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Archaeological Investigations in the Mangareva Islands (Gambier Archipelago), French Polynesia

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Eric Conte and
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ARCHAEOLOGICAL INVESTIGATIONS IN THE MANGAREVA ISLANDS

ARCHAEOLOGICAL INVESTIGATIONS IN THE MANGAREVA ISLANDS (GAMBIER ARCHIPELAGO), FRENCH POLYNESIA

ERIC CONTE AND
PATRICK VINTON KIRCH,
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The front and side views of the Mangarevan god image used as chapter opening figures are from Hiroa (1983a: fig. 63), and are of a specimen in the collection of the British Museum, originally obtained from the collection of the London Missionary Society.

Design by Lisa Holm.
Set in Adobe Garamond.

Dedicated to
Roger C. Green
Who pioneered modern
archaeology in Mangareva
and throughout Polynesia

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PREFACE

The Mangareva Archaeological Project was an outgrowth of an international conference on "Eastern Polynesian Archaeology: Retrospect and Prospect" held at the University of California at Berkeley's Gump Research Station, Mo'orea Island, in November 2000. The conference, organized and hosted by Conte and Kirch with financial support from the France-Berkeley Fund of the University of California, brought together nearly thirty archaeologists active in the Eastern Polynesian arena. Towards the end of a week of lively discussions and sharing of results, and at the urging of the then Minister of Culture for French Polynesia, Mme. Louise Peltzer, we addressed the question of whether any particular island or archipelago within French Polynesia should be considered a top priority for archaeological research. Although there was not complete unanimity, most of those present concurred that the Mangareva (Gambier) Islands remained a significant lacuna in our knowledge of Eastern Polynesian archaeology. The conference therefore recommended to Minister Peltzer that the Government of French Polynesia consider supporting an archaeological project in Mangareva, with international participation.

Located at the extreme southeast margin of French Polynesia, Mangareva can be inferred to have occupied a key position in the prehistoric colonization and settlement histories of the region. From similarities of human biology, artifacts, and language, Mangareva is a likely origin point for the founding populations of Rapa Nui (Easter Island). Geochemical characterization of Eastern Polynesian basalt adzes likewise indicate that Mangareva was within the orbit, if not indeed central to, a long-distance exchange system that at one time reached east to the Pitcairn Group, with linkages as far afield as the Marquesas and the Society Islands. From the perspective of human ecodynamics, Mangareva represents an example of a small, isolated island ecosystem where anthropogenic transformations of the biotic and physical landscape were likely to have been profound. For these and other reasons, it was felt that Mangareva might hold answers to some long-standing issues in Eastern Polynesian prehistory.

Members attending the 2000 Mo'orea conference were polled for their interest in collaborating in such an international project in Mangareva; representatives of the Australian National University (A.J. Anderson), University of California at Berkeley (P. V. Kirch), Université de Polynésie Française (E. Conte), and University of Otago, New Zealand (M. I. Weisler) agreed to participate in the first field phase of the project. Fieldwork was carried out between 11 November and 7 December 2001, with work focused on Mangareva, Akamaru, and Kamaka islands. During 2002, initial results were written up and a series of radiocarbon samples were dated and published (Anderson et al. 2003a, 2003b, 2003c). In August, 2003, Conte and Kirch returned to Mangareva for a second field season, concentrating on Agakauitai and Taravai islands, with some additional work on the main island of Mangareva.

This monograph presents the findings of the 2001 and 2003 field expeditions, as well as the results from laboratory analysis of zooarchaeological assemblages and portable artifacts. While we plan to continue fieldwork in the Mangareva Islands in the future, we felt that publication of a monograph synthesizing our results to date would be valuable both to the local community in Mangareva and to interested scholars.

* * *

ACKNOWLEDGEMENTS

Both the 2001 and 2003 seasons of the Mangareva Archaeological Project were supported financially by the Service de la Culture, Ministère de la Culture, Polynésie Française. We would like to express our gratitude to Mme. Louise Peltzer, former Minister of Culture, for her keen interest in advancing archaeological research in French Polynesia, and for supporting our project. We also thank M. Christian Gleizal and M. Jean-Luc Tristani of the Ministry of Culture for their advice and technical support. Additional financial support for the 2003 season, and for dating of radiocarbon samples, was provided through a grant to Kirch by the Committee on Research, University of California, Berkeley.

In Mangareva, we were assisted by various officials of the Commune, in the first instance by the mayor Monica Richton, who extended her personal hospitality and made the resources of the Mairie available to us. Engui Guifford lent valuable assistance whenever his other duties allowed. Benoit and Bianca Urarii were, as always, gracious hosts. Tihoni Reasin granted permission to excavate in the KAM-2 rockshelter on Kamaka Island, and helped us in numerous ways. We are especially grateful to Mateo Pakaiti and Simeon Tu who greatly facilitated our work on Taravai and Agakauitai in 2003, and made our stay on Taravai most memorable. Bruno Schmidt and Daniel Teakarutu shared their knowledge of ancient Mangarevan sites and traditions.

At the Oceanic Archaeology Laboratory, Berkeley, Kathy Kawelu and Lisa Holm prepared many of the maps and graphics for this volume. Thérèse Babineau assisted with photographs, and Lisa Holm formatted the monograph for publication.

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Résumé en Français

Chapitre 1

Introduction: Mangareva et la préhistoire de la Polynésie orientale

Les questions de l'archéologie de la Polynésie orientale

Malgré les grands progrès accomplis ces dernières décennies, les mêmes grandes questions se posent encore sur la préhistoire de la Polynésie orientale

Question liées à la chronologie

Les premiers travaux conduits en Polynésie orientale permirent d'élaborer un modèle de « dispersion et migration » dans lequel les Marquises et les îles de la Société occupaient la première place. Modèle qui fut contesté au début des années 80 par une critique des données archéologiques qui le supportaient et des dates des « anciens » sites. Les efforts accomplis en vue d'une « hygiène chronométrique » ont fait penser à une colonisation initiale beaucoup plus récente que cela était envisagé auparavant, vers le premier millénaire apr. J.-C et même au cours du deuxième millénaire pour la Nouvelle-Zélande. Il s'ensuivit un débat entre partisans d'une « chronologie longue » et d'une « chronologie courte ». C'est en redatant à nouveau les sites majeurs et en fouillant de nouveaux sites supposés correspondre à la période de colonisation que l'on pourra résoudre cette question. Dans cette perspective, dater le peuplement initial de Mangareva est important dans ce débat de part la situation centrale de l'archipel au sud de la confluence des chaînes des Tuamotu et des Australes et comme point de départ de voyages de colonisation pour Pitcairn et l'île de Pâques. Sur la base de ses travaux à Henderson et à partir de dates obtenues à Kamaka par Green, Weisler a émis l'hypothèse que la séquence de Mangareva pourrait remonter jusqu'à 800 apr. J.-C. Un des buts de notre projet est de tester cette proposition.

Dans ce débat, la place du langage de Mangareva dans les langues polynésiennes est importante. Cette langue a été classée dans la branche « *Marquesic* » des langues de la Polynésie orientale. D'après Fisher, la langue de Mangareva formait avec celle de Rapa Nui un sous-groupe nommé *Proto Southeastern Polynesian* qui, selon lui, correspond à une première expansion du *Proto Eastern Polynesian*, en même temps et parallèlement au *Proto Central Eatern Polynesian.* De ce fait, Mangareva serait probablement la patrie immédiate des gens de Rapa Nui. Green et Weisler ont pensé que le *Proto Southeastern Polynesian* concernait une sphère d'interactions incluant les habitants de Mangareva, Henderson, Pitcairn ainsi que certains atolls des Tuamotu de l'Est.

Ce n'est que plus récemment que se serait produit une importante « invasion » linguistique de la part de locuteurs marquisiens, assez importante pour que la langue de Mangareva puisse être rangée dans le sous groupe « *Marquesic* ».

Ajoutons que ces questions de chronologie ont aussi un enjeu plus théorique concernant l'évolution des chefferies polynésiennes et constituent donc une variable importante dans les modèles de changements culturels en Polynésie.

Variation des anciennes sociétés de Polynésie orientale

Il est également important de connaître la nature des anciennes sociétés et leur degré de variation entre elles. Après la reconstruction par Kirch et Green de la culture polynésienne ancestrale en Polynésie occidentale grâce à leur approche par « triangulation », il est à présent prioritaire d'obtenir des informations sur les sociétés de Polynésie orientale durant les siècles qui suivirent leur installation. Connaître ces sociétés sous tous leurs aspects, autant matériels qu'idéels, est essentiel pour retracer leurs évolutions à travers le temps. Il importe donc d'accroître la partie archéologique de la « triangulation », et, de ce fait, l'un des buts de notre projet à Mangareva a donc été de découvrir des sites datant de la période ancienne.

L'Évolution des paysages

L'un des grands thèmes développés par l'archéologie durant les deux ou trois dernières décennies a été le rôle de l'homme dans le façonnage des écosystèmes insulaires. Parmi les nombreuses manifestations de cet impact humain sur l'environnement, l'archéologie a pu mettre en évidence la déforestation, l'érosion et le dépôt de grandes quantités de sédiments dans les fonds de vallées et dans les plaines côtières, l'introduction d'espèces animales et végétales et la décimation d'espèces indigènes et endémiques, principalement des oiseaux.

L'une des variables à prendre en compte pour estimer la relative vulnérabilité des écosystèmes et l'impact de l'homme semble être l'âge géologique de l'île et son corollaire le degré d'érosion et de lessivage des sols et des nutriments du sol. Ainsi, la vulnérabilité (et donc l'impact de l'homme) serait plus importante sur une vieille île que sur une île plus jeune. Cette idée d'un rapport entre âge et vulnérabilité doit cependant être testée sur plusieurs études de cas et, à ce titre, Mangareva offre une très bonne opportunité. D'autant que les informations historiques comme l'ethnohistoire décrivent un environnement terrestre dégradé, les activités horticoles étant limitées aux étroites plaines côtières et au fond des ravins où les accumulations de colluvions offraient les seuls sols possédant des nutriments pouvant supporter des cultures. D'après Hiroa, ces conditions affectèrent les modes de vie et causèrent d'intenses compétitions entre les groupes sociaux à propos de ressources limitées.

Interactions sur de longues distances en Polynésie orientale

La question de savoir quel était le degré d'isolement des sociétés durant leur histoire est importante. Et cela renvoie aux connaissances maritimes et aux capacités de voyager des Polynésiens qui ont donné lieu à des théories variables et à des expérimentations dont celle de Hokulea. Aujourd'hui, la plupart des chercheurs estiment que les Polynésiens étaient capables de remonter au vent et de maintenir des contacts entre archipels distants. La présence de la patate douce atteste d'ailleurs que des Polynésiens ont atteint l'Amérique.

L'étude de l'origine des matières premières (sourcing) a permis de montrer sur une base scientifique l'ampleur et les directions de ces contacts inter-insulaires. Ainsi Weisler a-t-il mis en évidence une sphère d'interactions Mangareva-Pitcairn durant une période de 400-500 ans. On a la preuve archéologique d'importations de pierres de four à Pitcairn depuis Mangareva et de nacre, de pierres de four, de basalte, de verre volcanique et probablement de cochons et de plantes à Henderson depuis Pitcairn ou Mangareva. De plus, Mangareva entrait probablement dans une sphère d'interactions plus large incluant aussi les Tuamotu de l'Est et les Marquises.

Notre projet de recherche a également pour objectif d'obtenir des données archéologiques à ce sujet.

Changement économique et social

Quoique issues de la même origine, les sociétés Polynésiennes présentaient un degré de variation dont les ethnologues (notamment Salhins et Goldman) ont tenté de comprendre les causes. En reconstituant, grâce à l'archéologie, l'histoire de Mangareva dans sa *longue durée*, notre projet est de contribuer à une meilleure compréhension des mécanismes qui ont abouti à l'image donnée au moment du contact avec les Européens.

Travaux antérieurs réalisés à Mangareva

Après les premières descriptions des navigateurs et missionnaires, un travail archéologique fut conduit en 1921 par Routledge qui, hélas ne fut jamais été publié. Le premier travail significatif fut donc celui de la mission du Bishop Museum en 1934 au cours de laquelle

Emory et Hiroa passèrent plusieurs mois dans l'archipel. Du point de vue archéologique, Emory fut très déçu par la situation des îles hautes où il estima que tout avait été détruit et, en conséquence, il investit ses efforts sur l'atoll de Temoe. Il fit aussi quelques « fouilles » dans des abris, notamment à Agakauitai. Après le bref passage de l'équipe d'Heyerdahl en 1956, R. Green effectue un séjour dans l'archipel en 1959. Il se concentra sur l'archéologie stratigraphique notamment dans 6 abris, 3 à kamaka, 2 à Aukena et 1 à Mangareva. Il relèva également des structures de surface dans la baie de Tokani à Akamaru. Les résultats furent partiellement publiés en 2000 par Green et Weisler. Il n'y eu pas de nouvelles recherches avant les deux visites de Weisler en 1990 et 92 où il recensa 20 sites archéologiques (abris, terrasses horticoles, structures lithiques) dont certains non connus antérieurement, ce qui contredisait l'idée d'une totale destruction.

En avril-mai 2001, M. Orliac réalisa une mission de recherche dont le thème était « *la composition et l'évolution de la flore* ». Il orienta son travail sur la côte et les zones littorales de Gatavake, Rikitea; Atirikigaro sur l'île de Mangareva et découvrit notamment un dépôt culturel enfoui avec du matériel (hameçons, grattoirs en nacre, etc.) et des vestiges végétaux caractéristiques des arbres côtiers. Ce site a été daté entre 1030-1290 apr.J.-C.(date calibrée). Ce travail a aussi permis de montrer que le niveau de la mer avait monté de 0,5 m depuis le XIIème siècle.

Pour résumer, disons que le travail archéologique à Mangareva demeurait assez limité, d'autant que la plus grande partie des résultats n'avait pas été publiée jusqu'à une date récente et n'était donc pas prise en compte dans les débats sur le peuplement.

Les principaux objectifs de notre projet étaient les suivants: (1) Contribuer à l'inventaire des sites archéologiques à Mangareva, en particulier des structures lithiques qui n'avaient pas été recensées précédemment; (2) Obtenir une information nouvelle sur la chronologie du peuplement humain de l'archipel; (3) Contribuer à mieux comprendre les interactions et les échanges anciens entre Mangareva et les autres îles et archipels de Polynésie orientale et (4) Augmenter notre compréhension de la relation dynamique existant entre les populations et les écosystèmes de leurs îles.

