ontenu provenience is not questioned. During my two-months' period of field work among the Aiyura Gadsup in 1963-64, the ties between them, as well as Gadsup to the east of them, to Ontenu were clearly demonstrated. This datum would not be in an archeological record, however.

4. The second tanged artifact that Bulmer mentions is apparently the one Swadling attributes to Radford. In fact, Radford purchased it from Kevin Marsh, who reported purchasing it in the Gadsup area, and placed it in the Papua New Guinea Museum (Radford, correspondence, 15 March 1976).

estimates 1895 to be the date of evacuation of the site (ibid.: 27). The house at NIE, a circular house with planklike exterior posts around a central post, appears to be similar to our type K house, a structural form found in relatively late contexts in the study area, such as at NFC. The two circular hearths at NIE, type F in our scheme, are apparently similar to one late-context hearth in our sites.[5]

Cultural material at NMH consisted of two features which Swadling refers to as large round house depressions, both surface-collected and excavated samples of pottery and stone flakes, a core, an object that local informants called a magic stone, and cooking stones.[6]

The excavated area at NMH was a "small L-shaped square in the upslope round house. No post holes were found" (ibid.: 51). Inspecting figures 32 and 33 in Swadling (pp. 49-50), one is immediately impressed not only with the large size of this "round house" in which no post holes were found,[7] but also by its configuration: a circular embankment measuring approximately 27 m by 20 m in diameter and approximately 1.75 m in height with a "raised central area" approximately 1 m in diameter and .5 m in height. The similarity to the larger segment of the three earthworks found in the study area, NGN, NGP, and NGQ, is marked; the measurements are comparable to those of all three.[8] The unexcavated house depression at NMH is approximately 20 m in diameter, and Swadling's drafting convention indicates an encircling embankment. Might this not suggest identification of earthwork?[9] If the partially excavated earthwork at NMH is complete, it may be different from the three in the study area in consisting of but one unit or segment. Note, however, that it is situated approximately 2 m from a road so it is not impossible that there might

5. Although Cole did not collect material from that part of the Micro-evolution Project study area currently occupied by the Gadsup (of which the Arona Valley is a part), he did make two brief trips to the north of Kainantu town into Agarabi territory, one in mid-February 1967, the other in early May of the same year. Artifacts and debitage were collected from six locations, including NGV (thirteen tools and ten pieces of debitage [table 4]) and NGW (eleven stone tools and twenty pieces of debitage [table 4]). Small quantities of debitage only were collected from the other four locations, with the exception of the cutting end of an adz on which both chipping wear and abraded surface striations perpendicular to the cutting edge are clear. Some of these locations are in the general area of Kainantu village, founded, according to Giddings, by migrants from site NIE (Swadling 1973: 23).

6. Swadling also refers to these as hearth stones (Swadling 1973: 82), but in correspondence (24 March 1975) she clarifies this and indicates cooking stones to represent her interpretation.

7. The excavation at the periphery of the "depression" was approximately 2 m in width; whether one might not expect some evidence of supports in this distance if it were a house is moot.

8. NGN: 35.5 m by 30 m in diameter; 1 m height of embankment; 75 cm height of central raised area; 1.5 m diameter of central raised area. NGP: 37 m by 32 m in diameter. NGQ: the part not obliterated by road construction is 35 m by 18 m; the field party estimated that the whole probably measured approximately 35 m by 28 m.

9. The occurrence of cooking stones within an earthwork seems more understandable than their occurrence within a house.

have been a small circular embankment adjacent to the large one, most or all traces of which were obliterated in road construction. Apparently too, there is a smaller circular embankment at the site, although approximately 150 m from the larger, not adjacent to it. Thus, if there is evidence of earth ovens, earthworks, and pottery at NMH, the site in these respects is comparable to some Tentika Phase sites in the study area.

Although no excavations were conducted at NMK, Swadling's description of the round house depression also is suggestive of an earthwork. It has "a diameter of some 18 metres from one side of the outside bank to the other. The central raised area was about three metres in diameter. Cooking stones and flakes [and one pottery sherd] were scattered in the area around the central raised area" (correspondence, March 24, 1975).

There are, then, at two of Swadling's sites features that are to some degree comparable with features in the study area which I have called earthworks. Variation is apparent. Swadling does not mention a raised area in the center of the smaller earthwork at NMH nor is one reported for the smaller segments at NGN, NGP, and NGQ, whereas she does report a raised central portion in the earthwork at NMK. A raised central area is reported for the excavated earthwork at NMH and for the larger segment at NGN; none is mentioned in the notes for NGP or NGQ.

In using the term "earthwork" to refer to these features I indicate merely the existence of circular embankments; it must be emphasized that no inference is made as to their use. As noted in appendix 7, Tairora informants claimed that the smaller segment of the earthwork at NGN had once been a men's house. Only excavation will provide an answer. The diameter range of known small earthworks in the eastern highlands is from 16 m to 20 m; the range of excavated circular houses in the eastern highlands, from 6 m to 8 m. There is, thus, a large size difference between the smaller earthworks and known circular houses. If the smaller earthworks can eventually be identified as houses, they are of a type quite distinct from defined house types of the Tentika Phase. They are larger, they have an encircling embankment, and some, at least, leave distinctly different configurations on the ground. Swadling indicates that the three houses reported for NIE were recognizable "from ground surface *flattening*" (italics mine); she refers to the earthworks as "depressions" (Swadling 1973: 23, 51).

Unlike other contemporary archeological projects in the eastern highlands, Swadling was fortunate to recover quantities of pottery, both whole vessels and sherds, although as in the case of other artifacts no distinction is made between those ethnographically and those archeologically collected. When I read her monograph I hoped there might be the exciting potential in her material to utilize the data of prehistory, such as pottery retrieved from abandoned sites, to check ethnographic data, as, for example, her genealogically and ethnographically based chronologies as well as those of Frantz (1973) and Giddings (n.d. a, b, c, d). Many of her sites—those located in a relatively small area, belonging to a single tradition, and representing a fairly restricted range of time—would seem to satisfy criteria for possible frequency seriations. Among the many unique features that New Guinea presents anthropologists is the recent history-prehistory interface. Although this feature makes the temptation of guess-work attractive, it does provide the opportunity for the controlled manipulation of the data of both ethnography and archeology. A frequency seriation chronology of a set of sites, compared to ethnographically based dating of the same set, would be a valuable addition to the growing literature on the use of ethnographic analogy in archeology (Anderson 1969; Binford 1968; Bonnichsen 1973; Price 1974; Stanislawski 1973). Such an approach would be even more useful if still other kinds of data, such as radiometric determinations, could be exploited. Swadling suggests that a major drawback to this exercise is the lack of samples of decorated sherds of sufficient size to permit adequate seriation (correspondence, 24 March 1975). Perhaps in future, when archeological pottery in the area is more numerous and also when it has been more extensively studied, such a project will become a possibility.

NAE, NBY, AND NBZ

J. Peter White has excavated in three caves in the eastern highlands of New Guinea. Two of them, NAE (Aibura) and NBY (Batari), are within the study area; the third, NBZ (Kafiavana), is approximately forty km to the northwest (see maps 1 and 2). A comparison of his material, presented in an exemplary report (White 1972), with our data is most rewarding.

FLORA AND FAUNA

In this discussion I address two questions, the basis for inference of adaptive strategy during the Mamu Phase and the date of appearance of *Sus*. Fauna and flora from our sites are all from recent contexts; moreover, neither bone tools nor shells were retrieved. In contrast, White's collection of fauna in particular is larger and more varied, and it spans a longer segment of time. At NBY, forest-dwelling animals are present throughout the occupation of the site, which White considered to have been from at least 8,230 ± 190 B.P. to 850 ± 53 B.P. The predominant fauna during the occupations at both NAE and NBZ were wild animals. The evidence from White's three sites, then, suggests an adaptive system in which hunting was prominent, and on the basis of this our suggestion of hunting as a basic adaptive strategy during the Mamu Phase seems a reasonable inference. Evidence is still needed to support the inference of collecting as part of the adaptive system during the Mamu Phase.

In our material twenty-two pig teeth and one fragment of pig bone as well as seven teeth and fourteen fragments of bone which may be pig are all from late contexts—three sites dating from 290 ± 90 B.P. or later. It is clear from White's material that pig also occurs in late contexts at his three sites: 850 ± 53 B.P. at NBY, 20 cm above the level dated 770 ± 100 B.P., to the present at NAE, and by analogy with NAE, in the same time span at NBZ. Both sets of extant data from the eastern highlands would confirm the presence there of pig in fairly recent times.

Because of the poor conditions for preservation at open sites, the absence of pig remains in our earlier sites would not be positive evidence for the absence of pig in the eastern highlands at an earlier period than we have found it. Although the supporting evidence at his sites is somewhat less substantial than that from the later period, White indicates earlier dates for the occurrence of pig: at NBY "about 2000 years ago" (White 1972: 142) or 3,000 years ago (White ibid.: 30, 143) and at NBZ "6500 years ago" (ibid.: 108, 142).

HEARTHS, STRUCTURES, AND ROCK PILES

It is premature to attempt meaningful comparisons between hearths, structures, and rock piles as between open and sheltered sites. It can be noted, however, that the ash lenses at NAE, a complex of hearths at NBY, and hearths and hearth levels at NBZ (ibid.: 53, 13, 85, 86) seem not to be comparable to the hearths at our sites. The similarity of diameter of post holes and their occurrence in parallel rows at NAE and NFX is noted, as is the apparent rather wide chronological distance between them. Finally, White records for NAE "a congregation of small lime-stone boulders" for which he is unable "to suggest an explanation" (ibid.: 55). Although the rock material differs from the unidentified rock piles at NGG, the size of the grouping is somewhat larger than those at NGG, and there is a large temporal difference between NGG and horizon I at NAE, the occurrence of enigmatic rock piles at both sites should at least be noted.

ROCK ART

The Micro-evolution Project field party found rock paintings on limestone outcrops at three sites in the study area, NFL (figs. 51-54), NHE, and NHW (fig. 57); previously, in 1964, they were recorded by J. D. Cole and Roy Wagner at NBZ. Other sites with rock art reported for the study area are NAA, NAC, NAD, NAE, and NBY, with all but NAD occurring on limestone (White and White 1964).[10] White also reports the paintings at NBZ (White 1972: 83-84, pl. 3B). While detailed comparison is not attempted here, some general observations and recurring motifs are noted.

Charcoal is widely used as a pigment. Red/orange/yellow[11] and white

10. J. P. White kindly provided a copy of verbal descriptions of the paintings at NBY.

11. This may well represent semantic variation or a range of colors rather than discrete categories. The only colored photographs that I have seen are those of the art at

pigment occur frequently, sometimes alone (e.g., white at NAE, orange at NHW, red at NBY), sometimes in combination (e.g., orange/white at NFL, red/black at NBZ, orange/white/black at NFL, red/white/black at NBZ). Superposition of designs, especially black line drawings over colored paintings, occurs with some frequency. Motifs include "lizard-like anthropomorphs" (Wilde 1975: 14), often with three-digit extremities; stick figures; inverted triangular head; a variety of roughly parallel line delineations including cross, circle, and crescent; and repeated short lines perpendicular to curvilinear or longitudinal lines. The white dots, "leaf patterns," and hands reported by White and White (1964) are not present in the photographs or rough sketches which I have seen of the paintings at NFL, NHE, NHW, or NBZ.

POTTERY

The relatively few fragments of pottery in both White's and our data make meaningful comparisons, even on a gross scale, difficult. Although my classification of pottery, based on degrees of coarseness and applied uniformly to 332 fragments, differs from the groupings that Specht made of fourteen sherds from NAE based on varying criteria, such as color, temper, and thickness, which were not applied uniformly (White 1972: 62), some similarities are apparent. First of all, fragments of pottery with designs traditional among the Agarabi (who live immediately north of the study area) have been noted in both sets of data. White says that "from Watson's description it seems likely that some of the Aibura sherds are of this type of pottery, for example, the rim sherds in Specht's group 3" (ibid.). Although the designs on our decorated sherds are minimal, one sherd (fig. 94f) displays a design similar to, and those occurring on two sherds (figs. 94a and 94b) are suggestive of, what seem to be common motifs in Agarabi pottery. Three of our rim sherds have diagonal incised lines on the lip. The latter attribute is not limited to Agarabi pottery, nor do we know that it and the former motifs are diagnostic of it, although they occur commonly on the examples with which I am familiar.

Secondly, White suggests that one sherd from NAE "may well have been made somewhere in the Markham valley" (ibid.: 63). It is apparent from figure 94 that no designs on our pottery are indisputably suggestive of Markham Valley pottery, at least that with which I am familiar—fragments collected by Cole and the illustrations in Holzknecht (1957), Specht

NFL and NHW, both of which include designs which I would describe as reddish brown to orange; the terms "very indistinct red," "orange," and "dark orange" occur on the field pencil sketches of the NFL paintings. "Red" is the term used on Roy Wagner's ink sketches of designs at NBZ. The terms "red" and "yellow" are used by White and White, who also suggest that "red ochre" may have been the coloring material used for "red" paintings at NAC (White and White 1964: 776). In another context they mention "many shades of red" (ibid.: 775).

and Holzknecht (1971), and Swadling (1973). On the other hand, the shape of at least one rim sherd (fig. 100c) and the color, paste, and temper of several sherds, including figures 100c, 100e, and 100m, are suggestive of pottery of known Markham Valley provenience.

Thirdly, one of the sherds from NAE contains shell in the aplastic, which is not found in our sherds. Because of small samples, however, this difference cannot now be accorded great significance. It would seem prudent at this time merely to note aplastic material, to present sketches of designs and rim forms, possibly to make two measurements of coarseness (thickness of sherd and size of inclusions), and to extend comparative observations no further until such time as highlands, Markham Valley, and coastal pottery are better known and a valid comparative classification is established.

At present there is no evidence of pottery manufacture in the archeological record in the eastern highlands, and pottery seems to be limited to sites of fairly recent date, 770 ± 100 B.P. (?) or less to present[12] (but also see appendix 4).

ADZES

Although it is not necessary to the analysis discussed in this monograph to infer tool use, such inference seems indicated for the present comparative observations. On the basis of wear patterns, type IVD6f stone tool is inferred to be an adz (see chap. III, "Stone Tools, Identification"). White uses the terms "axe-adze" and "axe" to refer to "all pieces of ground stone which resemble those hafted and used as axes or adzes in recent times" (White 1972: 6). Hafted ethnographic specimens of type IVD6f tools with which I am familiar are hafted as adzes. Although definitive equivalence cannot be determined from the literature (White's definition of ax and ax-adz does not indicate that they are, in fact, type IVD6f tools), in the ensuing discussion it is assumed that type IVD6f tools and White's "axes" and "axe-adze" from his three eastern highlands sites are the same kind of tool. If this assumption is mistaken or if future research demonstrates that different types of tools are involved, some, if not all, of the succeeding remarks may be subject to modification.

One difference between type IVD6f tools and White's ax-adzes from NAE, NBY, and NBZ (the significance of which I am not able to assess) is the material from which they are made. The predominant rocks listed by White are metamorphic, with both sedimentary and igneous rocks occurring rarely. The majority of our adzes, on the other hand (including ethnographic specimens), are of igneous rock, both basic and volcanic

12. The date is from the base of horizon I at NAE, of which level four is the lowest. One sherd in White's group is from the same pit and level, but the relation of the sherd to the charcoal is not clear other than that they were found in the same square and level.

(including lava) with relatively few specimens of sedimentary or metamorphic rocks. The only comparable data of which I am aware are a sample of forty-one of the ax-adzes collected by Dr. and Mrs. A. J. Radford and Swadling at NDO, twenty-four of which are of igneous rock;[13] the adzes collected by the Berndts and reported by Adam, the bulk of which are of igneous rock (Adam 1953: 414-20); and those collected by Godelier among the Baruya, who used "les pierres dures d'origine volcanique" (Godelier 1973: 197).[14]

A second discrepancy between White's ax-adzes and our adzes is the time of their first appearance in the archeological record. Adzes occur with some frequency in the fairly recent Tesanee Phase of the Yofee Tradition. In the Nanoway Tradition adzes occur in some assemblages of the Tentika Phase, the earliest C_{14} date from which is 290 ± 90 B.P., although the inception of the phase may be earlier. In none of the assemblages of the earliest known phase of the Nanoway Tradition, the Mamu, is there anything which could be construed as an abraded tool, let alone one which may have been used as an adz or ax. The fourteen known Mamu Phase sites, six of which were partially excavated, cover a time span extending from 18,000 B.P. to 3,000 B.P. at least.

White makes the qualified suggestion that ax-adzes "may have occurred from about 3000 BP" at NBY and NAE (White 1972: 142). Our data would tend to support White's reservations about quite such an early date in the study area. From NBZ White reports "ground stone axe-adzes . . . at least 9500 years ago" and "at least 11,000 years ago" (ibid.: 109, 142), an antiquity not matched in our data.

PEBBLE TOOLS

In her initial excavations in the highlands, Bulmer recognized a category of tool, "pebble tools," although they were neither completely defined nor described (Bulmer 1964: 257, 262-64; Bulmer and Bulmer 1964: 59 ff.). White not only provides some clarification but he offers several reasons for questioning the existence of "pebble tool" as a distinct type of tool (White 1972: 7).

> Many Highlands artifacts not regarded as pebble tools by Bulmer are made on river pebbles. . . . The metrical limits of the class [do not] serve to distinguish this group from other tools made on pebbles. . . . Step-flaking which

13. Swadling submitted the artifacts to Dr. M. A. Worthing, Department of Geology, University of Papua New Guinea, for petrographic analysis. On the basis of hand specimen examination, he sorted them into groups; four thin sections were also examined. Dr. Worthing acknowledges the possibility of error because of the difficulty of typing the fine-grained polished rock by hand specimen (correspondence, 7 October 1975).

14. I have no data on the provenience of the rocks used in making archeologically retrieved type IVD6f tools (adzes). Godelier mentions two contemporary sources: near Okapa, a settlement not far from Tesanee Phase sites, and in Kukuku country, south and southeast of the southeastern part of the study area (Godelier 1973: 197).

