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Terry L. Hunt, Editor

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Editor's Note

Archaeological research on prehistoric and historic Hawai'i proceeds at a rapid, even accelerating pace. Despite global recession, development throughout the islands continues to generate a substantial amount of archaeological field work, reporting of primary data, and areal syntheses. Other research, independent of contract archaeology, also appears to be increasing. Public organizations involved in archaeological research, such as the University of Hawai'i, the State Historic Preservation Division, and the Bishop Museum (now designated the State Museum of Natural and Cultural History), now employ more professional, Ph.D. and M.A. level archaeologists than ever before. Undergraduate and graduate student enrolment in archaeology at the University of Hawai'i has also grown significantly in recent years. Recent publications reflect not only this growth, but also the prominence of Hawaiian archaeology to a national and international audience (e.g., recent issues of Asian Perspectives and recent symposia at national and international meetings).

The community of archaeologists working in Hawai'i is not only large, but more specialized than ever before. This specialization reflects a trend in the discipline demanding competent analysis of a variety of archaeological materials. With this trend has come specialized technology. We rely on analysts with expertise in areas such as compositional analysis, zooarchaeology, historical archaeology, geoarchaeology, and residue studies to name a few examples. Archaeology has reached a point where many questions can be addressed with a degree of certainty not previously attained.

These factors point to the importance of timely publication of research results. Publication, while critical for the professional community in Hawai'i and beyond, is also valued by the lay community. The people of Hawai'i maintain a strong interest in the Island's historic and prehistoric past. Archaeology in Hawai'i continues to build an understanding of that past.

Our goal with publication of Hawaiian Archaeology is to provide timely, synthetic papers, and reports of technical detail to the professional and lay community. This issue publishes two papers (Rosendahl and Athens) that have been part of a backlog of submissions.

I would like to thank the secretarial staff of the Department of Anthropology, University of Hawai'i for their assistance in retyping manuscripts. Special thanks go to Tom Dye for serving the role of both a managing and production editor. Tom also worked diligently to obtain funding for publication of Hawaiian Archaeology volumes 3 and 4. I also thank Michael Pfeffer for editorial assistance. T.L.H.

Archaeological Monitoring and Historic Preservation

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Archaeological monitoring has become an integral part of cultural resources management in the United States over the last decade. We have no hard figures on the subject, although if our experience with monitoring in Hawai'i is indicative of the situation in many states—and there is reason to believe that this is generally the case—then monitoring is indeed a significant element in the practice of modern American archaeology. In Hawai'i alone each of the four major archaeological contracting or consulting firms in the state typically will do four to eight monitoring projects per year.[1] Although some of these projects may involve only a day or two of field work, others may require up to several months of daily observation at a construction site. Clearly then, a lot of archaeological field time and funds are spent in the pursuit of this activity. What is surprising is that as far as I am aware, there has been no real discussion by archaeologists of what monitoring is, its appropriateness for CRM, and its limitations. Because many believe that there are serious problems in the way monitoring is employed, the following discussion, based on experience in Hawai'i, is offered in an attempt to clarify the nature of monitoring and its limitations for CRM.

The popularity of monitoring may be ascribed to several interrelated factors. One is certainly the increase in awareness of the value of archaeological resources and the public demand that sites be preserved and studied. This has resulted in the passage of federal, state, and local historic preservation laws. In Hawai'i and some other states, another factor quite obviously has to do with the general increase in the rate of development and land alteration activities during the 1970s and 1980s. Finally, and perhaps most importantly, archaeological monitoring is being performed more often simply because this is what professional archaeologists and regulatory authorities frequently recommend as an appropriate procedure for complying with historic preservation laws.

I contend that such recommendations are often inappropriate, failing at once to serve the needs of cultural resource managers, professional archaeologists (the scientific community), and developers. There is often little forethought as to the detrimental implications such a procedure can have for the preservation of archaeological resources. At best archaeological monitoring represents an expedient compromise to both historic preservation and professional archaeological concerns. It therefore stands to reason that recommendation of this procedure should not be made or regarded lightly.

A concern with the quality of archaeological monitoring projects is not new in Hawai'i. In order to establish a baseline for what constitutes adequate performance of monitoring tasks, the Society for Hawaiian Archaeology (SHA) prepared and adopted in 1984 a set of standards entitled "Minimum Requirements for Archaeological Monitoring." This document defines monitoring, discusses the scope of work that should be covered in projects, the procedures that should be involved, and guidelines for the preparation of a report. Though this was a laudable effort, it has had somewhat mixed results since not all archaeologists in Hawai'i regard SHA as a professional governing body.

More recently, the Historic Sites Section (now State Historic Preservation Division) of the Department of Land and Natural Resources (State of Hawai'i) has set forth a series of regulations concerning standards of performance for various kinds of archaeological tasks, including monitoring (Historic Sites Section 1987). Regarding the latter, the regulations specifically indicate that it is not to be used for the purposes of subsurface survey and data recovery. Furthermore, the regulations specify that a "monitoring plan" must be prepared prior to any monitoring project, and that this must be approved by the Historic Sites Section. A number of procedural details concerning the plan, field work, report preparation, qualifications, etc. are also specified.

Despite the admirable efforts of SHA and the Historic Sites Section in establishing standards, the more fundamental issues of the appropriateness of monitoring as an archaeological procedure and situations and contexts where its use may be warranted have been largely ignored (an exception, as noted above, is the brief specification by the Historic Sites Section that it not be used for subsurface survey and data recovery). This appears to be as true for Hawai'i as the nation. A perusal of the historic preservation literature reveals that the subject is not even mentioned (e.g., King et al. 1977; Knudson 1982; McGimsey 1972; McGimsey and Davis 1977; Schiffer and Gumerman 1977). Furthermore, federal standards and guidelines for archaeological monitoring do not exist, and the procedure in fact does not appear to be formally recognized by any federal government agency (e.g., Advisory Council on Historic Preservation 1986; National Park Service 1985).[2]

In the following discussion, after briefly defining monitoring, two examples based on experience in Hawai'i will be presented to 1) illustrate the specific difficulties that are inherent in its use, and 2) suggest ways that these difficulties can be avoided and the contexts where monitoring may be most appropriate. While I believe that this discussion will be generally applicable to the practice of cultural resources management archaeology throughout the United States, there will doubtless be some situations for which the viewpoint expressed herein may seem inappropriate. However, by opening the discussion it is believed that archaeologists and regulatory agencies will be less likely to accept the status quo unthinkingly, and perhaps will be motivated to develop guidelines and standards appropriate to their particular situations if this has not already been done.

What is Archaeological Monitoring?

As it has been practiced in the past and continues to be practiced in Hawai'i, archaeological monitoring consists of having a professional archaeologist on site to observe trenching, digging, grubbing, grading, soil coring, or other construction or land modification activities that have the potential for adversely affecting significant archaeological remains. Typically, there are three situations that call for monitoring. The first is where archaeological sites are not known but for which the potential exists for uncovering or disturbing archaeological remains during construction or land development. In this situation a monitor is used because someone has made the decision that a reconnaissance survey to locate sites before the construction project would be either impractical or too costly. The second situation occurs when there are known sites within the vicinity of the construction area and a monitor is needed to insure that the sites remain undisturbed. Finally, monitoring is frequently undertaken after data recovery projects when there is the possibility that isolated remains—particularly burials in Hawai'i—may be uncovered by construction equipment. This essay shall be primarily concerned with the first situation.

If archaeological remains are found during monitoring, they are usually recorded and/or collected within the context of on-going construction work. More likely than not, a carefully planned research design will not characterize the investigations. In fact, a research design is virtually antithetical to archaeological monitoring because the archaeologist does not have control over the discovery procedures, and frequently he or she will have little time to react when features or deposits are found. Furthermore, those with monitoring experience know how difficult it can be to discern archaeological features in the rough face of a backhoe trench or the uneven grubbed or leveled surface left by a bulldozer.

Obviously, careful attention to detail that should characterize archaeological field work may prove difficult in monitoring situations. Use of such sophisticated discovery procedures as chemical tests for anthropogenic soils and geophysical techniques are clearly out of the question. And despite attempts at coordination between archaeologists and construction crews, heavy equipment operators and construction foremen frequently are not sympathetic to slowdowns caused when archaeological deposits are encountered, further exacerbating the time constraints within which archaeologists must operate.[3]

To a certain extent the SHA minimum requirements and the Historic Sites Section draft regulations have alleviated some of the worst problems with monitoring insofar as field strategy, analyses, and reporting are concerned (at least insofar as archaeologists in Hawai'i are willing to conform to these guidelines and write their contracts with the appropriate stipulations and conditions). However, as noted above, a more fundamental problem may exist with the decision to recommend monitoring in the first place. This problem can be illustrated with the Pacific Beach Hotel Office Annex project in Waikiki, Honolulu (Figs. 1 and 2).

The Pacific Beach Hotel Office Annex Project

This project involved the demolition of an old wooden house and removal of asphalt paving and a gas pump facility on a small lot in the middle of the highly developed Waikiki area of Honolulu. In their place a six story modern office building was to be constructed. Archaeological field work was conducted between April and June of 1985 for a total of 19 days (see Kaschko in prep.). Archaeological investigations commenced after removal of the house.

The need for attention to historic preservation was mandated by inclusion of the project area within the Waikiki Special Design District, which incorporates a number of environmental regulations under the jurisdiction of the Department of Land Utilization (DLU) of the City and County of Honolulu. The decision was made within DLU to utilize an archaeological monitor in order to comply with rules concerning historic preservation. That archaeology was required at all was apparently the result of a letter sent by SHA to DLU expressing concerns that significant archaeological materials might be destroyed by construction activities, and that a subsurface reconnaissance should be undertaken by a qualified archaeologist. This concern was a direct result of significant archaeological materials having been found at the nearby Halekulani Hotel construction site (Davis 1984), and the even closer Queen Lili'uokalani Gardens condominium site.

The reason for DLU's decision to have the developer use a monitor rather than undertake a subsurface reconnaissance on the Office Annex lot was never made clear. However, it is this author's understanding that there was considerable resistance from the developer to doing any archaeological work. Pre-

Figure 1. Island of O'ahu showing project locations at the Pacific Beach Hotel Office Annex in Waikīkī (Honolulu) and Kualoa Regional Park.

sumably, DLU officials believed monitoring represented a simple expedient strategy that would satisfy both the developer (because it is a relatively inexpensive procedure) and the legal mandate of the Waikiki Special Design District. The consequence of this decision was to prove extremely troublesome to all concerned.

During the first day of monitoring, when major earth removal and leveling were initiated, a few traditional Hawaiian archaeological materials began to appear in disturbed contexts (mostly flaked basalt). This aroused suspicions that undisturbed deposits might be present elsewhere on the project parcel. There were also historic materials showing up on the surface (below the asphalt) in another area.

On the second day the backhoe operator was asked to dig several trenches so that the possible presence of archaeological remains in what was thought to be the most promising area for undisturbed deposits could be checked (the top meter or so of the coralline sand sediments was to be removed over most of the lot; as such the backhoe operator and construction foreman did not object to digging a couple of quick trenches for the archaeologists). This backhoe work resulted in the finding of several hearth features and other artifacts indicative of an intact and presumably prehistoric Hawaiian deposit (later, three radiocarbon dates placed the deposits in the 15th century [Kaschko in prep.])

At this point the developer was informed of the need to undertake data recovery before any further destruction of archaeological materials could occur (the monitoring contract specified a stop work procedure, mentioning the potential need for data recovery should significant archaeological materials be found).[4] The construction contractor was also advised of this necessity, and all work at the project site quickly came to a halt. As a result of negotiations among the developer, DLU officials, personnel of the Historic Sites Section, and this author's archaeological consulting firm, a total of five work days were allocated in which to conduct data recovery, whereupon monitoring was to continue as needed.

The developer was clearly irritated by this sequence of events. Not only did he not count on the data recovery aspect of the project (though this possibility was clearly stated in the monitoring agreement), but construction would now be delayed. Since construction was already underway, it is likely that this delay cost substantially more than the planned data recovery.

From the perspective of the archaeologists involved in the project, five days for data recovery was close to the bare minimum. That it sufficed at all was due to the good fortune of having a professional crew willing to work long hours as well as additional unpaid time on two weekends, and also the assistance of several volunteers (this must certainly be a familiar scenario for many archaeologists). The five day period was dictated not so much by purely archaeological concerns as the cost of the construction delay and what might be minimally adequate for the archaeology. Indeed, without causing considerable consternation among city and state officials and jeopardizing the entire data recovery operation, the archaeologists virtually had to accept this arrangement. One can only imagine the difficulties that would have arisen if major new areas of intact deposits or a cemetery had been found.

Figure 2. Archaeological investigations at the Pacific Beach Hotel Office Annex project.

As most CRM archaeologists are only too well aware, there is nothing unusual in any of this. However, the important point here is that even though there were contractual arrangements for the possible employment of a data recovery program (as opposed to just grabbing and recording during monitoring), its actual implementation was partially compromised as a result of being placed in the context of an on-going construction project. The real problem was that archaeological monitoring was utilized as a *primary* discovery procedure, which by definition means that investigations are done within the context of on-going construction. All other problems involving the implementation of a respectable program of archaeological investigation were derivative from this basic flaw in the planning process.

It should be quite apparent from the Pacific Beach Hotel example that monitoring cannot and should not be used as a primary discovery procedure, except possibly under very special circumstances.[5] The scientific value of data recovery was potentially compromised, and the developer may have suffered considerable financial losses as a result of what was thought to be a simple expedient way to comply with historic preservation laws. In effect, it is believed that in this case monitoring was somehow confused with data recovery and site recording by those recommending the procedure. Such confusion, at least in my experience, is quite common among personnel in regulatory agencies as well as professional archaeologists.

The nature of archaeological field work requires a much more intensive and studied effort than can possibly be implemented through monitoring procedures. The situation at the Pacific Beach Hotel Office Annex project was perhaps unusual in that data recovery was undertaken separately from the process of monitoring (but within an overall monitoring arrangement). In a sense, the preliminary trenches dug on behalf of the archaeologists made the project more like a subsurface reconnaissance followed by data recovery. In the more customary form of monitoring, however, the monitor is expected to make archaeological observations and retrieve samples within the context of construction. In such situations one may wonder how many features and deposits are destroyed by heavy equipment under the unknowing eyes of attentive archaeologists? There are no data on this, but experience suggests that the figure must be considerable.

There are other problems with monitoring. For example, rarely if ever will the complete site area be defined—even partially—in a monitoring situation. This is because the monitor is usually required to limit their observations strictly to the area under construction (i.e., foundation trenches, drill holes, etc.), which makes it impossible to determine the limits of the archaeological site area. Since this means that scientific usefulness of the archaeological data will be quite limited (i.e., problems of sample bias, lack of information on site size or growth through time, no information on the full range of activities that were taking place and whether they are all contemporaneous, etc.), the value of the retrieved data is often questionable. It may be legitimately asked: does monitoring fulfill the public mandate or does it merely accommodate non-archaeological interests when it is undertaken?

Also, what happens after a site is monitored and archaeological samples from construction trenches are retrieved and studied? There is frequently no consideration of secondary or indirect impacts once the on-going construction is completed. Yet future activities, such as landscaping and other property modifications may severely affect buried, and as yet unrecognized archaeological resources. Such information is of crucial significance to scientific research in archaeology, and is also within the purview of historic preservation concerns. Yet the monitoring procedure is severely restrictive as regards the amount and quality of this type of information that can be obtained.

The position of many CRM archaeologists to this will be that a good research design will maximize the value of limited data sets, that future impacts are restrained by law unless there is mitigation, and that historic preservation laws were not intended to give archaeologists open ended programs of field research. However, my point is that monitoring *as it is often presently performed* is not an adequate strategy for either CRM or scientific research purposes.

Monitoring at Kualoa Regional Park

The author's archaeological consulting firm undertook monitoring on a sporadic basis at Kualoa Regional Park between March and November of 1986 (Fig. 1). During this time there were forty-four days of monitoring (usually one archaeologist, but sometimes two), and nine days of data recovery (two to four archaeologists). This project is relevant to the present discussion because it illustrates a situation whereby monitoring can function relatively effectively to meet the differing needs of historic preservation concerns, the client (in this case the City and County of Honolulu for its program of park development), and professional archaeologists. However, despite the generally positive nature of this particular monitoring project, there were still several less than desirable aspects to the work. Thus, the point to be made here is that even under virtually ideal conditions, monitoring still has its drawbacks as a procedure for protection and/or preservation of archaeological resources.

Monitoring at Kualoa Regional Park was undertaken as a result of various construction activities, including building a new road and paved parking areas, construction of a large drainage ditch along the road, laying of irrigation pipe, and transplanting large trees for landscaping purposes. A considerable amount of trenching, grubbing, and grading was associated with this work (see Fig. 3), and there were also several small ancillary projects associated with construction. Archaeological monitoring, therefore, was a fairly major endeavor given the scope of the construction.

Prior to construction work and monitoring, Jo Lynn Gunness, an archaeologist with considerable experience at the park, had completed an extensive program of subsurface reconnaissance testing throughout the proposed construction area (Gunness 1986). Her work made it fairly clear that the construction area would be unlikely to contain anything other than very small and isolated archaeological deposits, features, and possibly burials. Indeed, her report indicated that these could be expected in quite low frequencies. Earlier work at the site by Gunness (1993), and others, had already established the high level of significance of archaeological remains at the park. Thus monitoring was recommended to insure that undetected archaeological materials in the proposed construction zone would be adequately recorded if encountered. This, of course, meant having an archaeologist continuously present during all ground disturbing activities.

In the Kualoa case it should be apparent that monitoring was not used as a *primary* discovery procedure. This had been already carried out by Gunness' subsurface reconnaissance. Thus, at the point where monitoring occurred it could be relatively certain that there would be no extensive areas of significant archaeological deposits in the construction zone, and furthermore, that what deposits or features there were would be highly dispersed and small (though not insignificant).

While archaeological monitoring at Kualoa seemed to be clearly warranted based on the above information, there are several factors that may create potential problems any time archaeologists are forced

Figure 3. Monitoring construction at Kualoa Regional Park.

to work in conjunction with contractors and developers. As noted earlier, the archaeologist has no control over discovery procedures, and the contractor or heavy equipment operators may not be sympathetic to archaeological concerns. At Kualoa, however, the primary difficulties with the contractor had more to do with design and schedule changes. Experience at other projects also suggests that these are widespread problems in most monitoring projects. Although careful attention on the part of the archaeologist sometimes can reduce the more deleterious consequences of these problems, they will, in some degree, always be present. This is another reason why the recommendation for monitoring should not be regarded lightly; there is an inherent risk any time an archaeologist has to rely on contractors and other development personnel in order to accomplish their work. Schedules and plans can change rapidly, and often the archaeologist is the last to find out.

In the case of the Kualoa project, these problems were clear well before the monitoring work was initiated. While Gunness' subsurface reconnaissance was in progress, construction plans were drastically altered. Although Gunness was able to compensate for this to a large extent, it created a serious problem for her in knowing exactly where to undertake her reconnaissance, and then to complete her work within the allotted schedule. Thus, there was initially a slight discordance between the area subjected to subsurface reconnaissance and the area to be affected through construction. This is a situation that does not promote the best possible archaeological work. As it turned out, however, Gunness' reconnaissance proved to be adequate for the monitoring work, and there were no major surprises. Such a favorable outcome, however, cannot always be expected if the reconnaissance has been inadequate due to circumstances beyond the control of the archaeologist.