CHAPITRE 2

CONTEXTE ÉCOLOGIQUE ET ETHNOGRAPHIQUE DE L'ARCHÉOLOGIE À MANGAREVA

Composé de 10 petites îles hautes encerclées dans le même récif barrière, l'archipel que l'on nommera ici « îles Mangareva » (le nom de Mangareva étant celui de l'île principale) a été « découvert » par le Capitaine James Wilson le 22 mai 1797. Aujourd'hui, l'usage administratif applique le nom « d'îles Gambier » (initialement donné par Wilson aux seules îles hautes) à tout un ensemble d'atolls proches (le groupe Actéon et Temoe).

HISTOIRE NATURELLE DE MANGAREVA

GÉOLOGIE ET GÉOMORPHOLOGIE

Le groupe Mangareva date d'environ 6 Ma, une grande caldeira étant située originellement à l'endroit occupé de nos jour par le lagon. En fonction de la protection plus ou moins effective du récif barrière selon les îles et selon leurs côtés, les rivages sont constitués de récifs frangeants, de plages ou de falaises comme par exemple à Angakauitai. Ces conditions variées, qui offraient des possibilités différentes dans l'exploitation des ressources marines, se traduisent dans la faune recueillie dans nos fouilles.

La subsidence très forte a provoqué la disparition de la plus grande partie de l'édifice volcanique initial. Elle s'est poursuivie, selon les travaux d'Orliac, avec une amplitude de 50 cm sur les 800 dernières années.

LE CLIMAT

Il est plus frais que celui des îles de la Société. Le vent s'établit surtout à l'Est et la température moyenne est de 24° avec une période plus froide de mai à octobre. Les précipitations annuelles varient entre 1400 et 1900 mm, les plus fortes se concentrant en décembre-janvier, même s'il n'y a pas une grande différence avec le mois le plus sec (août). Le climat de Mangareva est propice à la culture des plantes tropicales importées par les Polynésiens.

LES SOLS

Parce qu'elle pouvait supporter la plus grande surface de tarodières de l'archipel, une grande zone de sol hydromorphique se trouvant à Rikitea a sans doute été une cause déterminante pour l'installation ancienne dans ce secteur et un facteur important de la domination socio-politique de cette localité.

FLORE ET VÉGÉTATION

Les principales caractéristiques sont l'absence de forêt primaire sur les versants les plus en pente et sur les crêtes et le caractère très anthropogénique de la végétation des fonds de vallée et des plaines côtières dominée par des plantes économiquement utiles, la plupart étant d'introduction polynésienne. Cette dégradation de la végétation sur les sommets n'est pas un phénomène récent car le Capitaine Wilson l'avait déjà observée. Cela est probablement une conséquence de pratiques horticoles destructrices même si cette hypothèse reste à démontrer. L'impact humain sur la flore semble avoir été terrible puisque le botaniste de la *Bishop Museum Mangarevan Expedition* montra que la flore indigène avait été complètement détruite, ce que constata également le malacologue de l'expédition.

LA FAUNE ET RESSOURCES TERRESTRES

On note une grande pauvreté du milieu terrestre qui est surtout composé d'insectes. Il y a seulement 3 espèces de lézards, une anguille d'eau douce et le rat européen (*Rattus rattus*) qui a éliminé le rat polynésien (*Rattus exulans*).

Les oiseaux offrent, d'un point de vue économique, les seules ressources terrestres significatives avec un total de 23 espèces qui aujourd'hui sont surtout concentrées sur trois îles non peuplées par l'homme et difficiles d'accès. Pour ce qui est des autres îles, les fouilles ont montré que la faune y était plus importante avant l'arrivée de l'homme.

En revanche, la richesse et la diversité des ressources marines sont remarquables avec 246 espèces de poissons, 20 espèces de mollusques, etc. Il faut cependant noter que la ciguatera sévissait déjà à l'arrivée des Européens.

ETHNOGRAPHIE DE MANGAREVA

Après les récits de Beechey, Moerenhout, Lesson, l'ethnographie de Mangareva est surtout connue par les écrits de Laval basés sur des manuscrits indigènes et sur ses propres observations. Nos connaissances bénéficient également des enquêtes et de la synthèse de Hiroa en 1934.

LA POPULATION

Il est raisonnable d'estimer la population a environ 1500 habitants avant les épidémies, ce qui, si l'on ne conserve que les espaces propres à habitat, donne une densité très forte de l'ordre de 180 h au Km^2. Ceci explique peut être les récits ethnographiques relatant d'une intense compétition pour une surface et des ressources terrestres limitées.

LA CULTURE MATÉRIELLE

Hiroa avait remarqué la présence de haches qu'il associait à la confection des radeaux (plus aptes à couper les arbres qu'à les creuser pour les pirogues). Les hameçons sont en forme de U ou de V et le fait remarquable est l'absence d'hameçon composé pour la bonite.

L'ORGANISATION SOCIALE

L'organisation sociale était complexe, basée sur la primogéniture des mâles et sur l'affiliation par descendance ou adoption à un groupe propriétaire terrien. La distinction est établie entre les nobles (*togo'iti*) et les gens du commun (*'urumanu*). Les nobles selon Hiroa possédaient du pouvoir, de la terre, des maisons de type supérieur, une tribu et une source d'eau douce. Si les gens du commun ne pouvaient pas devenir nobles, il leur était possible de devenir des spécialistes comme les guerriers, les experts en artisanat, les prêtres. Hiroa parle aussi d'une « classe moyenne » incluant les lignées cadettes des familles nobles et les gens du communs qui s'étaient élevés de leur condition grâce aux terres reçues en récompense de leurs faits d'arme. Possédant de vastes terres, ils étaient nommés *ragatira*.

Le groupe Mangareva était divisé en diverses entités politiques souvent en guerre, chacune comprenant une île et, dans le cas de Mangareva, un des deux districts (Taku et Rikitea) dans entre lesquels cette vaste île était divisée. Le chef qui commandait cette entité était nommé *'akariki*. Le *'akariki* de Rikitea était supposé être né sur le *marae* Te kehika, le temple le plus sacré de l'île. Après avoir été mis sous la protection des dieux lors de la cérémonie *igogo*, l'enfant était amené dans une maison d'isolement située sur l'une des crêtes du mont Ao'orotini où il était gardé jusqu'à 12 ou 14 ans. A la puberté, il était installé dans la résidence royale à Marau-tagaroa, une maison mieux construite que celle des autres chefs et comportant une banquette en pierre sur laquelle il s'asseyait.

La tenure foncière était complexe, impliquant à la fois des droits héréditaires des groupes de descendance et des droits acquis par les vainqueurs dans les guerres de conquête.

Beaucoup de petits propriétaires terriens possédaient l'usufruit sur les parcelles qu'ils cultivaient et en retour versaient un tribut à leur chef, consistant par exemple dans l'offrande des premiers fruits de l'arbre à pain de la saison.

L'économie traditionnelle était conditionnée par le contraste entre des petites îles hautes avec un potentiel économique limité pour l'agriculture et un vaste lagon et des récifs fournissant une abondante nourriture marine. L'agriculture était basée sur l'arbre à pain, dont les fruits étaient conservés par fermentation (structures qu'il est possible de retrouver archéologiquement). Mais le taro, qui réclamait des aménagements spécifiques notamment des terrasses (qu'il est possible d'identifier en archéologie), était d'une importance équivalente. On cultivait aussi beaucoup le *ti* (*Cordyline fruticosum*) dont les racines cuites étaient mâchées. Le cochon et le chien étaient absents au moment du contact même s'ils étaient là auparavant. L'homme était le seul grand mammifère pouvant être mangé et le cannibalisme (dont on pourrait retrouver des traces dans les fouilles) est attesté. Les ressources terrestres étant très limitées, on exploitait surtout les poissons, les mollusques et les crustacés. Les techniques ressemblaient à celles employées ailleurs en Polynésie (pêche à l'hameçon, au filet) à l'exception de la pêche à la bonite avec le leurre qui n'était pas pratiquée, cela étant peut-être lié à la disparition des pirogues à balancier remplacées par des radeaux.

La préparation culinaire est susceptible d'avoir laissé des traces archéologiques, notamment les fours (*umu*). La plupart des instruments confectionnés en matières périssables n'ont en revanche pas dû laisser de trace mais les pilons pour écraser les fruits de l'arbre à pain et le taro ainsi que les grattoirs en nacre pour râper les noix de coco sont retrouvés lors des travaux archéologiques.

La religion et les rituels

Mangareva offre sa propre version du modèle religieux polynésien avec un large panthéon de divinités comportant les principaux dieux (Tagaroa, Rogo et Tu), des dieux inférieurs et des ancêtres déifiés. Tu était le dieu principal, dieu de l'arbre à pain, même si Rogo était associé à la pluie et à la production de nourriture. Les grands prêtres (*taura tupua*) qui officiaient sur le *marae* principal et représentaient Tu et Te Agiagi (dieu de la guerre), étaient membres des familles de haut rang. Les médiums et les sorciers venaient des gens du commun.

Les *marae* étaient les espaces où les prêtres conduisaient les rituels saisonniers associés à la récolte des fruits de l'arbre à pain. Tous les principaux *marae* furent pillés de leurs pierres ou complètement détruits à l'époque de la mission catholique, les pierres étant employées pour l'édification de grandes cathédrales et d'autres constructions. Hiroa donne une liste de 10 *marae* principaux sur Mangareva, Aukena, Akamaru, Taravai et Agakauitai. Le plus sacré était sans doute Te Kehika sur les flancs du Mt Duff. Emory disait qu'il n'en restait plus de traces mais, en 2001, nous avons repéré quelques gros blocs qui sont les restes de ce *marae*. De même, à Atituiti-Raro, se trouve un autre *marae*, le *marae* Te Mata o Tu dont il semble que restent en place les fondations en dalles de corail encore intactes.

Le cycle annuel rituel à Mangareva, lié au cycle horticole, était régulé sur le calendrier polynésien typique de 13 lunaisons. Alors qu'ailleurs en Polynésie c'est l'apparition des Pléiades en juin qui divisait l'année en deux saisons et était utilisée pour synchroniser le cycle lunaire avec l'année solaire, les Mangareviens développèrent une innovation unique dans le système de calendrier par l'observation du solstice solaire. Laval décrit en détail cette observation du soleil et note que des endroits particuliers à Akamaru , et à Mangareva (à Taku, et à Atituiti) étaient désignés comme des postes d'observation. Deux pierres dressées sont identifiées comme ayant été utilisées pour marquer la position du solstice mais des aménagements devaient être associés à ces observatoires. Il est possible que la grande plate-forme qui a été décrite à Atituiti-Ruga (cf. chapitre 3) soit un élément de l'observatoire mentionné par Laval.

CHAPITRE 3
LES TRAVAUX ARCHÉOLOGIQUES DE TERRAIN

MANGAREVA

TRAVAUX À RIKITEA

Cet espace possédant à la fois la plus grande surface utilisable de l'île et un vaste espace favorable à la culture du taro, il a sans doute été le premier peuplé dans l'archipel et c'est donc en priorité ici que nous avons recherché des traces des premières installations humaines. Des sondages en plusieurs transects ont été effectués à la tarière, complétés dans une des zones (« chez Louis ») par deux sondages de 1 m^2. De même, un sondage a été effectué dans un autre endroit du village (Chez Tihoni Reasin) où un hameçon avait été découvert en surface. Une longue tranchée ayant été pratiquée pour le drainage d'une zone marécageuse, nous avons pu observer sa stratigraphie et prélever des échantillons pour datation.

Tous ces travaux ont montré la présence d'un niveau culturel enfoui (la date calibrée entre 1160 et 1220 apr. J.-C. obtenue « chez Louis » étant encourageante) sans toutefois que l'on rencontre les dépôts profondément enfouis. On a sans doute davantage affaire à une « stratigraphie horizontale » qu'à une forte stratification verticale. Il faudrait investir davantage de travail pour pouvoir retrouver des espaces susceptibles d'être fouillés. Cela dit, les lieux où l'on a le plus de chance de découvrir les dépôts les plus anciens se trouvent probablement sous la Cathédrale et l'école et sont donc difficiles d'accès.

Nous avons également conduit une reconnaissance sur les flancs de la montagne qui a révélé la présence de nombreuses structures monumentales qui pourraient faire l'objet d'un travail intensif sur l'organisation spatiale de l'habitat.

ATITUITI

A Atituiti Ruga, un vaste complexe de structures lithiques bien conservées a été cartographié où l'on rencontre des *paepae*, des petits pavages, et des terrasses liées à l'horticulture sèche et humide. C'est l'un des rares endroits de Mangareva qui semble intact et ne paraît pas avoir été détruit au $XIX^{ème}$ siècle par la Mission ou par les travaux plus récents.

La plus grande structure de la zone consiste en un vaste *paepae* de forme plus ou moins carrée ayant environ 23 m de côté. Cette grande structure, qui comporte un escalier sur sa face Est, est partiellement pavée et possède en son centre une grande pierre plate qui a pu servir de siège. Ce *paepae* est orienté de telle sorte que ses côtés sont en direction Est-Ouest et Nord-Sud avec une déviation de seulement 9° par rapport à l'orientation cardinale. De ce fait, nous pensons que ce *paepae* a pu faire partie des aménagements servant(à l'observation du soleil au moment des solstices destinée à régler le calendrier lunaire sur le soleil plutôt que sur les Pléiades comme cela se faisait ailleurs en Polynésie. Nous avons réalisé un sondage de 1x1 m au niveau du pavage proche de la grosse pierre et recueilli des échantillons de charbon juste au-dessous du pavage qui ont donné une date calibrée de 1430-1470 apr. J.-C. Une tranchée pratiquée sur le côté Ouest de la structure n'a hélas pas pu permettre la découverte d'échantillons qui auraient servi à dater le remplissage du *paepae*.

A Atituiti Raro, dans la plaine côtière, des structures lithiques de surface, dont les restes du *marae* Te Mata o Tu, ont été relevées schématiquement tandis qu'un sondage de 1 m^2 était effectué dans un dépôt culturel enfoui visible sur le rivage attaqué par les vagues. On y a retrouvé de nombreuses pierres de four, beaucoup de coquillages. Un échantillon de bois y a été daté de plusieurs âges calibrés: 1650-1680; 1770-1800; et 1940-1950 apr. J.-C. En l'absence d'objets modernes, on peut penser que ce dépôt date de la période pré-européenne récente.

Vallée de Atiaoa

Plusieurs opérations archéologiques ont été réalisées dans cette vallée qui est l'une des plus importantes du côté Nord-Ouest de l'île.

Il y a tout d'abord le sondage d'un abri-sous-roche dont la surface protégée est de 8 m x 4 m dans lequel nous avons ouvert seulement 1 m^2 (identifié comme F-11). Ce sondage a livré peu d'artefacts (fragment d'herminette, un morceau d'hameçon en nacre, plusieurs limes en *Acropora*). Un échantillon provenant d'un four a donné une date calibrée de 1280-1300 apr. J.-C.