> commonly occurs on these artifacts . . . is characteristic of a majority of artifacts within Highlands industries [and] cannot be used to differentiate this group. . . . The majority of flaked artifacts is unifacially worked and this feature is not one exclusive to pebble tools. . . . None of these attributes [large size, kind of rock, "chunky" appearance, pebble cortex], . . . even when taken in combination, serves to distinguish absolutely "pebble tools" from other, smaller, flaked tools. . . . .

It should be noted that in spite of these observations by White, to him "it seems worthwhile admitting that this group [pebble tools] may exist pending fuller definition, since its occurrence does appear to be geographically and temporally variable" (ibid).

In the absence in the literature of what seem, for comparative purposes, to be adequate descriptions or definitions of what type of tool in the New Guinea highlands is indicated by the term "pebble tool," it is difficult to say if we have them in our collection or not. We do have fragments of water-worn rocks (i.e., pebbles) on which tools occur and on which a large proportion of cortex remains. If this statement is a correct description of pebble tools, then they do in fact occur in some of our assemblages. Type IA2a tools, for example, occasionally occur on such rocks.[15] A type IA2a tool occurring on a rock with much cortex, however, is not definitively distinct from type IA2a tools that occur on rocks with less cortex or with no cortex at all. That White included pebble tools with other artifacts in his edge-analysis suggests his concurrence with this position (ibid.). In the study area tools occurring on rocks with much cortex are not common; they are not found at all sites (making their reported absence at NAE and NBY not remarkable [ibid.]), and the sites at which they are found cover a range of time and space.[16] These artifacts occur with greatest frequency in the assemblage from NGG, a site located near a stream which contains an excellent supply of water-worn rocks. They also occur at NGH and NGJ, for example, both in the immediate vicinity of NGG. At NBZ, White reports a higher percentage of pebble tools in the lowest horizons, "although [they] occurred occasionally throughout the site" (ibid.: 102). His further characterization that "some of these [pebble] tools appear to be cores but others are step-flaked" (ibid.) is additional indication of the difficulty of determining from the literature what a "pebble tool" is. In Cole's material from the same site, NBZ, the tools on rocks with much cortex are commoner in the lower levels than in the upper, but there is nothing about the tools themselves to distinguish them definitively from other

15. See figs. 68b, 68d, 73a, 73d, 74b. See fig. 76c for a type IA2d tool occurring on a rock with much cortex.

16. The situation at NAE is one more example of the confusion surrounding the term "pebble tool." In a single publication White says that "many of the tools are made on pebbles and as such *could be called pebble tools,* but none are outside the general size range of the other scrapers, nor is there any apparent selection of a particular type of stone for them" (White 1972: 70, italics mine), and he also states that pebble tools are absent from NAE (ibid.: 7, 142, 143 [fig. 27]).

tools of the same type which occur on rocks with little or no cortex. It is clear from available data that the weight of tool-bearing rock (descriptive mode) diminishes through time in the study area and at NBZ. Tools occurring on rocks with much cortex are generally relatively heavy—it is not unusual, then, to find them, when they occur, commoner in early assemblages than in later ones. With our present state of knowledge of prehistory in the eastern highlands and until such time as the term "pebble tool" is clarified, it would seem to be of questionable value.[17]

UNIFACIALLY CHIPPED STONE TOOLS

Excepting chipping detritus, the most common kinds of artifacts found in archeological contexts in the study area and at NBZ are unifacially chipped stone tools. Because White and I have made different analyses of stone tools, exact comparison of our data is not possible. If selected descriptive and definitive modes are used, however, some general comparisons can be made. White mentions bifacial chipping, wavy edge (i.e., wavy plan), and convex edge (i.e., convex plan) (1969: 31, 26). Bifacially chipped tools are not common in our material (nor in White's); wavy plans occur in the Nanoway Tradition and they are of definitive significance in the Tesanee Phase of the Yofee Tradition. Convex plans are fairly well represented in our collection: they are important if for no other reason than that they provide types of tools in addition to the two commonest tool types which can be used in quantitative study.

White uses the terms "tool" and "implement" interchangeably, referring to an object—in the present context, a rock. His term "altered edge" would seem to be the equivalent of our unifacially chipped stone *tools*. So far as these artifacts are concerned, it seems reasonably clear to me that many of what White refers to as "retouched edges" are asymmetrically profiled unifacially chipped stone tools and many of his "utilised edges," "utilised flakes," and "use-wear" indicate symmetrically profiled unifacially chipped stone tools. Concave plans are common to both collections. White has a higher proportion of straight plans; but this may reflect a difference in definition rather than a difference of tool type proportions (appendix 2, note 4).

Accepting this rather gross correspondence, the changes through time of tool type frequencies which we have indicated for the sites in the study area are suggested in White's material from three stratified cave sites. (It is to be emphasized that these are gross comparisons of general frequency of tool types—percentage occurrences are not comparable in the two sets of data.) Following are some selected observations about White's three

17. It is possible to investigate the significance of "pebble tools." One example would be to select the dimension "structural characteristic of the tool-bearing rock," with at least four modes—flake, core, chunk, and pebble—to determine the distribution of tools occurring on each and to assess their significance.

sites (the words are White's, but the order of the quoted material is mine).

For the most recent material at NAE, in horizon I (post–770 ± 100 B.P.), White gives these statistics: ". . . Utilised flakes make up half of the total number of tools. . . . Two thirds of the tools weigh less than 10 gm. . . . Over 80% of the edges show use-wear. . . . Unretouched flakes are more commonly used [than in lower horizons]. . . . Nearly two thirds of the edges are straight or convex." In the lower horizons at NAE (horizons II and III) White found the following: ". . . Utilised flakes make up . . . only about 10% [of tools]. . . . The number [of tools] weighing less than 10 gm declines markedly [from horizon I]. . . . Just over half the edges show use-wear. . . . Two-thirds of the edges are concave" (White 1972: 70-72). At NBY, "nearly all use-wear is on acute angled edges"; " 'utilised' edges [are] on thinner, lighter implements"; and "there seem to be fewer tools weighing more than 10 gm in the top horizon" (White 1969: 38, 43, 32). Some observations previously made for NAE are also apparent at NBZ. In addition, "the weight of implements increases from the top horizons down"; "in Horizons I-II flakes with use-wear are more common [than in lower levels] and the number of retouched tools declines [from that of lower levels]" (White 1972: 104, 102).

Apparently there is a general similarity of the major unifacially chipped tool types and their frequency distribution through time in known sites in the study area and NBZ. For the data which White presents this is more clearly the case for the change in "profile" than for the change in "plan." Although these changes may appear to be slow, they are real; and if the two ends of the bar graphs in figures 104 and 109 are compared, the changes in, for example, types IA2a, IA1a, and IA1d are not negligible.

The changes in proportions of unifacially chipped stone tools in the eastern highlands are significant for a number of reasons: next to debitage, (1) these tools comprise the largest, most numerous group of artifacts recovered in archeological contexts; (2) they occur at the largest number of sites; (3) they are found at the widest range of sites; and (4) they extend over the longest period of time of any artifacts found to date in archeological contexts.[18] They can, in other words, provide a basic framework in terms of which other artifacts can be evaluated and integrated in a scheme; they are, for example, a means of relating bone tools, shell, and other perishable material found in sheltered sites to houses, hearths, earth

18. Some of these generalizations at least can almost certainly be extended to the area west of the Asaro-Watabung divide and possibly to coastal areas where, understandably, the emphasis in reports is often placed on pottery. The number of unifacially chipped stone tools retrieved from some sites is not negligible, however. Two examples from the Port Moresby region are Bulmer's report of over sixty sites on "many" of which "utilized flakes and flake tools with retouch . . . are very common" (Bulmer 1969: 13), and ACL (Nebira 4), where Allen retrieved a total of 866 "utilized cores, utilized flakes and retouched flakes" (Allen 1972b: 110, table 5), which are "usually unifacial: (ibid.: 113).

ovens, earthworks, and monoliths, to date found only in open sites. With a replicable classification of unifacially chipped stone tools now available, we would seem to have an analytic device of some utility as well as a stimulus to possibly more useful classifications based on alternative modes.

DISCUSSION

In general, to the extent that comparison is possible and acknowledging as has White (1971b: 190) that functional differences are to be expected, as between sheltered and open sites, there is similarity between cultural development and change at White's sheltered sites and our open sites in the eastern highlands. This is apparent in the changing frequency of the most common types of unifacially chipped stone tools and in the innovative items of the Tentika Phase and the augmented cultural inventories at NAE and NBZ in relatively late times. To be sure, White asserts that there is little culture change apparent in the eastern highlands throughout its known prehistory. "The dominating impression produced by a collection of prehistoric stone and bone implements from the Central Highlands [including the eastern highlands] is one of sameness and continuity. In spite of slight changes, the bulk of the tool kit is the same from Aibura to Baiyer River. . . . It is also very similar from 9000 BC to the present" (White 1972: 148).[19]

In contrast, based on my analysis of Cole's data, I recognize a long but slowly changing period of cultural development and change to at least 3,000 B.P. (perhaps later), best known from 4,000 B.P. to 3,000 B.P. An intensification of changes took place at some still more recent date(s); in the northern segment of the study area they are apparent after a break in time for which we have no data at present. Innovations which may or may not have been contemporaneous include pottery, adzes, round houses with substantial wall supports, eaves supports, ditches around houses, square or rectangular hearths, earth ovens, earthworks, and monoliths; all, with the exception of the last two for which we lack data, were apparently present by 290 ± 90 B.P., and possibly earlier.

White's comments to the contrary notwithstanding, there is evidence of culture change at his sheltered sites, including the change in proportions of kinds of unifacially chipped stone tools at all three sites already discussed. White's statement about highlands sites in general, that "not only do the same traditions continue but no major new items are added to the assemblage" (White 1971b: 190), apparently disregards in his own data from the eastern highlands the appearance of pottery and structures at

19. This position is repeated for the highlands generally in White 1971b: 190, White and Thomas 1972: 280; for NAE, White 1972: 68, 72, 73; for NBY, White 1969: 19, 45, White 1972: 28, 29, 31; and for NBZ, White 1972: 102, 107.

NAE, of ground stone at NAE and NBY, as well as of ax-adz, pig, and marine shells at these two sites and at NBZ.

Closer scrutiny of White's writing about all three of his sites discloses that he does, in fact, demonstrate culture change. His summary remarks about NAE are a case in point. "The use of Aibura began about 4000 years ago and *continued until* modern times. The character of *the* occupation appears to have been basically similar throughout . . ." (White 1972: 73; italics mine). To me this suggests continuous occupation of the site and general cultural similarity throughout. In the succeeding paragraph, however, White says that "the early occupation is marked only by a few stone implements and wild animal remains. . . . There is some suggestion that the site may have remained unoccupied for a period after this. . . ." In the next paragraph he continues: "The second phase of occupation (Horizon I) began 1000 years ago or less. In this level the occupation takes on a more definite structure . . ." (ibid.). He then proceeds to mention the "wide variety of artifacts" used, "trade items from scores of miles away," ash lenses, postholes, artifacts of bone and shell, new techniques of tool manufacture, changes in tool proportions, and pig (ibid.). Pottery can be added to the list.

At NBY "the earlier occupants of the site left only limited material, in the form of flaked-stone tools and animal bones. . . . The middle levels of occupation show little change . . ." (ibid.: 30). White continues: "It is only within the upper horizon . . . that different artifacts are found—axe-adzes, grooved and ground stone and marine shell. . . . Pigs began to supplement the meat part of the diet . . ." (ibid.: 30-31).

For NBZ, White reports that in "Phase I (about 11,000-4500 BP) . . . the stone and bone tool-kit changed to some extent after the earliest occupation. . . . Shells came along trade routes from the coast" (ibid.: 108). "From about 4500 BP Kafiavana was apparently less used or abandoned, but we do not know for how long. It was possibly reoccupied only around 1000 BP, for retouched tools were rarer and flaked tools were generally smaller after the re-occupation. . . . Occasional pieces of obsidian were used in this recent period" (ibid.: 142), and there is a "sudden increase in the number of pigs in Horizon I" (ibid.: 93).

In White's own material, then, there is evidence not only of comparable changes in the frequencies of unifacially chipped stone tools but of an increase in cultural complexity with the introduction of new items. At NAE and NBZ, the considerably richer cultural inventory is evident after a break in occupation of the sites. Although Cole's material from NBZ has not been analyzed, my inspection of unifacially chipped stone tools from unit K1C at the site reveals apparent similarities to White's comparable material. I would suggest that the similarity between the archeological record at NAE and our sites in the northern area in which it lies is evident, and that the similarities with NBY (little occupied, if at all, for the

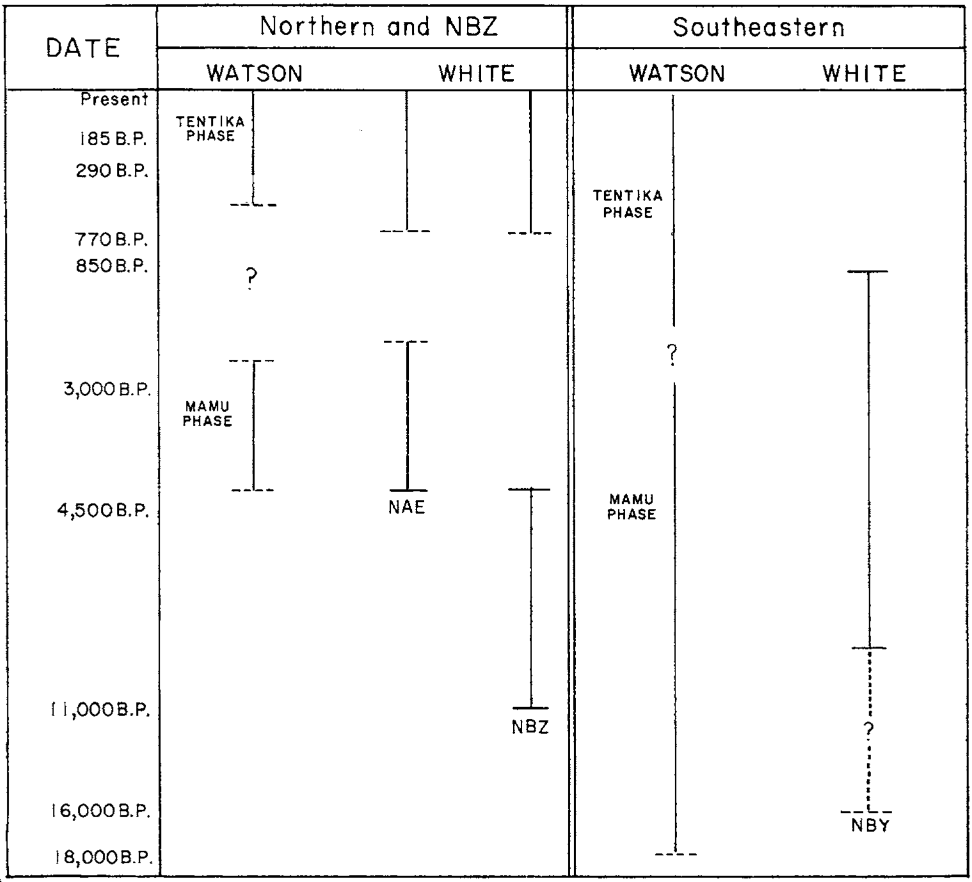


Fig. 111. Schematic representation of site occupation in the northern and southeastern segments of the study area and at NBZ, after Watson and White. Broken line and question mark indicate exact date unknown (dates not to scale); dotted line questions whether date is related to cultural material

past eight hundred years) and NBZ are also indicated, although less clearly. Figure 111 presents my interpretation of the extant data.[20]

Finally, in spite of the similarities between the archeological material retrieved from the eastern highlands by White on the one hand and the micro-evolution field party on the other, there are differences. Two of the

20. In the light of the C_{14} dates from NFX, I have taken the liberty of showing the date 15,850 ± 700 B.P. in fig. 111 for charcoal from NBY which was located "clearly within a matrix containing cultural material" (White 1972: 16). White was reluctant to accept the date as valid because the charcoal "was not in a hearth or other man-made feature" and because "it was at the same level as and only 20 cm laterally from undisturbed natural sediments which also contained carbon, though in much smaller pieces" (ibid.).

most striking are here reiterated. First is the earlier occurrence of pig bone at two of White's sites—a difference which may reflect no more than the different potential for preservation of perishable material as between open and sheltered sites. At the same time it must be acknowledged that there may be additional significance which I am unable to assess. Evidence of pig of antiquity comparable to White's has, of course, been reported from some sites west of the Asaro-Watabung divide, as well as a find of greater antiquity at NAW (Kiowa) (Bulmer 1974: 16).