Unpredictable scheduling changes were also a problem with the tree transplanting aspect of the Kualoa monitoring work. Despite the best intentions of the subcontractor, he did not always know in advance whether or not on any particular day he would be digging holes and need an archaeologist, or whether he would be using two backhoes and thus require two archaeologists. The archaeologist was therefore left guessing about exactly when to go out to Kualoa, or if a second archaeologist should go as well. There is no easy solution to the problem of scheduling and design changes. The best that can be done is to make certain that 1) the contractors, engineers, architects, and others understand their obligations to see that the archaeology is taken care of; 2) this concern is conveyed to the projects foreman and his workers; and 3) there is good communication between the archaeologist, the project director or manager, the construction foreman, and the workers; and any other personnel involved in the project.

At Kualoa the park manager took the archaeology requirement very seriously, conveying his concern directly and in no uncertain terms to the contractor, subcontractors, and foreman. Several preconstruction meetings were also held at the initiation of different project segments with the differing subcontractors, thereby facilitating communication of this concern and giving the archaeologist and other project personnel a chance to become acquainted with one another. The heavy equipment operators were also carefully instructed as to their responsibilities with respect to archaeology and the archaeolo-

Figure 4. Black firepit features in coralline sand matrix during data recovery excavations at Kualoa Regional Park (Tree Trench 26, Grids 1 and 2).

gists. As a result, the entire monitoring operation went relatively smoothly considering the length of time involved, the sporadic nature of the work, and changes in construction personnel.

But such is frequently far from the usual sequence of events. How many times do archaeologists show up at a project site to do monitoring and find that construction work has been on-going for some time? How many times do archaeologists arrive at a construction site and find out that work has been scheduled for another day? How many times do archaeologists arrive at a construction site expecting to do one thing, and end up doing another because construction plans have changed? It is simply impossible and unrealistic to expect perfect communication between the archaeologist and contractor or developer prior to, or during a project. To do monitoring, therefore, is to accept a certain level of risk in getting the job done properly. This risk, it may be argued, is acceptable only if alternatives to monitoring are either not feasible or are impractical.

One of the better aspects of the monitoring work at Kualoa was the conceptual distinction that was made between monitoring as a secondary discovery procedure with that of data recovery (the same was also true for the Pacific Beach project). What this means is that the monitor was only responsible for identifying the presence of archaeological materials and making a preliminary evaluation of their significance and excavation potential (besides various other observations such as location and manner of ground disturbing activities, the nature of the soils and sediments and their stratigraphic relationships, etc.). Most significantly, the monitor also had the authority to halt construction work in the area where archaeological materials were discovered. Following a discovery and consultation with park officials, an archaeological excavation crew was called in (usually on the following day) to handle the data recovery (Fig. 4). In the meantime, construction work and monitoring could continue uninterrupted at other locations in the park. Also, at Kualoa data recovery was not conducted as a rush procedure in the face of advancing bulldozers, but in a considered and responsible manner as should normally characterize any archaeological excavation. Had the monitor been required to undertake data recovery, both the data recovery and the ongoing monitoring activities would have been seriously compromised. Unfortunately, the monitor more often than not is expected to do both in Hawai‘i.

Conclusion

While most of the above problems are probably obvious to those archaeologists regularly involved in contract archaeology projects in Hawai‘i and elsewhere, it is clear that very little consideration has been given to how to improve the situation. One giant step forward in Hawai‘i was certainly the implementation of minimum standards by SHA and draft regulations of the Historic Sites Section. However, as noted, very little attention was given to the question of the appropriateness of monitoring as a legitimate archaeological procedure.

As the two examples from Hawai‘i indicate, there are serious flaws in the concept of archaeological monitoring and the way it is often practiced. This is true even when the procedure is used with the best of intentions in the most appropriate kinds of situations. Given this situation, professional archaeologists and public officials should be extremely cautious in any recommendation they may make for monitoring.

To a large extent, monitoring has often been utilized in Hawai'i as a simple expedient to satisfy historic preservation compliance statutes with the lowest possible cost, which is largely a result of pressure by various developers and governmental agencies who wish to keep their construction or development budgets as low as possible. As was noted, however, such a strategy may backfire with serious financial consequences for the developer as happened with the Pacific Beach project. Furthermore, professional archaeologists must be concerned with the fact that archaeological monitoring often results in a serious compromise to the quality, accuracy, and usefulness of the data recovered. Indeed, monitoring results in investigations directed or dictated by a non-archaeological contractor or developer whose schedule and plans are often very uncertain and subject to considerable change.

This is not to imply that archaeological monitoring should never be utilized. There are clearly situations, such as at Kualoa, where it can be employed as a practical and cost effective secondary discovery procedure capable of producing useful results. However, it should only be employed as such after a reconnaissance (either surface or subsurface as the particular case may warrant) has been conducted. Furthermore, it is critical that data recovery be viewed and practiced as a conceptually distinct procedure from monitoring. Finally, in those cases where there seems to be no alternative to archaeological monitoring, it is essential that considerable effort be made to establish good communications between all parties involved. If historic preservation is the goal of our cultural resources management efforts, then we should probably see less monitoring and more preliminary survey and test excavations in the future.

Notes

1. This estimate is based on monitoring performed in 1986 and 1987.

2. Thomas King (personal communication, Jan. 2, 1986) has brought to our attention a statement in the Advisory Council's "handbook" (1980:27) that recommends the use of archaeological methods "to avoid late or accidental discoveries that could cause costly construction delays" (Part III, Section VIII.E). As he notes in his letter, "since monitoring almost guarantees that discoveries, if they occur, will be late, it obviously is to be avoided where alternatives to its use exist." Unfortunately, I believe that as monitoring is presently practiced in Hawai'i, there are often alternatives (such as prior subsurface reconnaissance) that are not considered or pursued as vigorously as they should be.

3. Some construction personnel may even be quite belligerent and intentionally destructive of archaeological materials. This was my experience at a recent monitoring project in downtown Honolulu whereby a backhoe operator, out of spite for the archaeologist, purposefully dashed an early historic bottle against a concrete pile (see Athens 1986). Construction personnel are often avid bottle collectors, and they will sometime go out of their way to thwart the efforts of archaeologists.

4. It should be obvious that by "data recovery" I mean a formal excavation and site recording project. This is in distinction to the kind of data recovery an archaeological monitor may perform. The act of quickly jumping into a backhoe trench and scooping out a charcoal sample and midden remains from the exposed face during on-going construction work is not a valid form of data recovery.

5. I recognize that there are some situations where the nature of the project and its setting may make a preliminary reconnaissance or subsurface testing impossible or extremely impractical prior to the initiation of construction and monitoring. Deep water dredging may be an example.

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Aboriginal Hawaiian Structural Remains and Settlement Patterns in the Upland Agricultural Zone at Lapakahi, Island of Hawai'i

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Over the last two decades archaeologists in Hawai'i have begun intensive investigations into the nature and patterns of aboriginal Hawaiian settlement and agricultural adaptations to the varied environmental settings of the Hawaiian Islands. Prior to 1968, Hawaiian archaeology was essentially descriptive in approach, with an overwhelming emphasis upon extensive site survey and the study of such specialized topics as *heiau* (aboriginal ceremonial sites) and petroglyphs (Newman 1968). The very few attempts at synthesis or interpretation dealt almost entirely with aspects of aboriginal marine resource exploitation. Perhaps the only archaeological attempt during this period to investigate aspects of an Hawaiian agricultural adaptation was Pearson's study of irrigated taro cultivation in Hanapēpē Valley, Kaua'i (Pearson 1962, n.d.).

Intensive archaeological research at Lapakahi on the northwest leeward side of Hawai'i Island began in 1968 as part of the Lapakahi Project, an archaeological research program of the Department of Anthropology, University of Hawai'i.[1] One of three inter-related projects of settlement pattern-oriented archaeology initiated and carried out concurrently, the Lapakahi Project sought to provide—along with similarly conceived projects undertaken at Hālawa Valley on the east end of Moloka'i (Kirch and Kelly 1975) and at Mākaha Valley on the leeward side of O'ahu (Green 1980)—data on the nature and range of settlement patterns found in different environmental settings sufficient to permit investigation into the functional interrelationships of domestic residence patterns and agricultural systems. Lapakahi is significant because it exhibits probably the best preserved archaeological remains of both aboriginal dryland agriculture and marine resource exploitation to be found both surviving and readily accessible anywhere in the Hawaiian Islands. Three successive summer field seasons (1968–1970) of research were carried out at Lapakahi. The overall research focus was the aboriginal Hawaiian cultural adaptation to the marine and terrestrial components of their island ecosystem (Newman 1969), and within this general focus, specific programs of survey and excavations were conducted in both the coastal and upland zones at Lapakahi.

The initial 1968 field season work concentrated on the topic of marine resource exploitation, and consisted primarily of excavations conducted at the coastal site complex referred to as Koai‘e Hamlet. Only two weeks were spent excavating a single residential site—which proved to be historic—in the upland agricultural zone. The results of the 1968 investigations have been presented in T.S. Newman's dissertation (Newman 1970) on "Hawaiian Fishing and Farming on the Island of Hawai‘i in A.D. 1778," and in an edited volume of student research papers (Pearson 1968).

The subsequent 1969 and 1970 field seasons expanded to concentrate on both coastal and upland investigations (Griffin et al. 1971; Rosendahl 1971, 1972; Tuggle and Griffin 1973). The work conducted in upland Lapakahi during these two field seasons was carried out principally as part of my own dissertation research (Rosendahl 1972). The general problem of this upland research concerned the inter-relationships between the aboriginal dryland agricultural system and the domestic residence patterns at Lapakahi, and how these inter-relationships developed and changed over time. Solution of this general research problem entailed the achievement of several specific objectives, a major one of which was the detailed description of the general settlement patterns at Lapakahi—particularly the domestic residence patterns associated with the agricultural system. The basic purpose of the present paper is to provide an explication of the aboriginal Hawaiian surface structural remains and settlement patterns in the upland agricultural zone at Lapakahi. As an introduction to the account, it is useful to present both a statement of the general framework within which the research was undertaken, and a brief general summary of the upland Lapakahi research setting, strategy, and findings. Following upon this background, the surface structural remains found in the upland agricultural zone at Lapakahi are described in some detail, and a qualitative summary of the settlement patterns overall presented. Then these settlement pattern generalizations are examined through a quantitative analysis of structural remains within a sample transect of the upland agricultural zone. The concluding discussion will summarize a reconstruction of the prehistoric agricultural system at Lapakahi, and indicate the significance of Lapakahi in terms of the development of aboriginal agricultural systems in Hawai‘i.

Archaeological Research in Upland Lapakahi

Research Framework: Settlement Pattern Archaeology

The basic approach to the general research problem can be defined as settlement pattern archaeology. The fundamental goal of settlement pattern archaeology, which differs little from any other modern archaeological approach, can be defined as "…the identification of probable behavioral patterns of [economic,] social and political activity from the archaeological remains recovered and, in certain instances, the deduction of possible ideological patterns with which they are thought to correlate" (Green 1970a:13). The difference that characterizes the settlement pattern approach is the specific point of view the archaeologist assumes in regard to archaeological evidence. This point of view can be seen in the following early archaeological definition of the general term settlement patterns:

> …the way in which man disposed himself over the landscape on which he lived. It refers to dwellings, to their arrangement, and to the nature and disposition of other buildings pertaining to community use. These settlements reflect the natural environment, the level of technology…, and various institutions of social interaction and control which the culture maintained. Because settlement patterns are, to a large extent, directly shaped by widely held cultural needs, they offer a strategic starting point for the functional interpretation of archaeological cultures (Willey 1953:1).

Settlement patterns then, reflect human spatial distribution, in relation to physical environment. Such spatial distribution has usually been considered on three simultaneous levels of structural organization:

the individual structure or habitation, the structures forming the local community, and the local communities distributed over any geographic area.

In a concrete sense then, settlement patterns refer to the spatial distribution of the structural remains of human occupation, and include structures and features related to all aspects of society—technological, sociological, and ideological. Thus archaeological sites are regarded as the physical manifestations of local social groups, and the ethnographic human community is replaced operationally by the archaeological settlement (Chang 1958:324, 1968: 2–3).

In a more abstract sense, settlement patterns refer to the demographic structure—the population density, organization, and overall distribution—of any organized society. Settlement patterns can thus be regarded as population distribution, in relation to the total environment, at three simultaneous levels of social organization: the family or household, the local community, and the aggregate of related local communities.

Consideration of settlement patterns in the two senses mentioned above points up an important operational problem encountered in the study of actual archaeological remains. This problem, the different nature of observation units and analytic units, will be returned to below.

Settlement patterns are plainly the response to an extremely varied assortment of different determining factors, and therefore cannot usually be understood by reference solely to the physical environment or the social environment. The range of settlement pattern determinants includes the following: subsistence technology, natural environments, general technology, production relationships, class or ethnic differences, trade, warfare, political and religious systems, secular values, demographic factors, and cultural tradition. The range of determinants is quite wide, and different societies might respond differently to the same determinant, given sufficient flexibility and earlier solutions to similar situations. With this wide range of determinants, conflict between various factors is almost certain; but it is not clear whether resulting settlement patterns are more likely to represent the resolution of conflicting factors into a ranked order, or the establishment of a compromise between factors (Trigger 1968:55–70).

Settlement Pattern Archaeology in Polynesia

The development of the settlement pattern approach in Polynesia has been influenced greatly by work done since the early 1950's in American archaeology; but at the same time, it has developed its own particular strengths in response to specific operational problems encountered in Polynesia. One basic problem relates to the late dates of Western contact and the wealth of ethnohistoric data available. This situation presents both a problem and an advantage: the existence of substantial ethnohistoric materials provides a great amount of detailed information; but at the same time presents a problem in that it is most often quite difficult to separate truly aboriginal aspects of culture from subsequent changes that occurred during the poorly documented, protohistoric period that followed immediately after initial contact.

The second and perhaps more important problem encountered in Polynesia is the paucity of portable artifacts. Furthermore, the nature of the artifactual record itself is often biased and therefore misleading. For example, the typical range of portable artifacts tends to suggest a preoccupation with marine exploitation. This misconception results from the relative abundance and complexity of fishing gear, in contrast to the almost total lack of portable agricultural implements preserved archaeologically. The pessimistic point of view engendered by this absence of "a wide range of diagnostic artifact types" upon which "archaeologists elsewhere in the world traditionally have based their reconstructions" was stated by one archaeologist who, in discussing the nature of archaeological evidence available in New Zealand, opined that "…the chance for regional sequences and deduced settlement patterns [was] regrettably highly limited" (Terrell 1965:127).

> Thus, without a precise way of demonstrating culture complexes…, one is left with only the potential of general temporal phases with perhaps some geographic variation, and not, as one would ultimately desire, with the chance for finer spatial units defined in social and cultural terms (Terrell 1965:128).

Exhibiting a narrow view persistent in archaeology until very recently, this opinion received an immediate response arguing that such a position, bemoaning the lack of "diagnostic" artifacts traditionally used by archaeologists, ignored or greatly underrated the value of abundant architectural and structural remains that were present. The limitations on archaeological reconstruction were "…not the lack of 'diagnostic' artifacts but the lack of analysis" of the substantial structural remains which were available as evidence (Ambrose 1966:72–3).

Though earlier workers in Polynesia had studied various aspects of the wide range of structural remains or field monuments, J. Golson (1957:65) seems to have first stated explicitly the position that structural remains were just as much artifacts as were tools and weapons; that they were subjects for similar analytical manipulations; and that their functions, which were discernible through the study of their spatial distributions, local environmental factors, and through archaeological excavation, reflected the activities and organization of the social groups which were responsible for them.

This concept of structural remains as artifacts was subsequently developed much more fully by Green in his 1960–1962 investigation on Mo'orea, Society Islands (Green 1961; Green et al. 1967). His research program in the 'Opunohu Valley consisted of a detailed site survey of structural remains, followed by excavation of relatively few, carefully selected sites. The use of ethnohistoric and traditional materials, in conjunction with intensive survey and controlled excavations, enabled a relatively full reconstruction of native society in the valley during its early post-contact period.

Green's work emphasized two important points relating to the study of settlement patterns. First, structural remains represented categories of "non-portable" artifacts that were just as amenable to the processes of description, classification, and interpretation as were the more traditional categories of "portable" artifacts (Green 1967:102). This awareness was particularly important given the general paucity of portable artifacts, which stood in striking contrast to the abundance of surface structural remains found throughout Polynesia. Secondly, his work showed that quantitative relationships between structures and groups of structures, and the distributional patterns of such structures and groups within a geographical area, were factors of major importance in the interpretation of socio-political behavior (Green 1967:112).

Green's Mo'orea study also reinforced the validity of several points established in settlement pattern oriented research carried out earlier in New Zealand. Two basic lines of investigation had emerged (Green 1967:107). The first was the attempt to delineate settlement pattern changes throughout the entire prehistoric sequence, primarily on the basis of archaeological and environmental data. Green's reconstruction of the prehistoric sequence for the Auckland Province on the basis of settlement and ecological data is a good example of this first approach (Green 1963). Subsequent reviews and criticisms (Golson 1965, Groube 1967) have pointed out the weaknesses of this treatment, and Green himself subsequently cited his study as an example of the dangers in trying to use models from external areas, where quite possibly specific parallel social and environmental conditions did not apply (Green 1967:109). (Also see final chapter of 1971 reprint of Green 1963.) Nonetheless, Green's synthesis proved a valuable stimulus to further thought.

The second and more profitable approach was the use of ethnohistoric materials to reconstruct a firm contact period baseline from which to infer back into the prehistoric period. The practical value of this second approach was demonstrated by Groube (1964, 1965) in his attempt to establish, through intensive study of ethnohistoric documents and results available from limited excavations of known contact period sites, a contact period baseline for Classic Maori settlement patterns. Groube's study made important points (summarized in Green 1967:111) regarding both the use of ethnohistoric materials and the use of structural remains as non-portable artifactual evidence. The importance of identifying domestic units and all associated structures, and defining the relationships of these to the more impressive structural remains of primarily communal units is stressed. The most important points regarding the use of ethnohistoric materials were the value of constructing a firm baseline for making prehistoric projections; and the necessity of acknowledging, and controlling for, the distinct possibility of a period of rapid indigenous culture change during the poorly recorded protohistoric period.

Davidson (1969) subsequently discussed at some length in relation to Samoa, the problems and dangers of uncritically using ethnohistoric data to project back assumptions about the nature of settlement distribution, population size, and other related matters during the prehistoric period. In his later paper Green (1970a) pointed out the wealth of relevant ethnographic data relating to Polynesian settlement patterns; material that had been little used to date. Perhaps one of the most interesting discoveries made in his review of the available ethnographic sources was the high degree of consistency for Western Polynesian settlement patterns, especially when compared to the domestic and communal level patterns found in Eastern Polynesia. Finally, Bellwood's study of the Hanatekua Valley on Hiva Oa, Marquesas Islands must be noted (1972). This study illustrates what can be attempted on the basis of detailed surface survey alone, when integrated with available ethnohistoric and archaeological materials; and demonstrates the kinds of hypotheses for guiding future research that can be generated on the basis of such studies of surface structural remains.

Definition of Basic Terms

As well as a statement of approach, the explicit definition of basic terms used is desirable. The following discussion summarizes these few terms, and presents a series of operational definitions.

Domestic residence patterns refer specifically to the spatial distribution of the visible remains of human habitation, including all the various kinds of structures used by household groups for such activities as eating, sleeping, working, recreation, and general living. Such household units are co-residential groups, and not necessarily family units. This cautionary distinction is important because the organizational principle of the family is kinship, while that of the household is common residence (Bender 1967:493).