Trois transects de sondages à la tarière effectués dans la partie de la plaine en bordure de mer ont permis de mettre en évidence la présence d'un vaste dépôt culturel enfoui. Une date obtenues sur un échantillon collecté a donné une date de 1280-1300 apr. J.-C., identique à celle obtenue dans l'abri. Cette zone mériterait une étude ultérieure.

Nous avons également recensé, dans le secteur proche de la mer, les restes d'un vaste pavage (30 x 26 m) (nommé Taupapa) passant pour avoir été la résidence de la cheffesse Meriga Teipo. Sur le flanc de la montagne, nous avons également relevé un ensemble de structures de surface (*paepae*, terrasses horticoles, etc.).

Gatavake

D'après la tradition orale, c'était une zone importante de peuplement. Nous avons étudié la coupe créée par un ruisseau, la stratigraphie montrant un sol résultant d'activités horticoles (avec brûlis) et au-dessus les vestiges d'une construction (habitation, monument rituel) construit en blocs de basalte. Les dates obtenues font penser que ces dépôts culturels datent de la période des XVII-XVIII$^{\text{ème}}$ siècles.

Gaeata

Dans la petite vallée de Gaeata, une coupe dans la plaine côtière pratiquée par les vagues a été étudiée. La date obtenue sur 1 échantillon prélevé et qui date un dépôt d'argile le fait remonter vers les XVII-XVIII$^{\text{ème}}$ siècles.

Opérations diverses

Nous avons aussi visité rapidement d'autres sites, notamment le *paepae* o Uma autour duquel d'autres structures archéologiques de surface ont été repérées, ce qui laisse supposer que l'on a là un ensemble qui mériterait une étude plus intensive.

L'endroit qu'Emory nommait « la nurserie royale » a également été visité par Kirch au sommet du mont Auorotini (Mt Duff). Un grand abri que nous avons repéré dans le district de Gahututenohu a été interprété comme étant celui de Te Ana o Mea Hiti que Emory avait « fouillé » en 1934 et nous avons en conséquence abandonné le projet de le sonder. A Taku nous avons également repéré un abri qui s'est révélé être celui que R. Green avait sondé en 1959 (GM-1).

Ile de Akamaru

Durant les deux jours de travail effectués dans l'île en 2001, on a réalisé deux transects de sondages à la tarière dans la plaine côtière située sur la côte Nord de l'île. Un sondage de 1 m^2 a été pratiqué pour mieux observer les dépôts culturels. Profond de 50 cm, il a donné de la faune, des charbons et un seul hameçon en nacre. Un échantillon a donné une date calibrée à 1450-1520 apr. J.-C. et 1590-1620 apr. J.-C. Cela confirme la présence d'un dépôt d'occupation sur la côte Nord de l'île datant de la période des XV-XVI ème siècles, mais il faudrait explorer davantage le sous-sol pour repérer d'éventuelles zones plus riches à fouiller.

Un dépôt enfoui, avec des pierres de four et des *Lambis lambis* fracturés pour en extraire la chair, a été repéré sur la côte Nord de l'île à environ 150 m de la petite jetée. Avec ces vestiges, on a retrouvé des fragments de verre probablement du XIX ème siècle et ils datent donc probablement de la période missionnaire.

En contournant la pointe Nord, nous avons observé un autre dépôt enfoui érodé sur la côte avec des coquillages (turbo et nacre), des éclats de basalte au grain fin et une lime en *Acopora*. A l'Est de ce dépôt, dans une petite baie, nous avons repéré un alignement ou un mur de gros blocs de basalte dans la zone de balancement de la marée.

Kamaka

Nous avons décidé d'effectuer un sondage dans l'abri KAM-1, l'un des deux abris dans lesquels Green avait déjà fouillé et dans lequel il avait eu une date relativement ancienne (890 ± 70 B.P.). Cela, dans le but d'obtenir de nouvelles dates et d'acquérir, par l'utilisation d'un tamis plus fin que celui employé par Green, une meilleure information sur la faune, et notamment sur les oiseaux disparus. Ayant retrouvé les contours des fouilles de Green, nous avons pu dégager la face Ouest du carré Z-1 à partir de laquelle nous avons effectué un sondage de 1 x 0,5 m dans la partie non fouillée. La stratigraphie retrouvée est complexe avec 5 principales couches et de nombreuses fines lentilles. Grâce à la datation des principales couches, nous avons pu définir la séquence chronologique suivante:

(1) Occupation initiale durant les XI-XIII ème siècles suivie par un possible hiatus.

(2) Utilisation continue de l'abri aux XIII et XIV ème siècles avec de grands fours.

(3) Possible arrêt de l'utilisation durant les XV et XVI ème siècles

(4) Construction d'un pavage de beach-rock et occupation aux XVII-XVIII ème siècles.

Taravai

En 2003 Conte et Kirch effectuèrent en bateau une reconnaissance de la totalité du rivage de Taravai en visitant tous les lieux susceptibles d'intérêt, revisitant tous les sites déjà repérés par Weisler et en repérant d'autres.

Puis, les efforts ont été concentrés sur le site dunaire de Onemea où deux sondages de 1 m^2 chacun ont été effectués. Il est particulièrement notable que le TP-2 a donné dans ses niveaux les plus profonds (couche II et III) un grand nombre d'ossements d'oiseaux associés à des os de rat polynésien (*Rattus exulans*) et des coquilles de gastéropodes terrestres (*Allopeas gracile*) dont on sait qu'ils ont été importés par les Polynésiens. Les dates effectuées sur le site montrent qu'il a été occupé à partir des première décennies du XIème siècle et jusqu'à la fin du XIIIème siècle.

Agakauitai

Comme pour Taravai, une reconnaissante totale des côtes de l'île a été effectuée à la recherche des d'abris côtiers et, dans les vallées de Nenega-Nui et Nenega-Iti, pour retrouver plusieurs sites signalés par Emory. Un sondage de 1 m^2 a ensuite été effectué dans un abri de la vallée de Nenega-Iti. Il adonné quantité d'artefacts dont des hameçons en nacre, des limes en *Acropora*, etc. Les dates obtenues font apparaître que l'abri a été utilisé du XIII ème au XVème siècle.

Une rapide reconnaissance a été également effectuée sur l'île de Makaroa où des traces archéologiques (alignements, *paepae*...) ont été repérées et appellent à une exploration plus intensive. En quittant Makaroa, il a été possible de remarquer sur l'île de Motu Te Veru deux plants de *Cordyline fruticosum*. Comme cette plante stérile a besoin de l'homme pour se propager, nous savons donc qu'elle a été plantée sur l'îlot et devait constituer une très bonne source de glucides et de sucre.

AUKENA

En 2001, Kirch et Conte ont visité Te Ana Pu, un grand abri-sous-roche fouillé par Green en 1959 et en continuant sur le rivage vers la pointe Terua Kara ils ont relevé une grande structure rectangulaire en basalte, probablement dégagée par l'érosion de la côte par la mer.

CHAPITRE 4

DATES RADIOCARBONES ET CHRONOLOGIE DES SITES

Avant notre projet, on ne disposait pour Mangareva que de 8 datations radiocarbones effectuées par Green dans 4 abris à Kamaka et Aukena. Les plus anciennes dates avaient été obtenues à Kamaka et suggéraient que les sites étudiés sur cette île avaient été occupés au début du XIII$^{\text{ème}}$ siècle. Prenant argument du fait que la petite île de Kamaka n'avait probablement pas été occupée la première, Green et Weisler ont émis l'hypothèse que le peuplement initial de l'archipel devait remonter au moins à deux siècles avant celui de Kamaka.

24 échantillons provenant de 5 îles ont été collectés durant nos travaux et datés par AMS en prenant toutes les précautions d'usage pour éviter les contaminations et la perturbation des résultats (notamment en ne choisissant que des charbons provenant d'espèces à courte durée de vie, de brindilles ou des graines).

Les résultats obtenus permettent de formuler les conclusions suivantes:

(1) La découverte et le peuplement initial de l'archipel Mangareva ne sont pas intervenus plus tard que la fin du X$^{\text{ème}}$ siècle apr. J.-C. ou les premières décennies du XI$^{\text{ème}}$ siècle, d'après les dates obtenues sur le site de Onemea.

(2) Au XIII$^{\text{ème}}$ siècle, nous avons la preuve d'une occupation largement dispersée dans des sites ouverts comme dans des abris: à Mangareva à la fois à Rikitea et Atiaoa, à Taravai, Agakauitai et Kamaka.

(3) L'architecture monumentale, telle qu'illustrée par le *paepae* de Atituiti a été édifiée au XV$^{\text{ème}}$ siècle.

(4) Un épisode majeur d'érosion et de déposition de sédiments terrestres, comme cela apparaît à Gatavake et Gaeata est noté aux XVII-XVIII$^{\text{ème}}$siècles indiquant une dégradation et une instabilité considérable de l'environnement.

CHAPITRE 5

ANALYSE ZOO-ARCHÉOLOGIQUE DES ASSEMBLAGES FAUNISTIQUES

Les restes de faune analysés proviennent des abris de Atiaoa, Kamaka et Nenega-Iti et du site de bord de plage de Onemea sur l'île de Taravai.

LES INVERTÉBRÉS

LES MOLLUSQUES MARINS

En ce qui concerne les mollusques marins, on remarque qu'à l'exception de *Tridacna maxima* et de deux *Chama* spp qui demandent des substrats durs, la plupart des bivalves trouvés peuplent les substrats sableux ou sédimentaires du lagon. C'est pour servir de nourriture que la plupart des espèces retrouvées ont été collectées. Cependant si *Pinctada margaritifera* possède certes une chair comestible, ses grandes valves en nacre sont aussi la principale source de matière première pour la confection des hameçons. D'ailleurs de nombreux déchets de façonnage ont été retrouvés dans les fouilles.

L'abri de Atiaoa a donné 11 *taxa* avec une prédominance de *Gafarium pectinatum* ce qui reflète les conditions écologiques de l'endroit avec la zone très sableuse de la baie, et on remarque une augmentation dans le temps de la densité des vestiges de mollusques par m^3, même s'il n'est pas aisé d'interpréter ce phénomène.

A Nenega-Iti, 19 *taxa* ont été retrouvés sans que l'un d'eux ne domine vraiment. Mais 5 d'entre eux regroupent plus de 75% des vestiges.

On ne note pas d'augmentation de la densité dans le temps.

Onemea est le site le moins riche en *taxa* et celui où la densité est la plus faible. Il y a de fortes disparités entre les deux sondages. Dans TP-1, *Turbo setosus* et *Lambis truncata* dominent l'assemblage tandis que dans TP-2 c'est *Cellana Taitiensis* et *Pinctada margaritifera*. Cela dit, on ne sait pas si ces disparités sont le reflet de différentes activités dans le site ou bien de changements dans le temps.

Sachant d'après les sources ethno-historiques qu'à la période récente les habitants exploitaient intensivement le milieu marin, on a essayé de voir si cela avait eu un impact mesurable sur les vestiges récoltés en étudiant dans chaque site les *taxa* les plus exploités. Sur les deux sites où les matériaux s'y prêtaient (Atiaoa et Nenega-Iti) nous n'avons pas pu mettre en évidence une diminution statistiquement pertinente des espèces dans le temps.

LES ÉCHINODERMES ET LES CRUSTACÉS

Retrouvés en petite quantité, les échinodermes ne devaient pas constituer une ressource alimentaire régulière. Les épines d'oursins crayons retrouvées à Nenega-Iti ne portent pas de trace d'utilisation comme limes ainsi que cela se rencontre, par exemple, aux Marquises ou à Hawaii.

On a trouvé peu de restes de crustacés. Certains fragments de pinces de crabes trouvés à Onemea (TP-2) semblent appartenir à un crabe de terre de l'espèce *Cardisoma* très fréquente en Polynésie orientale et parfois consommée. D'après nos informateurs, cette espèce ne se rencontre plus de nos jours et, si l'information se confirmait, cela pourrait indiquer une extinction locale de cette espèce durant la période préhistorique.

LES GASTÉROPODES TERRESTRES

A ce jour, aucun des nombreux spécimens de gastéropodes de *taxa* endémiques récoltés par les différentes expéditions scientifiques entre 1934 et 1997 n'est représenté par un spécimen vivant. Toutes les espèces endémiques de gastéropodes terrestres anciennement présents dans les îles Gambier sont aujourd'hui éteints, ce qui indique qu'une crise écologique majeure a affecté ce petit archipel. La question de la chronologie et des causes de cette crise peut être abordée par la découverte de gastéropodes terrestres dans des contextes archéologiques datables.

Dans les 4 sites, nous avons retrouvés 8 espèces appartenant à 6 familles incluant à la fois des *taxa* endémiques et introduits. 4 espèces endémiques sont présentes dans les assemblages, la plus fréquente, présente dans 3 sites étant *Omphalotropis margarita*. Cette espèce persiste dans toute la séquence stratigraphique des deux abris de Ataioa et de Nenega-Iti et est également présente dans une coupe à Gaeata dont les dates calibrées sont de 1650-1670, 1770-1800 apr. J.-C., ce qui suggère qu'elle a persisté durant toute la période d'occupation humaine de Mangareva. Les *Gambiodonta grandis* ont été trouvés à la fois à Atiaoa et à Nenega-Iti où ils sont essentiellement concentrés dans les niveaux inférieurs, ce qui suggère que les forêts qui constituent l'habitat préféré de ces grands escargots endémiques ont disparu à la période préhistorique récente. Les deux autres *taxa* endémiques sont un *Minidonta* et un *taxa* du genre *Punctum*.

Les escargots introduits sont également intéressants, notamment les deux espèces *Lamellidea oblonga* et *Allopeas gracile* que l'on retrouve dans nos fouilles et qui furent introduits par les Polynésiens, adhérant aux plantes ou à la terres des plantes importées par eux. Le fait le plus intéressant est que *Allopeas gracile* a été retrouvé assez abondant dans la couche III de Onemea (TP-2) en association avec un assemblage d'oiseaux indigènes aujourd'hui éteints ou éradiqués de l'île. Ce qui prouve que l'homme était à proximité du site de Onemea à une période relativement ancienne (vers 1000 apr. J.-C.). Les deux autres espèces, *Subulina octona* et *Bradybaena similaris,* qui ces deux derniers siècles ont été largement dispersés par l'intensification des contacts, proviennent de contextes archéologiques postérieurs à l'arrivée des Européens (à Nenega-Iti et Onemea).

Les restes de vertébrés

Les restes de vertébrés de la campagne de 2001 ayant été perdus lors de leur transport vers l'Université de Floride, l'analyse n'a porté que sur l'abri de Nenega-Iti et de Onemea. Dans ces deux sites, les os de poissons constituent la majorité du matériel mais on note que le site TP-2 de Onemea a fourni une quantité significative d'os d'oiseaux dans les niveaux stratigraphiques les plus profonds.