A second difference is the absence of abraded stone at all Mamu Phase sites on the one hand and its occurrence in one of two excavations at a single site, NBZ (Kafiavana) (an occurrence from which White infers ax-adz) as early as 9,500 or 11,000 years ago. Perishability is not of significance in this instance, although functional differentiation of sites or other factors may be. Again, ground stone objects (referred to as axes and ax-adzes) of considerable antiquity are reported from some sites west of the Asaro-Watabung divide.[21]

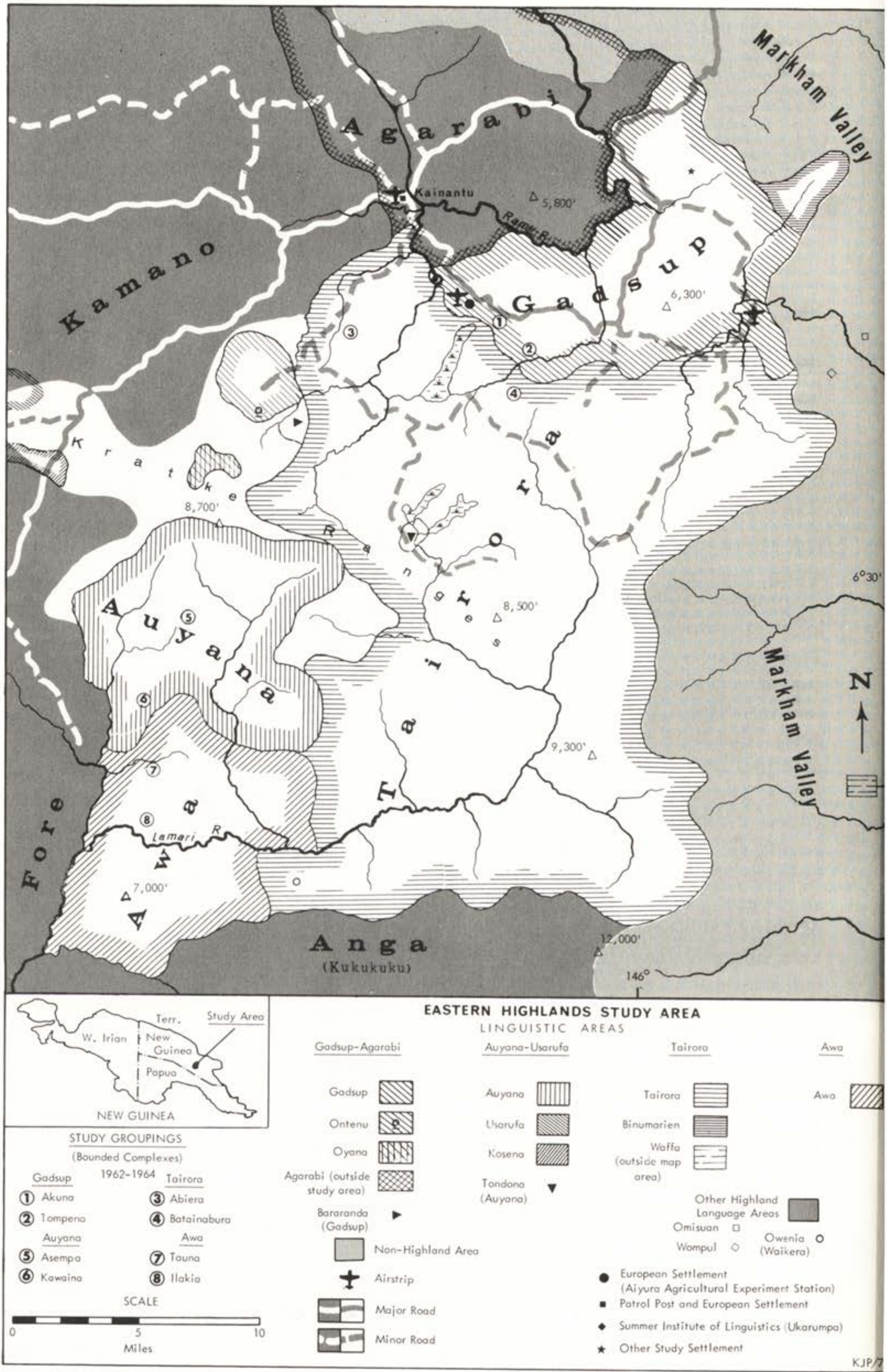
21. It may be pertinent to note that Vanderwal reports an absence of ground or abraded stone in the lithic zone at a coastal site, ADL (Kukuba Cave), a complex which is radiocarbon dated to almost 4,000 B.P. (Vanderwal 1973: 120).

VI. Ethnic Identification

The Micro-evolution Project of the University of Washington was at the outset most concerned to compare the genetic composition, ecological adaptations, cultures, and personality configurations of four closely related ethnolinguistic groups in the eastern highlands of New Guinea. These groups—Auyana, Awa, Gadsup, and Tairora (see map 3)—then occupied various segments of territory radiating to the east, southeast, and southwest from Kainantu. A hypothesis stated early in the research suggested that the four groups shared a single origin in the past, that they had diverged from a single group and subsequently developed cultural differences. The degree and intensity of these differences as well as some indication of the time of original diversity and developing changes were to be among the problems attacked by the investigators.[1] Linguistic research indicates that the languages of the four groups have diverged from a single protolanguage largely *in situ* rather than as a result of in-migrations of people whose speech diversification occurred outside of the present area, and that the original diversification of the four groups from a protoculture occurred within the last millennium (McKaughan 1964).

The Auyana, Awa, Gadsup, and Tairora are[2] horticulturists who also keep swine and engage in varying amounts of hunting and gathering. Sweet potato is the staple crop among Auyana, Gadsup, and Tairora, and although it is grown by the Awa, for them taro is a more important food for human consumption. Subsidiary crops among all four groups include banana, winged bean, edible pit-pit, several kinds of greens, and, with great variation in quantity, yams. The people live in nucleated villages and cultivate gardens located both nearby and at some distance. Forest environments and grassland, undulating as well as more highly dissected,

1. For a preliminary discussion of the Micro-evolution Project see J. Watson 1963.
2. In this discussion the historical present is the period of field work, 1959-67.



Map 3. Eastern Highlands study area

are exploited. Many Gadsup and Northern Tairora, particularly, occupy open grassland country, while many villages of the Southern Tairora, Auyana, and Awa tend to be located closer to forests, some of them at the forest's edge. Of the environmental areas discussed in chapter I, Gadsup and Northern Tairora are in the northern area, Southern Tairora in the southeastern area, and Auyana and Awa in the southwestern area. The cultural variations among the four groups are elaborated in the ethnographic monographs published in this series.

The archeological phase of the Micro-evolution Project became a reality only late in the history of the project; it was, in fact, the last field work to be accomplished. Originally it had been hoped that archeological work, if it were undertaken, could establish a time-scale for the four present populations and suggest the changes in artifacts and habitation patterns which had occurred since the initial diversification of the four groups; when the archeological phase of the project was in fact initiated, however, the emphasis was on a general chronology of the area in question. Although the conclusions derived from the archeological work are rather broad in nature, some observations relevant to the four ethnolinguistic groups studied by the Microevolution Project will be made.

The archeological data from the areas now occupied by the four ethnolinguistic groups are by no means of equal quality. Awa territory remains almost unknown archeologically, although some of it was surveyed. The field team undertook neither survey nor excavations in the Gadsup area, but Swadling's later work there produced some relevant data. As for the Tairora and Auyana areas, the greatest concentration of sites located is in Tairora, both Northern and Southern, and the excavated sites are all in Tairora territory. Clearly, the archeological data for the four ethnolinguistic territories are unequal. Moreover, it should be understood at the outset of discussion that no artifacts recovered from archeological contexts can be indisputably assigned to any one of the four ethnolinguistic groups to the exclusion of another.

Any attempt to link ethnographic and archeological data, except in a rather general way, is fraught with some difficulty, even when, as in New Guinea, the prehistory-history interface is so recent. In those aspects of culture in which the four groups differ most, such as language, there is no evidence in the archeological record. Conversely, in the realm of nonperishable artifacts, the differences among the four groups are less marked, although in Awa, for whom archeological data are almost nonexistent, artifactual differences now occur which might emerge in an archeological context, for example, in house types.[3]

Although the data are inadequate for a solid linkage of archeological material and ethnographic groups, I take the liberty of making some

3. This statement deserves closer scrutiny, for there may be a wider range of differences that can be expressed archeologically than I am aware.

suggestions for identification which may be substantiated and elaborated by future research. The data for each of the four areas are reviewed in turn. First, however, some comments are made about the sites in the Fore area, outside of the Micro-evolution Project study area.

Fore

At the time of the archeological field work, Awa territory was reached by a track which ran through North Fore territory; the field party entered this track at the conclusion of their traverse of the trail through Auyana territory, just north of Okasa (map 1). Because of the illness of one of the members of the field team, it was felt necessary to take a rest-break and several days were spent at the Okasa Resthouse. During this period, the able members of the party surveyed the surrounding area for archeological evidence and made ethnographic inquiries. It seems reasonably clear that many of these sites are fairly recent in time and that they may represent a movement of Fore people into the area as they cleared increasing amounts of forest and brought new land under cultivation (see chap. IV, "Summary"). The quantity of material recovered from all but four of the sites was insufficient to include them in the quantitative analysis, although an additional four were identified in the classification. Conclusions based on archeological data are limited primarily to the recognition of differences between the sites in Fore territory and those from the study area proper, to the extent of including the former in a separate tradition, the Yofee, and belonging to a single phase within it, the Tesanee. Other indications of fairly recent occupation are the remains of posts and hearths observed at several sites as well as informant input that some of the abandoned sites were once inhabited by them or their immediate forebears and that the forest near some of these sites was cleared in the not too distant past.

Awa

The field party surveyed in the Awa area (map 3), but the results were largely negative. One sheltered site, NHW, was located during the survey of the area around Ilakia. Ethnographic inquiries elicited no data about previous site locations; informants insisted they have always lived at Ilakia, as did their "fathers and grandfathers." The field notes indicate that there are potential site locations on ridge tops in the area, but no sites were located. (Much of the area is apparently difficult to survey, besides being hazardous on account of the presence of death adders.) No sites were discovered in the area between Ilakia and Mobuta or between Mobuta and Amoraba, nor were sites found in the vicinity of Amoraba. Although the field notes refer to quantities of debitage and a "large surface collection . . . of flake tools" at Mobuta, this material (except for four stone tools and three pieces of chipping detritus, NHX) is not in the laboratory and presumably was lost in transit. Whether it represents an earlier occupation of the site or an earlier period of current occupancy cannot be determined from the data at hand. Informants at Mobuta, like those at Ilakia, maintained they have never resided elsewhere. The Awa's purported lack of knowledge of (or reluctance to acknowledge?) former sites has also been noted by Philip L. Newman, the Micro-evolution Project ethnographer to the Awa (personal communication).

Auyana

Nine sites (NGX through NHF) are located in Auyana territory (maps 1 and 3), although the quantity of material collected from all of them, with one possible exception, is insufficient for adequate analysis. One site, NGX, which was viewed but not inspected, was indicated by informants to have been the origin place of the "Auyana" (the identity of the referent social unit is not indicated in the field notes).[4] There is no archeological evidence of this claim, of course.

On the basis of frequencies of some unifacially chipped stone tools, NHB appears to be more similar to some sites in the Tairora area than to Tesanee Phase sites in the Fore area. Furthermore, of the two known phases of the Nanoway Tradition, both the occurrence of adzes and the chipped stone tool frequencies at NHB indicate greater similarity to the Tentika Phase than to the Mamu Phase. For what it may be worth, informant input that the site was occupied at the turn of the century is compatible with this assessment. There is additional yet meager evidence of possible Tentika Phase assignment for sites in the Auyana area. Unifacially chipped stone tool frequencies at two sites, NGY and NHC, suggest Tentika Phase assignment (table 16, class X).[5] One type Q pottery sherd occurs in NGZ assemblage (figs. 94f, 95), an adz occurs in NHC assemblage, and an earth oven and house remains are reported for the same site.[6] An early-twentieth-century occupation of NHC is indicated by informant response. To conclude, very fragmentary extant data from the Auyana area include definitive and descriptive modes of Tentika Phase sites, possibly permitting a tentative assignment to the phase. There is at present no archeological evidence for earlier occupation of Auyana territory.

Gadsup

There is no project input from the Gadsup area (east-northeast of the study area, map 3), as no archeological reconnaissance or excavations were undertaken by the field party. Cultural material that Swadling has

4. This site was referred to as "Amaira" by informants, but it is not located at the contemporary villages of Amaira No. 1 and Amaira No. 2.

5. The samples of unifacially chipped stone tools are small—fewer than thirty, more than nine.

6. The field notes do not permit identification as to type.

excavated and observed at three sites, NMH and NMK in Gadsup territory and NIE in territory of the closely related Agarabi, is similar to that from some Tentika Phase sites in the North Tairora area (Swadling 1973; and see chap. V, "The Arona Valley"). This includes circular structures with center post and planklike exterior wall posts (type K house), pottery, type F hearth, earth ovens, earthworks, and adzes.

Tairora

The majority of sites located, NFA through NGU, are in the area currently occupied by the Tairora (map 3), both Northern Tairora (our northern area) and Southern Tairora (our southeastern area). At the same time that no indisputably "Tairora" artifacts can be recognized in the archeological data, some descriptive modes of the Tentika Phase occur in known Tairora sites. Moreover, Tentika Phase descriptive modes including house types J and K, earth ovens, earthworks, monoliths, pottery and adzes, constitute an artifactual inventory which, as indicated above in chapter IV, suggests a fairly sedentary existence with the inference of horticulture as its main subsistence base, an adaptive system not unlike contemporary Tairora. Ethnographic information indicates twentieth-century Tairora occupation at eight sites (NFB [component I], NFC, NFK, NFP, NFR, NFS, NFV, and NGN); at NFB (component I) this identification is confirmed by the occurrence of Western artifacts. For only the first two of these sites are the data adequate for archeological identification. NFB and NFC are assigned to Tentika Phase, although NGN has been placed there tentatively on other grounds (see chap. IV, note 12).

Archeologically, on the basis of chipped stone tool frequencies (excepting NGM), eleven sites in Tairora territory can be assigned to the Tentika Phase, six of them in the north (NFA, NFB [components I and II], NFC, NFD, NGK, and NGM), five of them in the southeast (NFN, NFT, NFZ, NGA, and NGB).

There are no absolute chronological controls for Tentika Phase sites in the southeast, although those that are assignable relatively are post–Mamu Phase. In the north, two radiocarbon dates are germane. A C_{14} date from component II at NFB, 185 $\pm$ 80 B.P., suggests an occupation somewhere in the time slot A.D. 1690 to 1850, at a site now occupied by Tairora and apparently occupied (possibly intermittently) by Tairora since the late nineteenth century at least. It is possible, but by no means established, that component II at NFB represents Tairora occupation. A C_{14} date from NGM, 290 $\pm$ 90 B.P., indicates a range of time of occupation from A.D. 1570 to 1750 (Seuss uncorrected), and possibly as early as 1470 (see appendix 3). Although NGM is in the vicinity of (one informant said "at") the legendary location of the initial occupation in the area by members of one sib of Phratry Tairora, whether the C_{14} date indicates time of Tairora occupation, as opposed to some other group, cannot now be established.

Although the identification of Tairora with Tentika Phase seems reasonable, this assignment cannot be made to the exclusion of other groups. There is, first of all, the suggestion in Swadling's data of Tentika Phase affiliation of Gadsup indicated above, and my very tenuous assignment of some sites in Auyana territory to the phase. Secondly, it is noted that the Oyana at Ontenu are separated from both Gadsup and Agarabi, to whom they are closely related, by Tairora (map 3). On the basis of ethnographic data James B. Watson suggests that an incursion of Tairora-speaking people into the area established a salient between the Ontenu Oyana and their Gadsup and Agarabi congeners to the north and east (J. Watson 1977). If it becomes established that what is now the Tairora Valley was once occupied by members of one or more of the Gadsup, Agarabi, and Oyana ethnolinguistic groups, that the earlier Tentika Phase sites in that area, including NGM, were not Tairora cannot be ruled out.

In conclusion, it is impossible to suggest either a more precise ethnic identification of Tentika Phase or the chronological depth of the identification. There is no evidence for ethnic identification of the Mamu Phase, the occupation of Awa territory cannot be placed in archeological perspective, and the archeologically identifiable sites in the Fore area are definitively distinct from those in the study area.

Appendix 1

Concordance of Field and Official Site Designations

At the time of the field work there was no uniform or official system of archeological site designation in New Guinea; the few excavated sites had been given proper or place names. The Micro-evolution Project archeological field party devised and employed a system, described in chapter II, which organized sites by ethnolinguistic territory. To avoid the ethnographic bias that this system would introduce into a study of prehistory, a scheme which indicated only that the sites were located in the eastern highlands was used in drafts of the monograph, the maps, plans, and figures. When I became aware that an official scheme had been established, a request was made to the University of Papua New Guinea for official designations to be assigned to our sites. Those supplied have been used in the monograph.

Subsequently, it was discovered, at the University of Papua New Guinea, that different designations had earlier been assigned to a few of the sites located by the field party, although they were not apprised of the action; to my knowledge these designations have not been published. The University of Papua New Guinea now considers the following list, used in this monograph, as the proper and correct designations (Swadling, correspondence, 13 July 1975). Their concordance with the labels assigned in the field is indicated.

Official Designation	*Field Designation*
NFA	TAI 1
NFB	TAI 1A
NFC	TAI 1B
NFD	TAI 43
NFE	Tae
NFF	TAI 21
NFG	TAI 22

NFH	TAI 2
NFI	TAI 3
NFJ	TAI 4
NFK	TAI 5
NFL	TAI 6
NFM	TAI 7
NFN	TAI 8
NFO	TAI 9
NFP	TAI 10
NFQ	TAI 11
NFR	TAI 12
NFS	TAI 13
NFT	TAI 14
NFU	TAI 15
NFV	TAI 16
NFW	ME 567/585
NFX	TAI 20
NFY	TAI 17
NFZ	ME 504/505
NGA	TAI 41
NGB	TAI 42
NGC	TAI 23
NGD	TAI 24
NGE	TAI L 1
NGF	TAI L 2
NGG	TAI 28
NGH	TAI 29
NGI	TAI 31
NGJ	TAI 40
NGK	TAI 26
NGL	TAI 27
NGM	TAI 35
NGN	TAI 35
NGO	TAI 37
NGP	TAI 37
NGQ	TAI 34
NGR	TAI 36
NGS	TAI 33
NGT	TAI 38
NGU	TAI 25
NGV	TAI 30
NGW	TAI 32
NGX	Amaira

NGY	AUY 1
NGZ	AUY 2
NHA	AUY 3
NHB	AUY 4
NHC	AUY 5
NHD	AUY 6
NHE	AUY 7
NHF	AUY 8
NHG	FORE 1
NHH	FORE 2
NHI	FORE 3
NHJ	FORE 4
NHK	FORE 5
NHL	FORE 6
NHM	FORE 7
NHN	FORE 8
NHO	FORE 9
NHP	FORE 10
NHQ	FORE 11
NHR	FORE 12
NHS	FORE 14
NHT	FORE 15
NHU	FORE 16
NHV	FORE 17
NHW	AWA 1
NHX	AWA 2

Appendix 2

Survey, Excavation, and Laboratory Procedures

SURVEY

The original plan of the field party was to spend the first three months of the field term surveying the study area and to conduct excavations for six months. A major purpose of the initial survey was to determine the potential for open-site archeology by locating the widest variety of sites over a maximum segment of the study area. This approach would permit a judicious selection of sites to be excavated. Secondly, the field party hoped to collect ethnographic data from local New Guineans about sites that were occupied in the recent past and other data relevant to the protohistoric period. Thirdly, during the survey special attention was paid to stone tool function and to the techniques of stone tool manufacture. Finally, the field party intended to record relevant information in regard to the location and exploitation of local resources, trade routes, trade items, village micro-environments, and activity areas within villages which were occupied in the recent past. In the original plans, an extensive collection of plants was anticipated, but this project was abandoned during the second week of the survey period.