As mentioned earlier, settlement patterns have usually been considered at three different levels: the individual structure, the aggregate or group of structures, and the distribution of groups within a geographic area. This point of view suggests an operational problem; what are the units of study? Attempts to use these three levels encounter various manipulation difficulties which can be avoided by considering the structural components of domestic residence patterns in light of two basic phases of research through which description and explanation are achieved: observation and analysis.

Comparability of study units is the fundamental problem. Difficulties encountered in attempting to manipulate settlement data in terms of the three suggested levels of investigation have shown that units of observation do not necessarily correlate with units of analysis—a structure, when classified as an observation unit, might well represent a different level of investigation when classified as an analytical unit. Table 1 diagrams the relationships involved, illustrating both the problem and a solution. Realization of the step involved in moving from observation to analysis seems to be a transfer generally ignored in most theoretical and methodological discussions of settlement pattern archaeology to date; this is true even though the step may be acknowledged implicitly by the assumption that archaeological sites are the physical manifestations of local social groups.

Agricultural system is used in a number of different senses. In the more general archaeological sense, it refers to the structural remains of agricultural activity in any specific area. Such remains include clearings, stone mounds, prepared soils, walled areas, water control features, defined field units, dry planting terraces, and irrigated pond-fields and terraces. An example of the term used in this sense is Yen et al. (1972). Used in the agronomic sense of the geographer, agricultural system denotes concern with essentially agronomic considerations of cultivation techniques and management, in conjunction with crop types and combinations. An example of the term used in this sense is found in Brookfield (1968). Finally, in a more specific cultural-ecological sense, the term refers to a subsystem within an integrated whole composed of various reticulated

Table 1 Settlement Pattern Data—Units of Observation and Analysis

Observation		Analysis	
Observation and recording of structural remains	Descriptive Classification	Interpretative Classification	Analysis of spatial distribution
Observation Units	Levels of settlement investigation	Analytical Units	
1) Individual structure	1st	1) Domestic unit:	a) single structure b) multiple structure c) special purpose
2) Group of structures (cluster)	2nd	2) Communal unit:	a) nucleated b) dispersed c) special purpose
3) Groups with a geographic area or region	3rd	3) Societal unit:	a) totality of communal units and their areal distribution b) special purpose

Domestic Unit: the basic, minimal unit of analysis; the household.
Communal Unit: the aggregate of domestic units; the community.
Societal Unit: the aggregate of communal units; the whole society.
Observation and analytical units do not necessarily correlate;
they often might represent differing levels of settlement investigation.

subsystems. Agriculture as a subsystem would be concerned with certain aspects of socio-politico-economic organization; with cultigens, practices, and techniques; and with various factors of the physical environment, such as soil, relief, climate, and natural resources. Examples of the term used to one degree or another in this sense are Spencer (1966), Brookfield and Brown (1963), and Conklin (1957). A further aspect of the term in this sense is an explicit concern with ecosystemic analyses in which agricultural systems are regarded as human-modified natural ecosystems that can be analyzed within the framework of specific properties shared by all systems in general: structure, function, equilibrium, and change. Examples of this term used in this systemic sense are found in Harris (1969), Rappaport (1968), and Geertz (1963).

Operational Definitions

Domestic Residence Patterns: the spatial distribution of the structural remains of human habitation, including the full range of temporary and/or permanent structures used by households or individual members of such co-residential units, for such activities as food preparation, eating, sleeping, working, recreation, and general living.

Domestic Unit: the basic, minimal unit of spatial organization and analysis; and the physical manifestation of the basic social unit, the household group.

Communal Unit: the aggregate of domestic units; and the physical manifestation of the local social group, the community.

Societal Unit: the inter- or supra-communal unit, the aggregate of communal units, distributed over a geographic area or region; and the physical manifestation of the society at large.

Agricultural System: in the general archaeological sense, the structural remains of agricultural activity in any specific local area; in the agronomic sense, the techniques and management practices associated with any crop or crop combination; and in the cultural-ecological sense, a subsystem within a reticulate whole, concerned with certain socio-politico-economic aspects of a social group, with agronomic factors, and with the natural environment. The sense in which the term agricultural system is being used at any one point in discussion is made obvious by the context in which it is used.

Settlement Patterns: the results of human interaction within the physical and cultural environment, as evidenced by the surviving archaeological remains. Settlement patterns are established by the combination of domestic residence patterns with the full range of physical environmental factors, and with patterns of human marine and terrestrial exploitation and social interaction.

Research Setting

Lapakahi is located in the North Kohala District, on the dry, northwestern leeward side of Hawai'i Island (Fig. 1). Though historically incorporated into extensive cattle-ranching operations, Lapakahi generally has been regarded as a traditional *ahupua'a*, a fundamental geographic unit of aboriginal Hawaiian social, political, and economic organization. The name refers to a narrow, wedge-shaped strip of land—ca. 7 km in length and 1.3 km in average width—that comprises a representative sampling of the local island environment from the coastal waters up almost to the ridges of Kohala Mountain (Fig. 2). The area of aboriginal Hawaiian occupation can be divided into three major zones: (1) the narrow coastal habitation zone associated with the exploitation of marine resources; (2) an open, sloping intermediate zone, with shallow soil and grassy vegetation, and little evidence of human occupation other than the foot trails which linked the coast with the uplands; and (3) extensive, gently-sloping upland zone with substantial surface stone remains of habitation structures and rectangular agricultural field units.

The upland agricultural zone at Lapakahi comprises only a small part of the system of permanent fields which extends approximately 20 km along the western flanks of Kohala Mountain, from near Upolu Point almost to Kawaihae-uka, and which averages ca. 3 km in width (Newman 1972, Smith and Schilt 1973). At Lapakahi, the upland agricultural zone begins about 3 km inland from the coast, at an elevation of ca. 240 m, and extends more than 3 km toward the ridges of Kohala Mountain, to an elevation of ca. 460 m. The agricultural zone at Lapakahi is typical of the gently sloping *kula* lands utilized by the Hawaiians for dryland cultivation. It is characterized by its leeward exposure; its mild temperatures; its fertile though shallow, red volcanic soils; and its low annual rainfall, restricted largely to the winter months.

Research conducted to date at Lapakahi suggests a general outline of a local sequence for the approximately 700 year span of occupation. The sequence outlined here is based principally upon upland research conducted in 1969 and 1970 (Rosendahl 1971, 1972), and differs somewhat from those based largely upon coastal excavations (Griffin et al. 1971:108–109; Griffin and Riley 1971; Tuggle and Griffin 1973:57, 61–65).

1) Approximately AD 1300—earliest known Lapakahi occupation, characterized by small population, possibly concentrated at the coastal Koai'e Hamlet site; initial focus on exploitation of marine resources, but with accompanying introductory agricultural activity;

2) AD 1300–1500—increasing local population and increasing agricultural exploitation; beginnings of upland field system formation, as result of land clearing under slash and burn cultivation; residential pattern of recurrent, seasonally shifting, occupation of widely dispersed habitation sites, on the coast and in the uplands;

3) AD 1500–1800—continued agricultural expansion, with extensive system of bound field

Figure 1. Maps showing location of the Lapakahi area on the northwest side of the Island of Hawai'i.

units eventually occupying entire Lapakahi area; evolution of formally defined land units associated with local social groups; imposition of outside political pressures, and establishment of *ahupuaʻa* territorial pattern; gradual change in residential patterns, from seasonally shifting, to permanent dispersed occupation of both the coastal and upland area;

4) AD 1800–1850—peak of agricultural development and population growth; dominant pattern of dispersed permanent residential occupation at both the coast and in the uplands; increasing European contact;

5) AD 1850–1900—rapid population decline and collapse of aboriginal agricultural system; general abandonment of Lapakahi area; few remaining *kuleana* (small parcels of native-occupied land) in the uplands; awarding of fee simple grants of government land to both natives and Europeans;

6) AD 1900 to present—virtually complete abandonment of Lapakahi area and incorporation of the area into extensive cattle-ranching operations.

Research Strategy and Findings

The 1969–1970 upland research program at Lapakahi began with the detailed plane-table mapping of all structural remains within a defined portion of the agricultural zone. This mapped area (designated the Detailed Study Area), a section 2.3 km long and averaging about 300 m in width, was delimited by a series of curbstone-lined foot trails (Fig. 2). On the basis of ethnohistoric documents and historic land grant records, the mapped area appeared to represent a native land unit, possibly an *ʻili*, a subdivision of the *ahupuaʻa* (Rosendahl 1972:111–119, 474–479). The detailed mapping was done in conjunction with more extensive surface survey of the upland area. Upland excavations focused on various residential sites, principally scattered, stone-walled C and L-shaped shelters of various sizes, but also included occasional raised stone and earthen platforms, and a few high-walled square or rectangular structures. Survey and mapping revealed that structures often clustered to form complexes of associated residential and agricultural features, burial mounds and platforms, curbstone-lined foot trails, modified natural water catchments, and three possible *heiau* or aboriginal ceremonial sites.

Three major kinds of agricultural units were defined: (1) rectangular field units, bound by low piled stone and earthen embankments; (2) garden areas, either open or enclosed by high stone walls; and (3) stone-walled animal pens. These major agricultural units were further differentiated on the bases of local topographic conditions, and associated minor agricultural features such as piled stone mounds, small clearings, low stone alignments, stone windbreaks, planting circles, informal terraces, and simple water diversion features.

Quantitative analysis of all surface structural remains within the Detailed Study Area sustained most qualitative generalizations made beforehand about the distribution and composition of surface structural remains in the upland agricultural zone. A nearest-neighbor analysis—a simple test for nonrandom distribution—was applied to a class of C-shaped structures thought to represent extended occupation residential features. Results indicated that the structures tended to be distributed in a nonrandom fashion, in scattered clusters of from two to five structures. These clusters were interpreted in social terms as representing the residential habitation sites of various local domestic household groups. Eight residential sites—seven prehistoric and one early historic Site (7403)[2]—were excavated (Fig. 2). The roster of excavated upland sites consisted of five C-shaped structures (Sites 4725, 4727, 4729, 7404, 7405), one L-shaped earthen windbreak wall (Site 7402), and two multiple feature complexes (Sites 7400, 7403). General stratigraphy was found to be strikingly similar in all cases: a cultural deposit ranging in thickness from 10 to 80 cm, but lacking any definable internal stratigraphy; a shallow, poorly developed overlying topsoil; and a clay-like underlying substrata of volcanic origin. By far the most common non-portable features uncovered were the round to rectangular and square firepits with peripheries of set stones. One prehistoric C-shaped structure (Site 4727, 5 m x 7 m

Figure 2. Major archaeological features of the Lapakahi area.

maximum external dimensions) contained 19 firepits in differing stratigraphic positions. A somewhat larger but similar structure (Site 4729) contained 36 firepits, including an underground oven (*imu*) 1.5 m in diameter and excavated approximately 1 m deep into the sterile substrate.

Site 4727 exemplifies the various characteristics shared by numerous, more substantial C-shaped residential structures (Figs. 3, 4, and 5). The pre-excavation plan and profiles (Fig. 3) and the revealed cross-sections (Fig. 4) illustrate the typical structural configuration and general nature of the associated deposits. A series of post-excavation site plans (Fig. 5) presents a generalized relative sequence of firepits, other non-portable features and structural modifications. The three phases were defined on the basis of relative subsurface depth of component features, and are therefore somewhat arbitrary and do not necessarily represent separate periods of occupation. Such a relative sequence does, however, suggest a complex and recurring series of occupation, modification, abandonment, and reoccupation.

The portable artifacts recovered from upland sites were typically Hawaiian, but the number (218 items in all) and range of artifacts was quite unexpected when compared to the almost total lack of artifactual material recovered from residential sites previously excavated by other researchers in the agricultural zones of Hālawa Valley on Molokaʻi (Kirch and Kelly 1975) and Mākaha (Green 1969, 1970b; Ladd 1973; Ladd and Yen 1972) and Kahana (Hommon and Bevacqua 1973) valleys on Oʻahu. Artifacts recovered in upland Lapakahi comprised the following: a wide range of tools, among which were stone adzes, abraders of lava, coral (*Porites* spp.), hammer stones, a basalt drill point, a sharpening stone, and utilized flakes of basalt stone and volcanic glass; fishing gear, including the shank of a one-piece bone hook, bone hook manufacturing tabs, a cowry (*Cypraea mauritiana* L.) shell octopus lure, and a coral octopus sinker; domestic equipment such as bone picks and awls, limpet (*Cellana* spp.) shell vegetable scrapers, a stone lamp, and a knobbed stone food pounder; shell ornaments; and a limited range of historic material, principally glass and ceramic ware.

The ecofact material contained a wide range of faunal and floral remains. Mammalian species identified were Polynesian rat (*Rattus exulans Hawaiiensis* [Stone]), dog (*Canis familiaris* L.), pig (*Sus scrofa* L.), and Hawaiian monk seal (*Monachus schauinslandi* Matschie)—all pre-contact species. As well, there were remains of some historically introduced species of mammals. Bird remains identified consisted of a form of duck; various medium-sized birds, including chicken (*Gallus* L.), Hawaiian coot (*Fulica americana alai* Peale), short-eared owl (*Asio flammeus sandwichensis* [Bloxam]), and a shearwater (*Puffinus* spp.); and a number of small shoreline or water birds, but no small forest birds.

Marine forms identified indicated transport inland of small and medium-sized fish of several species, echnoderms, and at least 32 different species of marine mollusk. Among the latter were many molluscan species that had not been identified previously in the coastal Lapakahi excavations, as well as a single species of fresh-water mollusk (*Limnaea* sp.).

A great deal of carbonized plant material was recovered. Much of it was fragmentary and unidentifiable; however, it was possible to identify several species. These were of particular value because they provided direct evidence of aboriginal agriculture. Species identified included a fresh or brackish water sedge (*Cyperus laevigatus* L.), coconut (*Cocos nucifera* L.), bitter yam (*Dioscorea bulbifera* L.), candlenut (*Aleurites moluccana* [L.]) Willd.), at least two species of cucurbits (*Sicyos* sp. and *Momordica charantia* L.), and sweet potato (*Ipomoea batatas* [L]. Lam) (Rosendahl and Yen 1971). In the last category were thirteen specimens of sweet potato from four of the eight excavated sites; all but one of which has been securely dated to the prehistoric period.

Age estimates are available for 54 radiocarbon and volcanic glass samples from the eight upland residential sites. For upland occupation at Lapakahi, the ten radiocarbon estimates yielded a time range of AD 1400–1750, while the volcanic glass hydration dates yielded a range of AD 1430–1760. The continued occupation of the upland zone well into the historic period is evidenced by excavated items of historic introduction, and by data in the ethnohistoric and historic record.

Figure 3. Pre-excavation plan map and profiles of upland Lapakahi Site 4727, a large C-shaped residential structure.

Surface Structural Remains

The density and variety of structural remains visible in the uplands of Lapakahi evidence the extensive prehistoric occupation and agricultural exploitation of the area. The upland agricultural zone is now separated into two sections, with the division being made at a fence line located along the 1250’–1300’ (381-396 m) elevation contour interval. Above this fence line, the remains of aboriginal occupation have been greatly altered by cattle ranching activities. The land was cleared around 1945 to make improved pasture lands for grazing stock. The lower section has been left relatively intact and, except where otherwise stated, reference made in the following discussion to any portion of the agricultural zone applies only to the section of undisturbed remains below the fence line.

The major structural features present in the upland zone at Lapakahi have been grouped into seven functional categories. These categories and the

Figure 4. Post-excavation cross-sections of upland Lapakahi site 4727, a large C-shaped residential structure.

principal forms of variation are outlined in Table 2. General function has been ascribed on the basis of ethnohistoric and ethnographic data, and previous archaeological research. Within the gross functional categories, basic kinds have been defined on the basis of formal variation, primarily architectural differences. Most structural features found in the upland zone were simple modifications of these few forms.

Residential Features

Four kinds of residential structures were observed: C-shaped structures, L-shaped structures, earthen and raised stone platforms, and square or rectangular stone-walled structures. Groups of residential features often formed residential complexes, sometimes enclosed by stone walls. Residential complexes were almost always associated with agricultural features, and occasionally with other special function features such as water catchments or burials. The term of occupation logically ranged from temporary (hours or days), to more extended (weeks or months) and permanent (years). An estimate of occupation term could be inferred from such attributes as location, situation, orientation, overall size, structural complexity, construction methods, associated features, surface midden and artifacts, and apparent extent and volume of subsurface cultural deposits.

C-Shaped Structures. This was the most common form of residential structure. The basic characteristic was a single, continuous stone wall in curved or semicircular form. The walls, which functioned as excellent windbreaks, were always concave to leeward, oriented perpendicular to the prevailing northeast tradewinds. C-shaped structures were generally of two forms, simple C (Fig. 3) or boxed C (Fig. 6).

Figure 5. Relative sequence of firepits and other architectural features revealed by excavation of upland Lapakahi Site 4727, a large C-shaped residential structure.

Table 2 Major Surface Structural Features Present in Upland Lapakahi

Residential Features
- C-shaped structures
  - Simple C
  - Boxed C
  - Compound C
  - L-shaped structures
- Platform structures
  - Earthen
  - Raised stone
- Square/rectangular structures
- Residential complexes

Agricultural Features
- Defined field units
- Garden areas
  - Field area garden enclosures
  - Gully garden enclosures
  - Knoll-top garden areas
- Animal enclosures/pens

Water Catchment Features

Religious (Ceremonial) Features

Burial Features
- Mounds
- Platforms

Trails

Other Features

The latter differed in that the single smooth curvature of the "C" was interrupted by the angular end portions of the wall, with the form more U-shaped than C-shaped. Two or more C-shaped structures were sometimes joined together to form compound C-shaped structures.

C-shaped structures ranged in length from 1 m to as much as 10–12 m. Increased structural complexity and number of interior and associated exterior features generally accompanied increased size. The stone walls varied in height from 0.5 to 2.0 m, and in construction from roughly piled, mound-like walls to substantial walls with well-fit vertical interior faces and sloping exterior faces. Larger C-shaped structures occasionally had hollow cupboards (possible food storage features) built into the walls, and almost always had a curved alignment of single stones which defined the interior limits of the structure on its open side (Fig. 3). These alignments also delimited a low mounded interior which excavations have shown to be accumulated cultural deposits. In many cases, the tops of stone periphery firepits were visible above the topsoil surface.

Though the general leeward orientation of C-shaped structures remained constant, their situation relative to other features differed. The smaller, less complex C-shaped structures were usually isolated, situated within a field unit or cleared areas (Fig. 6), or immediately below a field unit border embankment which was incorporated into the rear portion of the curved wall. The larger, more complex C-shaped structures usually had one or more associated structures of similar shape and form, and were usually situated immediately above a field unit border embankment, often in such a way that the embankment formed a low terrace wall in front (Fig. 3). Few portable surface artifacts were found within C-shaped structures, but the presence of scattered midden material such as mollusc shell, mammal bone, and/or charcoal fragments was not uncommon.

L-Shaped Structures. These structures were fairly common in the lower portion of the upland zone. They were formed by two stone walls, usually of unequal length, joined at an approximate right angle. The longer, frequently higher and more substantial wall, was always oriented perpendicular to the prevailing northeast tradewinds, and functioned as an efficient windbreak. The shorter wall extended out from either end. Except for the difference in shape and that they generally were less complex, the L-shaped structures had basically the same characteristics as those already described for the C-shaped structures.

Platform Structures. These structures were not very common in the upland zone, and those found were generally in the upper portion of the zone. Platforms were distinguished by well-defined sides, elevated level surface, and square or rectangular shape. The two kinds observed were earthen and raised stone platforms. Earthen platforms were low features defined on three or more sides by single course stone alignments or by low stone walls no more than two or three courses high. The elevated surface was usually quite flat and composed of earth, as was the platform fill. The tops of stone periphery

Figure 6. Plan map, profiles, and cross-sections of upland Lapakahi Site 4725, a boxed C-shaped field shelter structure.

firepits were sometimes visible. The maximum dimensions of earthen platforms were on the order of 6–7 m.