Les mammifères

Les seuls animaux connus par l'ethnographie étaient les cochons et les rats. Mais Green a également retrouvé des os de chiens dans plusieurs sites. Chien et cochon avaient disparu au moment du contact avec les Européens. Si une seule prémolaire découverte dans la couche II du site de Nenega-Iti appartient sans ambiguïté à un cochon, divers fragments d'os retrouvés pourraient être des os de cochon ou de chien.

Les os de rats du pacifique (*Rattus exulans*) sont assez abondants dans l'abri de Nenega-Iti mais rares à Onemea. A Nenega-Iti, on a également trouvé des restes du rat introduit par les Européens dans les niveaux supérieurs. Contrairement à ce qui a été remarqué dans l'abri de Tangatatau à Mangaia, il n'y a pas de trace de feu et de mastication sur les os, ce qui soutient l'affirmation de Hiroa selon laquelle le rat n'était pas mangé à Mangareva. Cela peut surprendre quand on sait les difficultés rencontrées par les habitants avec les ressources terrestres. On peut supposer que les ressources marines étaient suffisantes pour pourvoir à leurs besoins en protéines, les problèmes alimentaires résidant davantage dans les glucides d'origine terrestre.

On a également retrouvés 6 os d'*Homo sapiens* dans le niveau supérieur de Onemea (TP-1) sans que l'on puisse dire s'ils proviennent d'une sépulture perturbée ou bien s'ils représentent des restes de nourriture.

Les oiseaux.

Au total, 166 os identifiés d'oiseaux ont été retrouvés dans les deux sites, surtout à Onemea TP-2. Nous n'avons pas d'os de poulet domestique (*Gallus Gallus*) dont Green avait trouvé 4 os en 1959. Les espèces représentées sont des oiseaux marins même si une espèce de pigeon éteint ou chassée de l'archipel est aussi représentée. Il est remarquable que ces os d'oiseaux proviennent des niveaux les plus profonds de Nenega-Iti et de Onemea (notamment la couche III de TP-2 à Onemea). Une chapitre particulier (chapitre 6) est consacré aux os d'oiseaux.

Les poissons

Comme dans les fouille de Green en 1959, la majorité des os de nos sites appartiennent à des requins et des raies. 94 % des os de Nenega-Iti et 64 % de ceux de Onemea sont des os de poissons. Ces os n'ont fait l'objet que d'une étude préliminaire reposant sur les os aisément identifiables, notamment ceux de la tête et certaines arêtes remarquables.

A Nenega -Iti, les plus nombreux sont les Scaridés, puis les Balistidés. On rencontre aussi une grande quantité de Serranidés. Cette répartition de ces poissons dans notre échantillon est le reflet de leur fréquence dans les habitats lagonaires et benthiques de Mangareva. Un seul échantillon appartenant à un poisson pélagique a été retrouvé, il s'agit probablement d'un *Acanthocybium solandri.*

L'assemblage de Onemea est à la fois plus modeste et moins diversifié et les os des deux sondages sont très différents (comme pour les gastéropodes). TP-1 est dominé par les perroquets qui sont abondants dans les eaux du lagon le long de la côte Ouest de Taravai. Dans le TP-2, ce sont les os de requin qui dominent mais, en fait, la plupart (98 vertèbres et 23 dents) appartiennent à un seul petit individu trouvé dans la couche III qui contient aussi une forte densité d'os d'oiseaux. Ce petit requin a pu en réalité ne pas avoir été capturé par l'homme mais avoir représenté une proie pour un des grands oiseaux marins dont les os ont été retrouvés dans ce dépôt.

Il n'a pas été possible de constater une variation significative à travers le temps dans la taille des poissons pêchés mais on remarque cependant que ceux de Onemea sont en général plus grands que ceux de Nenega-Iti, peut-être parce que les habitants de ce premier site avaient accès à des zones de pêche plus profondes.

Pour conclure, on peut dire que même si l'échantillon est petit, il donne quelques indications sur certains aspects de l'économie de subsistance et l'environnement à la période pré-européenne.

A partir de nos propres analyses et de celles de Green et Weisler (2004), on constate l'écrasante supériorité des ressources marines sur les ressources terrestres. Ce n'est que dans les plus profonds niveaux de Onemea et de Nenega-Iti que les ressources terrestres sauvages sont représentées en quantité appréciables, en l'occurrence par des oiseaux marins et des pigeons. Comme dans beaucoup d'îles du Pacifique, les populations d'oiseaux nichant à Mangareva ont été décimées quelques décennies après l'arrivée de l'homme comme conséquence de sa prédation directe combinée avec l'action des rats qu'il avait introduits.

Le cochon et le chien étaient présents à Mangareva avant l'arrivée des Européens, mais ils ne semble ne pas avoir été abondants et ils ont dû être éliminés avant le contact avec l'Occident. Les cochons qui, comme Kirch l'a montré, peuvent dans certaines situations devenir à la fois des concurrents de l'homme pour la nourriture et gêner ses cultures, ont été éliminés par ce dernier avant l'arrivée des Européens. Le fait que plus de la moitié des os trouvés par Green à Kamaka venaient d'un *marae,* montre que le cochon était une nourriture réservée à l'élite et offerte lors des rituels. Alors que les indications données par les études sur la faune témoignent d'une extrême limitation des ressources terrestres, l'équivalent n'étant pas relevé à propos des ressources marines durant la même période. Il semble que le vaste lagon de Mangareva pouvait fournir assez de protéines marines à la population même à son plus haut niveau. Avant l'arrivée de l'homme, Mangareva comportait une faune d'oiseaux variée avec au moins 19 espèces, mais l'île connut, comme dans beaucoup d'autres îles du Pacifique, une extinction massive de l'avifaune après l'arrivée de l'homme.

D'autres tendances sont à relever dans les changements environnementaux: possible disparition d'une espèce de crabe terrestre; présence de deux espèces d'escargots terrestres connus pour avoir été transportés par les Polynésiens lors de leurs voyages inter-insulaires. L'une de ces espèces (*Allopeas gracile*) étant présente dans les plus anciens niveaux du site de Onemea, son introduction doit dater de la colonisation initiale de Mangareva. La diminution des escargots endémiques, notamment *Gambiodonta cf. grandis* dans les niveaux supérieurs doit être associée à des changements dans son habitat et à la réduction de la forêt primaire.

CHAPITRE 6

L'AVIFAUNE DES SITES DE NENEGA-ITI ET ONEMEA

L'étude des os d'oiseaux des sites de Onemae (Taravai) et Nenega-Iti (Agakauitai) a permis d'identifier 166 os représentant 9 espèces pour la plupart des oiseaux marins que l'on pouvait s'attendre à trouver compte tenu de ce que l'on savait de leur distribution géographique. Cependant deux espèces retrouvées sont éteintes: une pétrel *Pseudobulweria* et un pigeon *Ducula.*

S'ajoutant aux études déjà réalisées dans le passé, la connaissance acquise de l'avifaune des Gambier est à présent de 20 espèces dont deux retrouvées durant ces fouilles sont aujourd'hui éteintes.

CHAPITRE 7

LA CULTURE MATÉRIELLE ET ANALYSE GÉOCHIMIQUE DES ARTEFACTS EN BASALTE

Sont présentés ici à la fois les artefacts retrouvés lors des travaux de terrain et ceux (des herminettes) étudiés en 2001 dans la collection de la commune de Rikitea et chez des particuliers.

Les artefacts provenant des sondages

Nos sondages à Rikitea, Atiaoa, Akamaru, Kamaka, Onemea et Nenega-Iti ont donné un ensemble de 507 artefacts dont la grande majorité consiste en éclats. Notons que le site de Nenega-Iti a fourni la plus grande quantité de matériel associé aux hameçons et à leur fabrication (hameçons, fragments de nacre travaillés, limes en corail).

Les hameçons

14 hameçons, pour la plupart brisés, ont été retrouvés en fouille dont 9 à Nenega-Iti. Tous ces hameçons sont en nacre et ont été fabriqués en utilisant des limes en *Acropora* qui ont également été découvertes dans les sites. De tailles très différentes (longueur de hampe entre 13,5 et 37,5 mm), ces hameçons étaient pour les plus petits utilisés pour pêcher depuis les rochers et le platier, tandis que les plus gros devaient servir à pêcher à la ligne de fond dans le lagon ou sur le tombant du récif. La plupart des hameçons retrouvés - quoique souvent cassés - semblent avoir eu une pointe recourbée.

Les limes en *Acropora*

Au total, 20 limes ont été retrouvées en fouille dont la plupart proviennent de Nenega-Iti où les nombreux vestiges de façonnage d'hameçons ont également été collectés. Deux pilons on été découverts, l'un à Atiaoa qui est en fait un galet de forme conique utilisé et l'autre en surface à proximité de l'abri de Nenega-Iti qui est en corail.

Objets divers

On a aussi découvert à Onemea (TP-1) un petit disque de nacre dont la fonction n'a pas été déterminée, une aiguille formée d'une grosse arête de poisson dont la pointe a été aménagée. A Nenega-Iti on a trouvé une aiguille employée pour la fabrication des toits en végétaux taillée dans une côte de mammifère et mesurant 94,9 mm.

Les éclats lithiques

Une grande quantité d'éclats lithiques a été retrouvée à la fois à Onemea et à Nenega-Iti. Quelques spécimens montrent des traces d'utilisation et on pense que les éclats en forme de lame ont pu être employés comme couteaux, grattoirs etc. Il ne s'agit pas d'éclats de fabrication d'herminettes.

Les herminettes et les haches

Les herminettes, par leur étude typologique et, plus récemment, par l'analyse de la provenance de leur matière première, sont très utiles pour reconstituer les relations entre les îles de Polynésie orientale.

Cinq herminettes ont été collectées durant notre prospection et nos sondages à Mangareva et nous avons également photographié et étudié 31 herminettes dans des collections.

Selon la typologie de Green, la plupart des herminettes appartiennent au type 1. La plupart de ces herminettes sont d'origine locale, quoique 3 d'entre elles proviennent de Eiao aux Marquises. Aucune herminette de type 2 n'a été collectée durant notre mission mais une avait été trouvée sur le *motu* Tenoko. On n'a pas trouvé d'herminette de type 3. Une seule herminette a été attribuée au type 4 et une également au type 5A.

Même si seulement une seule herminette a été retrouvée en fouille, l'étude typologique nous donne quelques indications chronologiques. D'après les informations disponibles par ailleurs, il est possible de dire que les herminettes de type 1, qui sont les plus nombreuses, datent de la période récente de la préhistoire de l'archipel. Le type 5A, qui semble originaire des Marquises, est daté à Mangareva entre le XIII^{ème} siècle et le début du XIX^{ème}. La typologie comparée permet, à partir des types 1 et 5A, de tracer des relations entre Mangareva et le groupe de Pitcairn, les Marquises et les Tuamotu que les études sur l'origine des matières premières déjà effectuées montrent comme faisant partie d'une même sphère d'interaction.

Nous avons également 6 haches dans notre collection dont l'usage semble avoir été corrélé avec l'utilisation de radeaux à Mangareva. Aucune hache n'ayant été trouvée en contexte archéologique, nous ne pouvons dater l'apparition de son emploi dans l'archipel. On peut cependant supposer que cela est intervenu après le XV$^{\text{ème}}$ siècle, époque à laquelle semblent avoir cessé les relations de longue distance entre les divers archipels de la région et pour lesquels les pirogues doubles étaient nécessaires.

Analyse géochimique des artefacts en basalte

Les cinq herminettes collectées sur le terrain en 2001 ainsi que 18 fragments de débitage de basalte furent sélectionnés pour une analyse géochimique. Cela a mis en évidence à la fois des relations internes à Mangareva entre les populations qui habitaient Atiaoa, Gatavake, Atituiti et Rikitea et des relations extérieures à l'archipel grâce à une herminette provenant de Eiao aux Marquises et à 3 éclats dont l'origine se trouve à Pitcairn.

Chapitre 8

Principales tendances de la Préhistoire de Mangareva

Si l'on reprend les quatre principaux objectifs que nous avions assignés à notre programme de recherche à Mangareva, nous pouvons dresser un bilan des résultats obtenus et définir quelques axes de recherche pour l'avenir.

Les résultats atteints à ce jour

Inventaire des vestiges archéologiques

Contrairement à ce qui avait été dit par Emory, Mangareva est riche à la fois en monuments anciens et en sites stratifiés permettant de reconstituer l'évolution culturelle de l'archipel. On a pu repérer des sites de grands *marae* supposés disparus, étudier des vestiges monumentaux préservés (comme le grand *paepae* de Atituiti) et identifier et parfois sonder des sites enfouis à fort potentiel archéologique. Au total 79 sites archéologiques ont été recensés dans les îles Mangareva. Un inventaire bien sûr qu'il faudrait poursuivre et enrichir.

Chronologie culturelle

Nos fouilles sur le site de Onemea à Taravai ont apporté de nouvelles informations sur la date de la plus ancienne présence des Polynésiens à Mangareva que l'on a estimée vers 900 apr. J.-C. Notre programme de datation nous a aussi permis de mieux définir la chronologie culturelle de l'archipel. La plus ancienne phase d'occupation, représentée par le site de Onemea, réclame cependant d'être mieux connue à travers d'autres sites que nos prospections ont permis de localiser et qui restent à explorer sur différentes îles. La phase intermédiaire est à présent représentée par plusieurs abri stratifiés comme KAM-1 et KAM-2 à Kamaka, les dépôts inférieurs de Te Ana Pu à Aukena, par Nenega-Iti à Agakauitai et par l'abri de Atiaoa et le dépôt culturel côtier repéré également à Atiaoa. Les quelques derniers siècles de la séquence sont représentés par les dépôts supérieurs des abris de Kamaka et Aukena et probablement par les aménagements de surface répertoriés à Atituiti-Ruga à Mangareva et dans la baie de Tokani à Akamaru. Même s'il y a encore de nombreux trous dans cette séquence, elle commence à prendre forme et, avec des fouilles bien ciblées et des datations, il sera possible, dans les prochaines années, de produire une séquence culturelle plus précise pour l'archipel.

Les échanges de longue distance

Nous avons eu moins de réussite dans notre objectif de reconstituer les réseaux d'échanges inter-insulaires grâce à l'analyse de la provenance des matériaux dont sont faits certains artefacts, notamment les herminettes. L'information selon laquelle l'une des herminettes découvertes provient de l'île de Eiao aux Marquises s'ajoute aux autres preuves déjà répertoriées d'échanges avec, notamment, les Marquises et les îles de la Société. D'autres indices ont été collectés pour mieux connaître les échanges à l'intérieur de l'archipel et avec d'autres îles comme Pitcairn, et Rapa Nui.