The survey itself can be divided into three segments (see fig. 112). From 3 to 22 December 1966, a transect from Aiyura south through Obura to the southern Tairora villages of Asara, Himarata, Oraura, Ndumba (Habiina), and Tookena was surveyed. The second transect—from Aiyura southwest to Noreiaranda, continuing to Amaira, Waifina, and Okasa,[1] thence through north Fore to the Awa villages of Ilakia, Abomatasa, and Mobuta —was covered from 6 January to 5 February 1967.

In each of these transects similar procedures were followed. The survey party followed main tracks and roads, spent from one to three days each

1. Because of the illness of one member, the survey party spent several days at the Okasa Resthouse. The sites in the Fore area—outside of the Micro-evolution Project study area—were located at this time.

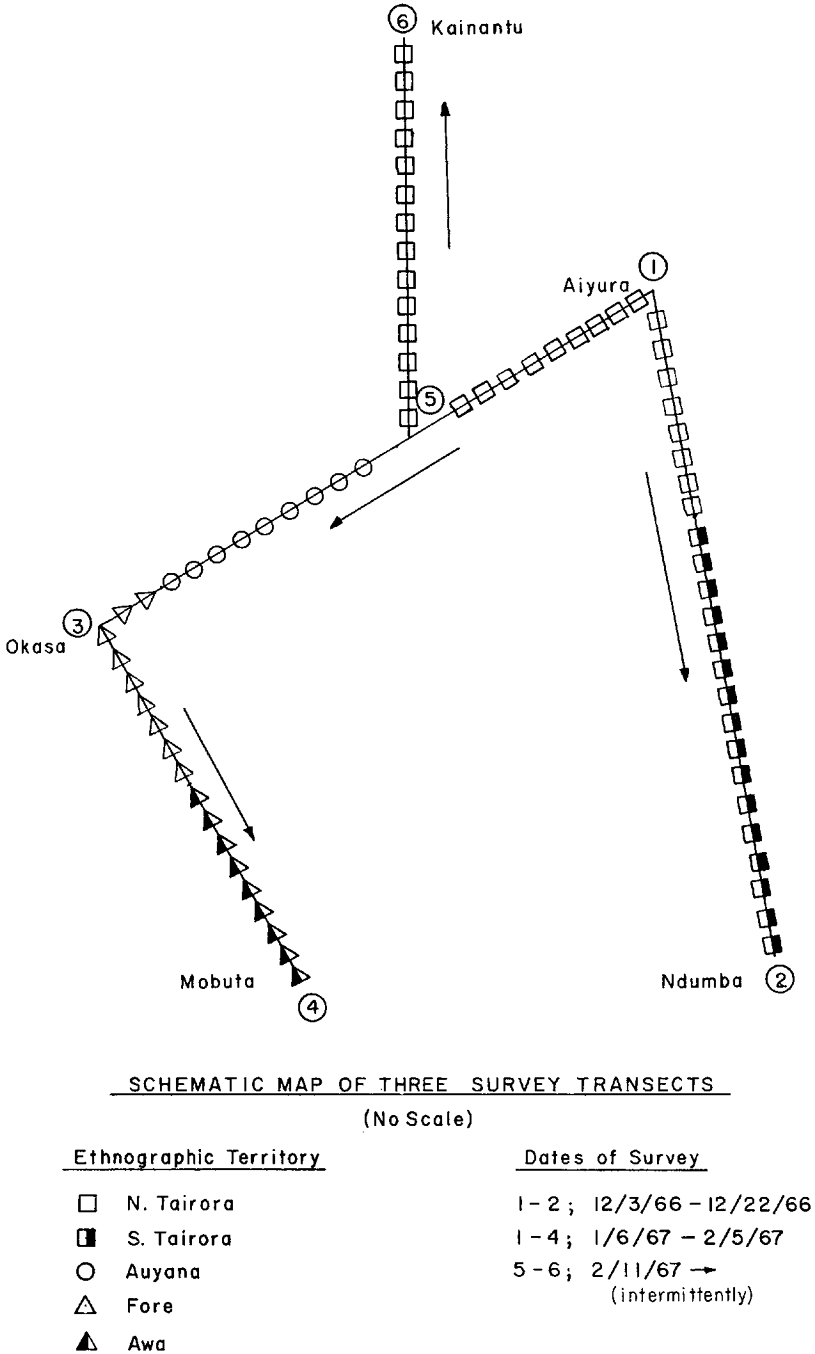


Fig. 112. Schematic diagram of three survey transects, indicating the territory of contemporary ethnolinguistic groups in which they lie

in villages selected for concentrated study, and inspected sites located at some distance from the roads and tracks. Roadbeds surfaced with local material provided a kind of test trench through the surveyed areas; several sites were located because they had been disturbed during road building. Erosion channels, washes, garden ditches, freshly cultivated gardens, and house excavations were also examined. Ethnographic interviews were conducted with local residents at each stop: information was gathered on genealogies, migrations, and abandoned villages, which were investigated, when possible, and surface collections were made. Finally, ethnographic specimens were purchased from those individuals who chose to sell them.

The North Tairora basin was the third area surveyed, beginning 11 February 1967. This included examination of the eastern margins of the Noreikora Swamp as well as the Kainantu–Noreikora road. Again, roads, gardens, garden ditches, and house excavations were the focus of investigation. Ethnographic inquiries were made, but they proved less fruitful than in the areas to the south. Time did not permit a survey of the Gadsup area, although it is a part of the Micro-evolution Project study area.

Seventy-six sites were located during the survey: seventy open sites and six caves or rock shelters. These sites have been described in chapter II. In addition, cultural material was obtained from other locations; during the survey period, local residents were encouraged to bring artifacts and debitage in their possession or which they found in their gardens or elsewhere. One hundred eighty clusters of material were acquired in this manner; although all of them may represent discrete sites, there may well be duplication. Moreover, the locations of these clusters are usually recorded in folk terms such as "near Nondato's house," "by the bridge over X river." Many of these clusters are small and they have not been used in the quantitative analysis, but they were used in the total sample of tools employed in constructing the tool classification. The original intention was to choose for excavation one site each from the different categories of sites encountered in the survey. In actual practice, the choices were more limited because of extenuating circumstances which arose during the excavation period itself.

Pre-excavation Procedures

The first task at a site selected for excavation was to cut the very dense grass to ground level. Artifacts collecting during this operation were added to the previously collected surface material.

Next, a datum point was selected. A stake was inserted with its top to ground level at that point and an inverted flat tobacco tin (Craven "A") was pressed into the ground over the stake. The tin was secured to the stake by a nail with a head one inch in diameter, which was driven into the center of the tin and stake, thus providing a flat, relatively permanent surface marker. All depth measurements refer to distances below the surface at the stated datum point, called "datum A." When the stadia rod was no longer visible in the transit, a new datum point, "datum B," was established at a specified vertical distance from datum A and readings were taken from it. Subsequently, a third datum and even a fourth datum were established when needed. Thus, when a single datum point was not sufficient, the total of two, three, or four datum readings would give the actual depth from the first fixed datum point, datum A.

The third step in making preparations for excavation was to establish a zero point marked with a stake, the zero stake, and to lay out a grid of one-meter squares over the area in which it was anticipated that excavations would be conducted. The grid could be expanded in future if necessary. Each one-square-meter pit, cut, or unit was identified by the coordinates at the stake in its northwest corner, e.g., 2S5W. Horizontal measurements were taken from the north and west grid lines of any unit; if the excavation did not reach the grid lines, horizontal measurements were taken from the north and west grid lines closest to the unit. One excavation procedure which sometimes differed among sites was the size of the units excavated; these differences are indicated in the site descriptions.

Excavation

The excavations were conducted and supervised by J. David Cole. He was aided by Rosemary Cole throughout the field period, by Keith Weigel from January to June 1967, and by R. J. Scarlett, June-July 1967. They were assisted by an excavation crew recruited primarily from Tairora and Auyana. These men were carefully selected and were given a rigorous course of training in excavation techniques. Their interest in their work, their patience, their attention to details, and their skill were impressive.

Extreme care was exercised in excavation, often at the expense of obtaining larger samples of artifacts than were recovered. Stripping of natural levels was the only procedure employed, with the exception that relatively thicker occupation zones were subdivided into arbitrary spits if morphological differences in the soil were not discernible. Initially, in any excavation unit, dirt was removed with trowels; after the stratigraphic situation was well understood, shovels were sometimes employed for dirt removal. All dirt was sifted in frames covered with one-quarter-inch hardware cloth (mesh). Occupation surfaces (i.e., levels in which concentrations of cultural material were found) were excavated with one-inch triangular deck scrapers, trowels, paintbrushes, biological picks and other surgical instruments. Horizontal and vertical sections of the units were often cleaned and re-examined. Maps which included topographical readings made with transit and stadia rod were made of all occupation surfaces and features; photographs were taken of features and profiles. Dirt was removed to a considerable depth after no more cultural material was found to insure that the excavators were, in fact, in culturally sterile soil.

The cultural material recovered was divided into categories—detritus, artifacts, features, fire-cracked rock—each of which was handled differently. Each portable artifact (excluding debitage), including "flakes and fragments of cryptocrystalline which displayed traces of edge wear or intentional retouch . . . potsherds, fragments of ground or polished stone, soil samples, carbon samples, non-indigenous hematite . . . quartz crystals and battered pebbles, was given a number and entered on a catalogue sheet along with its location expressed as coordinates in a three-dimensional grid system. The catalogue entry also included notes regarding stratification and association." Chipping detritus from a given level in each unit was placed in a paper bag which was labeled as to level and excavation unit. Fire-cracked rocks or fragments of them were weighed and counted by unit and level. Features were photographed, measurements and provenience recorded on catalogue sheets, and when possible (as, for example, post hole fill), brought back from the field.

LABORATORY

More than 26,000 stone artifacts (e.g., chipping detritus, stone tools, fire-cracked rocks) were recovered by the field party. Although "artifacts" as recognized in the field had been individually labeled in the field, most of the rocks were not: surface collections were placed in paper bags which were labeled as to site, excavated material (other than "artifacts") was put into bags which were labeled by the appropriate site, excavation unit, and level. My first task in the laboratory was to put catalogue numbers on approximately 22,000 pieces of rock and to make catalogue cards. This would enable me to intermingle the rocks in whatever way I deemed necessary in proceeding with the analysis. The labeling process did afford an opportunity to become familiar with a mass of unfamiliar data, although I realize that more efficient ways of doing it could have been chosen were it not for the labeling imperative.[2] Ideally, during the classifying procedure all of the rocks should have been placed on tables so that the entire collection could be seen and handled at will. The limitations of laboratory space precluded this, so I worked from the many trays in which the rocks were openly located.

My approach to stone tool analysis and classification has been patterned after earlier work by Dunnell (1971a) and one of his students (Thompson 1970); there was also feedback from the work of another student, Dancey, who was using the same approach concurrently with my

2. Although I have conducted ethnographic research in the eastern highlands of New Guinea for two and one-half years (1953-55, 1963-64), I was unacquainted with stone tools of the area except for adzes and a few chipped stone tools used in bloodletting operations.

activity (Dancey 1973). We all produced different classifications in response both to the different questions we were asking as well as to the material being analyzed, material which varied widely in content. The fundamental approach and method employed were the same, however; we classified "tools," not objects. In my analysis of stone tools I have used only those portable discrete objects that were in the laboratory at the time of my work. A few mislabeled items and "artifacts" listed in the field notes but missing from the laboratory (probably lost in transit) have not been used.

In actual operation, I first selected and isolated rocks that exhibited chipping wear and from a large sample of them recognized that there were two places on the rocks where chipping wear was located—on one or both sides of an edge.[3] Because the former were most numerous, they were selected for initial analysis. Further observation of the rocks confirmed that the profiles were either symmetric or asymmetric and the plans either concave, straight, or convex. Somewhat later I defined the mode, "wavy plan." At a later date too the mode "straight" was redefined so that any variation from a straight line (eyeballed) was considered either concave or convex.[4] All of the rocks were then once again re-examined.[5]

Classifying the unifacially chipped tools was an exceedingly time-consuming procedure, as much as anything because of the large number of rocks which had to be handled (i.e., examined thoroughly for signs of wear) and the number of times they were examined.[6] For example, each time a modification of a definition was made or a new mode added, all of the rocks had to be re-examined in the light of the change. The problem of defining wear, too, was not completely solved initially and with each modification of the definition a re-examination of all of the rocks was necessary. Moreover, I checked my own definitions of both wear and modes periodically to be sure that I was applying them consistently to all of the rocks. Ultimately, in using the modes selected I was able to classify the tools on all of the rocks which had chipping wear on a unifacial edge with sixty exceptions about which I had some doubt.[7]

3. For definitions of the modes see chapter III, under "classification."

4. Tests later conducted on classifications indicate that "straight" edges are often ambiguous cases of convex or concave edges. The likelihood of a perfectly straight edge is rather low (Dunnell, personal communication).

5. This re-examination resulted in reducing the number of members of the class with asymmetrically profiled tools, straight in plan, to very few; it also reduced the number of symmetrically profiled tools, straight in plan, although to a lesser degree.

6. Because of the innovative and experimental nature of the operations, as well as my initial unfamiliarity with the tools, the whole process was doubtless more lengthy than would be the case on a second run.

7. Since the analytic operations have been completed, the doubt about some of these tools has been resolved; but they still have not been included in the analysis.

Information about the tools was recorded on four-by-six-inch file cards, one card per rock: site number, location, type(s) of tool(s), and chunk or flake, as well as some data that have not been used in the analysis, such as possible breakage. The assignment of one card to one rock has both advantages and disadvantages when contrasted with assigning one card to one tool, in an analysis such as mine which was done without the aid of a computer—nothing more elaborate than an electronic pocket calculator was used for numerical manipulations. Finally, the class members were described and samples of them were measured (cf. appendix 3).

After the tools with chipping wear on a unifacial edge had been classified (they comprise 3,400 of a total of 3,674 stone tools in the collection), the other kinds of wear were dealt with in a similar manner and comparable data recorded on four-by-six-inch cards.

One category of rocks on which chipping wear appears but which have not been included in the analysis are sharpening flakes (resharpening flakes, trimming flakes), flakes which are inferred to have been struck from a rock to provide a new, sharp edge for use. Sharpening flakes have wear somewhere on their dorsal portion, wear from a tool, presumably, which had become dull through use. Most commonly this wear is similar to the wear on the members of classes of asymmetrically profiled tools. Some of the sharpening flakes were used at some time subsequent to the flake's having been detached from a rock for sharpening purposes; these are tools in their own right and have been included in the analysis.

After the classification of stone tools was completed, the quantitative manipulation of the data, such as Brainerd-Robinson coefficients of similarity and frequency seriations, was done, as well as the classification and description of assemblages. Site descriptions were organized concurrently. The emerging picture of eastern highlands' prehistory was then outlined, it was compared to other archeological work in the area, and its relevance to the whole Micro-evolution Project was considered.

Appendix 3

Stone Tool Descriptions

There is a wide range of information including descriptive modes or attributes which might be selected to convey to the reader some idea of the characteristics of the stone tools that have been identified according to the classification in chapter II. In addition to the first item below, I have selected six attributes which I think may be of value in transmitting further information about the kinds of tools in the eastern highlands about which I am talking.

(1) Of the total of 3,674 stone tools, the percentage represented by the members of each class is indicated. In addition, of the 3,400 unifacially chipped tools, the percentage represented by the members of each class is indicated.

(2) With the exception of twenty-nine of the ninety-nine type IVD6f tools (adzes) that were examined by a petrologist (see appendix 5), only a general assessment of the type of rock on which stone tools occur has been made. The most common kind of rock will be referred to as chert with no attempt made to identify related rocks more precisely, e.g., jasper, chalcedony, flint. Apparently, local sources of chert were exploited, and there is a wide range of color, texture, and fracturability of the rocks. Other kinds of rocks used for tools include silicified shale, sandstone, obsidian, volcanic, and basic rocks.

(3) More than one tool may occur on a single rock, so that there are more tools than tool-bearing rocks.[1] The percentage of members of each

1. One rock (ME 592/4) bears ten tools—the largest number of tools occurring on any single rock in the collection. The largest number of tools occurring on a single excavated rock is seven (NFG 405). The largest number of tools of one type occurring on one rock is six type IA2a tools. In addition to the multiple occurrence of tools of a single type, a variety of combinations of different types of tools can occur on a single rock. There are 31 different combinations of 2 tools of different type occurring on a single rock, 29 combinations of 3, 22 combinations of 4, 8 combinations of 5, and 1 combination of 6 and 7 tools.

class which occur on rocks alone, that is, one tool per rock, is indicated in the description, as well as the percentage of members of each class which occur with tools of different types. When these two percentages do not equal 100 percent, the difference is represented by tools which occur on rocks with other tools of the same type.