Raised stone platforms were distinguished by having stone side walls stacked three to five courses high, an interior fill of stone, and a level elevated surface paved with stones. The maximum size noted was about the same as that for earthen platforms. Very few raised stone residential platforms were found in either portion of the upland zone. Excavations conducted in 1970 suggested that some of the raised stone platforms identified as residential features were probably platform monuments that stood above burial crypts or pits.

Neither kind of platform—earthen or raised stone—comprised a complete residential feature. The platforms provided a level, elevated surface or foundation upon which a pole and thatch house structure most likely stood. Low earthen platforms frequently had a stone windbreak wall along one or more sides, but raised stone platforms rarely had such walls.

Square/Rectangular Structures. Square and rectangular residential features were commonly found only in the upper portion of the upland zone. These structures were four-sided, with high, well-built stone walls, and a door or entrance way. Such structures were usually associated with high stone-walled enclosures, and frequently yielded surface finds of historic artifacts and bones of introduced mammals, as well as other materials. Most, if not all, of the four-sided stone-walled residential features in the upland zone were probably historic period structures, as seemed to be the case for most of the walled structures in the Koaiʻe Hamlet coastal complex.

Agricultural Features

The most impressive prehistoric surface structural remains at Lapakahi are those of the extensive aboriginal field system, a portion of the greater North Kohala field system that stretches for over 10 km from ʻUpolu to Kahuā in a gradually widening belt that ascends from 200–500' to 2000–3000' in elevation (see Smith and Schilt 1973). However, there is more to the Lapakahi agricultural system than defined field units. Structural remains of a wide variety of agricultural features are present throughout the agricultural zone. The overall field system of Lapakahi has been summarized by Newman (Newman 1970:130, 137–148). The objective here is to describe in some detail the full nature and range of all agricultural features in the upland area. The classification of major agricultural features differs somewhat from that of Newman, and is based on a more intensive study of the full range of major and minor agricultural features.

Major agricultural features at Lapakahi can be grouped into three basic categories: defined field units, garden areas, and animal enclosures or pens. Associated with these major structural units is a wide range of minor agricultural features. A major feature might contain any number of these minor features in any combination. These minor structural features were related to specific agricultural techniques, cultigens, and/or environmental considerations. Possible micro-climatic effects indicated for various of the these minor agricultural features have been suggested by reference to work by J.-H. Chang (1968) and Symons (1968). The specific kinds of associated minor features are discussed in detail following description of the major agricultural features.

Major Agricultural Features

Defined Field Units. By far the most common of the major agricultural features found at Lapakahi were defined field units. The low piled-stone and earthen embankments—the borders which defined the individual field units—were distributed from the lower limits of the agricultural zone, from 700–800' elevation, and occasionally further beyond. Even though the area above the modern fence line situated along the 1250–1300' elevation contour interval had been cleared for pasture land, the remains of the field boundaries could still be found on aerial photographs and in ground field checks.

The field boundaries defined elongated rectangular field units oriented with their long axes roughly parallel to the surface contours, and perpendicular to both the general slope of the terrain and the prevailing northeast tradewinds. This orientation contrasts with the aboriginal field system of South Kona on the lands above Kealakekua Bay. The field units there were similar in size, shape, and most general features to those of the Kohala system, but field units in the Kona system were oriented with their long axes parallel to the slope of the land and the prevailing winds, and perpendicular to the surface contours (Soehren and Newman 1968; Newman 1970:135–7, Map 13).

While the long sides of the Lapakahi field units were formed by the 0.2–1.0 m high and 0.5–2.0 m wide stone and earthen embankments, the short end boundaries were formed by the edges of the inland-seaward extending foot trails. These trails were usually shallow depressions lined on one or both sides by low stone alignments or curbing. In some places a trail might have no curbing at all, and occasionally a trail appeared as a slightly elevated linear mound or ridge of earth rather than a shallow depression.

Field units were often occupied by a wide range of associated interior features, both agricultural and other. Most frequently field units were either entirely clear of surface features, or had scattered minor agricultural features such as piled stone mounds, low stone alignments, or small windbreaks, in varied combination. Additionally, field units often contained residential features or other non-agricultural features.

The orientation of the Lapakahi field boundaries was generally held unrelated to any possible water control functions (Newman 1970:143; Murabayashi, in Newman 1970:278). Their particular orientation, with the long axes perpendicular to the tradewinds, was explained by postulating the prehistoric presence of floral windbreaks planted on the intervening field boundaries which functioned to reduce surface wind velocity (Newman 1970: 143). Careful and intensive examination of these field boundaries supported the possible windbreak explanation, but concurrently suggested that the disregard of possible water control functions was open to question. Even though the field boundaries do not always follow the contours of the land, it seems possible that they still functioned as very simple, elementary water conservation features. Certainly they were not water control features on the level of formal terraces or earthen dikes associated with pond-field agriculture; but at the same time, frequent slight shifts in orientation in response to very localized topographic variation and the soil build-up noted behind field boundaries suggested that the field boundary embankments helped to retain and disperse available surface runoff. Possibly even more important functions were retardation of wind erosion and soil creep. The most common shift in orientation was to keep the border roughly parallel to the land contour and perpendicular to the slope. Examples of this shift were best seen on the slopes of knolls, and in the large hollows which formed the drainage basins of the shallow gullies—such as that in the area inland of Site 5110 (Fig. 2).

Garden Areas. Garden areas were plots of agricultural land defined in some way other than by the characteristic field boundaries defining rectangular field units. Garden areas were delimited in various ways: by localized natural topographic features such as boulder outcrops or sudden depressions, by stone walls or low stone alignments, or by a combination of features. The three most common garden areas noted were field area garden enclosures, gully garden enclosures, and knoll-top garden areas. Each of these garden features might contain a variety of minor agricultural features, such as stone mounds, windbreaks, informal terraces, planting circles, and low stone alignments, and occasionally some form of residential structure.

Field area garden enclosures were plots of agricultural land enclosed by fairly substantial, relatively high stone walls. The enclosures were generally square or rectangular in shape, and varied greatly in size. The major characteristic differentiating them from enclosures which otherwise might have been animal pens was the presence of minor agricultural features within the enclosed area. The most common minor agricultural feature found within field area garden enclosures were low, piled stone mounds. Other frequently noted features were low stone alignments, small clearings, and low windbreaks. Small residential features were commonly found within large field area garden enclosures. Good examples of this garden feature were the numerous walled enclosures located inland of Site 5110 (Fig. 2).

Gully garden enclosures were garden areas situated within the confines of a gully or dry stream channel and which were delimited by irregular-shaped, stone-walled enclosures. A very wide range of minor agricultural features was found within these garden enclosures, including low-piled stone mounds, planting circles, modified natural and artificial plant windbreaks, low stone alignments, informal semicircular terraces on the sloping gully sides, small clearings, and short spreader terraces situated across the bed of the channel. Site 5110 was a good example of an enclosed gully garden exhibiting most of these features (Choy 1973). Another minor feature found limited apparently to the series of garden enclosures located on the major Lapakahi gully in the upper portion of the agricultural zone were boulder slope planting features. These were small, cleared and leveled, well-sheltered planting spots situated among the natural boulders on the southern side slope of the gully. Gully garden enclosures usually did not contain any residential features or other non-agricultural features, but in many cases did have associated residential features or complexes nearby. Some small gully garden areas that lacked the enclosing walls were noted in the uplands, but these areas were relatively rare.

Knoll-top garden areas were agricultural units situated on the sides of scattered knolls and hilly prominences composed largely of exposed natural boulder and bedrock outcroppings. These garden areas were found both open and enclosed by low stone walls. The most common minor agricultural features noted were modified natural windbreaks, planting circles, and small clearings, and on the sloping sides of the knoll, informal semicircular terraces. Knoll-top gardens occasionally had associated residential features. A good example was the habitation-garden enclosure located about 60 m west-northwest of Site 7400 (Fig. 2). The luxuriant vegetation growth noted among the features of the various knoll-top gardens suggested that available subsurface moisture was greater than that of surrounding lower terrain. The probable answer lay in the subsurface geological structure of the knolls, which is discussed in the section on water catchment features.

A fourth kind of garden area consisted of those specific garden areas which did not fit into the three major forms previously described. This kind of garden area was usually a small, open, irregular-shaped area delimited by actual local topographic features such as large boulders, natural bedrock outcroppings, or shallow depressions in the ground surface.

Animal Enclosures or Pens. This third category of major agricultural features consisted of square, rectangular, and irregular-shaped stone-walled enclosures of varying sizes which, based on the absence of interior minor agricultural or other features, could not be designated as garden areas.

Most likely some enclosures identified as animal pens were actually garden enclosures or features of some other function. One possible way suggested for determining whether an enclosure was for cultivation or for animals was to note the relative vertical flatness of the interior and exterior faces—flat vertical interior faces supposedly functioned to enclose animals (pens), while those with flat vertical exterior faces functioned to exclude animals (cultivation enclosures) (Newman 1970:140). Small enclosures were commonly found associated with residential structures or complexes.

Minor Agricultural Features

The major agricultural units discussed above incorporated a wide variety of minor features. The range of minor agricultural features noted at Lapakahi included field unit borders, stone mounds, low stone alignments, windbreaks, planting circles, small clearings, simple terraces, elementary water control and/or diversion features, and boulder slope planting features.

Field Unit Borders. Though integral parts of the field units, the field borders were also considered agricultural features. These borders, which usually formed the long side boundaries of the rectangular field units, were low linear mounds or ridges constructed of piled stone and/or embanked earth. Field borders found above the 1200' (366 m) contour tended to be earthen with few visible stones. Whether this was a function of the less stony terrain found at higher elevations or a function of other factors remained unclear. The field borders varied in height from 0.2 to 1.0 m and in width from 0.5 to 2.0 m. They extend in relatively straight lines except where local topographic features led to some deviation.

As indicated by ethnohistoric accounts describing the very similar field system in Kona, Hawai‘i (King 1967:521; Menzies 1920:77), field borders served at least two purposes—they functioned both as boundaries delineating individual fields, and as planting features. Both sugar cane and ti were commonly planted on the boundary embankments. Rows of such vegetation along the field unit borders would have formed a series of floral windbreaks, spaced at 20–30 m intervals, which would have served to deflect the high velocity flow of the tradewinds that sweep so strongly down the slopes of Kohala. Such windbreaks would have served a number of functions: protection of plants from physical wind damage, reduction of evapo-transpiration rate, increase of ground surface soil temperature, and decrease in soil drying and subsequent wind erosion.

Stone Mounds. The single most common minor agricultural feature, low stone mounds were found in various shapes and sizes, but most seemed to be informal piles of stones. Mounds were usually roughly circular, linear, or triangular. Some mounds appeared to be curved, but these most likely were low windbreaks. Mounds measure 1–3 m, depending on shape, and range in height from about 25–75 cm. Individual stones varied from small cobbles to small boulders. Sometimes mounds consisted of similar sized stones, while in others they consisted of stones of varying sizes.

Two methods of construction were noted: one entailed simply the piling up of stones until the desired mound size was reached, while the other method involved constructing a one or two course high perimeter of stones which was then filled-in with smaller stones. Mounds were distinguished from cairns (ahu) in that the latter were better constructed of carefully fit and stacked stones, while the former had stones piled haphazardly.

Piled stone mounds were found distributed throughout the agricultural zone as integral parts of almost every major agricultural feature. They occurred most frequently in concentrations of from six to forty or more mounds, evenly spaced 1–2 m apart, and often occupying a large portion or the complete interior area of a field unit or garden enclosure. Small stone mounds were also occasionally found in the immediate vicinity of residential structures.

Mounds apparently had various and often combined functions. They may have been the result of clearing a patch of ground for planting, with cultigens then being planted in the spaces among the mounds. A series of mounds excavated during the summer of 1970 (Sugiyama 1973:266–271) suggested two kinds of agricultural mounds, one consisting of stone piled directly upon the existing ground surface and a second consisting of stones piled up over a small hill of intentionally mounded soil. The first kind of mound was possibly used to support the vines and foliage of sweet potatoes and yams which were cultivated in the clear spaces among the mounds. A second, and not necessarily alternative use, could have been to provide support for gourds, preventing rot caused by ground contact. The other kind of mound was possibly a planting feature. Cultigens such as sweet potatoes and yams could have been planted in the soil mounds which were then covered with piled stones. The stone mound structure would then have functioned in assisting with soil water retention, preventing wind erosion of soil, and providing support for vines and foliage.

Low Stone Alignments. Single course alignments of irregularly to closely set stones were noted within a number of defined field units. These alignments were almost always oriented parallel to the boundary embankments. The alignments were 2–15 m long, and when more than one was present they were set about 0.5–1.0 m apart and parallel to one another. There did not seem to be any regular pattern of distribution of this feature in the agricultural zone, and the function of these low alignments remains uncertain. They did not seem high enough to provide physical protection from the winds, though they might have been of some value for small or young plants. The parallel series of alignments might have functioned as "starter beds" for cultigens requiring intensive care. Single alignments seemed in some cases to represent an internal division of field units.

Agricultural Windbreaks. These features were small C-shaped structures which varied in height from 30–100 cm and in overall length from 0.5 to as much as 2 m. The degree of curvature varied, from almost none to semicircular, and in some cases to almost a full circle. In all instances the highest portion of the structure stood perpendicular to the winds. Two principal forms were noted. One was a curved linear mound of piled stones, higher at the rear, and roughly triangular in cross-section. The section was similar but was constructed by incorporating larger natural boulders among which were placed smaller stones to complete the structure. Both kinds were found throughout field units and garden areas, with the distribution of the second conditioned by the presence of natural boulders.

Other varieties of agricultural windbreak structures included low unattached sections of stone wall and low walls which were raised portions of field border embankments. Both averaged 25–75 cm in height, were irregular in length, and oriented perpendicular to the winds.

The primary function of these agricultural features was to provide physical protection from the strong winds that swept down the slopes of Lapakahi. Such structures would have sheltered young plants especially sensitive or liable to wind damage, such as *wauke* (paper mulberry), *'awa* (*Piper methysticum*), or banana (*Musa* spp.). Other functions, though not so obvious as physical protection, included reduction of wind soil erosion, slight increases in ground surface temperature on the leeward side during the daylight hours and, if high enough, prevention of rapid ground surface moisture evaporation by acting as a shield against both the wind and the early morning sunlight.

Planting Circles. These features were roughly circular, single course arrangements of stones with soil inside. The average diameter was about 1 m. Cultigens were apparently planted within the circles. The cross-section of an excavated planting circle (Choy 1973) showed the presence of a worked soil deposit within and beneath the limits of the circle. The soil deposit had been worked to a greater depth than the adjacent soil, and appeared to contain a higher proportion of organic matter.

Planting circles were commonly found within knoll-top garden areas and within field areas and gully garden enclosures, but only rarely within defined open field units. The specific function of these features was uncertain, but most likely they served to define and contain shallow pits of cultivated soil which might have been mulched. An interesting example of this feature was a concentration of eleven planting circles found located about 700 m inland from the coast (Rosendahl 1972: Fig. 4). The presence of the latter in such an arid situation agrees with various ethnographic and ethnohistoric accounts which described the occasional cultivation of small sweet potato mounds by fishermen (Handy 1940:164; and others).

Small clearings. These features were small, relatively stone-free, cleared areas—usually found in field units, field area garden enclosures, and gully and knoll-top garden areas—which stood out from the rest of the generally stony ground surface. They normally were found in terrain where the surface was heavily covered with rocks of all sizes, and were made simply by removing the rocks, which were usually piled into low stone mounds but occasionally just thrown out haphazardly. The function of these clearings was to provide planting space for cultigens, most likely sweet potatoes, which were planted between the stone mounds.

Simple Terraces. Terraces are leveled surfaces approached on one or more sides by some kind of scarp, usually an earthen embankment or stone retaining wall. Terraces function to provide level cultivation areas in sloping terrain, and to control soil slumping and erosion. The examples of terracing found at Lapakahi were not the impressive well-built terraces that made up the irrigated pond-field systems in such valleys as Hālawa and Mākaha. The dryland terraces at Lapakahi were small and informal, with size and shape dependent upon local terrain, and usually associated with knoll-top and gully garden areas.

The finest, though atypical, examples of terracing were the 3–4 terraces which descended in series the sloped side of the knoll in the garden enclosure/habitation complex located about 60 m west-northwest of Site 7400 (Fig. 2). These terraces were rectangular, each about 3 m x 4 m in size. They were defined in front by rough terrace retaining walls some 0.5–1.0 m high, and on the sides by rough walls and natural outcrops. Such well-defined terraces were rare at Lapakahi.

The two most common variations of simple terracing were found on the sloping sides of knolls and gullies, and across gully bottoms. Slope side terraces were informal in construction, usually small and irregular in shape, but tending to be convex or outward bowed. The typical method of construction was to utilize naturally occurring stones or boulders by placing additional stones in the gaps to produce a low terrace wall averaging 30–50 cm in height. These simple terraces were usually only 1–3 m long, and were most commonly found in the lower portion of the agricultural zone.

Gully bottom terraces consisted of low terrace walls, usually 25–75 cm high and no more than 2–3 m long, which were built perpendicular to and across the flow channel and had a flat area behind them. These features were found in both open and enclosed gully garden areas. The primary functions of these gully bottom terraces were to provide level planting areas, and to pond or spread any available flowing water over the widest possible area as a form of dryland irrigation. They also functioned to prevent or control erosion along gully channels.

Excavated examples show that these low terraces were constructed by placing an alignment of stones across the channel bed and filling in behind with more rocks and loose soil (Choy 1973; Sugiyama 1973). Frequently the construction incorporated small natural boulders that were present. The gully associated with the gully garden enclosure Site 5110 contained the best examples of this form of terracing.

Nothing in the structure of either slope side or gully bottom terraces suggested specific cultigens, but since gully bottom planting features were situated in probably the wettest available areas, the terraces might possibly have been planted with rapidly maturing varieties of taro.

Water Control/Diversion Features. Two forms of elementary water control features were noted at Lapakahi, both associated with gully garden areas. The first, gully bottom or spreader terraces, have already been described. The second form observed were low, roughly built diversion walls which extended across general contours. These walls were rare, but were noted occasionally along the edges of shallow gully channel beds. Never more than 50 cm high, these walls apparently represented simple attempts to divert or direct available water flow. Similar but better developed "dryland irrigation" features were found in dry cultivation areas of Mākaha Valley (Hommon 1970:32, Fig. 4).

Boulder Slope Planting Features. These features were located on the steep, boulder-strewn side slopes within a number of gully garden areas, the best examples found in the series of gully garden enclosures situated in the upper portion of the agricultural zone between the 1050' and 1150' (320 m) elevation contours. These planting features consisted of small spaces, often only 1 m^2, that had been leveled among the natural boulders and surrounded by naturally occurring and artificially placed stone windbreak formations to provide extremely well-sheltered planting spots. These features were almost always situated on the steep south side slopes of the gully, thus having a northern exposure. *Wauke* (paper mulberry) was observed growing in these protected spots in a number of gully garden areas during the summer of 1970. Bamboo was also noted in a few locations. Other possible cultigens that might have been grown in such features included bananas (*Musa* spp.), *ti*, *'awa*, and pandanus.