Transformation de l'environnement

Notre quatrième objectif était de comprendre les relations dynamiques entre les populations et les écosystèmes insulaires.

Nos travaux, notamment le site de Onemea, ont montré que des populations d'oiseaux, abondantes et variées, étaient présentes dans l'archipel. Ces oiseaux constituèrent une source alimentaire importante pour les premiers colonisateurs polynésiens. Notons que ces oiseaux marins devaient également jouer un rôle dans l'enrichissement du sol en nutriments par la déposition de guano qui a pu être essentielle dans le maintien d'un riche l'écosystème terrestre. On peut penser que la décimation de ces colonies d'oiseaux, directement par la chasse ou indirectement, par exemple, par l'introduction du rat, a rompu ce cycle d'enrichissement. Cela a dû jouer un rôle, avec les défrichages liés à l'horticulture, dans la déforestation des îles de l'archipel. Les changements dans l'environnement sont également perceptibles grâce aux escargots terrestres. Ainsi, plusieurs espèces endémiques qui sont à présent éteintes dans les îles ont été retrouvées dans nos fouilles. Si ces espèces sont encore présentes dans les sites de la période intermédiaire, elles semblent avoir été en déclin à la période préhistorique récente. De plus, des escargots terrestres associés à l'introduction de plantes cultivées ont été retrouvés dans les plus anciens niveaux de Onemea (TP-2) ce qui indique que des plantes furent introduites à l'époque de l'installation humaine initiale sur l'île de Taravai.

En revanche, nous n'avons pas mis en évidence un changement significatif dans l'environnement marin (diminution des tailles, de certaines espèces, etc.) qui indiquerait son appauvrissement sous la pression de la prédation. En raison de l'étendue du lagon de Mangareva par rapport à la faiblesses des terres arables disponibles, nous pensons que ce sont les ressources terrestres et non celles du milieu marin qui ont pu être un facteur limitant à croissance démographique.

Questions pour de futures recherches

Même si la question est d'une grande complexité, il faudra poursuivre les efforts, par l'étude de la provenance des basaltes, mais aussi de la nacre; pour comprendre à quel degré et de quelles manières les populations de Polynésie orientale étaient en contacts les unes avec les autres, sur quelle amplitude elles étaient capables de partager des innovations culturelles et pourquoi et quand elles devinrent plus isolées, voire coupées de contacts avec l'extérieur.

A présent que sont posés les grand jalons de la chronologie culturelle de l'archipel (qui bien sûr doit être affinée), il est possible de s'intéresser à des questions plus précises.

Notamment, il s'agirait, en reconstituant les changements socio-économiques intervenus durant les huit ou neuf siècles avant l'arrivée des Européens, de mieux comprendre la nature de la société mangarévienne telle que décrite par l'ethnohistoire. C'est-à-dire d'écrire l'histoire de la société de Mangareva dans sa dynamique de *longue durée*. Pour cela, il faudra mieux reconstituer l'évolution démographique de la population dans le temps, puisque l'on sait que ce facteur est déterminant dans les transformations socio-politiques. Il en est de même des changements économiques que nous avons commencées à étudier par les analyses zoo-archéologiques des faunes terrestres et marines. En revanche, on sait bien moins de choses sur la façon dont les bases de l'horticulture se développèrent dans le temps. Y a-il eu la mise en place de cultures extensives sur les pentes des montagnes? Quand se développèrent les cultures particulièrement importantes de l'arbre à pain et du taro dont parlent les sources ethno-historiques?

Pour savoir, en outre, comment les superstructures (au sens marxiste du terme) évoluèrent dans le temps, il faut étudier l'organisation de l'espace, l'architecture monumentale comme les restes de *marae* et des maisons des élites. Certaines études pouvant révéler d'éventuelles tensions entre les chefs et les prêtres par exemple.

Mangareva semble une lieu idéal pour étudier les relations complexes entre les hommes et leur environnement. Parmi les différents cas étudiés à ce jour dans divers endroits de la Polynésie, Mangareva possède des particularités qui en font un cas inédit à ce jour avec cette opposition entre des ressources terrestres limitées et des ressources marines très abondantes.

* * *

CHAPTER 1

INTRODUCTION: MANGAREVA AND EASTERN POLYNESIAN PREHISTORY

P.V. Kirch and E. Conte

Archaeological research in Polynesia had its beginnings during the late 19th and early 20th centuries, with pioneering work in Hawai'i, Aotearoa, and Rapa Nui. As we enter a second century of continuing modern investigations, the goals and aims of archaeology in Polynesia have evolved a long way from those which motivated our predecessors (Kirch 2000a:12-41). Similarly, the substantive knowledge base upon which Polynesian prehistory is constructed has expanded exponentially. Yet, some of the same questions remain with us: when did Polynesians first arrive in the islands of the eastern Pacific? Were their voyages made at random or did they follow planned strategies of colonization? To what extent and for how long did the early settlers continue to maintain contacts between far-flung islands? What was the culture of the earliest settlers, and how did this change over the centuries that they occupied particular islands and archipelagoes?

Historians of science never tire of pointing out that all research is conceived and conducted within a broader social and intellectual context. In the case of our Mangareva Archaeological Project, our goals and objectives were influenced by the results of previous research in the islands, and by ongoing debates concerning key aspects of Polynesian prehistory. In this chapter we summarize some of these major research issues, as well as the results of prior research in Mangareva. We conclude with a statement of the specific objectives that we defined for the first two seasons of our project.

ISSUES IN EASTERN POLYNESIAN ARCHAEOLOGY

At a time when archaeologically based knowledge of time depth and cultural change was virtually nonexistent, Edwin G. Burrows (1938) used the classic comparative method of ethnography to infer the historical relationships between Western and Eastern Polynesia (Kirch and Green 2001:70-73). Now, with the benefit of many decades of excavation and radiocarbon-dated sequences, we know that Western Polynesia (Tonga, Samoa, and adjacent smaller islands) was the immediate homeland of those people—descended from the Early Eastern Lapita colonizers—who from the Solomons moved eastwards to Fiji around 1000 B.C. By the late first-millennium B.C.

these occupants of the Tonga-Samoa region had become the speakers of the Proto Polynesian (PPN) dialects, which were already differentiating into Proto Tongic and Proto Nuclear Polynesian branches (Marck 1996).

Sometime during the first millennium A.D.—and the timing here has been an issue of contention (see below)—Polynesian speakers once again began to move eastwards beyond the Western Polynesian archipelagoes, moving successively into the core archipelagoes of Eastern Polynesia: the Cooks, Society Islands, Australs, Marquesas, Tuamotus, and Mangareva. From this central region, voyages extended to the marginal peripheries of the Polynesian Triangle: to Hawai'i, Rapa Nui, and Aotearoa (New Zealand). What Burrows recognized so clearly, however, was that all of the Eastern Polynesian cultures—whether in the tropical core or at the subtropical to temperate margins—share a significant number of linguistic and cultural innovations (it might be more precise to say lexically-marked cultural innovations) that set them off collectively from the Western Polynesian societies. Clearly, these innovations had to have arisen and been "fixed" in the ancestral Eastern Polynesian culture at an early stage, prior to the ultimate dispersal to the margins of the Triangle, and prior to subsequent isolation and independent cultural change.

We make the above points to underscore the fact that Eastern Polynesia is fundamentally a cultural and historical construction, rather than a strictly geographic entity. Our Mangarevan research project seeks to understand the prehistory of the Mangareva Islands within this culture-historical concept of Eastern Polynesia. That is to say, we seek to enhance the broader understanding of cultural history and cultural evolution within Eastern Polynesia by focusing our investigative "lens" on one particular manifestation of the Eastern Polynesian cultural pattern. Although we are working within a local geographic and cultural context, it is essential to maintain a broader comparative perspective, continually assessing the local evidence from Mangareva in terms of what is emerging from parallel investigations elsewhere in Eastern Polynesia. This is particularly so now that archaeology has demonstrated that many early central Eastern Polynesian communities were in contact and maintained complex long-distance interaction and exchange networks.

QUESTIONS OF CHRONOLOGY AND SEQUENCE

Pioneering stratigraphic archaeology in Eastern Polynesia in the 1950s and early 1960s (Suggs 1961a; Emory and Sinoto 1965; Sinoto 1966, 1970) led to a model of Polynesian "dispersals and migrations" in which the Marquesas and Society Islands played a primary role. Initial movement of people from Western Polynesia to the Marquesas was thought to have occurred as early as 150 B.C. (Suggs 1961a), with settlement of such remote islands as Hawai'i and Rapa Nui by the first few centuries A.D. By the early 1980s it was no longer possible to support such a simple model on the emerging archaeological evidence (Kirch 1986; Irwin 1981, 1992), which among other complexities displayed serious inconsistencies in radiocarbon dates from the earliest sites. Efforts to "cleanse" the radiocarbon database (the so called "chronometric hygiene" approach) led to the proposal that initial human settlement of Eastern Polynesia had occurred more recently than originally thought, towards the close of the first millennium A.D. or even well into the second millennium in the case of New Zealand (Spriggs and Anderson 1993). A debate ensued over a "long" versus "short" chronology for Eastern Polynesian settlement (Anderson 1995, 2003; Conte 1995; Kirch and Ellison 1994). Several investigators have now attempted to resolve these chronological issues through re-dating of key sites, and excavation of new sites thought to represent early colonization (Anderson et al. 1994; Anderson and Sinoto 2002; Conte 2002; Kirch et al. 1995; Rolett 1998; Rolett and Conte 1995; Walter 1998; Weisler 1994). Our Mangareva research continues this effort.

Establishing, on empirical archaeological evidence, a date for initial Polynesian colonization of Mangareva is critical in this continuing debate over Eastern Polynesian settlement chronology, because Mangareva occupies a central geographic position, at the southeastern confluence of the Tuamotu and Austral island chains, poised as the most likely take-off point for voyages further eastwards to Pitcairn, Henderson, and ultimately, Rapa Nui (Fig. 1.1). Based on a large series of radiocarbon dates from his excavations on Henderson Island, Weisler (1995:388-390, table 2, fig. 5) suggested that Henderson may have been settled "as early as the 8th century A.D."[1] A more cautious analysis of the Henderson radiocarbon date corpus is that "... colonization of Henderson clearly took place by A.D. 1050," leaving open the possibility of slightly earlier dates (1995:389). Reviewing the available data from Mangareva, Green and Weisler (2002:237) felt that the attested basal dates of ca. A.D. 1100-1200 from Green's 1959 rockshelter excavations on Kamaka and Aukena islands derived from a period *sometime after* initial colonization of that island group. Referencing Weisler's Henderson Island chronology, they proposed that the Mangarevan sequence might extend back to A.D. 800. One of the goals of our current project is to test this temporal hypothesis for initial settlement of Mangareva.

The historical relationship of the Mangarevan language to other Eastern Polynesian languages is relevant to this discussion of Mangareva's position within the larger history of human expansion into Eastern Polynesia. Although it has never been adequately studied or sufficiently documented, enough evidence exists to place Mangarevan within the Marquesic branch of Eastern Polynesian languages (Green 1966; Marck 2000), along with Marquesan, Hawaiian, and Rapan. Based on a study of lexical doublets in Mangareva, however, Fischer (2001) has proposed that what he calls 'Original Mangarevan' formed a subgroup, together with Rapanui, which he labels 'Proto Southeastern Polynesian'. Fischer would regard Proto Southeastern Polynesian as an early split off of Proto Eastern Polynesian, at the same time as and parallel with Proto Central Eastern Polynesian. One implication of Fischer's proposal, if correct, is that Mangareva is the most probable immediate homeland of the people who settled Rapa Nui. However, Fischer's proposed terminological changes are rejected by Marck (2002), and the complex subgrouping relationships (which involve a network-breaking model of language change) are best portrayed by Green (1999, figs. 5 and 6). Green and Weisler (2002:236) have suggested that the early speech community in southeastern Polynesia was comprised of an inter-archipelago network including the occupants of Henderson and Pitcairn islands, along with Mangareva and some of the Eastern Tuamotu atolls. Fischer (2001) presents evidence that sometime after the emplacement of this early speech community, there was a significant period of linguistic "invasion" of Mangarevan by Marquesan speakers, sufficiently changing Mangarevan so that it now falls within the Marquesic subgroup. This putative phase of linguistic contact and influence from the Marquesas to Mangareva also has implications, need we point out, for cultural interaction between these two Eastern Polynesian groups.

The question of the date of initial human colonization of Mangareva is also linked to wider, more theoretical issues. In particular, whether the Mangarevan prehistoric sequence (as with other cultural sequences in Eastern Polynesia) was relatively longer or shorter in duration, has implications for the *rate* of cultural change after colonization. As Conte put it:

> Si la présence humaine dans ces îles s'avérait plus récente, il faudrait soit supposer une évolution plus rapide, ce qui remettrait en cause tout l'agencement du modèle, soit admettre que certaines chefferies étaient initialement déjà plus développées que le stade de "chefferie simple" . . . (2000 :224).