(4) An assessment has been made of whether the rock on which a tool occurs is a flake or a chunk. This division seems more useful than the more traditional one between flake and core; many rocks which are technically flakes are so large and thick that they have attributes of cores. During the laboratory operations, a third cateogory, "chunk/thick flake," was used to accommodate the pieces of rock which are technically flakes but are so thick and large as to possess some of the qualities of a chunk. In this monograph, this category has been eliminated and its members have been included with chunks. The distribution of the members of different classes between chunks and flakes is indicated. Admittedly, the distinction between the two is not always precise: (1) a thin part or segment of a chunk may have the potential of a flake, and (2) a thick proximal end of a flake may have the potential of a chunk. In other words, some of the chunks on which symmetrically profiled tools occur have a "flakelike" part, and some of the flakes on which asymmetrically profiled tools occur have a thick, "chunklike" part. A higher percentage of symmetrically profiled tools are on "flakes" and a higher proportion of asymmetrically profiled tools are on "chunks" than the figures suggest.

(5) To give some idea of the size of the rocks on which tools occur, a random sample of the rocks of each type was weighed and the percentage distribution of the weight (in grams) is indicated. For the two numerically predominant types of tools, IA1a and IA2a, the distribution of the tools on rocks weighing less than ten grams is also given (see fig. 113).

(6) Another indicator of size of rock is the maximum lineal dimension of the rock with no regard to its relation to the tool or tools occurring on it. A random sample of the rocks bearing each type was measured and the percentage distribution of the length (in centimeters) is indicated. Measurements were made with a sliding caliper.

(7) On a random sample of unifacially chipped tools, the angle formed by the intersection of the surface of the rock which constitutes the tool and the surface adjacent to it was measured and the percentage distribution of the angle size is given. Measurements were made with two hinged metal strips, which were then laid against a protractor. Because of the technique of measurement and the fact that angle size tends to vary on some tools, great accuracy is not claimed for the results.

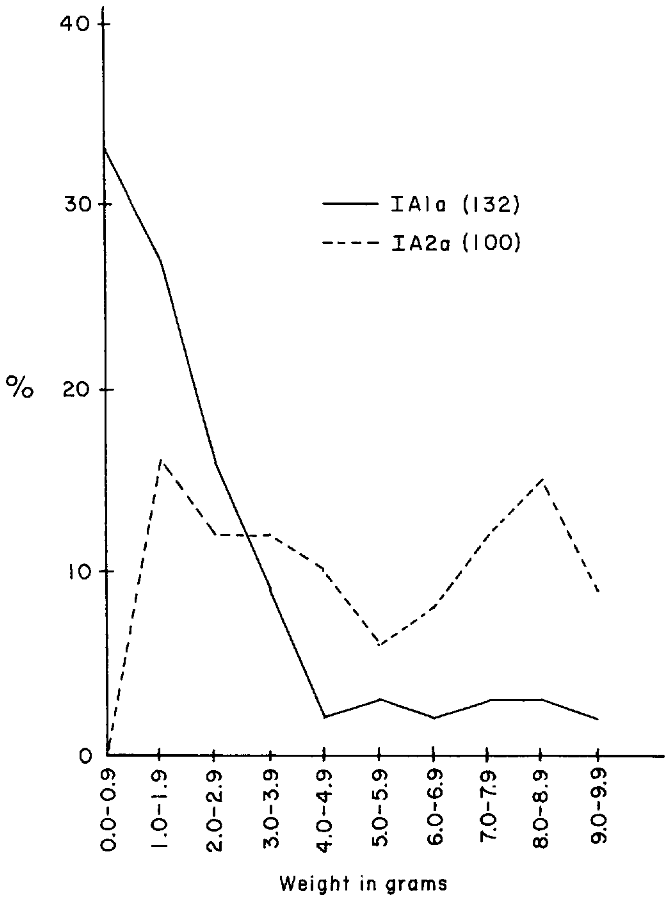


Fig. 113. Percentage distribution of weights of rocks, less than ten grams, on which members of the two most common classes of stone tools, IA1a and IA2a, occur (sample sizes in parentheses)

IA1a

Definition

I *chipping wear* on a
A *unifacial edge* which is
1 *symmetric in profile* and
a *concave in plan*

Description (figs. 59 [a and b], 60-64)

The 603 tools of this type (constituting 16.41 percent of all stone tools and 17.74 percent of unifacially chipped tools) are usually located on pieces of chert with a mean length of 2.7 cm and a mean thickness of .7 cm; they have the appearance generally of small, thin pieces of rock. Of the tools of this type, 62.02 percent occur on flakes, 37.97 percent on chunks—usually on a thin part of a chunky piece of rock (see fig. 114a); 64.34 percent of the tools occur on rocks with no other tools (see fig. 114b), 23.71 percent occur on rocks with tools of other types. The distribution of the weights ($\bar{x}$ = 5.1 gm) and the maximum length of the rocks on which type IA1a tools occur are presented in figures 115 and 116, respectively. The distribution of the edge angles of the tools, which tend to be not steep ($\bar{x}$ = 49.1°), is given in figure 117.

IA1b

Definition

I *chipping wear* on a
A *unifacial edge* which is
1 *symmetric in profile* and
b *wavy in plan*

Description

The twenty-one tools of this type (comprising .57 percent of all stone tools and .62 percent of unifacially chipped tools) are usually located on pieces of chert with a mean length of 3.1 cm and a mean thickness of .65 cm, so that they have the appearance generally of small, thin pieces of rock. Of these tools 42.86 percent occur on flakes, 57.14 percent on chunks—usually on a thin part of a chunky piece of rock (see fig. 114a); 42.86 percent of the tools occur on rocks with no other tools (see fig. 114b), 57.14 percent occur on rocks with tools of other types. The distribution of the weights ($\bar{x}$ = 6 gm) and the maximum length ($\bar{x}$ = 3.1 cm) of the rocks on which type IA1b tools occur are presented in figures 115 and 116, respectively. The distribution of the edge angles of the tools, which tend to be not steep ($\bar{x}$ = 36.7°), is given in figure 117.

IA1c

Definition

I *chipping wear* on a
A *unifacial edge* which is
1 *symmetric in profile* and
c *straight in plan*

Description (figs. 59 [c, d, e], 65)

The 104 tools of this type (constituting 2.83 percent of all stone tools and 3.06 percent of unifacially chipped tools) usually occur on pieces of

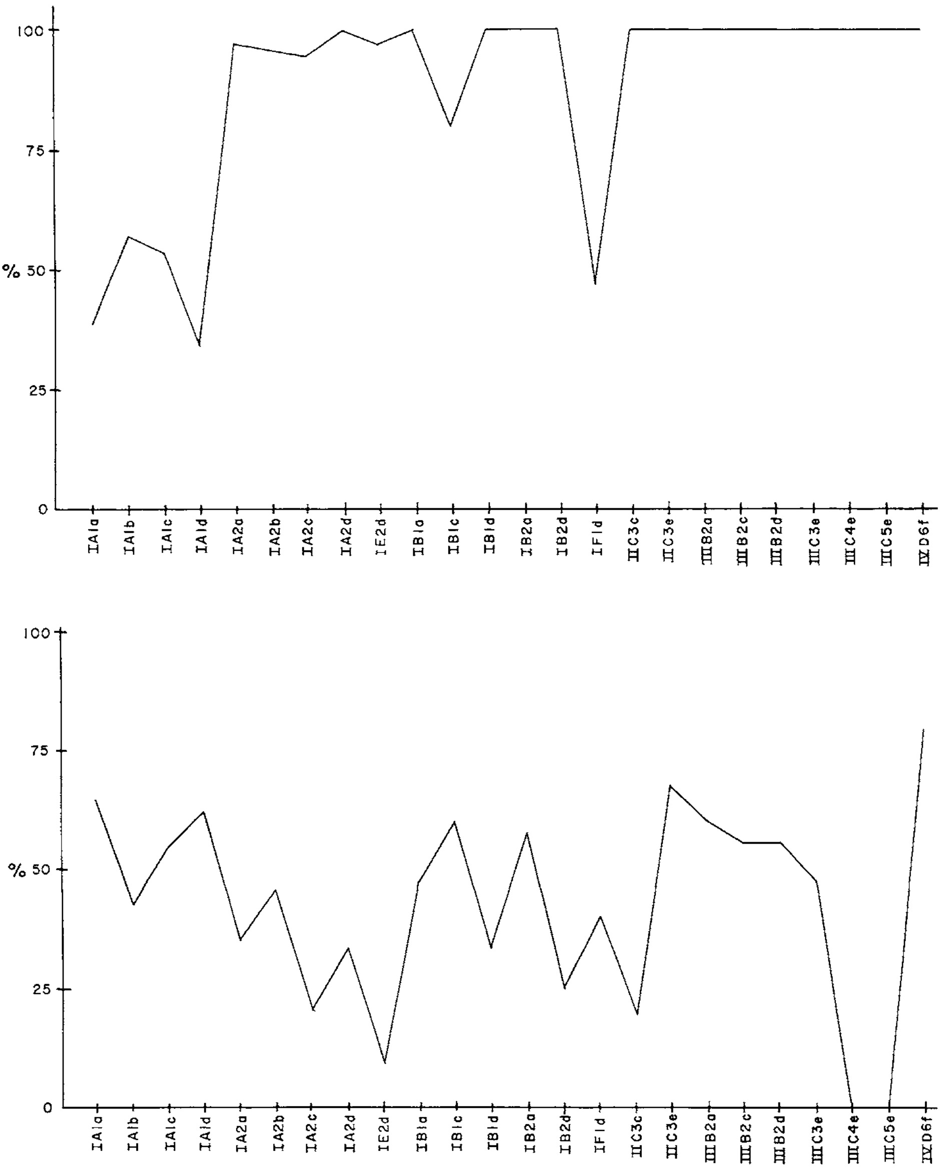


Fig. 114. Percentage distribution of stone tools occurring on chunks (top graph) and on rocks alone (bottom graph), by class

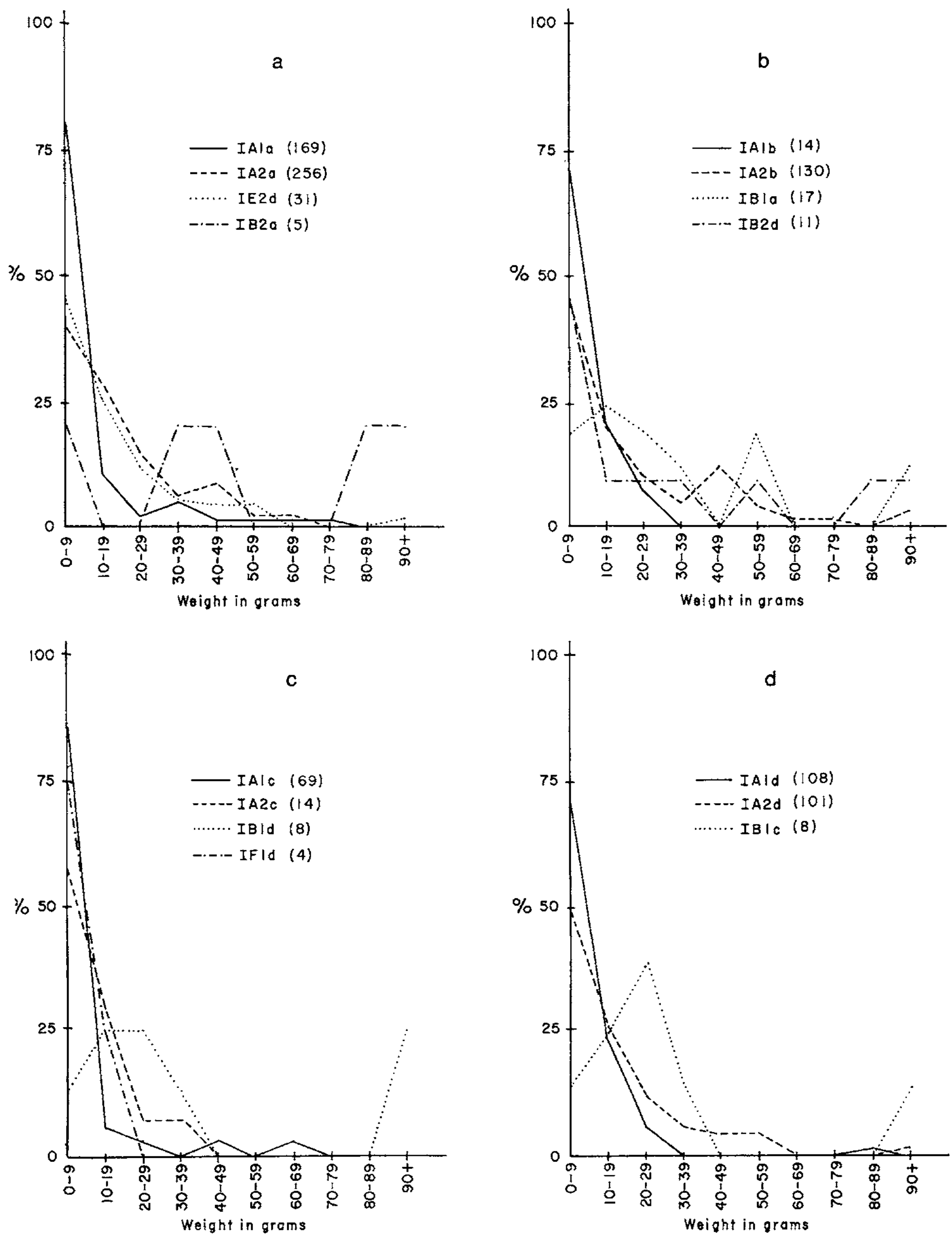
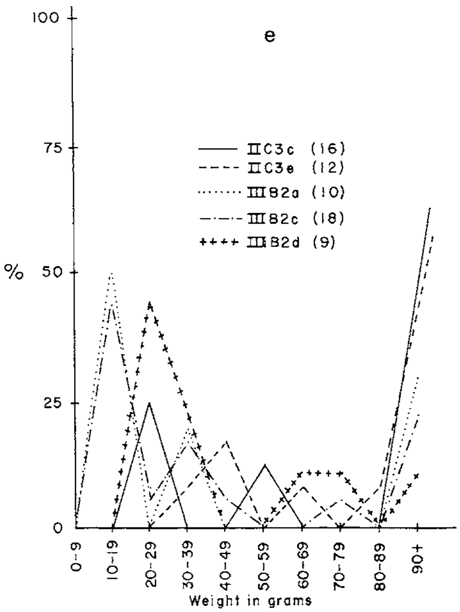
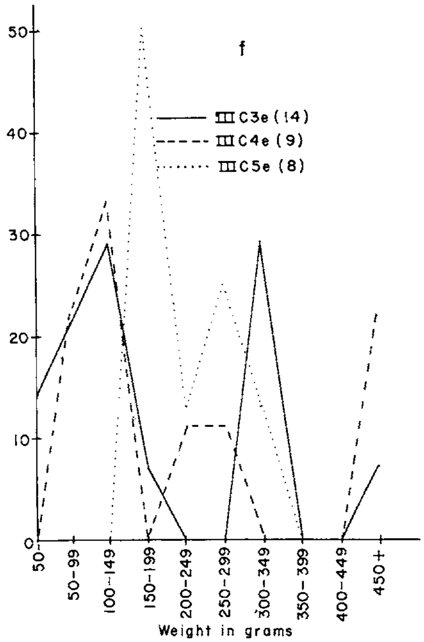
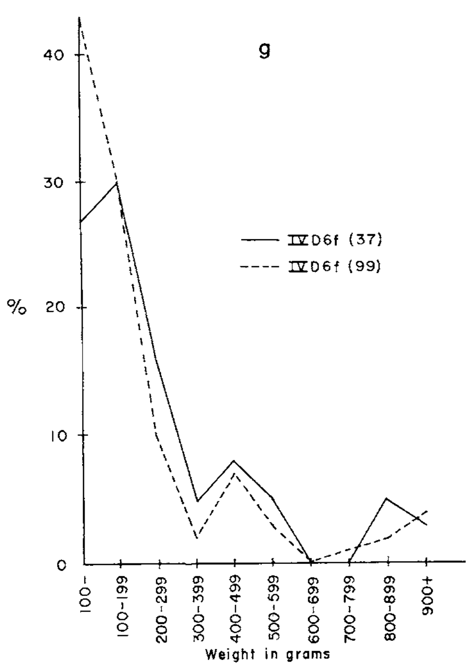


Fig. 115. Percentage distribution of weights of rocks, in grams, on which tools occur, by class. Both the total sample (99) of type IVD6f tools and the sample of complete specimens (37) are indicated (sample sizes in parentheses)


e
100
75
50
25
0
%
—— II C3c (16)
---- II C3e (12)
······· III B2a (10)
—·—·— III B2c (18)
++++ III B2d (9)
0-9
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90+
Weight in grams


f
50
40
30
20
10
0
—— III C3e (14)
---- III C4e (9)
······ III C5e (8)
50-
50-99
100-149
150-199
200-249
250-299
300-349
350-399
400-449
450+
Weight in grams


g
40
30
20
10
0
%
—— IV D6f (37)
---- IV D6f (99)
100-
100-199
200-299
300-399
400-499
500-599
600-699
700-799
800-899
900+
Weight in grams