Other Minor Agricultural Features. Two additional features that should be mentioned were field cupboards and shelter structures. Field cupboards looked like stone mounds, but had hollow interior compartments usually formed by a combination of natural boulders and a few well-placed arching stones. Occasionally these cupboard features were constructed entirely of large flat stones. The dimensions of the hollow interior space averaged no more than 50–75 cm in height, width, and depth. The distribution of these features was irregular. Completely artificial ones were rare, but modified natural cupboards were more common and were often found in gully and knoll-top garden areas where the terrain was quite rocky. The function of the cupboards are uncertain. They did not appear to have served as cultivation features. Possibly they were for field storage of harvested crops. Another function stated by an elderly local informant was that they were storage places for gourds containing water for human consumption (Sugiyama 1973).

Shelter features, usually small and boxed C-shaped structures, were commonly encountered within garden areas and field units among the various minor agricultural features. The tops of stone periphery firepits were sometimes visible above the topsoil surface. These small residential features possibly served dual functions; as temporary field shelters for workers during the day, and as storage facilities. Site 4725 provides a typical example (Fig. 6).

Water Catchment Features

Acquiring sufficient water for human consumption was probably a problem in the dry uplands of Lapakahi. The two major sources were stream flow and rainfall catchment. The stream at Lapakahi was most likely not a very dependable source if, as has been suggested (Rosendahl 1972:57–61), the stream was inactive or periodically dry for years at a time. Rainfall must have been the most important source of potable water. Two methods of catchment were used. The first method utilized puddles and shallow pools formed by rainfall caught in natural or modified depressions on large boulders and exposed bedrock surfaces. The second, more productive method was the modification and utilization of natural geologic water entrapment structures as catchment and storage facilities.

Several such water catchment features were noted principally in the upper portion of the agricultural zone. These features appeared as open or covered depressions atop elevated, dome-like bedrock outcroppings of collapsed natural lava flow blisters or bubbles. Such geologic structures were formed during the flow and subsequent cooling of lava when gas trapped between an impermeable basement and the viscous outer skin expanded to form a natural mound as the lava cooled. As the lava continued to cool, tensile stresses caused it to fracture, and because the subsurface gas had either escaped or contracted, the weight of the blister skin could no longer be supported. The collapse of the blister surface formed the basin-like depression commonly found atop elevated bedrock outcrops. Such collapsed lava bubble structures subsequently functioned as natural geologic water traps when subsurface ground water from high elevations moved downslope along the top of the impermeable basement and were retained in the bowl-shaped depression of the collapsed blister.

Two major human modifications of the natural lava blister water catchments were noted, and frequently both were exhibited by the same catchment feature. The first was a low stone wall constructed to encircle the top of the feature, and which most likely served to exclude animals and mark the location. The second major modification was a stone roof constructed over the central depression, usually utilizing the natural lava slabs that surrounded the blister. The roof served two important functions; it reduced surface evaporation and filtered out windblown debris. It also allowed direct rainfall to percolate down into the interior blister cavity. Entrances through such roof structures were usually small openings at the side from which water could be dipped out.

The distribution of these water catchment features was obviously conditioned by geologic occurrence; but for reasons that were unclear, most of these features were found in the upper portion of the agricultural zone. The same underlying geologic structures were undoubtedly responsible for the subsurface water in the knoll-top garden areas, the presence of which was evidenced by the lush grassy vegetation that flourished among the various minor agricultural features there.

Religious (Ceremonial) Features

Three features found in the uplands of Lapakahi were tentatively identified as aboriginal ceremonial or religious sites (*heiau*) (Fig. 2). The first two were found in the upper portion of the Detailed Study Area, situated about 250 m apart on the same elevation contour of 1175' (358 m). The third was found about 130 m southeast of the second, at an elevation of about 1210' (369 m). Thus all three were situated along the same approximate ridgeline contour with commanding views of the general area below. Each seemed to be situated within a different local land unit, as defined by the system of inland-seaward extending foot trails. These possible religious features are described in some detail since they were the only such features found in the uplands.

Religious Feature 1. Religious Feature 1 was located about 4.9 km inland from the coast, at an approximate elevation of 1175' (358 m) above sea level (Fig. 2). The feature consisted of a rectangular shaped area defined by a low stone wall on one side, and by a series of low steps or alignments on the other. A square, low, raised stone platform occupied the center of the area.

The dimensions of the defined area were about 26 m x 19 m. The eastern half was delimited by a low stone wall averaging 65–70 cm high and 50–60 cm thick. The wall was constructed of carefully stacked stones averaging 20–35 cm in size. Both the interior and exterior faces were vertical, and the interior face had, incorporated into the wall, several intermittently spaced upright stones. The western half was delimited by a 20 cm high step formed by a single course alignment of stones which extended almost the full length of the western side. A second parallel step was located 2–2.5 m inside and above the first step. Similar in form but slightly lower (15 cm), it adjoined the front edge of the central platform. A third alignment or low step extended along the rear edge of the platform, parallel to and about 4 m distant from the rear wall. A rough flat stone pavement seemed to be present beneath the thick grass cover in the area immediately north of the central platform.

The central platform was approximately 10 m^2, and had elevated sides a single course high (20 cm) on three sides, and about 30–35 cm high on the fourth side where the lower step adjoined. The interior area of the platform was divided into three sections. The southern half consisted of a coral and basalt pebble/cobble paving. The materials were both angular and waterworn. The northwest quarter was paved with large basalt cobbles only slightly smaller than the platform periphery stones. The northeast quarter was a depressed earthen surface defined on all four sides by closely-set stones. The surface level of this quarter was the same as the ground immediately outside, and was thus about 20 cm below the surface level of the rest of the platform. No surface artifacts or midden material was noted on the platform or nearby to suggest that it might have been a residential feature.

The feature appeared to be structurally well-balanced, especially if the various single step alignments were hypothetically extended through the southwest portion of the defined area. Such alignments might well have been disrupted or removed during the later construction of the high stone-walled rectangular structure and the rest of the large enclosed residential and agricultural complex located next to Religious Feature 1.

Religious Feature 2. Religious Feature 2 was situated about 250 m south of Religious Feature 1. As with Religious Feature 1, this feature was also partially incorporated into a later residential and agricultural complex. Religious Feature 2 consisted of a large, partially paved, raised stone platform elevated on two sides and defined on the other two by a stone wall and a natural rock outcropping. The northeastern portion of the platform surface had a smaller, low-stepped earthen platform.

The dimensions of the feature were about 15 m x 19 m. The major platform was elevated for most of the length of its west and south sides, which were constructed of large rough upright stone slabs which gave the platform a maximum height of 1.0–1.2 m. The slabs average 1.0–1.2 m both in length and width, and about 40–50 cm in thickness. The east side of the platform was delimited by a well-built wall of stacked stone construction approximately 1 m high and 50–60 cm thick. Most of the north side of the platform was delimited by a bedrock outcrop, from which a number of large natural slabs had been propped upright. The rest of the north side was occupied by a rectangular, high stone-walled structure which stood upon a roughly-built earth and stone platform adjacent to the major platform of Religious Feature 2. Excavations would be necessary to clarify the various structural relationships involved.

Most of the southern half of the major platform surface, especially the southwest portion, was paved with large rough slabs similar to those which stood upright to form the sides of the platform. These paving slabs rested atop a fill of small boulders and cobbles. Two large chunks of coral were found on the surface among the paving slabs. The rest of the platform surface was earthen. The smaller, earth filled platform was about 10 m long and 7 m wide. Both the south and west sides were formed by two 15 cm high steps which consisted of parallel single course stone alignments. The total height of the smaller earthen platform was about 30 cm above the surface level of the larger platform. A rectangular firepit with periphery stones visible above the topsoil was located in the southwest corner area of the earthen platform. A similar firepit was located about 2 m in front of the high-walled rectangular structures, and was most likely associated with that feature.

A feature of unknown function, possibly associated with Religious Feature 2, was noted immediately outside the eastern rear wall. It was roughly circular, stone-outlined and filled pit, approximately 1 m in diameter, and partially sheltered beneath an overhanging large boulder.

Religious Feature 3. Religious Feature 3, situated about 100 m south of the Detailed Study Area and the same distance south of Religious Feature 2 (Fig. 2), was a large stepped platform constructed of rough boulders, and a few associated small earthen terraces. The total area of the platform and the terraces was about 10 m x 12 m.

The major feature consisted of a raised stone platform of five steps, fronted by a small rectangular earth-fill terrace. The dimensions of this major feature were 5–6 m wide and 7–8 m long. The platform, situated at the edge of a steep slope, was constructed of large boulders and stones, and incorporated numerous natural boulder outcrops. Scattered upright stones were used throughout the platform, both as step riser facings and to define the northern side of the platform.

Immediately below the bottom step were earth filled terraces, roughly rectangular in shape with rounded corners, and measuring 12 m long by 2.5–3.0 m wide. The northern end of this terrace was delimited by an alignment of seven upright stones. Below this small terrace was a series of two or three curving terraces that descended the immediate slope. Whether or not they were associated with the stepped platform feature was uncertain.

Religious Feature 3 was quite similar in general characteristics to three stepped platforms mapped and test excavated in Mākaha Valley on Oʻahu during early 1969 (Ladd 1970:81–95). The report concluded on the basis of the very limited ethnohistoric, ethnographic, and archaeological data available that the three stepped platforms probably represented lesser *heiau* or religious sites. "Because they did not exhibit the usual construction features associated with a domicile or structure having an agricultural function, they are best regarded as religious structures whose functional and sociological roles are not yet completely evident" (Ladd 1970: 95). This conclusion is appropriate for the religious structures described here.

Burial Features

A number of stone structures in the upland area were tentatively identified as burial features; and without excavation, specific feature identifications remain tentative. However, burial function might be inferred on the basis of structural similarities to other features at Lapakahi and at other areas where features were confirmed as burials through excavation.

Two major kinds of burial structures were distinguished in upland Lapakahi, stone mounds and raised stone platforms. Subsurface pit burials lacking overlying structural monuments seemed to be present but generally unrecognizable; their presence was revealed by human skeletal remains found eroding out of soil deposits which had slumped into one of the upland gully channels.

Burial mounds were classified as formal or informal; both variations shared the same size range of 2.5–4.0 m in length, 1.5–3.0 m in width, and 50–60 cm in height. Informal mounds were roughly rectangular or ovoid piles of cobble or slightly larger stones. Sometimes a stone-filled pit was noted beneath the mound, but in most cases the mounds were probably built up over pits with earth fill. Formal mounds differed in that they were more rectangular with better defined corners, and consisted of a stone alignment periphery which had been filled up inside with stones. In both formal and informal burial mounds, the actual burials were apparently interred in subsurface pits, and the mounds functioned as markers or monuments.

The second kind of burial feature conformed to the previously designated "platform monument" burial structure (Bowen 1961:129). Such features usually consisted of a raised, single level, roughly paved, rectangular or square stone platform approximately 3–4 m long, 2–3 m wide, and 0.5–1.0 m high. Excavated examples at Lapakahi and elsewhere generally have revealed skeletal remains interred in a subsurface pit or stone slab-lined crypt beneath the platform. Occasionally platforms of this type were noted in which the interior seemed to have collapsed, suggesting the possibility of an above ground crypt. Sometimes burial platforms appeared to have been constructed to resemble residential platforms. Site 7400 had two examples of this form.

Both kinds of burial features, mounds and platforms, were found more frequently in the upper portion of the agricultural zone. They were usually found concentrated in groups of two or more, and were almost always observed to be associated with residential features or complexes. Such groups possibly represented family burial grounds.

Trails

Reconnaissance of the upland area during the summer of 1969 revealed an extensive system of prehistoric foot trails extending inland-seaward. This system had gone unrecognized during the work done in 1968, when the various trails on the aerial photographs and maps made from the aerials had been interpreted simply as the end borders of the rectangular field units. Further study of the aerials and maps in 1969 focused attention upon the apparent mismatch frequently noted between the ends of adjacent field units (see Fig. 2 for examples of this mismatching). A field check of mismatched sections revealed the presence of narrow (1.0–1.5 m wide) foot trails, usually defined by parallel stone alignments or curbing, which formed the end boundaries of the field units. With the distinct possibility that these trails might correspond with the boundaries of the several native land units named on the early maps and land record documents, an attempt was made to equate land unit names with the sketchy archaeological evidence derived from a re-examination of the aerial photographs (Newman 1970:146–8). Because this interpretation was not checked out by a field examination of the actual trail system, the specific tracks of a number of trails were plotted incorrectly on the map (Newman 1970: Map 4) and other trails were overlooked completely, and the resulting correlation of land unit names with discrete sections of land at Lapakahi remained tentative at best. During the summer of 1970, an intensive investigation of the Lapakahi trail system was conducted. A detailed full report of this study has been published in the Lapakahi Project Report for 1970 (Kaschko 1973). The present discussion outlines the research program and summarizes the most important points.

Trails observed on the aerial photographs of upland Lapakahi were followed in the field, and their correct positions plotted. All new trails encountered in the field, not visible on the aerials were also followed out and plotted. While the trails were being traced, detailed notes were kept on trail construction, associated structural features, and any other observations made. After the intensive tracing of upland trails, the same methods were used to trace the trails that extended seaward through the barren zone to the coast, and inland through the bulldozed pasture land toward the inland limits of Lapakahi. Following trails to the coast was hampered by the lack of adjacent field units, the discontinuous stone curbing, washed-out sections of trail, and heavy tree and underbrush vegetation present near the coast. Tracing trails further inland was hindered by the late historic clearing which has greatly disrupted the field system and destroyed structural features. The results of intensive field tracing are shown in Figure 2.

Seven major trails—designated as Trails I, II, III, III-A, IV, V, and VI—were defined on the basis of mismatched field unit end borders. In some places where curbing was absent, this mismatch was the only way a trail could be traced. Of the seven major trails, five (I, II, III, V, and VI) were found to be associated with numbered historic land survey markers. These markers, usually sections of iron pipe anchored in a concrete plug inscribed with a number and occasionally with a date, had been placed during a government survey in 1931. The purpose of that survey had been to mark the boundaries of the government land tracts present in the Lapakahi area. In the process, the survey had at the same time re-established the boundary limits of the several historic land grants sold in fee simple to various individuals during the period 1856–1860. The original land grant survey marks, usually a cross chiseled onto a boulder, or a cairn of stacked stones, were found frequently right next to the iron pipe markers.

The original Land Grant Patent certificates, and the boundary survey records upon which the patents were based, are deposited in the State Archives Building in Honolulu. These documents have proved valuable in defining the named native land units present in the Lapakahi area, and supporting the argument that the major trails represented the prehistoric boundaries between the native land units. In a number of cases it was possible to correlate both early and late historic survey markers with major trails. It was also possible to find descriptions in the Land Grant Patent certificates of the same line between two specific points which had been described in 1856–1869 as the boundary of one, or between two, of the named native land units. The original survey maps (1856–1860) often also showed the location of these named units, as well as features such as stone walls, houselots of named individuals, specific kinds of trees, and other land marks.

There were seven major, or boundary, trails defined at Lapakahi, but only five named land units were known. This presented a puzzle. Of possible explanations, the following alternatives might be considered: 1) one of the designated major trails had not functioned as a land boundary; 2) the name of a sixth land unit had been lost or forgotten; or 3) of six units present at an earlier time, two had been joined together, yielding the five known named units.

Several minor trails, ones which cut through field unit boundary embankments without the characteristic mismatch of major trails, were also traced out in the upland area. These trails were difficult to follow because they often were short and/or discontinuous. These minor trails probably were access trails. In many instances, a network of minor trails seemed to criss-cross a unit formed by two major trails. Minor trails were always restricted to such a defined area, and almost always branched off from one or the other of the two major trails. And finally, there was a tendency for each unit bound by two major trails to have a centrally located, relatively substantial and continuous, minor trail.

The two kinds of structural features most commonly found with major trails were small shelters and stone cairns (*ahu*). The shelters were usually small C-shaped structures. Site 7401, an example of a group of such features, was situated at the juncture of two trails (Fig. 2). The cairns were found along trails, or in pairs straddling a major trail or the juncture of two major trails. These cairns were possibly boundary monuments.

Both the patterned archaeological remains and the historic survey and land grant documents supported the interpretation of major trails as land unit boundaries and minor trails as access routes through field units. The pattern of fields within each area defined by two major trails displayed a highly organized and self-contained system constructed without necessary reference to the field unit end borders immediately adjacent beyond either major trail. This pattern suggested that the tracks of the major trails were already present and recognized before field unit boundary embankments were constructed. The distribution of cairns interpreted as boundary monuments also supported the argument for major trails as boundaries. The internal network of minor trails which criss-crossed any area defined by major trails were most easily explained as access trails. These trails often rejoined major trails or led to residential or other features.

The historic survey records and land grant documents also strongly supported the argument for interpreting the major trails as boundaries between the named land units. The boundary lines of various grants, as defined according to numbered and identified survey markers, were specifically referred to in the survey records and Land Grant Patent certificates as the boundaries of, and between, the various named land units of the Lapakahi area.

Other Features

This final category of structural remains consisted of those features which did not fit into any of the other categories, or could not be ascribed a function. Various other features observed in the Lapakahi uplands included isolated walls, stone alignments and firepits, cairns, a small cave, rock shelters, and a small concentration of petroglyphs.

Unassociated stone wall sections, low stone alignments, and visible stone periphery firepits were occasionally noted throughout the agricultural zone. Two small rock shelters consisting of unmodified natural rock outcrop overhangs with associated stone periphery firepits were found. Both stacked stone cairns and high piled mounds were seen, usually associated with curb-stone lined trails. In at least two instances the juncture of two major trails was marked by a pair of cairns, one on either side of the juncture point. On the basis of similar cairns recorded elsewhere in Hawaiʻi, it was likely that some of these cairns were boundary monuments. Several poorly preserved petroglyphs—geometric representations of human figures—were found scattered over the seaward-facing surface of a natural boulder outcrop located on the brow of a knoll near the seaward limits of the agricultural zone, at a point where Trail VI crossed the 825' (251 m) contour line (Fig. 2). Its location possibly put the group just outside the limits of the Lapakahi area.

A small lave tube cave, lacking any evidence of human occupation, was found in the lower portion of the agricultural zone (Fig. 2). This feature, which extended underground for perhaps as far as 100 m inland, was referred to as "Sweet Potato Cave" because of the live specimens found growing among the rough stone slabs of the collapsed lava blister entrance hole. The cave may well have been utilized as a water catchment feature; its geologic structure was that described earlier for water catchment features found in the upper portion of the agricultural zone. Inspection of the low, narrow cave interior indicated that water still collected in shallow pools on the floor at various times, probably during the winter months.

General Settlement Patterns

The nature and spatial distribution of residential and agricultural features, and their relationships with other kinds of features, are important for investigating the aboriginal Hawaiian agricultural adaptation evidenced by the extensive surface structural remains found on the leeward slopes of Lapakahi. The following summary presents some qualitative generalizations regarding the overall distribution of the structural remains found in the upland agricultural zone.

By far the most common residential feature found in upland Lapakahi were C-shaped structures. These ranged from temporary shelters to extended habitation structures. C-shaped structures were found throughout the agricultural zone, but were more common above 950' elevation. C-shaped structures in the seaward portion of the agricultural zone were generally shelters, smaller and less substantial than those farther inland. Larger C-shaped structures, usually with frontal stone alignments and cultural deposits, often occurred in groups of two to five in the middle and upper portion of the agricultural zone.

Neither as common nor as substantial as C-shaped structures, and almost always lacking any visible indication of cultural deposit, L-shaped structures were found principally in the lower portion of the agricultural zone. L-shaped structures were almost always isolated features, or if not, were associated with similar L-shaped structures. In a few instances, of which Site 4727 represented an excavated example, L-shaped foundations were noted beneath standing C-shaped structures.