In short, time itself is a critical variable in our models of cultural change in Polynesia, and

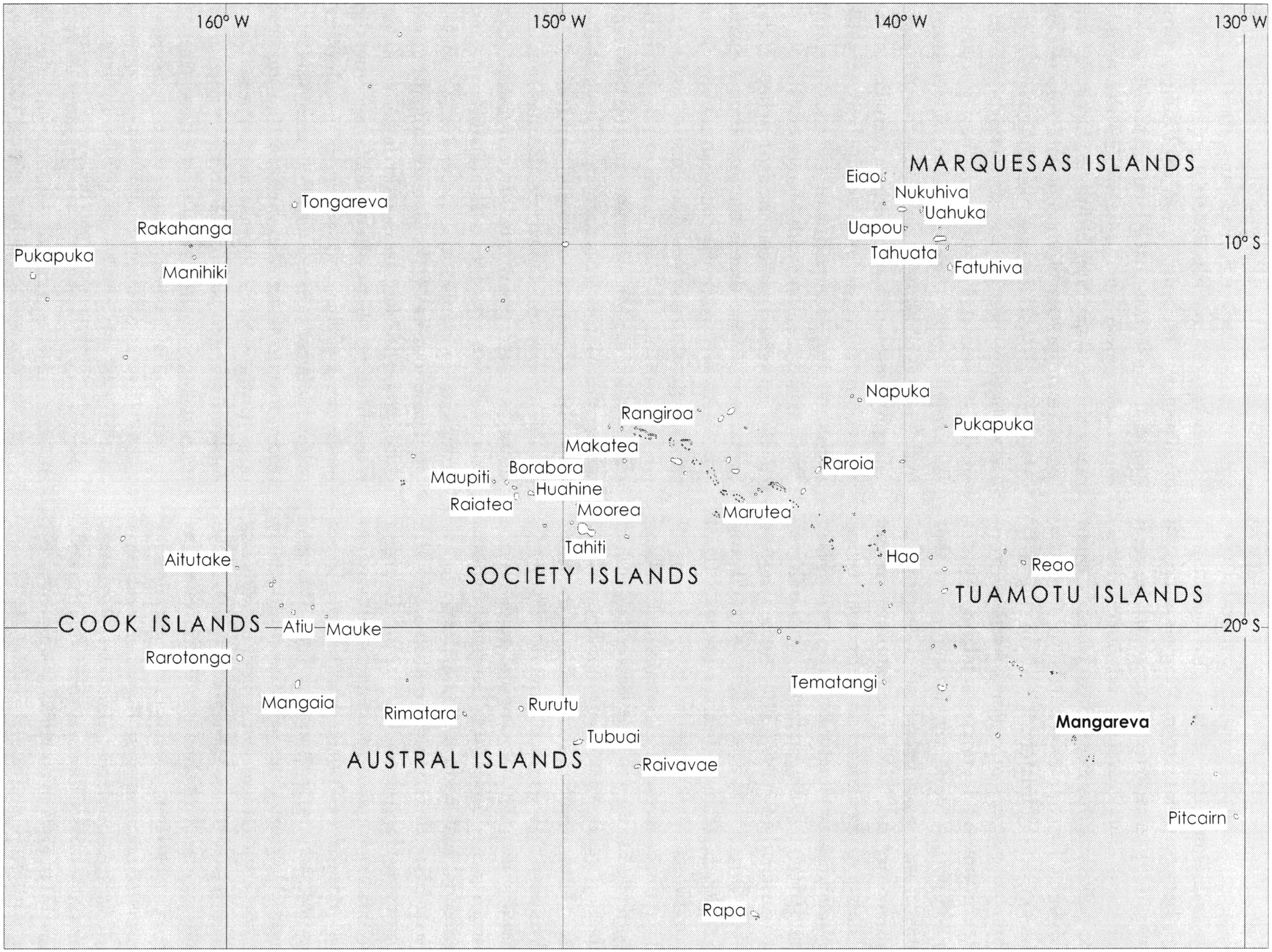


FIGURE 1.1 Southeastern Polynesia, showing the location of the Mangareva Islands in relation to other major archipelagoes and islands.

thus it is incumbent upon us to refine our chronologies as closely as possible, within the constraints of available radiometric techniques.

Variation in Ancestral Eastern Polynesian Societies

Equally critical—and as refractive to scientific inquiry—as the question of chronology is the nature of the early societies which emplaced themselves on the islands of southeastern Polynesia, and the range of variation among them. Kirch and Green (2001) have applied what they call the "triangulation approach" in historical anthropology, which draws upon archaeology, historical linguistics, and comparative ethnography, to reconstruct the major contours of Ancestral Polynesian culture in the Western Polynesian homeland, prior to the dispersal of populations into Eastern Polynesia. It was beyond the scope of their exercise to trace the various changes which set off early Eastern Polynesian culture from its immediate Ancestral Polynesian predecessor, although they point to some key transformations in the lunar calendar and in religious practice (Kirch and Green 2001:273-76).

A major effort is now required to build upon Kirch and Green's baseline for Ancestral Polynesia, by outlining the key changes which led to differentiation of the early Eastern Polynesian cultures and societies in the centuries immediately following their arrival in the Eastern Polynesian archipelagoes. Understanding the nature of these early societies—including their *mentalités*, their social and political structures, economic basis, and material modes of existence—is essential if we are to be able to trace their later histories of change and social evolution. For this effort to be successful, however, the archaeological "leg" of the triangulation approach must be fully developed through adequate sampling of sites dating to the early phase of Eastern Polynesian settlement. Thus, another long-term goal of the Mangareva Archaeology Project is to find and sample stratigraphic deposits dating to the early Eastern Polynesian time period.

Patterns of Landscape Evolution

A major theme emerging over the past two to three decades in Polynesian archaeology is the role of human populations in shaping their island ecosystems. No longer seen merely as passive actors on a largely static environmental canvas, Polynesians actively transformed island landscapes from pristine associations of plants and animals which had evolved slowly over long periods of bioevolutionary time, into frequently highly anthropogenic landscapes, managed for a variety of economic purposes (Kirch 1983, 1997a).

Archaeological and linked paleoecological research on a number of Eastern Polynesian islands has yielded a plethora of direct and indirect evidence for several kinds of Polynesian influence and impact on island landscapes. Among these are: clearance and replacement of original forest cover, either with managed arboriculture (as in the ‘Opunohu Valley, Mo‘orea [Lepofsky et al. 1996]), or with fernlands, grasslands, or other pyrophytic vegetation (as on Mangaia [Ellison 1994], Rapa Nui [Flenley et al. 1991], or in Hawai‘i [Athens 1997]); erosion, and subsequent deposition of sometimes large quantities of sediment in valley bottoms and onto coastal plains (Lepofsky et al. 1996); the introduction of a variety of domestic and commensal species, including not only crop plants but also pigs, dogs, chickens, and rats; and the frequent decimation and often extinction of indigenous and endemic biota, especially land birds (Steadman 1989, 1995, 1997a).

The degree to which such human-induced environmental changes should be regarded as "degradation" of the landscape, and the extent to which such changes were deleterious to the island cultures, is a matter for empirical investigation and must not be simply assumed. Certainly, the implantation of intensive horticultural systems on islands, and their progressive spatial extensification over time were inevitable consequences of successful cultural adaptation and population growth. The expansion of fields, gardens, and orchards, even to the extent that on many islands these dominated the lowland zones, may have resulted in serious reductions or replacements in native flora and fauna, yet without major negative consequence for the human populations. On the other hand, some islands reveal instances where overly intensive or expansive application of land use practices on vulnerable or fragile substrates led to serious land degradation, inhibiting or preventing later use of these areas. Mangaia appears to be such a case, where the interior volcanic slopes were stripped of forest cover soon after Polynesian settlement, and where as a consequence later Polynesian agriculture was intensively focused on limited areas of valley bottomland (Kirch 1996, 1997b; Kirch et al. 1995).

One variable of possible significance in assessing the relative vulnerability of particular island ecosystems to human impact is geological age and its corollary, degree of weathering and leaching of soils and soil nutrients. Ecologist Peter Vitousek (2004) has shown through extensive work on the age gradient of the Hawaiian Islands that natural ecosystem parameters are closely linked with biogeochemical gradients controlled fundamentally by a combination of age and climate. Applying Vitousek's model in a comparative way, Kirch (1997c) argued that the relative vulnerability—and consequently the impact of human land use—was much greater on 20-million-year-old Mangaia than on the youthful (<80 kyr) surface of Tikopia. More recently, Vitousek et al. (2004) and Kirch et al. (2004) have demonstrated how such biogeochemical gradients directly influenced patterns of human settlement dispersion and farming practices on Hawai‘i and Maui islands.

If this model of island age/vulnerability has wider potential, it needs to be tested on a number of other comparative cases. Mangareva offers an excellent opportunity to examine a set of small islands with geological ages of 5-6 million years (see Chapter 2), which given a relatively high annual rainfall regime, should put them at or past the threshold of nutrient weathering evidenced on the older Hawaiian Islands. Historic period descriptions of Mangareva, as well as ethnohistorical accounts (Hiroa 1938a), stress the degraded nature of the terrestrial environment, with hillslopes dominated by a pyrophytic association of *Miscanthus* caneland, *Dicranopteris* fernland, and scrub *Pandanus* (see Chapter 2). Horticultural activities were confined to the narrow coastal plains and valley bottoms (Hiroa 1938a:226), where colluvial and alluvial accumulations offered the only soils with sufficient nutrient regimes to support sustainable cultivation (Tercinier 1974). To read Hiroa's reconstruction of traditional Mangarevan society, these constraints affected many aspects of Mangarevan life, and led to a condition of endemic competition between social groups over limited economic resources. Determining when such landscape transformations first arose, in what ways humans were (or were not) responsible for them, and tracking the linked pathways of environmental change and economic adaptation, are tasks that require careful field and laboratory investigation, involving collaborative research between archaeology and the natural sciences.

Long-Distance Interactions in Eastern Polynesia

The extent to which the various societies of Eastern Polynesia were—throughout the course of their respective histories—more or less isolated from each other is a matter on which anthropological opinion has changed considerably over time. Certainly, at the moment of initial European contact, there is no evidence that the societies at the marginal extremes of Polynesia (Hawai‘i, Rapa Nui, and Aotearoa) had been in regular contact with the central archipelagoes in the near past. To the Hawaiians, for example, Kahiki was an ancestral homeland over the horizon, to and from which the deified god-chief Lonoikamakahiki "voyaged" annually, bringing fertility to the land. The real Kahiki (Tahiti) was no longer a place visited by Hawaiians, although they continued to recount oral traditions of long-departed ancestors, such as Pa‘ao, Mo‘ikeha, and

Kila who had, it was said, made return voyages between Hawai‘i and Kahiki (Finney 1994). In contrast, at the same time in the central archipelagoes of Eastern Polynesia the first European observers encountered abundant evidence of regular inter-island and inter-archipelago contact. The most famous case is surely that of Tupaia, the Raiatean priest-navigator who dictated to Captain Cook the names of more than 100 islands known to him, and pointed out sailing directions and canoe-travel distances, which Cook converted into a Western navigational map (Salmond 2003:110-111).

Western perspectives on Polynesian voyaging abilities have ranged from the romantic views of 19th century scholars such as Percy Smith, who invoked vast "fleets" of canoes, to the mid-20th century opinion of Andrew Sharp (1956) who held that Polynesian discovery of the islands had largely been a matter of random drift. Thor Heyerdahl's *Kon-Tiki* raft adventure, and the beginnings of stratigraphic archaeology in the 1950-60s, began to bring the question of voyaging into sharper relief. Early computer simulations (Levison et al. 1973) suggesting that random voyages could *not* explain the pattern of Polynesian settlement were soon followed by the experimental voyages of the replicated canoe *Hokule‘a* and others to follow (Finney 1994). From this work a much more sophisticated view of Polynesian seafaring capabilities and of settlement strategies has emerged (Irwin 1992). Many scholars now agree that early Polynesian canoes were capable of sustained upwind voyages of discovery and colonization, and of maintaining contacts between distant archipelagoes.[2] It seems likely, on the evidence of prehistoric introduction of the sweet potato (*Ipomoea batatas*) into central Eastern Polynesia by ca. A.D. 1000 (Hather and Kirch 1991), that at least one group of Polynesians ventured as far as the coast of South America and returned.

The development by archaeologists of accurate methods of spectro-chemical characterization and sourcing of artifacts—especially adzes or other tools made of Oceanic basalts—has likewise fueled interest in the question of long-distance interactions in Polynesia (Weisler 1997; Rolett et al. 1997). Weisler and Kirch (1996), for example, demonstrated that stone adzes originating from the Tatangamatau quarry on Tutuila Island in the Samoa group had been imported to Mangaia in the southern Cook Islands. Several studies within the southern Cook Islands have shown substantial inter-island transfers of basalt artifacts, and pearl-shell is likely also to have been moved in this manner (Sheppard et al. 1997; Allen and Johnson 1997). Rolett et al. (1997) have documented the movement of Eiao Island basalt artifacts in the Marquesan archipelago. Subsequently, Weisler (1998; Weisler and Green 2001) has demonstrated the movement of adzes of Marquesan (Eiao Is.) origin to both Mo‘orea and Mangareva, as well as the movement of an early Type Ia adze from the leeward Society Islands to Mangareva. These discoveries have prompted a reconsideration of the degree of long-distance interaction among early Eastern Polynesian communities. Even the previously supposed "total isolation" of remote Rapa Nui is now open to question, as Conte avers:

> On peut même se demander si l'ile de Paques, entre toutes synonyme d'isolement, et ce des son peuplement initial si l'on en croit l'opinion couramment admise, a toujours été aussi isolée qu'on le prétend. Les conditions de navigation sont difficiles mais non insurmontables, notamment depuis Pitcairn, et dans le sens îles de Pâques Tuamotu elles semblent même assez aisées si l'on en croit Irwin (1992 :162). Penser a une colonisation unique et sans retour, et même nier la possibilité de contacts avec l'extérieur après la colonisation, est-il conforme a la logique comme aux connaissances disponibles sur l'ancienne culture pascuane, ou est-ce céder une fois de plus au mythe de l'ile isolée au bout du monde, dérivent vers un chaos magnifique peuple de géants de pierre? N'est-ce pas oublier la chaîne d'îles (Henderson, Ducie, Pitcairn) qui, depuis les Gambier, étaient autant d'escales, de foyers de peuplement et de contacts ultérieurs possible (2000:264-65).

Based primarily on his extensive research on Henderson Island, Weisler (1997) outlined a specific model for a "Mangareva-Pitcairn interaction sphere" that may have operated between these far-flung islands over a period of 400-500 years; the model was further elaborated by Weisler and Green (2001). Archaeological evidence for imports from Mangareva to Pitcairn/Henderson include volcanic oven stones of Mangarevan provenance, as well as pearl shell which is abundant in Mangareva but does not grow in the Pitcairn-Henderson group. From Pitcairn to Henderson, there is additional evidence for importing of oven stones, fine-grained basalt, and volcanic glass, as well as of pig and crop plants which might have come from either Pitcairn or Mangareva. Weisler's model for this Mangareva-Pitcairn interaction sphere is graphically depicted in Figure 1.2. As can be seen, he infers the movement of other kinds of goods, such as turtles and red feathers from Henderson, but these need to be tested on direct archaeological evidence.

In a detailed application of a "holistic approach" to interaction studies (i.e., one incorporating multiple lines of evidence, including those of historical linguistics as well as archaeology), Weisler and Green (2001) further develop the case for Mangareva as a central locality in southeastern Polynesian interaction networks. They write that "Mangareva held a pivotal position in long-distance interactions not only involving the Pitcairn group, but including the more distant archipelagoes of the eastern Tuamotus and the Marquesas" (Weisler and Green 2001:440). One aim of our Mangareva Archaeological Project is thus to obtain additional empirical evidence to help test this hypothesis.

Economic and Social Change

Finally, a topic of long-standing interest which has stimulated a diversity of theoretical perspectives is that of the differentiation and diversification among the Eastern Polynesian societies in the centuries following initial discovery and settlement. Although the Eastern Polynesian societies share much in common, and clearly can be traced—from a phylogenetic or cladistic perspective—to a shared Ancestral Eastern Polynesian culture during the early phase of Polynesian expansion out of Western Polynesia, they are by no means all simple "clones" of each other. In contrast, while sharing certain common features, they display an amazing degree of variation, in subsistence economy, social structure, political organization, and religion. Accounting for these differences, and explaining how and why they have arisen, has engaged the efforts of both comparative ethnographers (Sahlins 1958; Goldman 1970) and prehistorians (Kirch 1984; Kirch and Green 1987, 2001; Conte 2000).