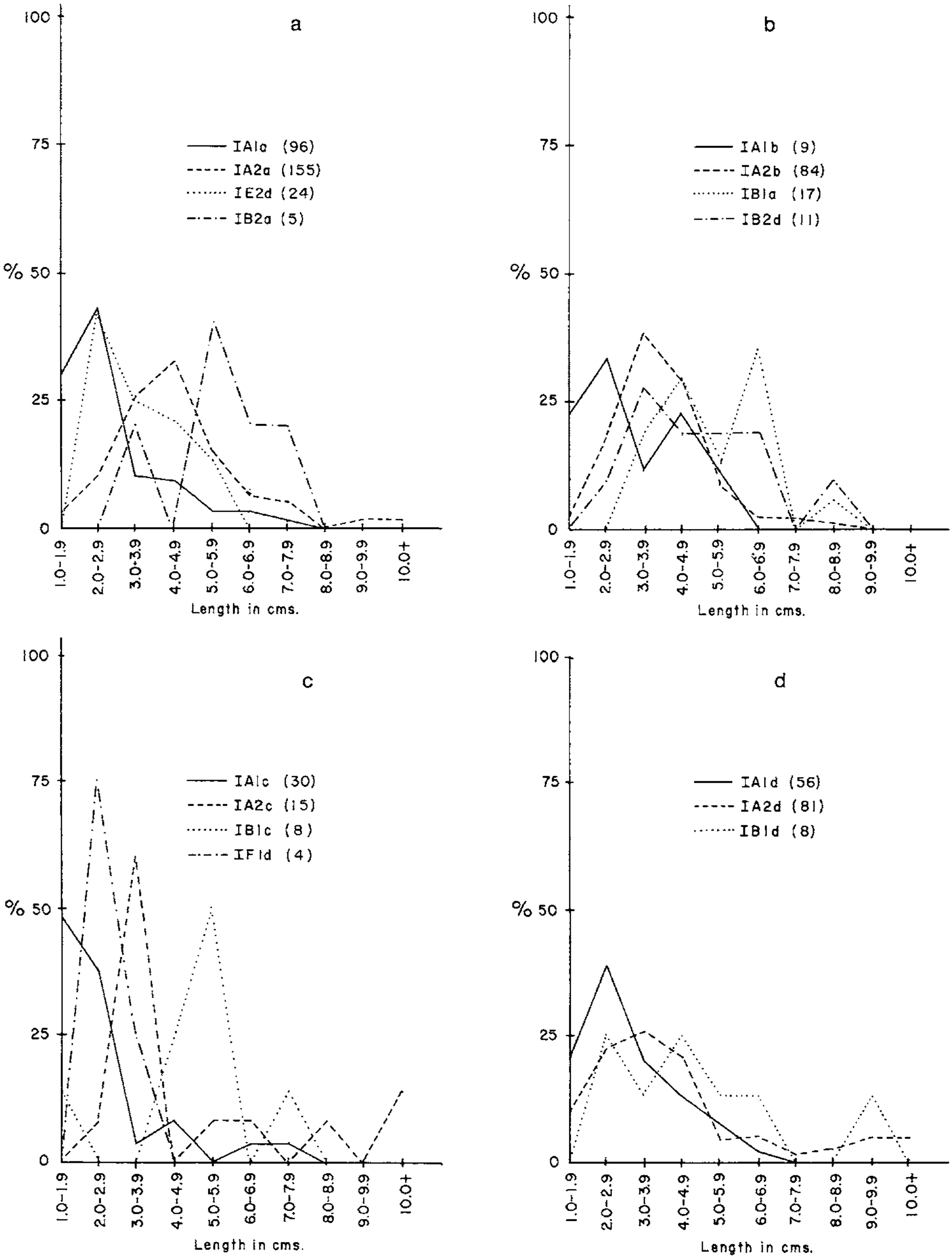
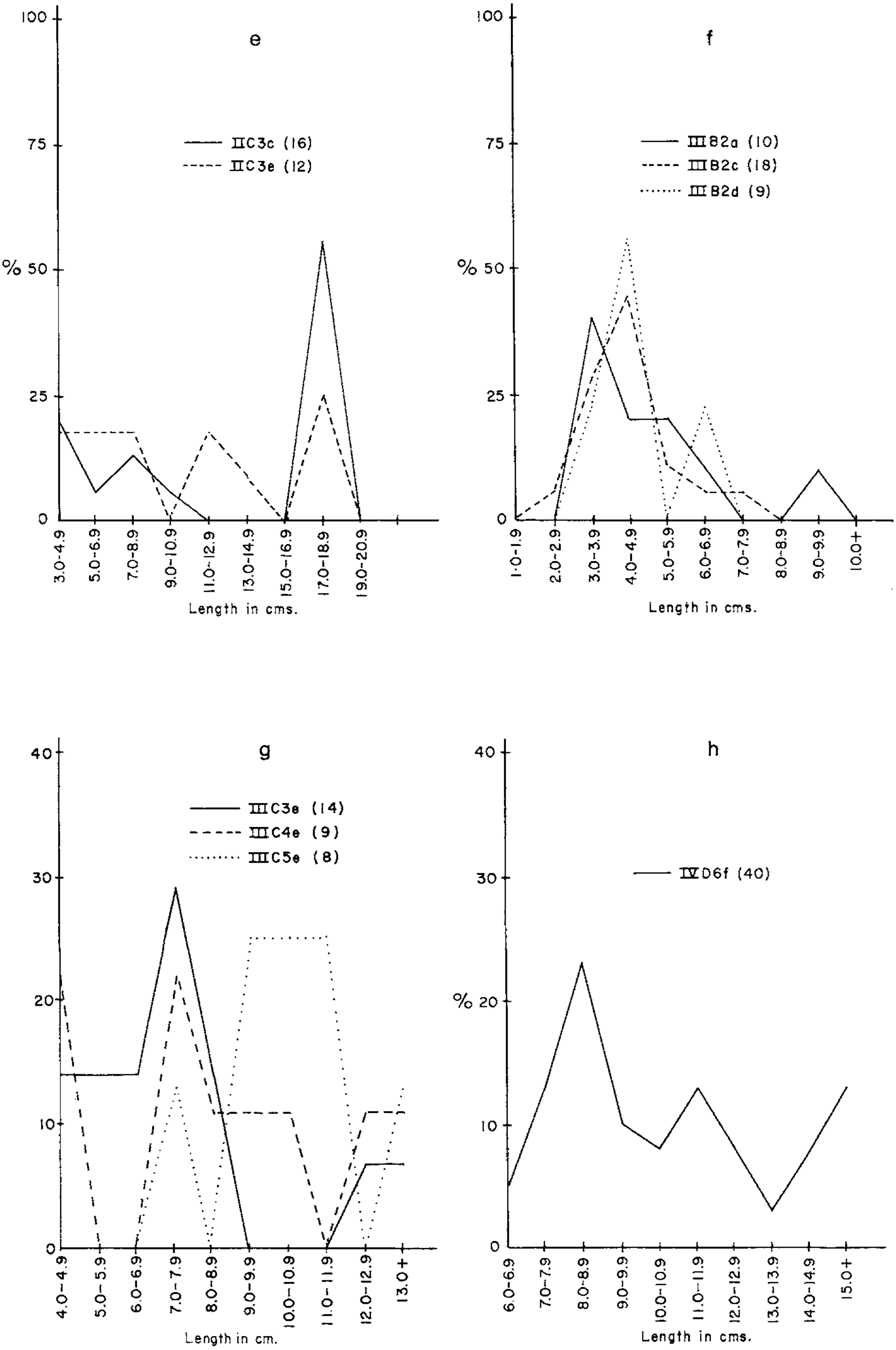
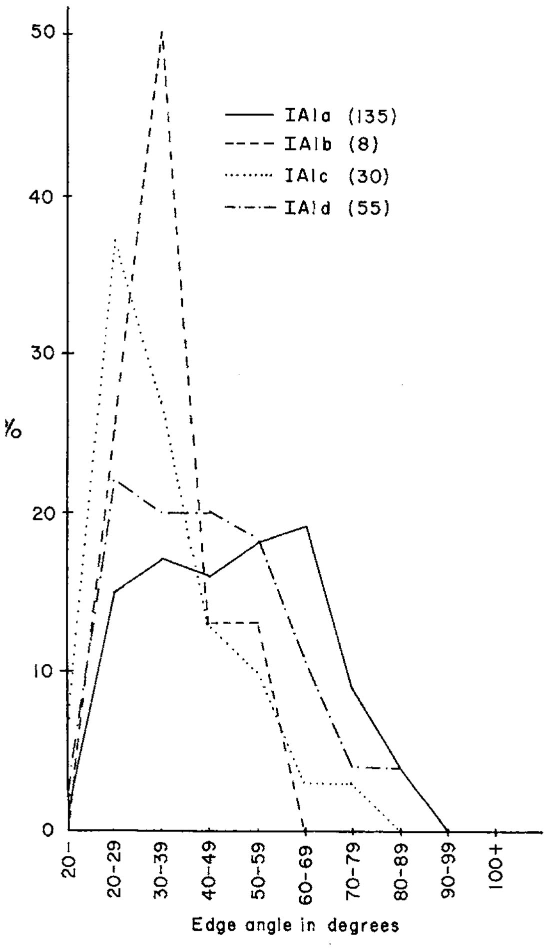


Fig. 116. Percentage distribution of maximum length of rocks on which tools occur, by class (sample sizes in parentheses)


e
IIC3c (16)
IIC3e (12)
%
Length in cms.
f
IIIB2a (10)
IIIB2c (18)
IIIB2d (9)
%
Length in cms.
g
IIIC3e (14)
IIIC4e (9)
IIIC5e (8)
Length in cm.
h
IVD6f (40)
%
Length in cms.



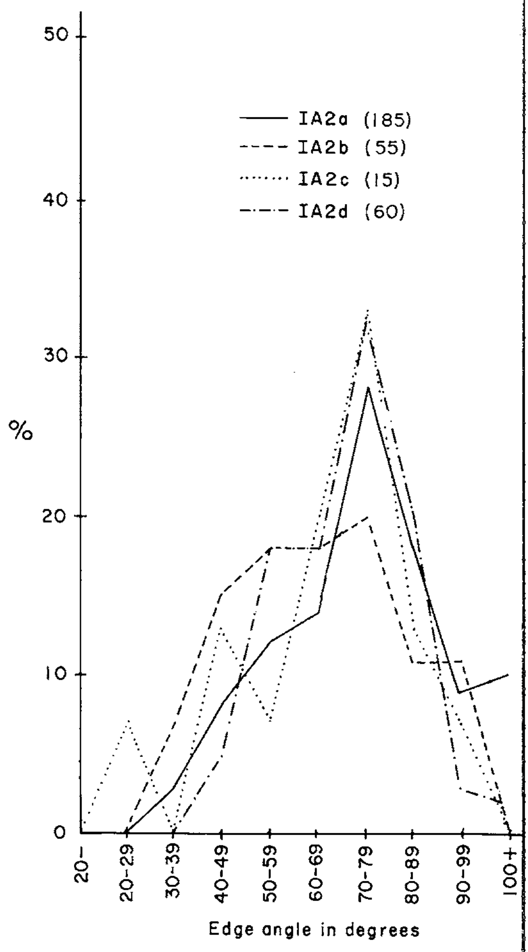


Fig. 117. Percentage distribution of size of angles, in degrees, of unifacially chipped stone tools, by class (sample sizes in parentheses)

chert with a mean length of 2.6 cm and a mean thickness of .6 cm, so that they have the appearance generally of small, thin pieces of rock. Of these tools, 47.12 percent occur on flakes, 52.88 percent on chunks—usually a thin part of a chunky piece of rock (see fig. 114a); 51.92 percent of the tools occur on rocks with no other tools (see fig. 114b), 46.15 percent occur on rocks with tools of other types. The distribution of the weights ($\bar{x}$ = 4.5 gm) and the maximum length of the rocks on which type IA1c tools occur are presented in figures 115 and 116, respectively. The distribution of the edge angles of the tools, which tend to be not steep ($\bar{x}$ = 41.4°), is given in figure 117.

IA1d

DEFINITION

I *chipping wear* on a
A *unifacial edge* which is
1 *symmetric in profile* and
d *convex in plan*

DESCRIPTION (figs 66 [a and b], 67)

The 323 tools of this type (making up 8.79 percent of all tools and 9.5 percent of unifacially chipped tools) are usually located on pieces of chert with a mean length of 3.3 cm and a mean thickness of .67 cm, so that they have the appearance generally of small, thin pieces of rock. Of these tools, 66.56 percent occur on flakes, 33.44 percent on chunks—usually on a thin segment of a chunky piece of rock (see fig. 114a); 62.23 percent of the tools occur on rocks with no other tools (see fig. 114b), 26.63 percent occur on rocks with tools of other types. The distribution of the weights ($\bar{x}$ = 5.9 gm) and the maximum length of the rocks on which type IA1d tools occur are presented in figures 115 and 116, respectively. The distribution of the edge angles of the tools, which tend to be not steep ($\bar{x}$ = 42.7°), is given in figure 117.

IA2a

DEFINITION

I *chipping wear* on a
A *unifacial edge* which is
2 *asymmetric in profile* and
a *concave in plan*

DESCRIPTION (figs. 68 [a, b, c, d], 69-73)

The 1,544 tools of this type (constituting 42.03 percent of all stone tools and 45.41 percent of unifacially chipped tools) are usually located on pieces of chert with a mean length of 4.7 cm and a mean thickness of 2.2 cm, so that they have the appearance generally of rather thick chunks of rock. Of these tools, 4.45 percent occur on flakes, 95.55 percent on chunks (see fig. 114a); 46.23 percent of the tools occur on rocks with no other tools (see fig. 114b), 42.47 percent occur on rocks with tools of other types. The distribution of the weights ($\bar{x}$ = 22.6 gm) and the maximum length of the rocks on which type IA2a tools occur are presented in figures 115 and 116, respectively. The distribution of the edge angles of the tools, which tend to be steep ($\bar{x}$ = 61.9°), is given in figure 117.

IA2b

Definition

I *chipping wear* on a
A *unifacial edge* which is
2 *asymmetric in profile* and
b *wavy in plan*

Description (figs. 74c, 75)

The 292 tools of this type (comprising 7.95 percent of all stone tools, 8.58 percent of unifacially chipped tools) usually occur on pieces of chert with a mean length of 4.5 cm and a mean thickness of 2.0 cm, so that they have the appearance of chunks of rock. Of these tools, 4.45 percent occur on flakes, 95.55 percent on chunks (see fig. 114a); 46.23 percent of the tools occur on rocks with no other tools (see fig. 115b), 42.47 percent occur on rocks with tools of other types. The distribution of the weights ($\bar{x}$ = 22.6 gm) and the maximum length of the rocks on which type IA2b tools occur are presented in figures 115 and 116, respectively. The distribution of the edge angles of the tools, which tend to be steep ($\bar{x}$ = 61.9°), is given in figure 117.

IA2c

Definition

I *chipping wear* on a
A *unifacial edge* which is
2 *asymmetric in profile* and
c *straight in plan*

Description

The sixty-eight tools of this type (constituting 1.85 percent of all stone tools, 2 percent of unifacially chipped tools) are usually located on pieces of chert with a mean length of 3.6 cm and a mean thickness of 2.0 cm, so that they have the appearance generally of chunks of rock. Of these tools, 5.88 percent occur on flakes, 94.11 percent on chunks (see fig. 114a); 20.59 percent of the tools occur on rocks with no other tools, 72.06 percent occur on rocks with tools of other types (see fig. 114b). The distribution of the weights ($\bar{x}$ = 12.5 gm) and the maximum length of the rocks on which type IA2c tools occur are presented in figures 115 and 116, respectively. The distribution of the edge angles of the tools, which tend to be steep ($\bar{x}$ = 60.7°), is given in figure 117.

IA2d

Definition

I *chipping wear* on a
A *unifacial edge* which is
2 *asymmetric in profile* and
d *convex in plan*

Description (figs. 74d, 76)

The 367 tools of this type (comprising 9.99 percent of all stone tools, 10.79 percent of unifacially chipped tools) usually occur on pieces of chert with a mean length of 3.6 cm and a mean thickness of 2.0 cm, so that they have the appearance generally of chunks of rock. Of these tools, 1.36 percent occur on flakes, 98.64 percent on chunks (see fig. 114a); 32.7 percent of the tools occur on rocks with no other tools, 58.86 percent occur on rocks with tools of other types (see fig. 114b). The distribution of the weights ($\bar{x}$ = 12.3 gm) and the maximum length of the rocks on which type IA2d tools occur are presented in figures 115 and 116, respectively. The distribution of the edge angles of the tools, which tend to be steep ($\bar{x}$ = 71.9°), is given in figure 117.

IB1a

Definition

I *chipping wear* on a
B *bifacial edge* which is
1 *symmetric in profile* and
a *concave in plan*

Description (fig. 77 [a and b])

The nineteen tools of this type represent .52 percent of all tools and usually occur on pieces of chert with a mean length of 5.1 cm and a mean thickness of 1.65 cm. All of the tools occur on chunks, none on flakes (see fig. 114a); 42.37 percent of the tools occur on rocks with no other tools (see fig. 114b). The distribution of the weights ($\bar{x}$ = 42.8 gm) and the maximum length of the rocks on which type IB1a tools occur are presented in figures 115 and 116, respectively. The average edge angle of the tools is 40.1°.

IB1c

DEFINITION

I *chipping wear* on a
B *bifacial edge* which is
1 *symmetric in profile* and
c *straight in plan*

DESCRIPTION (figs. 77 [c and d], 78)

The ten tools of this type constitute .27 percent of all tools and are usually located on pieces of chert with a mean length of 5 cm and a mean thickness of 1.6 cm. Of these tools, 20 percent occur on flakes, 80 percent on chunks (see fig. 114a); 60 percent of the tools occur on rocks with no other stone tools, 40 percent occur on rocks with tools of other types (see fig. 114b). The distribution of the weights ($\bar{x}$ = 21.1 gm) and the maximum length of the rocks on which type IB1c tools occur are presented in figures 115 and 116, respectively. The average edge angle of the tools is 41.1°.

IB1d

DEFINITION

I *chipping wear* on a
B *bifacial edge* which is
1 *symmetric in profile* and
d *convex in plan*

DESCRIPTION

The nine tools of this type comprise .24 percent of all stone tools and are always located on chunks of chert (see fig. 114a) which have a mean length of 4.8 cm and a mean thickness of 1.6 cm. Of the tools, 33.33 percent occur on rocks with no other tools, 66.67 percent on rocks with tools of other types (see fig. 114b). The distribution of the weights ($\bar{x}$ = 41.85 gm) and the maximum length of the rocks on which type IB1d tools occur are presented in figures 115 and 116, respectively. The average edge angle is 41.7°.

IB2a

DEFINITION

I *chipping wear* on a
B *bifacial edge* which is
2 *asymmetric in profile* and
a *concave in plan*

Description

The seven tools of this type which constitute .19 percent of all stone tools are always located on chunks of chert (see fig. 114a) that have a mean length of 5.5 cm and a mean thickness of 1.7 cm. Of the tools, 57.14 percent occur on rocks with no other tools, 42.86 percent occur on rocks with tools of other types (see fig. 114b). The distributions of the weights ($\bar{x}$ = 46.6 gm) and the maximum thickness of the rocks on which type IB2a tools occur are presented in figures 115 and 116, respectively. The average edge angle is 57.4°.