Residential platform structures were not common, even though there were many in the Lapakahi coastal zone. Except for those associated with enclosed residential complexes, raised stone platforms appeared never to have been used as habitation features, and were likely platform burial structures. Two such examples were excavated in Site 7400 (Features B and C). Earthen residential platforms were uncommon, and usually were associated with some kind of windbreak wall and/or were part of a larger residential complex. Both types of residential platform structure were found located in the upper portion of the agricultural zone.

High stone-walled square and rectangular residential structures were found in the upper portion of the agricultural zone, and were in most cases part of a residential or combined residential and agricultural complex. Most of these examples had associated historic artifacts, and midden that included remains of introduced animals.

Residential complexes were of two forms: unenclosed clusters of 2–5 larger C-shaped structures with associated field units and other minor agricultural features; and occasionally unenclosed, but generally enclosed complexes of square/rectangular platform residential structures and associated agricultural features, or nearby small animal pens and garden enclosures. The first kind of residential complex was found in the middle and upper portions of the agricultural zone, and was most likely prehistoric; while the latter was limited principally to the upper portion, and was historic, or possibly late prehistoric and historic. These late prehistoric and historic residential complexes were probably the functional and spatial equivalents of kuleana awarded to native tenants by the Land Commission under the Act of August 6th, 1850 (Chinen 1958: 29–31). *Kuleana* were portions of land improved or cultivated by native tenants for their own livelihood, and which by weight of substantiated claim were received in fee simple title from the Land Commission. *Kuleana*, indicated by Land Commission Award Number (L.C.A.) on the map of grants and awards located in the Lapakahi general area (Rosendahl 1972: Fig. 9), were awarded in areas adjacent to Lapakahi; but for unknown reasons, none were applied for or awarded within the Lapakahi area.

The nature of aboriginal occupation in the further inland portion of Lapakahi where structural remains had been disturbed remains a problem. The incomplete remains of structures were sometimes observed beneath piles of bulldozed rubble, suggesting that attention paid to the distribution of such rubble piles might possibly give some idea of the nature of settlement in that area. On-the-ground observations and the study of aerial photographs indicated similar clusters of residential features, both unenclosed and enclosed complexes; but the density of complexes appeared lower and they were distributed rather irregularly, found below the 1550' (473 m) elevation level. Possibly the major concentration of residential occupation did not extend much further inland. However, structural remains further inland have suggested greater destruction.

Rectangular field units defined by piled stone and earthen embankment borders were the most common major agricultural feature in upland Lapakahi; and piled stone mounds, generally scattered within many of these field units, were the most common minor agricultural feature. The range and distribution of the various minor agricultural features were most likely related to specific cultigen requirements, certain agricultural techniques, and/or very localized environmental conditions.

The area of individual field units was dependent in most cases upon its length, the distance between the two major trails that defined its end boundaries. The width of field units was generally quite constant. The total agricultural area available within any field unit might have been related to various agronomic considerations: for example, the area of land necessary to produce a certain output of a specific cultigen; or the area possible to prepare and/or maintain in cultivation for a given labor input. Possibly the area was related to sociological factors also, rather than strictly agricultural ones.

The distribution of gully and knoll-top garden areas was directly related to topographic and environmental factors. Agronomic techniques might have had some influence. On the other hand, available cultivation area within field area, gully, and knoll-top garden enclosures was based on human decisions on where to build stone enclosure walls, as well as by environmental factors. Often a similar range of minor agricultural features was observed both inside and outside the enclosure walls, suggesting that the enclosed garden areas represented an attempt to cultivate a restricted and protected portion of land under conditions of stress. An example of such stress would have been the historically documented problem of severe crop damage caused by the large numbers of introduced domestic and feral animals such as cattle and sheep, which were permitted to forage at will throughout the Lapakahi area (Newman 1970:105–6, 145).

Small enclosures lacking interior minor agricultural features and frequently associated with residential features were probably animal pens for restraining a few pigs, a horse or mule, or perhaps a cow. In many cases, these small enclosures or pens were associated with historic residential complexes. The place of animal husbandry (pig and dog) in aboriginal Hawaiian agricultural systems is poorly understood. The agricultural system evidenced at Lapakahi was most likely based on sweet potato cultivation, and probably was able to support a large domestic pig population. It remains unclear whether pigs were kept in pens where feeding was controlled, or whether they were allowed to forage in abandoned fields and gardens. Possibly the two techniques were combined, with children seeing that fields and gardens still under cultivation were not destroyed, and that the animals were returned to pens in the evening. In any case, pig husbandry is a topic demanding future investigation.

The correlation between major trails and mismatched field unit end borders suggested that the locations of boundary lines and/or trails, possibly only foot trails without stone curbing, were established and recognized before the full development of the defined field unit system located within the confines of any two major trails. Field unit boundaries were visible to the inland limits of Lapakahi and beyond. This did not necessarily mean that the entire area had been completely under simultaneous and/or permanent cultivation; however, it did suggest that all available land had been cultivated at one time or another, even though the level of intensity was unknown.

No evidence of irrigation or any manner of water control beyond the most elementary dryland irrigation techniques of spreader terraces and low diversion walls was noted in the upland agricultural zone. The primary source of water for cultivation was rainfall, both direct showers and in the form of "drift" clouds. The lower portion of the agricultural zone might have been periodically too dry for cropping, or possibly cropping was limited to the wetter winter months. The upper portion, and certainly the disturbed further inland area, received increasingly adequate rainfall for year-round cropping.

Water for human consumption was obtained from modified natural geologic structures which functioned as water catchments, as well as from periodically active streams. The distribution of water catchment features was determined by the geologic occurrence of suitable structures, but it was not clear why such suitable structures were found only in the upper portion of the agricultural zone. The presence of agricultural features and lush stands of grasses on knolls in the lower portion of the agricultural zone evidenced the presence of the same underlying natural geologic structures, but they were not open to the surface or available for human utilization—with the possible exception of the small lave tube cave described above.

Human modifications of suitable natural catchment were the addition of enclosing walls and artificial stone roofs which functioned primarily to exclude animals and windblown debris. Some of these water catchments work today, even though long-filled with refuse, as shown by the presence of pooled water noted several times during the summer of 1970.

Water catchment features located in the upper portion of the agricultural zone were associated with nearby residential features, usually square or rectangular structures and open or enclosed residential/agricultural complexes. Four of the six land units defined by major trails had at least one water catchment feature, and this represented only the undisturbed portions of the agricultural zone. Furthermore, all but one of the water catchment features were located immediately adjacent to a major or minor trail.

At least three possible religious/ceremonial features were found in the upper portion of the agricultural zone. None fit into any of the other structural features categories, and all had structural or other characteristics similar to other features regarded as religious elsewhere in Hawai'i. A residential function was eliminated for each feature, even though each was located close to a later residential-agricultural enclosure complex. An occurrence commonly noted in other areas of Hawai'i, this partial inclusion into residential complexes was most likely an historic period development subsequent to the breakdown of the native religious system following its formal dissolution in 1819.

The three possible religious features shared four locational characteristics. All were located the same distance from the coast, 4.9–5.0 km, all were situated at similar elevations contour, between 1175' and 1200' (358–366 m) above sea level, and because of the increased slope at this elevation, all had prominent positions with sweeping views of the area to seaward. Each was located within a different land unit, as defined on the basis of the major trails. Finally, all three were approached by recognized trails. Religious Features 1 and 2 had major trails (III, IV) passing right along their edges, while Religious Feature 3 was located equidistant between two major trails (IV, V) and was approached by a centrally located minor trail that led directly to the front of the seaward side.

Tentative burial features, both mounds and raised stone platforms, were found mostly in the middle and upper portions of the agricultural zone. Single burial features were either isolated, or associated with C-shaped structures, usually a cluster of C-shaped structures with obvious cultural deposits. Burial features usually occurred in groups associated with residential features, particularly residential complexes of unenclosed C-shaped structures, or combined residential/agricultural enclosure complexes having raised stone platform and square or rectangular residential features.

Based on the distinctive patterns of mismatched field unit end borders, seven major inland-seaward extending prehistoric foot trails were defined in the upland area. These trails often had stone cairns—possibly boundary monuments—associated with them. The system of seven major trails delimited six land units, each with an internal network of minor trails which criss-crossed the field units and the best of which was usually centrally located within the land unit.

Major trails were interpreted as actual land unit boundaries, or as the locations of previously recognized and acknowledged early boundary lines. Minor trails were interpreted as access trails facilitating movement within each bound land unit. Both the archaeological evidence of the patterned structural remains and the written evidence of the historic land survey and land grant documents argued for the presence of at least five named native land units, the boundaries of which coincided with major trails. The problem of six apparent land units defined by the seven major trails has not been explained satisfactorily.

A small number of other structural features were encountered in the upland area, including isolated walls and stone alignments, unassociated firepits, cairns, a small cave, boulder-overhang rock shelters, and a small group of petroglyphs. The small lava tube was important because it was the only natural geologic structure located in the lower portion of the agricultural zone which could have functioned as an accessible water catchment feature. The petroglyphs, the only ones found in the Lapakahi area, were prominently located at the crest of a steep rise. In that position they could be seen from a distance by anyone approaching from the coast by the major trail (VI) which passed only a few meters to the north.

Analysis of Structural Remains in the Detailed Study Area

The intensive investigation of a single area provides the data necessary for quantitative analysis of qualitative generalizations about the distribution of surface structural remains. This was the reasoning behind the concentrated research program within the land section at Lapakahi designated as the Detailed Study Area. The following discussion defines the Detailed Study Area, characterizes it in terms of its structural remains, and presents the results of a limited quantitative analysis. These results may then be compared to the qualitative statements already made about the overall settlement patterns of Lapakahi.

Data

The Detailed Study Area (hereafter referred to as the DSA) was a section of land approximately 2.3 km long (west to east) and averaging about 300 m in width (Fig. 2). On the basis of land grant records and ethnohistoric materials, this section of land seemed to represent the undisturbed portion of a named traditional land unit. A detailed plane table map, made with telescopic alidade and stadia rod to a scale of 1:750, located all surface structural remains and natural topographic features present in the delimited area (Fig. 7). Most cultural features were also recorded individually with a sketch map and written description.

The mapped section extended from about 775' to 1275' (236–389 m) in elevation, and included a total area of approximately 611,900 m^2 (151.22 acres). The specific boundaries defining the DSA were as follows (Figs. 2 and 7): on the north an inland-seaward extending curbstone-lined foot trail (Trail III); on the south, a similar foot trail (Trail IV); on the east, the inland end, a fence line along the edge of the cattle pasture land; and on the west, the seaward end, the lower distribution limits of the agricultural field unit boundaries. Defined in this manner, the DSA constituted about 14% of the total maximum area of the upland agricultural zone at Lapakahi. If the land section as defined by Trails III and IV were extended to the inland limits of Lapakahi—apparently a valid extension on the basis of ethnohistoric material, land grant records, aerial photographs, and a ground level field check, then the total area of this extended DSA section would be approximately 23% of the total maximum area of the upland agricultural zone. Other selected proportions and representative land area data are summarized in Table 3.

For analytical purposes, the DSA was divided in two different ways (Fig. 7). On the basis of possible socio-cultural differences, the DSA was divided into two basic units: Unit A, defined as that area between Trails III and III-A; and Unit B, that area between Trails III-A and IV. On the basis of arbitrarily imposed, equidistant grid lines set approximately parallel to the elevation contours and perpendicular to its long, inland-seaward axis (lines along margin, Fig. 7), the DSA was subdivided into

Figure 7. Archaeological features of the upland Lapakahi Detailed Study Area.

a series of eight arbitrary units approximately 300 m^2. Arbitrary subdivisions 1–4 are referred to as the upper portion of the DSA, while subdivisions 5–8 are referred to as the lower portion. Further sets of equidistant lines might be added to provide a series of finer subdivisions.

Detailed basic data on the structural remains found in the DSA are presented in two tables. Table 4 summarizes feature type and distribution according to both arbitrary subdivisions and possible sociocultural units. Table 8 summarizes the defined agricultural field units located in the DSA. For purposes of the latter table, only rectangular field units in which all four sides could be traced or accurately inferred were included.

Results

Excluding specific exceptions to be noted, the generalizations made earlier on the overall composition and distribution of structural remains at Lapakahi were largely supported by the quantitative analysis of features located within the defined representative sample designated as the Detailed Study Area. Features inferred to be residential were the most common category of structural remains found in the DSA, composing approximately 67% of all features. The composition of structural remains within the DSA is summarized on the basis of major features in Table 5-a. The proportion of major feature types within each of Units A and B is much the same as for the DSA. Comparison of the upper and lower portions of the DSA indicates a similar composition, with apparent differences most likely the effect of extremely small sample size (for example, water catchment and religious features), and/or small total sample of features within a specific area (for example, the lower portion of Unit A). The only anomaly lacking an obvious explanation was the consistently greater proportion of agricultural features (both garden areas and enclosures) found in Unit B.

The distribution of each major kind of feature is compared on a basis of the upper/lower subdivision in Table 5-b. Both residential features and, to a lesser degree, agricultural features were distributed about equally between the upper and lower portions of the DSA. The apparent inconsistency of distribution with Unit A, but not Unit B, is most

Table 3 Representative Area Figures for Lapakahi[1]

Detailed Study Area	Acres	Hectares[2]
DSA total	151.22	61.19
Unit A	35.32	14.29
Unit B	115.90	46.90
DSA extended total	254.24	102.88
Extended, unmapped portion	103.02	41.69
Unit A; extended total	93.95	38.02
Unit A; extended, unmapped portion	58.63	23.73
Unit B; extended total	160.29	64.87
Unit B; extended, unmapped portion	44.39	17.96
Lapakahi Area		
Lapakahi area total	2049.49	829.41
Coastal habitation zone	45.10	18.25
Middle barren zone	902.79	365.35
Upland agricultural zone	1101.60	445.81
Undisturbed portion	612.76	247.98
Disturbed portion	488.84	197.83
Combined middle and coastal zones	947.89	383.60
Selected Proportions		**%**
Of total Lapakahi area,		
coastal habitation zone:		2.20
middle barren zone:		44.04
upland agricultural zone:		53.74
Of total upland agricultural zone,		
DSA:		13.72
DSA-extended total:		23.08
Unit A-extended:		8.52
Unit B-extended:		14.55
undisturbed portion:		44.37
Of total DSA,		
Unit A:		23.35
Unit B:		76.64
Of undisturbed upland agricultural zone,		
DSA:		24.67

[1]Refer to Figures 2 and 7, Lapakahi maps.

[2]1 hectare = 10,000 square meters = 2.471 acres

Table 4 Major Structural Features in the Detailed Study Area: Socio-cultural Units and Arbitrary Subdivisions

Arbitrary Subdivisions	1		2		3		4		5		6		7		8		Unit Subtotals		DSA
Socio-cultural Unit	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	total
Major Features	14	31	30	54	37	43	30	46	24	44	23	39	5	41+	+	18+	163+	316+	479+
Residential	5	6	12	26	16	14	10	25	6	26	3	20	-	18	-	14	52	149	201
C-shape	5	4	10	18	16	2	6	23	5	15	2	12	-	13	-	4	44	91	135
Cs[1]	3	4	8	12	14	2	5	14	3	14	2	10	-	10	-	3	35	69	104
Cb	1	-	-	2	1	-	-	4	1	-	-	1	-	1	-	1	3	9	1
Cc	1	-	2	4	1	-	1	5	1	1	-	1	-	2	-	-	6	13	19
L-shape	-	-	-	-	-	2	2	-	1	5	-	2	-	4	-	2	3	15	18
Platform	-	2	1	6	-	10	1	2	-	3	-	2	-	1	-	6	2	32	3
Pe	-	1	1	6	-	6	1	-	-	3	-	2	-	1	-	6	2	25	27
Ps	-	1	-	-	-	4	-	2	-	-	-	-	-	-	-	-	-	7	7
Sq/Rec.	-	-	1	2	-	-	-	-	-	-	-	3	-	-	-	-	1	5	6
Misc.	-	-	-	-	-	-	1	-	-	3	1	1	-	-	-	2	2	6	8
Agricultural	6+	18	15	21	17	21	18	20	18	17	19	11	3	16+	+	2+	96+	126+	222+
Field units	6+	18	13	19	16	10	15	13	17	15	19	9	3	5+	+	+	89+	89+	178+
Gardens	-	-	-	1	1	1	2	1	-	2	-	2	-	7	-	2	3	16	19
Gf	-	-	-	-	-	-	-	1	-	2	-	-	-	1	-	-	-	4	4
GfE	-	-	-	-	-	1	1	-	-	-	-	1	-	2	-	-	1	4	5
Gg	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	1
GgE	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	1	2	3
Gk	-	-	-	-	-	-	-	-	-	-	-	1	-	3	-	2	-	6	6
Enclosures	-	-	2	1	-	10	1	6	1	-	-	-	-	4	-	-	4	21	35
Ea?	-	-	2	-	-	8	1	6	1	-	-	-	-	3	-	-	4	17	21
E	-	-	-	1	-	2	-	-	-	-	-	-	-	1	-	-	-	4	4
RA Complex[2]	-	1	1	2	-	1	1	-	-	-	-	2	-	-	-	-	2	6	8
Water Catchment	-	1	-	1	-	3	1	-	-	-	-	-	-	1	-	-	1	6	7
Religious	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
Burial Features	2	6	1	3	2	3	1	1	-	-	-	3	-	1	-	1	6	18	24
Bm	2	2	1	2	1	3	1	1	-	-	-	2	-	1	-	-	5	12	17
Bp	-	4	-	1	1	-	-	-	-	-	-	1	-	-	-	-	1	6	7
Other Features	1	-	1	2	2	2	-	-	-	1	1	5	2	5	-	1	7	16	23
M	1	-	1	2	2	2	-	-	-	-	1	5	1	2	-	-	6	11	17
Mc	-	-	-	-	-	-	-	-	-	1	-	-	1	3	-	1	1	5	6

[1]Key to abbreviations located on Detailed Study Area map (Fig. 7).

[2]RA Complexes excluded from totals because they are composed of varying numbers of individual structural features.

likely a function of the attenuation of Unit A in the lower portion of the DSA.

C-shaped structures were consistently the most common residential feature, comprising approximately 67% of all the residential features located within the DSA. Table 6-a summarizes the composition of residential features in the DSA. While C-shaped structures were the most common residential feature in both Units A and B, L-shaped structures and platform features were proportionately much more common in Unit B than A.

The proportion by unit of C-shaped structures was consistent for both the upper and lower portions of the DSA, but in all cases, L-shaped structures were much more common in the lower portion. At all levels of comparison, simple C-shaped structures were the most common variety of C-shaped structures. The unusually high proportion of platform features found in the upper portion of Unit B was a function of the large number of such features found associated with and/or adjacent to the large residential/agricultural enclosure complex located on the 1100’ (335 m) elevation contour.