This is not the appropriate venue to review the range of theoretical perspectives on the "evolution" or "transformation" of Polynesian societies (but see Conte 2000 for one critical perspective). However, we do wish to comment on the possible significance of Mangareva within such theoretical constructions. Sahlins advanced a model in which the varied Polynesian cultures were seen as exemplifying "members of a single cultural genus which has undergone adaptive differentiation" (1958:248). In his model, social stratification (hierarchy) was seen to be directly correlated to the environmental potential of a particular island or archipelago and to economic productivity, as regulated through Polanyi's concept of "redistribution" (Polanyi 1944). Sahlins classified Polynesian societies into four categories, ranked in order of their degree of stratification, with Mangareva included in Group IIa (along with Mangaia, Rapa Nui, and 'Uvea), which "had stratification systems structurally divisible into two status levels" (1958:68). Distinctions between the elites (who were marked by several lexical categories) and commoners were pervasive, ranging from houses and material insignia, to special life-crisis rituals, to control of economic production and craft specialization. Within his Group IIa, "Mangareva appears to have been the most stratified" (1958:70). As

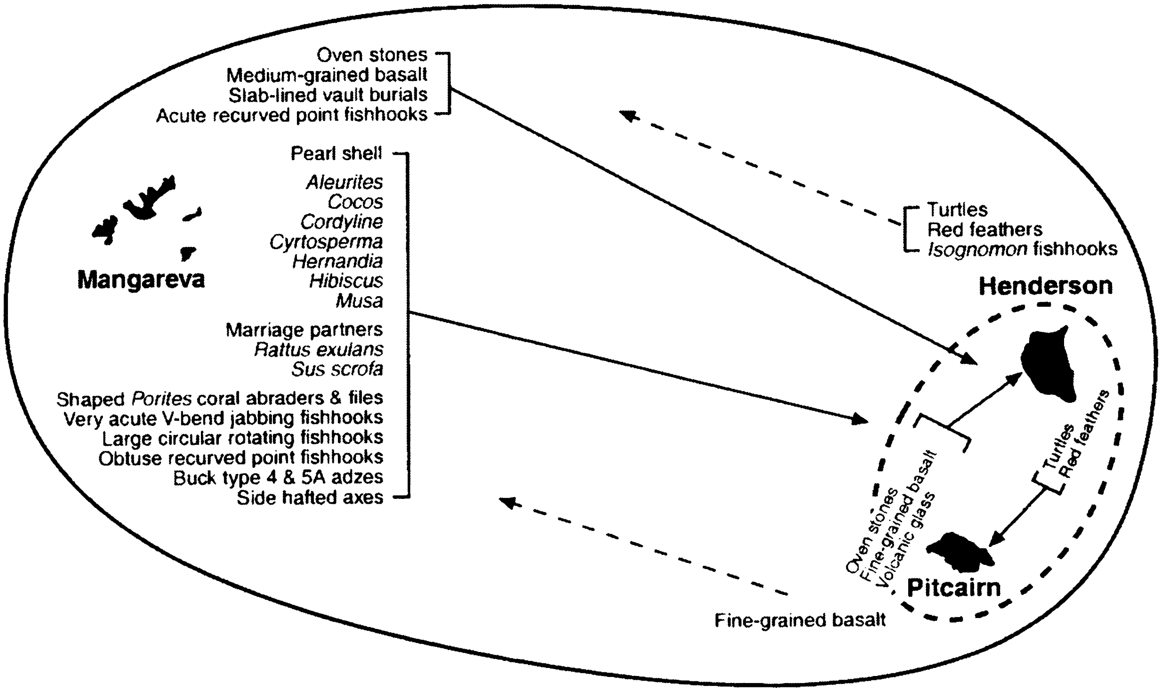


FIGURE 1.2 Weisler's hypothetical model of the Mangareva-Pitcairn interaction sphere, with commodities exchanged (after Green and Weisler 2002, fig.11).

Sahlins was working within an explicit model of "multilineal cultural evolution" (see Sahlins and Service 1960), the implication of his classification is that late pre-contact Mangarevan society represents the endpoint of an evolutionary trajectory towards increased hierarchy and social differentiation over time.

Goldman (1970) who, like Sahlins, depended largely upon 19th and 20th century ethnographic sources for his analysis, adopted a theoretical position emphasizing social agency, downplaying the primacy of environmental and economic factors (in Marxist terms, one might say that where Sahlins insisted on the primacy of infrastructure, Goldman looked to superstructure for the determinant forces of change). Goldman classified Polynesian societies into three groups, ranging from 'Traditional', to 'Open', to 'Stratified', forming an implicit evolutionary sequence. To Goldman, Mangareva was "a small version of the Stratified society" (1970:150); indeed, Mangareva is by far the smallest instance (both in terms of island area and of population) of Goldman's Stratified category. Goldman emphasized scarcity, rather than abundant resources, in assessing the role of environment and economic production in social evolution, with Mangareva as a key witness:

> The appearance of a Stratified society on these small and isolated islands that resemble atolls refutes at once the conventional thesis that political evolution can be explained from conditions of economic surplus. If Mangareva illustrates any economic thesis at all, it is rather the opposite—the stimulus of economic scarcity. The four [sic] islands comprising the archipelago have a combined area of no more than six square miles . . . most of it rocky and barely cultivable. The islands have no permanent streams, no secure water supply other than a few springs, rain runoff, and seepage. The small areas of fertile soil lie in scattered patches along coastal flatlands and within the short mountain valleys (1970:150).

Although placing Mangareva in the Stratified category, Goldman nevertheless drew many parallels between Mangareva and the societies of his "Open" category, including the Marquesas, Mangaia, and Rapa Nui, especially the fluidity of social statuses (hereditary chief, warrior, priest). Summarizing the oral traditions of Mangarevan political history, Goldman writes:

> We see . . . all of Mangarevan history as a record of political unrest and of acute rivalries for power. In the course of these struggles the principles of traditional status were never really overcome or abandoned. They were stretched, and even reshaped to meet the actualities of political life (1970:154).

Clearly, Goldman struggled with the Mangarevan case, putting it in his Stratified category while recognizing that it perhaps shared more in common with the Marquesas or Mangaia. Recent historical and anthropological analyses of Marquesan social change (Thomas 1990; Kirch 1991) have pointed to the emergent tensions between traditional status groups and to the breakdown of hereditary chiefship. Kirch (1991) has argued that the Marquesas exemplify a case of "competitive involution"; a similar argument might perhaps be advanced for Mangareva.

The models of Sahlins and Goldman, however interesting, were both beset by a fundamental problem of being in essence evolutionary models that were dependent upon atemporal, ethnographic depictions of societies at the point of, or even after, European contact. The societies classified by Goldman as Traditional, Open, and Stratified (or by Sahlins as Groups I to III) cannot in reality form a true evolutionary sequence. Rather they are contemporary, static endpoints of lengthy sequences of cultural change. The methods of comparative ethnography can suggest hypotheses of how differences between such related groups may have arisen, but they cannot directly unravel the real *longue durée* of history. In the absence of written records, only archaeology and prehistory have that privilege.

As archaeologists in Polynesia have moved from early efforts at establishing cultural sequences and documenting and describing material culture change over time, they have increasingly begun to look to their archaeological data to test models of cultural and social change. Predictably, there is a wide spectrum of theoretical positions, ranging from the cultural evolutionary stance of Kirch (1984) or Kirch and Green (1987), or the "selectionist" evolution exemplified by Allen (1996), to Conte's (2000) critique of evolution and emphasis upon agency and identity as underlying principles of social differentiation. This is not the place to argue for or against particular theoretical paradigms. The point we wish to make is that it is archaeologists, who—unlike the comparative ethnographers—are able within the limits of material evidence to directly access the past and can therefore study cultural change over time. The societies of Eastern Polynesia, as their individual histories are painstakingly revealed through detailed archaeological investigation, have enormous potential to test a variety of anthropological models and theories. Mangareva has already been pointed to, by Sahlins and Goldman, as a case study of great interest within the Polynesian spectrum. As our archaeological knowledge of the Mangarevan past continues to expand, we expect that Mangareva will continue to stimulate intellectual debate about the course of the Polynesian *longue durée.*

PREVIOUS ARCHAEOLOGICAL RESEARCH IN MANGAREVA

The early explorers and missionaries (including Beechey [1831], Moerenhout [1837], and Laval [1938]) briefly described some of the religious structures and burial sites then still in use, but archaeological investigations per se did not commence until the early part of the 20th century. From late 1921 until the end of 1922, Katherine Routledge—best known for her pioneering archaeological and ethnographic research on Rapa Nui—carried out fieldwork on Mangareva, assisted by her husband William Scoresby Routledge (Van Tilburg 2003:209-212). Routledge's Mangareva research appears to have been for the most part ethnographic and linguistic, although Scoresby evidently photographed and mapped some stone ruins. Unfortunately, due to Katherine's tragic illness, her results were never written up for publication.[3]

The first significant archaeological work, therefore, did not commence until the arrival of the Bishop Museum's 1934 Mangarevan Expedition, during which Kenneth P. Emory and Te Rangi Hiroa (Peter H. Buck) spent several months based in Rikitea Village (Hiroa from 12 September to November 20, Emory from 12 September to November 5; see Gregory [1935] for details of the Mangarevan Expedition). Emory and Hiroa were disappointed with what they could find of surface archaeological remains; in Hiroa's words: "Every *marae* has been obliterated and though the sites and the names of ancient religious structures were known, there were no remnants that could assist Emory in reconstructing the *marae* pattern" (in Gregory 1935:59). Hiroa concentrated on "salvage ethnography", producing a monograph (Hiroa 1938a) which remains the key work on Mangarevan traditional society.

Emory made a rapid survey of the islands in the main group, locating the remnants of several *marae* and other structures (including the "royal nurseries" on the slopes of Mt. Duff), and summarizing relevant information from the accounts of early explorers and missionaries, reported in his monograph (Emory 1939). Emory, like Hiroa, made it clear that he was deeply disappointed with what traces were left of surface archaeology:

> After my experience in investigating ancient stone work in the Society Islands and the Tuamotus, where ancient ruins abound, the complete disappearance of all important structures in the Mangarevan group was most discouraging. The destruction is accounted for by the immense amount of stone required for the great cathedral at Rikitea and the numerous stone buildings set up in the first days of the missionary régime (1939:5).

The situation on the isolated atoll of Temoe proved to be different, for here the remains of numerous *marae* were found intact, and Emory therefore concentrated most of his work on recording these structures.

Emory did, however, carry out some "excavation" in the main Mangareva group, although his methods were shockingly crude. Presumably inspired by the recovery of adzes and other artifacts from "bluff shelters" on the northwestern Hawaiian islands of Nihoa and Necker during the Tanager Expeditions of the 1920s (Emory 1928), Emory made a similar effort to locate and dig in the floor deposits of rockshelters, especially on Agakauitai Island, where he was assisted by a local American expatriate named Stephen Garwood:

> We camped on the little island of Agakau-i-tai for several days and were able to explore it thoroughly. . . . The site of Marae Te Aga-o-Tane is at the northern end of the level land directly in front of a little shelter cave formed by the overhang of the bluff. . . . In the shallow earth of the floor Garwood and I dug for an hour and a half, but found no artifacts.
>
> Several yards south of the hiding cave of Te Akariki-tea, at the very foot of the overhanging bluff, is the largest shelter seen on the island, called by the natives Te Ana-vehivehi. . . . Discovering part of a pearl-shell fishhook on the floor, we deemed this site worthy of thorough excavation and in the course of our stay sifted half the soil of the floor and combed through the other half (Emory 1939:28-30).

Their "thorough excavation" (which lacked any spatial or stratigraphic control, and did not make use of sieves) yielded a few objects including some scrapers and a "tiny fishhook of pearl shell". Regrettably, Emory's digging in a number of rockshelters on Agakauitai and Taravai probably destroyed some of the best stratigraphic deposits on these islands.

In April, 1956, the Norwegian Archaeological Expedition to Easter Island and East Pacific, having completed its work on Easter Island, spent a week at Mangareva, to allow the expedition's four archaeologists "to become personally acquainted with sites already described in the literature" (Heyerdahl and Smith 1961:17). They "verified" Emory's statement concerning the destruction of "all important structures", but did note the probability that "future work in these islands will locate unobtrusive sites from which an archaeological sequence may be derived."

Just three years later, Roger C. Green arrived in Mangareva under the sponsorship of the American Museum of Natural History (New York), with a focus on stratigraphic archaeology which enabled him to locate precisely the kind of "unobtrusive sites" from which a cultural sequence could be constructed. (Accompanied by his wife Kay, Green worked in Mangareva from July 2 to December 6, 1959; they were assisted for part of this time by Tihoni Reasin.) Green found that rockshelters were common in the low basaltic cliffs of the islands, and he carried out stratigraphic excavations in six of these, three on Kamaka, two on Aukena, and one on Mangareva. Green's work was conducted within the dominant North American culture-historical paradigm current at the time, hence the focus on well-stratified sites that could produce a "cultural sequence" exemplified by material culture. Nonetheless, his emerging interests in the "settlement pattern approach", soon to be developed in his subsequent work on Mo'orea Island, were reflected in Mangareva by detailed mapping of a surface archaeological complex at Tokani Bay, on Akamaru Island (Green and Weisler 2000, fig. 2).[4]

Initial radiocarbon dates from Green's excavations at "Kitchen Cave" and a second rockshelter at "Sancho's Cove" (Kamaka Is.), and from Te Ana Pu (Aukena Is.) were reported by Suggs (1961b), who noted that resemblances between artifacts types from the Mangarevan sites and early sites in the Marquesas "[led] Green to believe that Mangareva may have been settled by Marquesans" (1961b:92). Green prepared a preliminary report and an incomplete manuscript account of the excavations (with copies deposited in the Bishop Museum and Musée de Tahiti), but these regrettably remained unpublished for several decades. A summary of the 1959 excavations, including stratigraphic descriptions and radiocarbon dates, but not including the artifactual or faunal materials, was eventually published by Green and Weisler (2000). Figure 1.3 shows the stratigraphic correlations between Green's excavated sites and their chronology based on eight available radiocarbon dates (for the ^{14}C dates, see Green and Weisler 2002, table 1). The oldest deposits are those of the Kamaka Island rockshelters (sites GK-1 and -2), followed by the GA-1 rockshelter on Aukena Island.