IB2d

Definition

I *chipping wear* on a
B *bifacial edge* which is
2 *asymmetric in profile* and
d *convex in plan*

Description

The sixteen tools of this type comprise .44 percent of all stone tools. They are always located on chunks of chert (see fig. 114a) with a mean length of 4.5 cm and a mean thickness of 1.7 cm. Of the tools, 25 percent occur on rocks with no other tools, 75 percent on rocks with tools of other types (see fig. 114b). The distribution of the weights ($\bar{x}$ = 33.4 gm) and maximum length of the rocks on which type IB2d tools occur are presented in figures 115 and 116, respectively. The average edge angle is 44.9°.

IE2d

Definition

I *chipping wear* on a
E *point and two unifacial edges* which are
2 *asymmetric in profile* and
d *convex in plan*

Description (fig. 79a)

The seventy-eight tools of this type constitute 2.12 percent of all tools and are usually located on pieces of chert which have a mean length of 3.5 cm and a mean thickness of 2.1 cm. Of these tools, 2.56 percent occur on flakes, 97.44 percent on chunks (see fig. 114a); 8.97 percent of the tools occur on rocks with no other tools, 91.03 percent occur on rocks with tools of other types (see fig. 114b). The distribution of the weights ($\bar{x}$ = 16.9 gm) and maximum length are presented in figures 115 and 116, respectively.

IF1d

DEFINITION

I *chipping wear* on a
F *point and three bifacial edges* which are
1 *symmetric in profile* and
d *convex in plan*

DESCRIPTION

The fifteen tools of this type constitute .41 percent of all stone tools and are located on pieces of chert. Of these tools, 53.34 percent occur on flakes, 46.66 percent occur on chunks (see fig. 114a); 40 percent of the tools occur on rocks with no other tools, 60 percent occur on rocks with tools of other types (see fig. 114b). The distribution of weight and maximum length of rocks on which tools of this type occur are presented in figures 115 and 116, respectively.

IIC3c

DEFINITION

II *abrading wear* on a
C *surface* which is
3 *concave in profile* and
c *straight in plan*

DESCRIPTION (figs. 80b, 81, 82)

The sixteen tools of this type make up .44 percent of all tools. They occur on chunks of sandstone or volcanic rock (see fig. 114a) with a mean length of 11.48 cm and a mean thickness of 34.88 cm; 18.75 percent of the tools occur on rocks with no other tools, 81.25 percent occur on rocks with type IIC3e tools (see fig. 114b). The distribution of the weights ($\bar{x}$ = 319.3 gm) and maximum length of the rocks on which tools of this type occur are presented in figures 115 and 116, respectively.

IIC3e

DEFINITION

II *abrading wear* on a
C *surface* which is
3 *concave in profile* and
e *irregular in plan*

DESCRIPTION (figs. 80a, 83, 84)

The twelve tools of this type constitute .33 percent of all stone tools. They occur on chunks of sandstone and volcanic rock with a mean length of 10.49 cm and a mean thickness of 19.41 cm. Of these tools, 66.66 percent occur on rocks with no other tools, 33.34 percent occur on rocks with tools of type IIC3c (see fig. 114b). The distribution of the weight ($\bar{x}$ = 312.6) and maximum length of the rocks on which type IIC3e tools occur are presented in figures 115 and 116, respectively.

IIIB2a

DEFINITION

III *crushing wear* on a
B *bifacial edge* which is
2 *asymmetric in profile* and
a *concave in plan*

DESCRIPTION (fig. 86)

The ten tools of this type constitute .27 percent of all stone tools. They occur on chunks of chert (see fig. 114a) with a mean length of 4.4 cm and a mean thickness of 19.3 cm. Of these tools, 60 percent occur on rocks with no other tools, 40 percent occur on rocks with tools of other types (see fig. 114b). The distribution of the weights ($\bar{x}$ = 44.86 gm) and the maximum length are presented in figures 115 and 116, respectively.

IIIB2c

DEFINITION

III *crushing wear* on a
B *bifacial edge* which is
2 *asymmetric in profile* and
c *straight in plan*

DESCRIPTION (fig. 79b)

The eighteen tools of this type constitute .49 percent of all stone tools. They occur on chunks of chert (see fig. 114a) with a mean length of 4.3 cm and a mean thickness of 18 cm. Of these tools, 55.55 percent occur on rocks with no other tools, 33.33 percent occur on rocks with tools (see fig. 114b). Distribution of the weight ($\bar{x}$ = 34.2 gm) and maximum length of the rocks on which tools of this type occur are presented in figures 115 and 116, respectively.

IIIB2d

DEFINITION

III *crushing wear* on a
B *bifacial edge* which is
2 *asymmetric in profile* and
d *convex in plan*

Description

The nine tools of this type constitute .24 percent of all stone tools. They occur on chert or volcanic rock with a mean length of 4.7 cm and a mean thickness of 18.1 cm. Of these tools, 55.55 percent occur on rocks with no other tools, 44.45 percent occur on rocks with tools of other types (see fig. 114b). The distribution of the weights ($\bar{x}$ = 46.9 gm) and the maximum length of the rocks on which type IIIB2d tools occur is presented in figures 115 and 116, respectively.

IIIC3e

Definition

III *crushing wear* on a
C *surface* which is
3 *concave in profile* and
e *irregular in plan*

Description (fig. 87)

The seventeen tools of this type comprise .46 percent of all stone tools. They occur on pieces of chert or volcanic rock with a mean length of 7.88 cm and a mean thickness of 43.9 cm. Of the tools, 47.06 percent occur on rocks with no other tools, 52.94 percent occur on rocks with tools of other types (see fig. 114b). The distribution of the weights ($\bar{x}$ = 182.5 gm) and the maximum length of the rocks on which type IIIC3e tools occur are presented in figures 115 and 116, respectively.

IIIC4e

Definition

III *crushing wear* on a
C *surface* which is
4 *straight in profile* and
e *irregular in plan*

Description (fig. 79c)

The nine tools of this type constitute .24 percent of all stone tools. They occur on chunks of chert or volcanic rock with a mean length of 9 cm and a mean thickness of 44 cm. All of the tools of this type occur on rocks with other tools (see fig. 114b). The distribution of the weights ($\bar{x}$ = 181.1 gm) and the maximum length of the rocks on which type IIIC4e tools occur are presented in figures 115 and 116, respectively.

IIIC5e

DEFINITION

III *crushing wear* on a
C *surface* which is
5 *convex in profile* and
e *irregular in plan*

DESCRIPTION

The eight tools of this type comprise .22 percent of all stone tools. They occur on pieces of chert or volcanic rock with a mean length of 10.43 cm and a mean thickness of 44.1 cm. All of the tools of this type occur on rocks with other tools (see fig. 114b). The distribution of the weights ($\bar{x}$ = 222.8 gm) and the maximum length of the rocks on which type IIIC5e tools occur are presented in figures 115 and 116, respectively.

IVD6f

DEFINITION

IV *abrading and crushing wear* on
D *surface and edge* which are
6 *asymmetric and convex in profile,* and
f *convex and irregular in plan*[2]

DESCRIPTION (figs. 88 [a, b, c], 89 [a and b], 90, 91)

The ninety-nine tools of this type (adzes) constitute 2.69 percent of all stone tools. They occur predominantly on pieces of volcanic or basic rock, with some on chert and silicified shale (see appendix 5), with a mean length of 11.3 cm and a mean thickness of 21.16 cm on the thirty-seven complete specimens of this type, 20.36 cm on the eighty specimens on which the measurement can be made, although distance from cutting edge or butt is not always ascertainable. Of the tools of this type, 78.78 percent occur on rocks with no other tools, 21.22 percent occur on rocks with tools of other types (see fig. 114b). The distribution of weights ($\bar{x}$ = 263.4 gm) and maximum length of the adzes are presented in figures 115 and 116, respectively (see table 17 for some adz measurements).

I have not included adz cross section with the descriptive modes, although it is dealt with in a paper currently in preparation. Because some investigators have placed rather great importance on this attribute, I note here that with three exceptions the transverse cross section, where it is ascertainable, at a location midway between butt and cutting edge is el-

2. For comment on the use of "double modes," see chapter III, note 10.

TABLE 17

MEASUREMENTS OF THIRTY-THREE TYPE IVD6f TOOLS (ADZES)

Field Catalogue Number	Weight (gms)	Max. Length (mm)	Max. Thickness (mm)	Max. Width* (mm)	Loc. of Maximum Width	Cutting Edge Width† (mm)
NFB/4	80	77	8	51	Cutting edge	50
NFI/8	1,115	193	34	81	Midsection	78
NFB/22	845	183	34	76	Midsection	61
NFB/823	85	88	14	43	Cutting edge	43
NFA/ME 813	288	121	25	56	Midsection	51
NFN/1	273	114	27	64	Cutting edge	67
NHB/19	273	121	23	65	Cutting edge	65
NHB/20	302	122	26	66	Cutting edge	63
NHB/21	506	161	34	58	Midsection	56
NHJ/1	180	116	20	48	Midsection	45
NHL/14	134	82	18	51	Cutting edge	51
NHL/15	328	144	21	66	Midsection	62
NHL/16	434	142	25	65	Midsection	58
NHN/2	94	80	9	48	Midsection	43
NHN/3	130	83	19	49	Midsection	41
NHN/94	84	77	11	48	Cutting edge	47
NHN/ME 232	452	115	26	54	Cutting edge	54
NHN/ME 215	155	90	21	52	Cutting edge	51
NHO/1	400	145	25	61	Midsection	55
NHQ/1	81	83	9	44	Midsection	43
NHQ/23	116	91	12	55	Midsection	53
NHR/2	828	192	34	80	Midsection	53
NHR/4	45	71	11	24	Cutting edge	25
NHR/5	187	106	28	49	Cutting edge	53
NHR/7	250	114	23	64	Cutting edge	64
NHR/8	540	161	33	62	Cutting edge	62
NHR/11	216	107	21	60	Cutting edge	58
NHR/14	43	66	15	26	Midsection (?)	22
NHR/15	297	138	21	62	Cutting edge	62
NHR/53	176	93	21	61	Cutting edge	60
NHU/1	84	116	25	47	Cutting edge	47
NHU/2	140	86	21	43	Midsection	32
NHU/3	97	81	15	51	Cutting edge	54

* Maximum width perpendicular to long axis.
† Chord of the arc; may not be perpendicular to long axis.

liptical on all archeologically retrieved tools classified as IVD6f.[3] In the exceptional cases this cross section is square on NHQ 24 (fig. 90); it is rhomboidal on NHR 4 (fig. 90); and one flat side and one rounded side occur on NHR 14.

3. The term "elliptical" may suggest a geometric regularity which does not exist. It conveys that the sides are "rounded."

Appendix 4

Radiometric Determinations

All samples of material of possible use in obtaining C_{14} dates were carefully collected by J. David Cole or Keith Weigel under conditions that would insure the samples to be free of contamination. Each lot of material was wrapped in aluminum foil and placed in a paper bag that was labeled appropriately for identification purposes. The samples eventually submitted for analysis were sent to the respective radiocarbon laboratories in these wrappings plus sturdy outer ones.

Two of the determinations (UW 107, UW 108) were made in late 1967; the remainder were obtained in 1973 and 1974. Cole selected all samples for dating, every one but the first two after discussing with me the kinds of questions which had priority. With one exception, I 7285, the samples appear to be well chosen and reliable.

UW 107. 3,300 ± 120 B.P. A 12.5 gm charcoal sample (5.8 gm cleaned charcoal, 1.1 gm pure carbon) from the level of concentration of cultural material ("habitation surface") in the southwest quad of unit 1S18W at NGG. This is not from the area of greatest concentration of artifacts at the site, but there were very few samples of charcoal from the site which were adequate for dating.

UW 108. 3,780 ± 120 B.P. A 13 gm charcoal sample (7.6 gm cleaned charcoal, 2.3 gm pure carbon) taken from within the hearth at NGH (fig. 40, 41); 1.8 gm of ferric material was removed in cleaning.

UW 260. 3,530 ± 130 B.P. Scatter sample of charcoal under the fragment of stone mortar which lay at a depth of 70.5 cm in the balk between units 16N8W and 16N10W at NFB. There were no intrusive influences and continued excavating produced only culturally sterile soil.

UW 261. 3,070 ± 95 B.P. Small, but well-controlled sample of charcoal in balk between units 16N6W and 16N8W at NFB. It lay just above the level of the fragment of stone mortar in the balk between units 16N8W and 16N10W. This sample was run on a minicounter used on samples of less than 1 gm of carbon, designed and built by Professor Arthur Fairhall and Anthony Young of the University of Washington Radiocarbon Dating Laboratory.

UW 262. 11,510 ± 140 B.P. A large scatter sample of charcoal associated with a few artifacts and chipping detritus under the heaviest concentration of artifacts in unit 3S20W at NFX. There was no indication of intrusions, and continued excavation revealed only culturally sterile soil.

I 7284. 12,620 ± 280 B.P. A 13 gm sample of charcoal (5.1 gm cleaned charcoal) from the hearth in unit 1N12W at NFX. The sample appeared to be all charcoal, and the technician was surprised to have only .86 gm of carbon left after burning. Because of its small size, the sample was run on a minicounter.

I 7284C. 13,210 ± 270 B.P. An 8 gm charcoal sample (1.22 gm pure carbon) associated with debitage and fire-cracked rocks in unit 3N12W at NFX, just under the main concentration of artifacts.

I 7285. 2,060± 85 B.P. A scatter sample of 13 gm charcoal (8.1 gm cleaned charcoal, 1.8 gm pure carbon) from unit 8N6W at NFB, which was associated with unifacially chipped stone tools, chipping detritus, and pottery. This date has not been included in table 16, and it has been accorded little weight in the discussion because of the possibility of its being unreliable. In a site with evident fluctuation of the water table making possible the movement of charcoal, it seems prudent to view with caution a scatter sample from a level that is underlain by culture-bearing deposit. I include the date in this list in an attempt to present as many data as possible and in case, as a result of better controlled data in the future, it becomes reasonable. By itself, it should *not* be used as a reliable date for the occurrence of pottery.

I 7286. 185 ± 80 B.P. A 3.4 gm charcoal sample (3.2 gm cleaned charcoal, 1.46 gm pure carbon) from level 3 in unit 6S9W at NFB. It was associated with stone tools, debitage, and pottery. The cultural material is related to component II and is in the level of the site overlying the level of the excavated house and the cultural material associated with it also assigned to component II.

RL 370. 18,050 ± 750 B.P. A 21.5 gm sample of mineralized charcoal post remains (2.0 gm cleaned charcoal) found in the west wall of unit 3N12W at NFX (depth of 65.4 cm datum B).[1]

1. The dates obtained from NFX show a range of time, not to mention an age of time, which deserves comment. The sample that was first dated came from unit 3S20W (3S22W?) (11,510 ± 140 B.P., UW 262). It was a large scatter sample which Cole felt was free of contamination, since there were no intrusions in the level, which was apparently sealed. A few stone tools were associated with it; greater quantities of tools and debitage were above it. The date obtained was surprisingly old, we thought, although White had received a date almost as old from the not far distant NBY site (Batari), and an older date which underlay the bulk of the cultural material at the site (cf. chap. V, note 20). A second sample from NFX, weighing 13 gm, from the hearth in unit 1N12W,

RL 407. 3,960 ± 170 B.P. A 20 gm sample of charcoal (7.6 gm cleaned charcoal) found in the hearth in unit 6S6W at NFB. It underlay the level of the excavated house of component II.

RL 408. 290 ± 90 B.P. A 14.2 gm sample of charcoal (4.8 gm cleaned charcoal) from the feature in unit 2N0E at NGM, inferred to be an earth oven. The laboratory suggests the calendar date range of A.D. 1470 to 1650, with the ± 90 years' uncertainty included in this range. In my discussion, however, I have used corrections for no dates.

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was then selected for dating. Although the material appeared to be charcoal, the laboratory was surprised to have approximately only .86 grams of charcoal left after burning. The sample was run on a minicounter and a date of 12,620 ± 280 B.P. (I 7284) was obtained. Because the sample was so small, the laboratory requested another sample from the same site. Eight grams of charcoal from just under the main concentration of cultural material in unit 3N12W in an area with fire-cracked rocks and debitage was run and date of 13,210 ± 270 B.P. (I 7284c) obtained. Finally, a 21.5 gram sample of mineralized charcoal, the remains of a post in the west wall of unit 3N12W, was run and a date of 18,050 ± 750 B.P. (RL 370) obtained.