Table 5 Composition and Distribution of Structural Remains in the Detailed Study Area[1]

(a)
% of feature type by unit

Feature	DSA overall			Upper portion			Lower portion		
Types	DSA	A	B	DSA	A	B	DSA	A	B
Residential	66.8	70.3	65.6	65.1	70.5	62.3	69.0	69.2	69.0
Agriculture	14.6	9.6	16.3	14.9	9.8	17.5	14.3	7.7	15.0
Water catchment	2.3	1.4	2.6	3.4	1.6	4.4	0.8	-	0.9
Religious	0.7	1.4	0.4	1.1	1.6	0.9	-	-	-
Burial	8.0	8.1	7.9	10.9	9.8	11.4	4.0	-	4.4
Other	7.6	9.5	7.0	4.6	6.6	3.5	11.9	23.1	10.6
Totals	100.0%	100.3	99.8	99.9	99.9	100.0	100.0	100.0	99.9

(b)
% of feature type in Upper and Lower portion

Feature	Sample size			DSA		Unit A		Unit B	
Types	DSA	A	B	Upper	Lower	Upper	Lower	Upper	Lower
Residential	201	52	149	56.7	43.3	82.7	17.3	47.0	53.0
Agriculture	44	7	37	59.1	40.9	85.7	14.3	54.1	45.9
Water catchment	7	1	6	85.7	14.3	100.0	-	83.3	16.7
Religious	2	1	1	100.0	-	100.0	-	100.0	-
Burial	24	6	18	79.2	20.8	100.0	-	72.2	27.8
Other	23	7	16	34.8	65.2	57.1	42.9	25.0	75.0
Totals	301	74	227						

[1]Excluding defined field units.

The distribution of residential features is compared on a basis of the upper/lower subdivision in Table 6-b. In all cases, C-shaped structures—the most common form of residential feature overall—were proportionately more common in the upper portion of the DSA, while L-shaped structures were more common in the lower portion. The apparent exception noted for the distribution of L-shaped structures in Unit A was a function of the small sample size within that unit.

Surface and excavation evidence supported the proposition that C-shaped structures were significant prehistoric residential features. Primarily simple C-shaped forms, these structures shared characteristics which indicated extended rather than temporary residential occupation. They exhibited (a) high mounded interior surfaces, defined by frontal stone alignments, and demonstrated by excavation to be the result of accumulated cultural deposits; (b) they were larger, structurally more substantial and complex, and better built than other C-shaped structures; (c) walls and other architectural features showed sequences of modifications, additions, and rebuilding; and (d) they usually were found located in clusters composed of 2-5 similar and/or other C-shaped structures.

A total of 45 such C-shaped structures was found within the DSA. Simple C-shaped forms composed about 78% of the total, while boxed C and compound C-shaped ones composed about 11% each. Data relevant to consideration of these structures are summarized in Table 7. The first section (7-a) indicates composition and distribution by possible socio-cultural unit and arbitrary subdivision on a basis of formal variation, while the second section (7-b) of the table indicates composition and distribution at less specific levels of structural variation. Approximately 31% of the extended occupation C-

Table 6 Composition and Distribution of Residential Features in the Detailed Study Area

(a)
% of residential feature type by unit

Feature	DSA overall			Upper portion			Lower portion		
Types	DSA	A	B	DSA	A	B	DSA	A	B
C-shaped	67.2	84.6	61.1	73.7	86.0	66.2	58.6	77.8	56.4
Simple	51.7	67.3	46.3	51.4	69.8	45.1	48.3	55.6	47.4
Boxed	6.0	5.8	6.0	7.0	4.7	8.5	4.6	11.1	3.8
Compound	9.5	11.5	8.7	13.2	11.6	12.7	5.7	11.1	5.1
L-shaped	9.0	5.8	10.1	3.5	4.7	2.8	16.1	11.1	16.7
Platform	17.0	3.8	21.5	19.3	4.7	28.2	13.8	-	15.4
Earth	13.4	3.8	16.8	13.2	4.7	18.3	100.0	-	15.4
Stone	3.5	-	4.7	6.1	-	9.9	-	-	-
Sq./Rect.	2.9	1.9	3.4	2.6	2.3	2.8	3.4	-	3.8
Misc.	4.0	3.8	4.0	0.9	2.3	-	8.0	11.1	7.7
Totals	100.1%	99.9	100.1	100.0	100.0	100.0	99.9	100.0	100.0

(b)
% of feature type in Upper and Lower portion

Feature	Sample size			DSA		Unit A		Unit B	
Types	DSA	A	B	Upper	Lower	Upper	Lower	Upper	Lower
C-shaped	135	44	91	62.2	37.8	84.1	17.1	51.6	48.6
Simple[1]	104	35	69	73.8	82.4	81.1	71.4	68.1	84.1
Boxed	12	3	9	9.5	7.8	5.4	14.3	12.8	6.8
Compound	19	6	13	16.7	9.8	13.5	14.3	19.1	9.1
L-shaped	18	3	15	22.2	77.8	66.7	33.3	13.3	86.7
Platform	34	2	32	64.7	35.3	100.0	-	62.5	37.5
Earth[1]	27	2	25	68.2	100.0	100.0	-	65.0	100.0
Stone	7	-	7	31.8	-	-	-	35.0	-
Sq./Rect.	6	1	5	50.0	50.0	100.0	-	40.0	60.0
Misc.	8	2	6	12.5	87.5	50.0	50.0	-	100.0
Totals	201	52	149	56.7%	43.3	82.7	17.3	47.0	53.0
				% of total residential features					

[1]Proportion of varieties within feature type.

shaped structures were located within Unit A, while about 69% were in Unit B. In all cases, they formed a consistent proportion of both total residential features and of total C-shaped features, with the exception of the lower portion of Unit A. This inconsistency is most likely a function of the small total number of features within the area. Distribution on a basis of the upper/lower subdivision is about equal, again with the exception of the lower portion of Unit A. In this case, the inconsistency most likely resulted from the attenuation of Unit A.

A series of calculations was made on the agricultural field units located within the DSA. Basic measurements used were the average length and width of each rectangular field that was clearly defined on all four sides. Measurements were taken from the original plane table map field sheets. In cases of irregularly defined rectangular fields, averaged dimensions were taken. Using these data, the following calculations were made for each of the arbitrary subdivisions of Units A and B, and for Units A and B each as a whole: mean length, width, and area;

Table 7 Composition and Distribution of Substantial C-Shaped Structures in the Detailed Study Area

(a)

	1		2		3		4		5		6		7		8			% of
Type	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	Total	Total
Simple C	2	-	-	4	5	1	1	5	3	8	-	2	-	4	-	-	35	77.8
Boxed C	1	-	-	-	-	-	-	2	1	-	-	1	-	-	-	-	5	11.1
Compound C	-	-	-	1	-	-	-	1	1	-	-	-	-	2	-	-	5	11.1
Totals	3	-	-	5	5	1	1	8	5	8	-	3	-	6	-	-	45	100.0

(b)

	DSA overall			Upper portion			Lower portion		
	DSA	A	B	DSA	A	B	DSA	A	B
n =	45	14	31	23	9	14	22	5	17
% of residential features	22.4	26.9	20.8	20.2	20.9	19.7	25.3	55.6	21.8
% of C-shaped features	33.3	31.8	34.1	27.4	24.3	29.8	43.1	71.4	38.6
% per unit	100.0	31.1	68.9	51.1	64.3	45.2	48.9	35.7	54.8

total area; and the standard deviation of length, width, and area. These calculations, as well as the ranges for field length, width, and area, are summarized in Table 8. The total field area within the DSA, based on this method, was 532,157.5 m^2. The total area of the DSA as calculated with a polar planimeter was 611,900 m^2. The difference between these two estimates might be taken as one indication of the magnitude of total DSA area not utilized for field scale cultivation of major subsistence crops. Such area would have been either nonproductive, being occupied by residential, other structural, or natural features, or cultivated for industrial and/or minor subsistence plants. The difference in area suggests that land not utilized for field scale cultivation was on the order of 10–15% of the total area of the DSA, calculated as:

$$(611{,}900 - 532{,}157.5) / 611{,}900 = 13.03\%$$

Variation in field length and width, expressed in Table 8 as measures and standard deviations, demonstrates certain points about the field system within the DSA boundaries: (a) field length changes at a fairly constant rate, with Unit A fields becoming progressively shorter while those of Unit B become progressively longer; (b) field width remains relatively constant, with somewhat more variation in Unit B than A; and (c) therefore, field area is primarily a function of variation in field length. The implication for the Lapakahi field system as a whole, and possibly for the rest of the leeward Kohala field system is that within any defined set of bound field units, field width remains relatively constant, and the progressive increase or decrease in the area of adjacent field units, a function of changing field length, follows a gradual rather than sudden progression. The simple field unit system analysis provides quantitative support to a visual impression.

Densities of selected residential features were calculated on a basis of both total delimited area and total field area for the DSA as a whole, and for Units A and B as independent units. Densities involving upper/lower comparisons were calculated on a basis of total field unit area only, because total delimited areas for individual arbitrary subdivisions were not determined. The comparative figures presented in Table 9-a, however, do suggest a valid extension of comparability. The relative order and degree of density differences are generally consistent.

Table 8 Statistical Analysis of Field Units Located in the Detiled Study Area

	Arbitrary Subdivisions							
UNIT A	1	2	3	4	5	6	7	unit totals
no. of fields	6	13	16	15	17	19	2	88
mean length	110.5	102.1	91.0	76.5	66.1	44.5	26.3	75.2
mean width	21.7	23.0	18.8	19.6	17.6	15.8	21.0	18.9
mean area	2,393.7	2,363.8	1,714.8	1,502.9	1,169.6	714.7	589.8	1,474.0
total area	14,362.0	30,729.8	27,436.5	22,542.8	19,883.8	13,579.8	1,179.5	129,714.0
s.d. length	1.61	6.88	2.46	3.61	6.36	6.74	3.89	23.33
s.d. width	4.55	5.52	4.58	4.85	5.74	3.95	19.80	5.68
s.d. area	500.23	630.75	429.05	385.04	418.15	249.03	432.78	723.48
UNIT B								
no. of fields	18	19	10	13	15	9	5	89
mean length	165.2	170.4	147.9	192.0	227.1	252.9	284.8	195.4
mean width	17.8	15.1	29.0	25.0	19.8	32.2	37.0	22.3
mean area	2,818.8	2,567.6	4,606.2	4,821.4	4,507.4	8,242.5	10,477.3	4,521.9
total area	50,737.5	48,785.3	46,061.5	62,678.5	67,611.0	74,182.3	52,386.5	402,442.5
s.d. length	8.24	10.32	9.32	14.50	6.90	13.55	8.38	39.33
s.d. width	3.10	3.81	11.07	5.40	5.53	16.98	13.44	10.35
s.d. area	506.71	658.87	1,808.61	1,139.62	1,307.39	4,515.71	3,617.93	2,392.05

	Ranges for Length, Width, and Area					
	length		width		area	
	min	max	min	max	min	max
UNIT A	23.5	116.0	7.0	35.0	372.8	3,622.5
UNIT B	148.0	293.5	9.0	71.0	1,426.5	18,353.5

Note: all figures are in meters or square meters.

Densities of selected residential features, determined on a basis of field unit area only, are presented in Table 9-b. Densities for other kinds of features were not calculated for this analysis, but could be readily determined with the data presented in Tables 3, 4, and 8. The densities of the selected residential features are generally consistent, except for a slightly greater degree of variation in Unit B for the upper/lower comparison, and for the apparent reversal of trend in Unit A for the upper/lower comparison. The overall consistency within Units A and B, and within the DSA as a whole, suggests that the density anomalies noted above reflect the non-random, or clustered distribution of residential features within the two possible socio-cultural units, A and B.

As a test for this indicated non-random distribution, a simple form of nearest neighbor analysis was conducted using the distribution of the substantial, extended occupation C-shaped structures discussed earlier. This analysis utilized the distance to the nearest neighbor as a measure of spatial relationships within a population. The specific measure of spacing adopted was one developed by Clark and Evans which measured "…the manner and degree

Table 9 Density of Residential Features in the Detailed Study Area

(a)

Density per hectare of total delimited area

	DSA	Unit A	Unit B
Residential features	3.28	3.36	3.17
C-shaped features	2.20	3.07	1.94
Extended occupation C-shaped features	0.73	0.97	0.74

(b)

Density per hectare of total field unit area

	DSA overall			DSA		Unit A		Unit B	
	DSA	Unit A	Unit B	Upper	Lower	Upper	Lower	Upper	Lower
Residential features	3.77	4.00	3.70	3.75	3.80	4.52	2.68	3.41	4.04
C-shaped features	2.53	3.39	2.26	1.45	3.97	3.89	2.02	2.25	2.26
Extended occupation C-shaped features	0.84	1.07	0.86	0.75	0.96	0.94	1.44	0.67	0.87

to which the distribution of individuals in a population on a given area departs from that of a random distribution" (Clark and Evans 1954:446). This measure of departure from randomness is the ratio (R) of the actual mean distance between nearest neighbors (r_A) to the expected mean distance (r_E):

$$R = r_A/r_E$$

where R is a simple measure of spacing with a limited range. In a situation of maximum aggregation, R = 0; in a random distribution, R = 1; and in a situation of maximum spacing, R = 2.1491 (Clark and Evans 1954:447).

Values of R were determined for the distribution of the extended occupation C-shaped structures located within the DSA overall, and within Units A and B as independent units (Table 10). The most important point to be noted is the clear, positive indication of non-random distribution found within both Units A and B. This supports the interpretation advanced earlier on the basis of the density analysis that the substantial, extended occupation C-shaped structures tended to cluster. The same generalization was made even earlier, based on the field reconnaissance of surface structural remains found in the general Lapakahi area.

Concluding Discussion

Agricultural System Reconstruction

On the basis of ethnohistoric sources and the upland archaeological research, it is possible to reconstruct the aboriginal agricultural system at Lapakahi in terms of certain aspects of the component horticultural and socio-economic complexes (Rosendahl 1972:441–491, 503–511). The summary presented here represents one specific local variation in the aboriginal Hawaiian cultural adaptation to their island ecosystem.

The prehistoric agricultural system at Lapakahi involved intensive dryland swidden cultivation, predominantly of sweet potato (*Ipomoea batatas* [L.] Lam) and, to a lesser degree, dryland taro (*Colocasia esculenta* [L.] Schott), in permanent field units. In addition to these two dominants, a wide range

Table 10 Non-random Spacing of Extended Occupation Structures in the Detailed Study Area

	Unit A	Unit B	DSA Overall
R	0.55	0.75	0.67
r_A	27.9 m	46.4	39.6
r_E	51.0 m	61.7	58.8
sample size	14	31	45

of secondary subsistence and industrial plants were cultivated or encouraged, including sugar cane (*Saccharum officinarum* L.), *ti* (*Cordyline terminalis* [L.] Kunth), yam (*Dioscorea* spp.), pandanus (*Pandanus odoratissimus* L.f.), paper mulberry (*Broussonetia papyrifera* [L.] Vent.), bamboo (species unknown), *hau* (*Hibiscus tiliaceus* L.), arrowroot (*Tacca leontopetaloides* [L.] O.Ktze.), turmeric (*Curcuma domestica* Valet.), candlenut (*Aleurites moluccana* [L.] Willd.), *pili* grass (*Heteropogon contortus* [L.] Beauv.), coconut (Cocos *nucifera* L.), banana (*Musa paradisiaca* L.), *olonā* (*Touchardia latifolia* Gaud.), *'awa* (*Piper methysticum* Fors.f.), gourd (*Lagenaria siceraria* [Molina] Standley), and *'ilima* (*Sida fallax* Walp.).

The practices and techniques comprising the horticultural complex included a system of shifting or discontinuous cultivation of permanent fields defined by low piled stone and earthen embankments; a cropping scheme involving fallow periods of unknown length; clearing of fallow cover by burning; digging stick as the principal agricultural implement; partial soil tillage; full field scale planting of dominant subsistence cultigens, with scattered plantings of most other cultigens; ti, sugar cane, and possibly bamboo planted on field border embankments; sweet potato planting in individual soil mounds raised in clearings among piled stone mounds; taro planting in spaced individual holes and/or raised soil mounds; extensive mulching of taro and possibly sweet potato, using grasses and sugar cane tops; informal terracing, depending upon immediate terrain; use of numerous micro environments, such as gully bottoms and side slopes, and broken rock outcroppings, for cultivation of specific plants; and an animal husbandry component, based principally on pigs, but also including dogs and chickens.

The rectangular fields were aligned parallel to the coast, and were grouped into a number of larger units defined by the system of curbstone-lined foot trails that extended inland-seaward. These trails concurrently formed the short ends of the rectangular fields. The trails functioned as land unit boundaries, and as paths for the movement of people and produce both between the coast and the uplands, and within the upland agricultural zone itself.

Distributed throughout the field units were varied residential features, principally C-shaped structures of differing forms and sizes. Some of these C-shaped structures were small, crude field shelters—temporary occupation structures—which stood isolated within field units or at the edge of field units. Other C-shaped structures were large, well-built, substantial residential features which functioned as extended occupation structures. Dispersed over the fields within each trail-defined land unit were clusters of these extended occupation structures which, with a variety of smaller associated structures, comprised domestic residential units occupied by household groups. The aggregate of these household groups comprised the local community.

Each local community held a specific section of land, and each land unit had a number of general characteristics in addition to the residential patterns, including rectangular bound field units, irregular gardens, small enclosures or pens, water catchments, scattered burial features, and an internal system of criss-crossing access trails. Perhaps the most significant single structural site present within each land unit was the religious or ceremonial site associated with each local community group. This site was usually situated about midway between the inland and seaward limits of the agricultural area.

Residential units in the upland agricultural zone were generally occupied for extended periods of time, according to a pattern of shifting residence. This pattern was basically seasonal in nature, and was characterized by recurrent sequences of occupation, structural modifications and repairs, firepit construction, and eventual abandonment, with reoccupation commencing again after some time interval. Seasonal occupation of upland residences was obviously in connection with agricultural activity, particularly the major harvest, and subsequent clearing and planting activities conducted just prior to and after the beginning of the rainy winter season.

The shifting of residences was a pattern of alternating coastal and upland occupation; upland in the rainy winter season in connection with agricultural activity, and coastal during the rest of the year in connection with fishing and other marine resource exploitation activities. At any one time the majority of inhabitants resided in one zone, but a few people generally remained in the other. In addition to the major seasonal upland occupation for harvest, clearing, and planting, short term shifts were also made for purposes of tending and harvesting during the period when the major occupation was coastal. Even when the major occupation was upland, contact with the coast was maintained by the movement of people along the major trails, bringing various marine resource—both food and manufacturing—to upland residences. In addition to coastal contact during the upland occupation, contacts were maintained beyond the immediate area for obtaining various products and resources that did not occur locally.

The pattern of shifting residence was predominant most of the prehistoric occupation sequence at Lapakahi. During the later portion of the prehistoric period, the incidence of dispersed permanent occupation increased, eventually becoming the dominant historic period pattern. Such a gradual change in the nature of residence patterns possibly also came about in the coastal area. This trend toward permanent occupation at the coast was manifest in the enlargement of the Koaiʻe Hamlet settlement. It is this pattern of dispersed permanent occupation accepted as the traditional Hawaiian residential pattern (Handy and Pukui 1958). This pattern stressed the reciprocal exchange of subsistence products and other goods and services, between widely dispersed members of the local community, some living permanently at the coast and engaged principally in marine resource exploitation, and other members living permanently in the upland area and engaged principally in agricultural activity.

The overall structural and excavation evidence of residential occupation and agricultural activity at Lapakahi indicated a capacity to support the relatively large aboriginal population which must have been present. The existence of such a population in the western Kohala area, of which Lapakahi was a part, is supported for the immediate pre-contact period by the early ethnohistoric record (King 1967:619).

Significance of Lapakahi

The significance of Lapakahi can be best viewed in relation to the development of aboriginal agricultural systems in Hawaiʻi. These have been characterized as mixed permanent pondfield systems with extensive swidden components, and modified integral swidden systems (Yen et al. 1972:91). The former are exemplified by wet valley systems dominated by well-developed irrigated pondfield cultivation; the latter by tableland systems based on extensive dryland cultivation; but just as there is a wide range of local environmental variation between the extreme contrasts of wet valley and dry tableland, so too there is a wide range of variation among the component elements of Hawaiian agricultural systems. Still, the two principal strategies represent the main developmental endpoints along a continuum of agricultural variation in Hawaiʻi.

Consideration of the basic horticultural elements of Hawaiian agriculture generally supports the concept of the transfer of these elements from within eastern Polynesia; at the same time, comparisons demonstrate both the segregational effects of the Hawaiian environment and the flexibility of development within the limited horticultural set (Yen 1971:10–12; 1973:70–71, 76, 80). The most distinctive developmental characteristics of Hawaiian agricultural systems can be summarized as these:

1) wide-spread development of large-scale valley systems based on irrigated pondfield cultivation of taro;

2) development of extensive dryland systems based on the cultivation of sweet potato and dry taro under a slash and burn regime;

3) importance of dryland irrigation, involving intermittently-flowing natural streams; and
4) development of dryland permanent fields which were cropped under intensive swidden cultivation schemes.

Consideration of dryland horticultural variation noted among other archaeologically known Hawaiian agricultural systems (Rosendahl 1972: 516–533) indicates that the reconstructed horticultural complex of Lapakahi exhibits, at a comparable or later time depth, virtually the full range of dryland agricultural variation found in other Hawaiian dryland contexts. The particular emphasis at Lapakahi on certain cultigens, structural features, and techniques was most likely a function of specific local environmental factors—principally limitations in the form of low annual rainfall and frequent strong winds. In terms of aboriginal Hawaiian agricultural development, the Lapakahi dryland system can be regarded as a developmental endpoint, or culmination. The various dryland horticultural features characteristic of Lapakahi were conditional factors which permitted and facilitated expansion from wet valleys with irrigated pondfield systems into extensive, semi-arid areas such as leeward Kohala. One major permissive factor was the sweet potato, a cultigen extremely adaptable to a wide range of edaphic and climatic conditions, and well-suited to field-scale cropping. Originally, the sweet potato would have occupied a secondary subsistence role in the earlier wet valley taro systems, but its adaptability was a factor, not shared by taro, which permitted the subsequent major expansion of settlement into marginal, semi-arid areas, and the development of extensive dryland agricultural systems in Hawai'i (Yen 1971:12).

While environmental conditions and horticultural features were the limiting and conditional factors defining the range of possibilities within which dryland agricultural systems such as Lapakahi could develop, still missing are the causative factors involved, and the processes through which such factors could operate. Consideration of the development of agricultural systems in Hawai'i suggests that agricultural intensification is the basic process through which change has occurred. If intensification can be regarded as a response to increasing needs within an on-going agricultural system, then the most useful definition of intensification is one which views any change that functions to increase agricultural productivity.

Thus defined, intensification can take a number of different forms. The use of additional labor per unit of cultivation area and an increased frequency of cropping are obvious strategies. Other alternatives include the expansion of total area under cultivation, the development of food storage techniques (Yen 1973:79–80), the development of full-time agricultural specialists, and the adoption of, or an increased emphasis on, other horticultural elements such as a previously minor or unknown cultigen or technique. The basic factors which limit the form any intensification may take—the conditions of the physical environment and the features of the horticultural complex—define the range of possibilities within which agricultural development could proceed, but these are not the factors which initially stimulate or necessitate change within an agricultural system.

The cause to consider would be increasing demands for subsistence products. Such demands are generally interpreted as a function of increasing population growth pressures. A strong case has been made for population growth as the major determinant of agricultural development in primitive subsistence economies (Boserup 1965). However, this argument fails to consider an alternative cause, one which ethnohistoric reconstructions of the highly stratified aboriginal Hawaiian society suggest to be of importance. This factor is social or socio-political pressures, such as those that were imposed in the form of increasing demands for subsistence and other products by the upper strata of Hawaiian society upon the lower (Yen 1973: 81–82, see also Brookfield 1972). Thus looking at the significance of Lapakahi, it is important to consider that the intensification of the agricultural system might well exemplify responses to more complex socio-political pressures rather than simple population increase pressures alone.

In conclusion, the significance of Lapakahi can be summarized as follows:

1) typifying an endpoint in Hawaiian agricultural development, Lapakahi stands out as a dryland agricultural adaptation of such magnitude as to be found in few other places in Hawai‘i;

2) Lapakahi demonstrates agricultural intensification to be a fundamental process of agricultural development, and indicates the utility of defining intensification in the least restrictive terms; and

3) Lapakahi argues the necessity of considering both simple population growth and more complex socio-political pressures, rather than population growth alone, as non-exclusive determinants or causative pressures for agricultural development.

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Notes

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2. Individual sites recorded within the Lapakahi area were assigned four-digit numbers from a master list of Hawai'i Island site numbers provided by the Parks Division of the Hawai'i State Department of Land and Natural Resources. The entire Lapakahi area was subsequently incorporated into a single archaeological district, referred to as the Lapakahi Complex, and assigned Hawai'i Register of Historic Places site No. 50–10–02–2245. According to this system, 50 denotes the State of Hawai'i, 10 denotes the island of Hawai'i, and 02 identifies a specific U.S.G.S. quandrangle map (7.5 minute series). The final four-digit number, 2245, is a unique site number from the Hawai'i Island master list of numbers. In the present paper, sites are referred to by their unique four-digit numbers, with deletion of the 50–10–02 prefix, as a matter of convenience. The extensive Kohala Field System, a portion of which lies within the Lapakahi Complex, has been assigned Hawai'i Register of Historic Places Site No. 50–10–02–6600.

Ancestral Oceanic Society and the Origins of the Hawaiians

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In *Evolution of the Polynesian Chiefdoms*, Patrick Kirch (1984) discussed Ancestral Polynesian Society, reconstructed from linguistics, archaeology, and comparative ethnography. This is seen as the baseline from which the Hawaiian and other contemporary Polynesian societies originated and from which they have been transformed over time (Kirch and Green 1987). Ancestral Polynesian Society did not of course appear out of nothing, its own origins were in the Lapita Culture which can be traced back to the Bismarck Archipelago to the immediate east of the Island of New Guinea.[1] The question of ultimate Lapita origins is a more controversial one and will not be pursued in detail in this paper (but see Allen and White 1989, Gosden et al. 1989; Spriggs 1989). Instead, the nature of early Lapita culture in the Bismarcks will be examined as the culture directly ancestral to Ancestral Polynesian Society.

This examination seems worth attempting for several reasons. The issue of Polynesian origins is still a hot topic in Pacific archaeology as it has been since the inception of the subject. Since Kirch's 1984 book a lot of new data have come to light bearing on this issue in archaeology, linguistics, and genetics, and these confirm the centrality of the 'Lapita homeland' region in addressing it. Second, it seems important in assessing the uniqueness, or otherwise, of Polynesian culture and sociopolitical organization that its degree of transformation from an ancestral base outside Polynesia is evaluated and that the different subsequent histories of Polynesia and Island Melanesia are examined in relation to this ancestral base. Third, there is a tradition of Polynesian racism as regards the inhabitants of Melanesia, typified by Peter Buck's *Vikings of the Sunrise* (1938) but going back to the last century. Restating the Melanesian roots of Polynesian culture helps to confound that racism, a racism bolstered by a particular reading of the region's prehistory.

Lapita Culture in the Bismarcks

In looking at Lapita culture in the Bismarcks one is struck by how similar it is to Lapita and early Polynesian culture in the Fiji-Tonga-Samoa area, except more so: the pottery is more complex in design and vessel form, there are a wider range of domesticated plants in evidence and the Lapita occupation begins earlier.

Based on pottery from three Bismarcks sites, Dimitri Anson in 1983 defined a 'Far Western' Lapita pottery style with more complex and more finely-executed dentate stamped designs than found in previously defined 'Western' and 'Eastern' Lapita styles (Anson 1983, cf. Anson 1986). The explosion of archaeological work in the Bismarcks as a result of the 1985 Australian National University's Lapita Homeland Project (Allen and Gosden 1991) has confirmed this picture, despite an initial questioning of the 'Far Western' concept (Kirch et al. 1987). The earliest Lapita sites have the most complex vessel forms and designs and there is a trend towards simplification in both over time and as Lapita culture expanded east to Polynesia.

Several of the Bismarcks' Lapita sites have produced plant remains (Gosden et al. 1989:574; Kirch 1988a) which show that the full complement of the Oceanic root and tree crop complex was present at that time. Several of the tree species which remain important in Melanesia were apparently never transported as far as Fiji and/or Polynesia.

In a review of Lapita dates, Kirch and Hunt (1988) suggested an archaeologically instantaneous spread of Lapita, with sites in Fiji and Western Polynesia being as early as any in the Bismarcks. A re-study of these, and analysis of further dates, now available suggests a pause in the Bismarcks before rapid spread to the east at about 3200–3000 BP (Spriggs 1990). How long this pause took is not yet established. The earliest secure dates for Lapita sites in the Bismarcks start at about 3650–3450 BP with the single early date of 3850 BP from Kohin Cave, Manus (Kennedy 1981) now looking increasingly unlikely.

Early Lapita culture was fully horticultural with domestic pigs, dogs, and chickens. Settlements were nucleated, permanent villages, some at least consisting of stilt houses out over the reefs. Evidence for social organization is equivocal. Shell ornaments resembling ethnographic shell 'valuables' have been taken to imply ranking (Kirch 1988b), and evidence for intrasite spatial differentiation in the occurrence of decorated pottery might also be interpreted in this way (but see Gosden 1989 for alternative views on Lapita social organization). The new Lapita evidence is summarized by Gosden et al. (1989), but see also some more recent results and opinions (Allen and White 1989; Gosden 1989; Kirch 1988a, 1988b; Specht et al. 1988; Torrence et al. 1990).

The question of the origins of Bismarcks Lapita culture is hotly debated, the two extremes of opinion being that it is intrusive to the region from Southeast Asia, or alternatively that it is an indigenous development in Melanesia. The truth is probably that it is a bit of both. While at one level it can be seen as an extension of the Island Southeast Asian Neolithic, this does not explain the Lapita design system which is not paralleled in earlier Southeast Asian pottery styles although there are later echoes of it there (Spriggs 1989:607). Nor does it explain the suite of root and tree crops that are present in the earliest sites and are clearly of Melanesian origin. Long-distance exchange networks for obsidian and other materials had existed in the region for thousands of years prior to Lapita. There is no earlier pottery tradition in the Bismarcks, however, and also no earlier occurrences of the Southeast Asian pig, dog, and chicken. The range of shell ornaments also seem to have no local antecedents but do have clear parallels in Island Southeast Asian assemblages (Spriggs 1990).

My view is that Lapita is basically an intrusive culture but one that took on a suite of local plants and aspects of technology from the populations among whom its culture bearers settled. The longer these cultures lived side by side, the greater the influences which passed between them.

The post-Lapita prehistory of the Bismarcks suggests a lot of continuity from Lapita times to the present and I see no reason to alter the views on this matter I put forward in 1984 (Spriggs 1984). Lapita is ancestral to many modern Island Melanesian societies, just at it is ancestral to *all* Polynesian and presumably many Micronesian societies. The difference is that parts of Island Melanesia were already settled prior to Lapita and modern Island Melanesian societies are also descended from these. Polynesia was settled early in the Lapita period and developed in comparative isolation from this 'dual inheritance' in Melanesia. To put it crudely Bismarcks Lapita culture became progressively 'Melanesianized' after Polynesia had been settled and so the latter area retained a 'purer' Lapita-based culture because of isolation. Both areas, however, are the inheritors of Lapita culture.

A Lapita Language?

It has long been a commonplace assumption that there is a link between the Lapita expansion and the spread of Austronesian languages in the Pacific (Pawley and Green 1973, 1984), but recent advances in linguistics have made the connection much clearer by a revision of the subgrouping of Austronesian (AN) languages in Western Melanesia by Ross (1988, 1989). If we attempt to 'map' the linguistic prehistory of the region on to the archaeological prehistory we find that there is not only a plausible fit, but that there are also important additional implications for the archaeology posed by the linguistic picture. The Southeast Asian origin of the AN languages has never been seriously challenged, despite arguments put forward by Terrell (1981, 1986). An ultimate Southeast Asian origin for the many AN languages of Melanesia and Polynesia points up the links between the cultures of these two areas also witnessed by the spread of Lapita culture across both. AN languages of Island Melanesia and Polynesia both belong to the Oceanic Subgroup. Ross (1989) reconstructs the place where Proto-Oceanic was probably spoken as being on the north coast of New Britain in an area that centers on the Willaumez Peninsula, the area of the Talasea obsidian quarries and a concentration of early Lapita sites currently being investigated by Jim Specht and his colleagues at the Australian Museum (Specht et al. 1988). The pattern of spread makes it clear that the makers of Lapita pottery spoke Proto-Oceanic and its successor stages down to Proto Central-Pacific in Fiji-West Polynesia. Going back 'Pre-Lapita', if a map of major AN subgroups in Southeast Asia with an understanding of the sequence of language splits from Proto-Austronesian is put down over a map of the spread of the Neolithic in the region, it fits almost perfectly (Spriggs 1989:608). This further supports a Southeast Asian origin for Lapita culture.

Polynesian and related languages in the Southeast Solomons and Vanuatu do not show features explicable by contact with Non-Austronesian languages and so the movement out of the Bismarcks of languages ancestral to them must have occurred at a time before significant contact-induced language change took place. This suggests that early Oceanic speakers kept themselves apart from other language groups in the Bismarcks. That the 'stay at home' AN speakers in the Bismarcks did later undergo such contact-induced change is clear from Ross' analysis. This parallels the 'Melanesianization' of Lapita culture in the Bismarcks. It is also interesting to note that the AN languages along the north New Guinea coast do not represent the original west to east movement to the Bismarcks out of Island Southeast Asia but a back-migration from the Bismarcks westward. The spread of AN language to the Bismarcks appears to have been a direct movement from the Biak area at the western end of New Guinea to the Willaumez Peninsula, perhaps following already long-established obsidian exchange networks back to their source. A subsequent pause in the Bismarcks for the innovations characteristic of the Oceanic group to develop is also indicated.

A Lapita People?

Advances in genetics over the last few years hold out the hope of establishing the biological origins of the Polynesians (Hill and Serjeantson 1989). An origin in Island Southeast Asia now seems certain, with some evidence of genetic admixture with populations in northern Island Melanesia.

As summarized by Serjeantson and Hill (1989: 287–88):

> The lack of particular coastal New Guinea [genetic] markers in Polynesians, such as the highrequency $-a^{4.2}$ thalassaemia Selection, the albumin NG variant, the HLA-B13.Cwf haplotype, and the B allele of the ABO blood group, all argue that the pre-Polynesians moved rapidly through this part of Melanesia. However, the presence of a substantial frequency of the Melanesian a-globin haplotypes IIIa and IVa in all Polynesians indicates that at some point there was significant interbreeding with Melanesians. The presence of the $-a^{3.7}$III but not the $-a^{4.2}$ a thalassaemia deletion indicates that this contact was probably mainly in northern island Melanesia rather than in New Guinea, unless the $-a^{4.2}$ thalassemia deletion was uncommon in northern New Guinea at that time and has been rapidly selected by malaria since then.

Not all bearers of the Lapita culture moved to Polynesia of course and the genes of the 'stay at homes' can be found in coastal and island Melanesian groups who are genetically the descendants of the Pre-Lapita populations in the area and of the intrusive Southeast Asian population who also gave rise to the Polynesians. The latest evidence is that Fijians have undergone admixture with Island Melanesian groups post-Lapita, thus restating an earlier and partly discredited view of Fijian culture history (Serjeantson and Hill 1989:288–89). The original Fijian population would have been more Polynesian in appearance. The new genetic evidence also disproves any direct link between Polynesians and Micronesians. Micronesian populations are diverse but in general are a distinct Island Southeast Asia population with genetic input from Melanesia in varying degrees (Serjeantson and Hill 1989:290–91). You certainly can't get a Polynesian out of a Micronesian, as Howells (1973) once believed.

'Ancestral Oceanic Society'

Ancestral Polynesian Society can be taken back further to its immediate roots in the Bismarck Archipelago, almost certainly on the north coast of New Britain in the area of the Talasea obsidian sources about 3500 years ago. Members of this 'Ancestral Oceanic Society' were agriculturalists and fisherpeople who lived in villages, in part at least consisting of stilt houses. They were accomplished sailors who had 'captured' the regional obsidian exchange network. They spoke a language which we today call 'Proto-Oceanic' and initially at least they would perhaps have looked somewhat like modern Polynesians, although intermarriage with local populations progressively led to a genetic 'swamping' of this phenotype. Interaction with groups already occupying the area led to the adoption of a range of local useful plants, many of which were later transferred to Polynesia. They made highly decorated Lapita pottery of 'Far Western' (perhaps better called 'Early Western') style. There is some evidence that they had hereditary leaders and may have been organized in clans called *kainana* (Pawley and Green 1984:132–3).

After several generations some groups of these people moved off to settle the rest of Island Melanesia and Polynesia. Although regular contacts were maintained between the Bismarcks and areas as far away as the Southeast Solomons for many hundreds of years, those who reached Fiji and Western Polynesia were effectively beyond regular communication range and began to diverge culturally in isolation. Those who remained, continued to mix with other Bismarcks populations and their distinctive identity faded as a variety of more local cultures developed from Lapita and pre-Lapita roots to produce the diversity found in the Island Melanesian region today.

Polynesian Racism

In the colonial encounter in Polynesia it was sometimes comforting and useful to both sides to stress apparent similarities between institutions and appearance, aristocracy, and light skin. An accepted racial hierarchy was soon adopted. Whites at the top of course, then Polynesians, then Melanesians, with Australian Aborigines, and particularly Tasmanians at the bottom. Of similar skin color to Polynesians were Island Southeast Asians whose languages were clearly related to Polynesian languages.

Polynesia was not thought to have been long-settled and an Asian and ultimately 'Europoid' (Buck's term for Caucasian) origin was therefore postulated. The problem was that Melanesia lay in between, large areas of which were not under colonial control until well into this century and whose inhabitants were not only 'savage' in reputation but whose cultures were more diverse and very different in organization to those in Polynesia. Among educated Polynesians the idea of a Melanesian past was unthinkable and stories of earlier dark-skinned races exterminated by the later arriving Polynesians were either re-made or created to identify the defeated as Melanesians.

Sadly this colonial legacy is still with us and can be seen enshrined in the Hawai'i Maritime Museum in Honolulu in its large wall map (observed in 1989) showing the settlement of Polynesia by a route studiously avoiding all contact with the islands of Melanesia, and in the process ignoring the vast weight of archaeological, linguistic, and genetic data now available.

Conclusion

In 1984 my remarks were apparently misunderstood (see reviews by Bellwood 1986 and Turner 1985) so they are perhaps worth restating. The archaeological and other evidence links Polynesia and Melanesia culturally, and in a very real sense the origins of the Polynesians can be seen in the Melanesian Lapita culture. Part of colonialist 'tactics' involved creating an artificial separation between the inhabitants of the two regions, with the Polynesians seen and seeing themselves as superior and of different origin than the inhabitants of Melanesia. The political results of this 'tactic' are still with us today and are hindering the development of a Pan-Pacific consciousness and nationalism. Full recognition of the evidence that this separation has no real basis will help to foster links between the nations of Polynesia and Melanesia which can only be to the better welfare of their inhabitants. There are important political implications in getting the picture straight and not cutting off the Polynesian story at the present boundaries of Polynesia.

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Notes

1. Terrell, along similar lines, in a recent review of *Evolution of the Polynesian Chiefdoms* suggests that Kirch's use of the term 'Ancestral Polynesian Society' is misleading for many aspects of the founding culture of Polynesia as there is "little that is peculiarly 'Polynesian' about" them (Terrell 1990:29 cf. Green 1991; Thomas 1989).

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