Appendix 5

PETROGRAPHIC ANALYSES

By George W. Goodspeed,
Professor Emeritus, Department of Geology,
University of Washington

Type IVD6f Tools: Adzes

Artifact Identification	*Color*[1]	*Kind of Rock*
1. NFA/24	Light brownish gray	Weathered volcanic rock
2. NFA/ME 814	Brownish gray	Weathered lava; shows flowage
3. NFA/ME 816	Medium light gray	Weathered volcanic rock; flow structure
4. NFA/ME 821	Greenish gray	Altered volcanic rock; flow structure; few small white phenocrysts
5. NFB 1638	Pale red purple	Weathered lava; flow structure
6. NFB 1876	Yellowish gray	Weathered volcanic rock
7. NFB 1878	Light olive gray	Weathered volcanic rock
8. NFB 1881	Brownish gray	Weathered basic lava; crushed laths of feldspar diopside
9. NFB 1897	Brownish gray	Weathered lava; flow structure
10. NFN 1	Dark greenish gray	Rather basic obsidian; few feldspar phenocrysts
11. NHC 42	Grayish black	Basalt, mostly a dark glass
12. NHE 11	Dusky yellow green	Probably andesite; ophitic texture, flow structure
13. NHI 6	Brownish gray	Weathered volcanic; flow structure evident
14. NHJ 1	Grayish olive green	Basic lava rock
15. NHN 7	Medium light gray	Chert, slightly banded
16. NHN 140	Brownish gray	Weathered lava; some evidence of flow structure
17. NHN 141	Grayish purple	Weathered basic lava; flow structure
18. NHN 145	Light olive gray	Weathered lava
19. NHQ 1	Brownish gray	Silicified shale; slightly banded
20. NHQ 22[2]	Dark greenish gray	Basic andesite

1. Geological Society of America Rock-Color Chart.
2. Two thin sections of this object were examined.

21. NHQ 24	Greenish gray	Chert
22. NHQ 54	Dark greenish gray	Basic andesite
23. NHR 4	Very dusky purple	Chert
24. NHR 10	Grayish olive green	Basic lava rock
25. NHR 31	Medium dark gray	Basic andesite
26. NHU 1	Dusky yellowish green	Lava; shows diabasic structure
27. NHU 2	Dusky yellowish green	Basic lava; slightly weathered; flow structure
28. NHU 4	Light olive gray	Silicified banded shale
29. NHV 44	Light medium gray	Silicified shale, somewhat banded

PETROGRAPHIC DESCRIPTION OF NHQ 22 (TWO SECTIONS)

This artifact has a greenish color and is covered with numerous shallow indentations, 0.5 cm to 1 cm, which appear to have been caused by weathering. A fresh fractured surface is dark greenish gray with numerous minute whitish spots. The polished pieces cut for thin sections also show lenticular white spots, and indistinct small minerals are noticeable.

In thin section under the microscope, flow structure is apparent in the mesostasis wrapped around larger phenocrysts. The mesostasis contains minute grains of mafics and laths of feldspar. The phenocrysts are K feldspar, plagioclase, oligoclase (An 26), and andesine (An 35), hornblende, cummingtonite, and pyroxene (diopside). The phenocrysts have many small inclusions, some of which are magnetite. They are also fractured and penetrated by the mesostasis. The fracturing may have resulted from a pasty condition of the freezing lava. This rock can be classified as a somewhat basic andesite.

NOSE PLUGS[3]

NFC 54: Fine material is silt consisting of K feldspar and plagioclase with a few mafics (use inferred)

NFC 94: Consist chiefly of very fine ferruginous clay, probably derived from pyroclastic material (use inferred)

ME 1033: (Ethnographic specimen.) Crushed fragments are silt consisting chiefly of K feldspar, some of which are somewhat altered, and plagioclase with andesine (An 45)

POTTERY

NFB 1594: Crushed fragment in oil 1.594 is chiefly limonitic material

3. All three of these specimens superficially look like calcite, but upon examination prove not to be.

with a few clear quartz grains and a few grains of K feldspar and plagioclase (type Q)

NFB 1927: Powder in oil 1.545 consists mostly of opaque limonitic material with a few grains of quartz and feldspar (type R)

NFC 58: A few grains of quartz in a dark brown matrix of burnt clay (type Q)

NFC 59: A few grains of feldspar and quartz in a dark brown matrix of burnt clay (type Q)

NFA 20A: Several grains of quartz and a few of feldspar in a dark matrix of clay (type Q)

ME 1203: Crushed fragments are chiefly dark brown clay material with numerous grains of quartz and K feldspar and a little plagioclase (type Q)[4]

4. ME 1203 is a fragment of contemporary pottery. It is thicker in diameter than most of the archeological examples, many of which show signs of weathering. The jar was collected from the Agarabi just north of Kainantu town; the owner reported that he had obtained the pot from Bilimoia village, where it had been manufactured. Generally, ethnographically collected specimens are thicker than excavated specimens of pottery (Coutts 1967: 487; Key 1972: 160; V. Watson 1955).

Appendix 6

Obsidian Analysis

Thirty-two pieces of obsidian were retrieved (excluding an adz from NFN). Of the twenty-two from NFB, eighteen were from excavations; of the remaining ten pieces, all but one are from the northern area (five are from Abiera), and one example is from NHC in the southwestern area. Five samples were submitted for examination to Dr. Joseph A. Vance, associate professor of geological sciences at the University of Washington, who made a determination of the refractive indices. His findings are in the table below.

Field Number	*Refractive Index*	*Locale*
ME 867/7	1.489	Between NGM and NGN (surface)
NFB 1226	1.490	NFB, unit 14N6W
ME 870/2	1.490	200 m east of NGM (surface)
NHC 1	1.490	NHC (surface)
Tx	1.491	Vicinity of NGM and NGN (surface)

Vance notes that these values are very close and perhaps identical within the limits of determinative error.

Samples of obsidian from five well-known deposits in New Guinea, sent to the author by Mr. G. A. M. Taylor, Australian Bureau of Mineral Resources, Geology, and Geophysics in Canberra, were also examined by Dr. Vance. The sample from Lou Island measures 1.498, that from Dobu Island, 1.503, making it extremely unlikely that they are sources of the artifact obsidian in question. The sample from Talasea, New Britain, measures 1.487, from Southwest Fergusson Island, 1.488, and from North Pam Island, 1.492, placing these three samples within the range of possible sources.

More recently, Dr. Roger Bird of the Australian Atomic Energy Commission and W. R. Ambrose of the Research School of Pacific Studies, Australian National University, have analyzed twenty-three obsidian specimens by proton-induced gamma rays and density measurements. The counts of aluminum (channel 1013), sodium (channel 440), and fluorine (sum), and density determinations, indicate that twenty specimens match the source samples from Talasea, one specimen matches the source samples from West Fergusson Island, and the remaining two are not clearly allocated to any of the major obsidian sources which have been identified.

Appendix 7

Ethnographic Data and Defensive Position Assessment

During the period of field work New Guineans were interviewed with respect to former village locations, genealogies, migrations, and myths. These data have not been incorporated in this monograph for several reasons, such as (1) they are not properly data of prehistory and (2) they were obtained, for the most part, from rather superficial inquiry rather than exhaustive interrogation of a number of informants—a very time-consuming procedure but one which is absolutely essential to insure reasonably accurate information. In table 18, I present (1) field assessment of the defensive quality of a site's location, when recorded; (2) informant assessment of the date of (most recent?) occupation of a site, as recorded in the field notes; and (3) a brief notation of the kind of site, usually functional, which is recorded in the field notes. The latter two categories of data are to be regarded with extreme caution; most of the data, as already mentioned, are based on brief interviews and were not cross-checked.

TABLE 18
Ethnohistorical and Defensive Position Data

Site	Defensive Position	Ethnohistorical Notes	Date of Occupation
NFB		Most recent occupation unexcavated; earliest occupations not reported	± 1945
NFC		Men's house of Noreikora phratry; also two other men's houses and several women's houses to make large village arrayed to south of NFB on edge of Noreikora swamp; called Batontaida	
NFF	Not bad		
NFH		Ancestors earlier resided here	
NFI	Good	Refuge in times of war; now used for catching swiftlets	
NFJ	Good		
NFK	Poor	Formerly men's house	± 1935
NFL	Poor	Used as rain shelter	
NFM	Good		
NFN	Good	Formerly men's house	± 1935
NFP	Good	Abandoned because of disease	Recent
NFQ	Good		
NFR	Poor	Used as rain shelter and for cooking rats	± 1955
NFS	Poor	Used as rain shelter and for cooking rats	± 1955
NFT	Good		
NFV	Good	Formerly men's house	± 1945
NFW		Ancestors once lived here	
NGD	Good		
NGE		Two men's houses and women's houses	
NGN		Dance ground and men's house	± 1900
NGS	Not bad		
NGX		Origin place of the Auyana people	
NHB	Good		± 1900-1910
NHC	Good		± 1910-1920
NHD		Refuge in war and rains	
NHE	Poor		
NHG	Good		
NHH	Poor		
NHI	Poor		
NHK	Poor		
NHL		Occupied for a short period	
NHN	Good		± 1925
NHO	Poor		± 1925
NHQ	Good		± 1915-1935
NHR	Good		± 1945
NHT		Houses once stood here	
NHU		Men's house, later pig houses	
NHV	Good	Ancestors once lived here	
NHW	Good	Burial site	

Appendix 8

History of the Project

Because a decade has elapsed since the field work on which this monograph is based was conducted, it may be useful to place it in historical perspective.

Archeological Work in the New Guinea Highlands Previous to the Present Project

To Susan H. Bulmer, sponsored by the American Museum of Natural History, goes the distinction of having conducted the first controlled excavations of archeological sites in the highlands of New Guinea. Earlier archeological activity consisted almost entirely of sporadic, fortuitous finds of stone adzes, axes, bowls, mortars, pestles, club heads, annulae, and figurines. One tangential exception was an article on pottery in the eastern highlands which was "intended primarily as an historical reference point for future archeological investigations" (V. Watson 1955: 121). It was, if anything, an example of archeo-ethnography—an ethnographic account of potential relevance to archeologists.

From September 1959 to May 1960, Bulmer spent four months in reconnaissance and four months in excavations, all in the western highlands, that is, west of the Asaro-Watabung divide. Her work resulted in several papers, published and mimeographed, which outlined her excavations and her conclusions and in which she made some attempt to link them to the larger area of Australasia (see bibliography). Her M.A. thesis at the University of Auckland describes in somewhat more detail the results of her work. This document has not been published and I have not seen it.

In 1962 I outlined a program for archeological reconnaissance and excavations in the Kainantu Subdistrict of the Eastern Highlands District of New Guinea, and attempted to obtain funds which would permit a large-scale program to be undertaken in 1963-64. This project, independent of the Micro-evolution Project of the University of Washington, yet to run concurrently with one segment of the project, would have addressed itself to a survey of the strategic area in which headwaters of the Ramu, Wanton-Markham, and Lamari-Purari river systems are located, in an attempt to discover sites, both cave and open, in a range of micro-environments and ecologic niches. The survey was to have been followed by site excavation. The proposed project was ambitious and would have engaged the services of three or four archeologists for a period of four or more years. No funds could be engendered for this project, however.

In preparation for the anticipated program of survey and excavation, the archeological potential of the eastern highlands was assessed and a list of sites assembled. Information was contributed by Nancy Glick, Jon Holmes (reported to me through the kindness of Susan Bulmer), Lewis Langness, Howard McKaughan, Philip Newman, Kerry Pataki, Sterling Robbins, David Royds, Brian duToit, and Alex Vincent. I take this opportunity to thank them for their interest and aid in the project. Some of the sites reported were legendary sites of origin for local groups. Some of them were locations of former villages reported by contemporary New Guineans. A few were cave sites, including Aibura (first reported to me by Holmes via Bulmer, secondly by Vincent) and Legaiyu (reported by Royds), which was also known as Kafiavana and Koeagu.

In Port Moresby, late in 1963 if memory serves, James B. Watson met J. Peter White and Carmel White, then graduate students at Australian National University, who were conducting archeological reconnaissance in that area. They professed to having been unsuccessful in locating the kinds of sites for which they had hoped (i.e., those with some antiquity), and Watson encouraged them to consider the highlands where, he felt reasonably sure, they would find the kinds of sites they sought. Subsequently, they changed their base of operations and in April 1964, while headquartered at the University of Washington Micro-evolution Project house in Ukarumpa, they conducted a survey in the Kainantu area. During their first visit to our house at Batainabura, we made available to them the material we had gathered about potential archeological sites, and they conducted their first excavation in the highlands at NAE (Aibura), a few miles distant. White's excavations were extended in 1964, and again in 1965, to NBY (Batari), NBZ (Kafiavana), and NAZ (Niobe); they were geographically fairly widespread and they have been well published. White is to be commended for the speed with which he has brought the results of his research to the attention of fellow scholars (see bibliography).

Late in May of 1964, J. David Cole visited my husband and me in Ukarumpa. We had heard of each other previously, but this was our first direct contact. Cole, then resident in Goroka, Eastern Highlands District, New Guinea, had, at an earlier date, been a student at the University of Washington. At the time of our meeting he expressed a desire to return to that institution to complete his studies toward the baccalaureate.

By letter of 2 July 1964, J. Peter White contacted Cole requesting help in locating "caves and rock shelters with archeological potential in the area around Goroka." Cole replied on 7 July 1964 with a list of caves and rock shelters between Henganofi and Kundiawa. On 26 July 1964 Cole sent White reports of test pits he and fellow members of the Goroka Caving Club had made at Mabic and Goro Gombogo. On 31 August 1964 Cole took White to a "number of rock shelters in Chuave" (correspondence, J. D. Cole to J. B. Watson, 8 September 1964), including NAZ (Niobe), in which White later excavated. On 5 September 1964 Cole guided White to Yonggamugl to show him sites that Cole and his associates of the Goroka Caving Club had previously located, including Mabic and Goro Gombogo. The club members intended to excavate further at Mabic and to that end had had a shelter erected to be used during the period of exploration. Of the sixteen rock shelters and caves in the area, White elected to excavate Mabic, and Cole courteously extended the use of the house to him. On weekends Cole assisted in the excavations, adding to his own knowledge and command of archeological techniques.

In September 1964, as a result of his increasing interest in archeology, Cole made the decision to return to the University of Washington to pursue a course of studies in anthropology, specializing in archeology. In anticipation of this he outlined a project of archeological survey and testing in New Guinea and applied to the University of Washington for financial support. He was awarded grants of five hundred dollars each by the Thomas Burke Memorial Washington State Museum and the Graduate School, both of the University of Washington. With these funds he conducted an intensive site survey in the Daribi area, he conducted the initial excavation at NBZ (Kafiavana), and he organized and enlarged his surveys of Yonggamugl and Gimi. Cole returned to the United States in January 1965 to matriculate at the University of Washington.

Archeological Phase of the Micro-evolution Project

Late in 1965 it became apparent that funds would be available to the Micro-evolution Project of the University of Washington, under the direction of James B. Watson, to undertake a modest archeological venture in the project study area. This area was currently occupied by members of four ethnolinguistic groups: Auyana, Awa, Gadsup, and Tairora. Ultimately, Cole was chosen to direct the field project which

> was designed to add prehistoric background and perspective to synchronic studies provided by other project members. The purpose of the field research was the development of a local sequence or a set of local sequences within the Study Area. . . . It was hoped that local sequences could then be integrated into a tentative regional sequence of prehistoric events by correlation with (1)

> reports issued by other archaeologists, (2) unstratified material collected during the site survey, (3) ethno-historic data recorded during the research periods, [and] (4) materials collected and recorded by the author [Cole] during a previous period of field research in the Eastern Highlands District. The underlying strategy of the field program was a somewhat opportunistic exploitation of the widest possible range of data sources. Special emphasis was placed on data pertaining to socio-economic, or domestic, conditions. Tactical considerations therefore naturally rested upon the possibility of locating suitable village or encampment sites. . . . There was little reason to believe that open sites would not be found by ordinary survey methods and ethno-historic interviews.[1]

Cole, meanwhile, had obtained his B.A. degree in anthropology and had participated actively in archeological excavations of the University of Washington under the direction of Dr. Robert Greengo. Cole returned to New Guinea in November 1966 to proceed with archeological survey and excavation, which was to continue through November 1967.

Because of Cole's status as a predoctoral graduate student and in view of the lack of immediate supervision by his university sponsors, the funding agency, National Science Foundation (NSF), felt it was prudent to have an archeologist currently active in New Guinea and nearer to the scene of the research discuss his project with him in advance and visit him during the period of field work. Indeed, the NSF made this a stipulation for their acceptance of Cole as the field archeologist. With the approval of NSF, Mr. Jack Golson of the Australian National University was approached by James B. Watson, principal investigator of the Micro-evolution Project. After several exchanges of correspondence briefly mentioned below, Golson kindly accepted the invitation to act in an advisory capacity to Cole. I take this opportunity to acknowledge with gratitude and appreciation his participation.

Cole spent several days in Canberra en route to New Guinea, discussing his plans with Golson. At the time Golson agreed to the sponsorship he was still doubtful, as he had all along declared, about Cole's plan to concentrate on open sites. He felt that open sites, especially any but very recent ones, would be difficult, if not impossible, to locate. On these grounds, indeed, he had at first been reluctant to act as local adviser to Cole, but he acceded to a compromise proposal: if Cole, fairly soon after commencing his survey, did not locate what seemed to be promising open archeological locations, he would change the plan of his work and concentrate on cave and sheltered sites, even though this might not meet the intentions of the Micro-evolution Project, which was financing the work. Golson's view was shared by his student, Peter White, who had written to Cole before Cole's departure from the United States: "I . . . do think that you will be lucky to find many [open sites], especially those older than a

1. Quotations, unless indicated otherwise, are from Cole's field notes or reports.

few generations" (correspondence, 22 September 1966, J. Peter White to J. David Cole). Accordingly, Cole's initial task in New Guinea was to locate as many sites as possible within a relatively short period of time and then to choose for initial excavation a site that gave every promise of being productive.

Cole was quite successful in locating open sites, some of them with respectable antiquity, and he pursued an intensive program of survey and excavation with vigor. His accomplishment stands as the pioneering strategy directed at open sites in the highlands of New Guinea.[2]

After his return to Seattle in January 1968, Cole resumed his graduate work in archeology at the University of Washington, where he held a research assistantship, until December 1968, when illness forced him to discontinue his studies. When, by June of 1969, he was still unable to resume his analysis of the material and it seemed assured that he would be unable to do so in the foreseeable future, it was imperative to find someone to proceed with the project and ultimately bring it to a conclusion. Because all of the funds for the archeological phase of the Micro-evolution Project had been spent in financing the field work, the present writer volunteered to undertake the task. Cole continued to be involved, helping to clarify inconsistencies and obscurities in the field notes, discussing some problems of site interpretation with me, selecting charcoal samples for dating, and preparing maps, house plans, profile drawings and illustrations of stone tools.

2. A chance find at the Manton site in the Wahgi Valley, of "stone and wooden artefacts" (Golson et al. 1967), led to some excavation at the site in mid-1966. This was not part of a planned attack on open sites, however, and even in November of that year, Golson, the director, still expressed his disbelief in the utility of open-site archeology for any but very limited problems.

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