Further details of Green's 1959 excavations are now finally appearing in print. Steadman and Justice (1998) reported on bird bones recovered from Green's 1959 excavations, while Green and Weisler (2004) recently summarized the zooarchaeological evidence for chickens, dogs, pigs, and rats, based on the 1959 excavations. Aspects of the material culture record from the rockshelter sequences, such as the fishhooks, adzes, octopus lure rigs, harpoons, and ornaments, are presented in Green (1998) and in Weisler and Green (2001).

Despite the promising results obtained by Green in 1959, no further fieldwork was carried out in Mangareva for three decades, until 1990-1992 when Marshall Weisler made two visits to Mangareva in connection with his archaeological research on the Pitcairn and Henderson islands (Weisler 1996). However, Weisler's Mangareva work was restricted to reconnaissance-level survey and to the collection of rock samples for geochemical analysis. Weisler reported 20 archaeological sites, including rockshelters, buried midden deposits, agricultural features (terraces), and stone structures. Many of these sites had previously been reported by Emory and/or Green, but several new sites were included. These hinted that the earlier claims for "complete destruction" of the archaeological record were indeed overstated.

Immediately prior to our own project, in April-May 2001, a C.N.R.S. team headed by Michel Orliac carried out field research ostensibly focused on the "composition and evolution of the flora" (Orliac 2002). The team carried out work primarily in the coastal or littoral zone, in the vicinity of Gatavake, Rikitea, and Atirikigaro on Mangareva Island. The work at

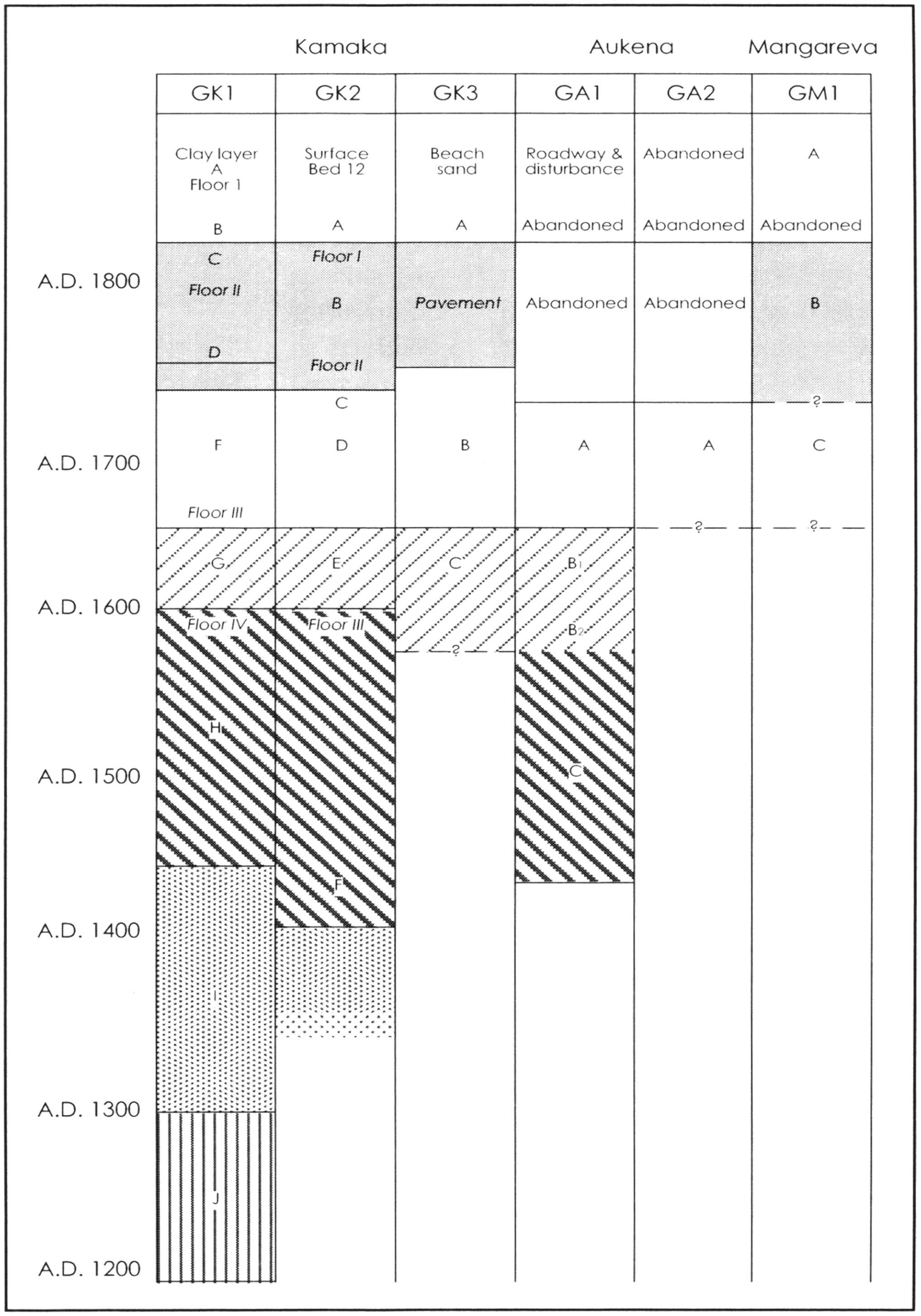


FIGURE 1.3 Stratigraphic correlations and time sequence for the six rockshelters excavated by Roger Green in 1959 (after Green and Weisler 2000, fig. 24).

Gatavake has been described in greater detail by Orliac (2003), where stratified deposits were discovered in the subtidal zone, associated with stone alignments which are now exposed only at low tide. This evidence strongly suggests fairly rapid submergence and coastal regression, and Orliac proposes that *relative* sea level may have risen as much as 0.5 m since the 12th century. Test excavation in a buried cultural deposit, which yielded fishhook fragments, a serrated coconut grater, and worked pearlshell along with flaked lithics and dikestone, produced a ^{14}C sample dated to 830 ± 70 B.P. (calibrated to A.D. 1030-1290). Preserved plant remains from this level were identified and included typical coastal trees (*Thespesia populnea, Calophyllum* *inophyllum, Guettarda speciosa*) along with Polynesian introduced trees (*Cocos nucifera, Aleurites moluccana, Casuarina equisetifolia*).

To sum up, prior archaeological studies in the Mangareva Islands had been fairly limited in scope; where significant results had been obtained they remained in large part unpublished. Emory felt that most of the important surface architecture had been destroyed by the missionaries, and his "excavations" were so crude as to be more destructive than contributing to archaeological knowledge. Green's 1959 rockshelter excavations yielded time depth and an important artifact sequence, but remaining unpublished these results did not begin to influence broader discussions of Eastern Polynesian prehistory until recently. Fortunately, with the collaboration of Marshall Weisler, Green's pioneering work has now begun to appear in published form (Green and Weisler 2000, 2002, 2004; Weisler and Green 2001).

THE 2001-2003 MANGAREVA ARCHAEOLOGICAL PROJECT

RESEARCH STRATEGY AND OBJECTIVES

In the research proposal submitted by our team to the Ministry of Culture in January 2001, we outlined four major objectives for our project in the Mangareva Islands. These objectives were influenced by the major research themes described earlier in this chapter, but were somewhat more focused and modest, given the limited time and resources available to us.

Objective 1: To contribute to the inventory of archaeological sites in Mangareva, especially stone structures which had not been previously recorded. As noted above, Emory had set the tone for virtually all archaeologists working in Mangareva when he lamented "the complete disappearance of all important [stone] structures in the Mangarevan group" (1939:5). However, settlement pattern archaeology in Polynesia has advanced a great deal since Emory's time, with the realization that entire settlement landscapes—and not just the large *marae* or other ceremonial structures—are worthy of archaeological attention. Despite the evident destruction of the principal *marae* by the Catholic missionaries, we suspected that it might still be possible to find intact archaeological landscapes, especially on the outer islands, as Weisler's brief reconnaissance had suggested (Weisler 1996). Thus a primary goal was simply that of reconnaissance survey, to assess the potential for settlement pattern studies.

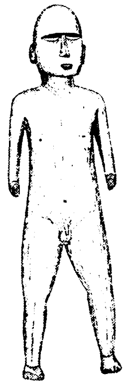
Objective 2: To obtain new information relative to the chronology of human settlement of the archipelago. Locating the earliest sites in any Polynesian archipelago has met with much controversy, and archaeologists actively debate the date of colonization for particular island groups. Finding the earliest sites for a particular island or archipelago is of extreme importance for it "starts the clock" for examining cultural differentiation and evolution of island societies. From excavations on Kamaka Island, Green established a first culture-historical sequence for Mangareva beginning at A.D. 1200 (Green and Weisler 2000). However, basalt adze material and volcanic oven stones from Mangareva may date to as early as A.D. 800-1000 in habitation sites on Henderson Island, some 400 km east of Mangareva (Weisler 1995). We therefore hypothesized that perhaps 200 to 400 years of the earliest period of Mangareva prehistory awaited discovery. We proposed to address this question of colonization and settlement chronology through the use of transect coring in locations judged likely for early settlement (such as the Rikitea Village area), combined with test excavations.

Objective 3: To contribute to the evolving archaeological understanding of prior interactions or exchanges between Mangareva and other islands and archipelagoes of Eastern Polynesia. As discussed above, the nature of long-distance interactions or exchange between islands and archipelagoes in Eastern Polynesia has emerged in recent years as a major theme of archaeological research. The use

CHAPTER 2

ENVIRONMENTAL AND ETHNOGRAPIC BACKGROUND

P.V. Kirch



Mangareva is the collective name for a group of ten small "high" volcanic islands encompassed within an encircling barrier reef (23°07' S., 134°58' W.), as well as the proper name of the largest of these islands. Captain James Wilson of the missionary ship *Duff*, encountering the islands on May 22, 1797 (Hiroa 1953:47), named them after Admiral Gambier.[1] In its proper historical usage, *Gambier Islands* applies strictly to this cluster of high islands including Mangareva (Brigham 1900:96). Recently, however, the name Gambier Archipelago has been applied to a larger geographic entity including the nearby atoll of Temoe, as well as several atolls in the Actaeon Group (Tenararo, Vahanga, Tenarunga, Matureivavao, and Marutea). It is in this broader geographic sense that *Îles Gambier* is used by the administration of French Polynesia. Here we use the term *Mangareva Islands* to refer to the group of high volcanic islands encompassed by its barrier reef and lagoon system, and *Mangareva* to refer to the principal high island, where the administrative center of Rikitea is situated.

Archaeological research in any Polynesian island benefits through close familiarity with the relevant natural history and ethnographic literature. Many aspects of the Mangarevan environment directly affect the archaeological record (such as dynamic sea levels and shoreline processes), or aid in the interpretation of that record (such as the influence of soils or biotic resources on settlement patterns). Archaeological interpretation is likewise informed by reference to the ethnographic and ethnohistoric literature. In Polynesia, the cultures and societies documented at the time of European contact represented the "endpoints" of unbroken cultural sequences that can be traced back to initial colonization. Therefore, our use of ethnography in Polynesian archaeology falls within what has been termed—in North American usage—the "direct historical approach" (Steward 1942; Strong 1953; Lightfoot 1995; Conte, in press), which is distinct from the practice of "ethnographic analogy". In this chapter, we summarize relevant aspects of both Mangarevan natural history and ethnography as these relate to the archaeological record.

NATURAL HISTORY OF MANGAREVA

Being small and isolated, the Mangareva Islands have not been as thoroughly investigated by naturalists as other Eastern Polynesian archipelagoes. The Bishop Museum's 1934 Mangarevan Expedition made important terrestrial biological collections, but these have been only partly described or published (e.g., Kondo 1962; Solem 1976; Zimmerman 1936). In the late 1960s to early 1970s, a multidisciplinary team of researchers from the Service Mixte de Contrôle Biologique of France carried out a series of investigations for the Direction des Centres d'Expérimentations Nucleaires, in conjunction with the nuclear bomb tests at nearby Mururoa and Fangataufa atolls. The results of these investigations were published in two substantial volumes in the series *Cahiers du Pacifique* by the Fondation Singer-Polignac; we have drawn heavily from reports in these volumes in preparing this summary of Mangarevan natural history.

GEOLOGY AND GEOMORPHOLOGY

As is typical of true "oceanic" islands situated on the Pacific Plate, Mangareva has a "hot spot" origin, on the same volcanic alignment with Pitcairn Island to the southeast (Munschy et al. 1998). Radiometric (K-Ar) dating of volcanic rocks from the Mangareva Islands have yielded ages of 4.77-5.98 Ma (Bellon 1974), and 5.66-6.26 Ma (Guillou et al. 1994). With this age of roughly six million years, Mangareva has migrated in a northwesterly direction from its original position on the Pitcairn hot spot, in the process undergoing both subsidence and extensive subaerial erosion. The highly dissected islands encompassed within the barrier reef and lagoon are thus what remains of a once much more extensive high island (Fig. 2.1). Table 2.1 lists these ten volcanic islands in order of size, giving their respective areas in square kilometers, and their maximum heights.

The igneous rocks making up the Mangareva Islands are varied in type and geochemical composition, and include block lavas and pyroclastic breccias as well as many intrusive dikes (Brousse 1974; Brousse and Guille 1974). The orientation of the numerous dikes exposed along the coasts of Mangareva, Taravai, Agakauitai, and Akamaru suggests that a large central caldera was originally situated in the area now occupied by the central lagoon, between these islands (Brousse and Guille 1974, fig. 1). Our archaeological work has shown that many of these dikes were exploited as sources of raw material for stone artifacts, and flaked dikestone is abundant in some archaeological contexts, as at the Nenega-Iti and Onemea sites (see Chapter 6). As Brousse (1974:178) points out, the chemical composition of the Mangarevan basalts is highly varied, with at least three distinct groups ("tholeiites", "basalts alcalins", and "océanites"). Weisler (1996:76-78, fig. 6) collected and geochemically analyzed 26 rock samples from seven islands in Mangareva, as part of his program of tracing prehistoric exchange between the Mangareva and Pitcairn islands. The variability in Mangarevan rock geochemistry has obvious implications for archaeological efforts to characterize and source artifacts made of volcanic rocks.

The high islands and lagoon are protected on the west, north, and east by the extensive barrier reef system; however, the reef is submerged to the south, permitting storm swells to enter the lagoon from that direction. Fringing reefs are found along the coasts of the high islands, although the southern coastlines tend to be more exposed and in places are marked by formidable sea cliffs. This is the case with Agakauitai, for example, which has a fringing reef on the northwest, but exposed cliffs on the south and east. Likewise, Makaroa and Kamaka islands have fringing reefs and small sand beaches only on their more protected, northern shores. The large island of Mangareva, being the most protected by the barrier reefs, has extensive fringing reefs and sand flats surrounding it. Deep, protected bays are found along the northwestern coasts of Mangareva and Taravai islands. These variable coastal conditions profoundly influence

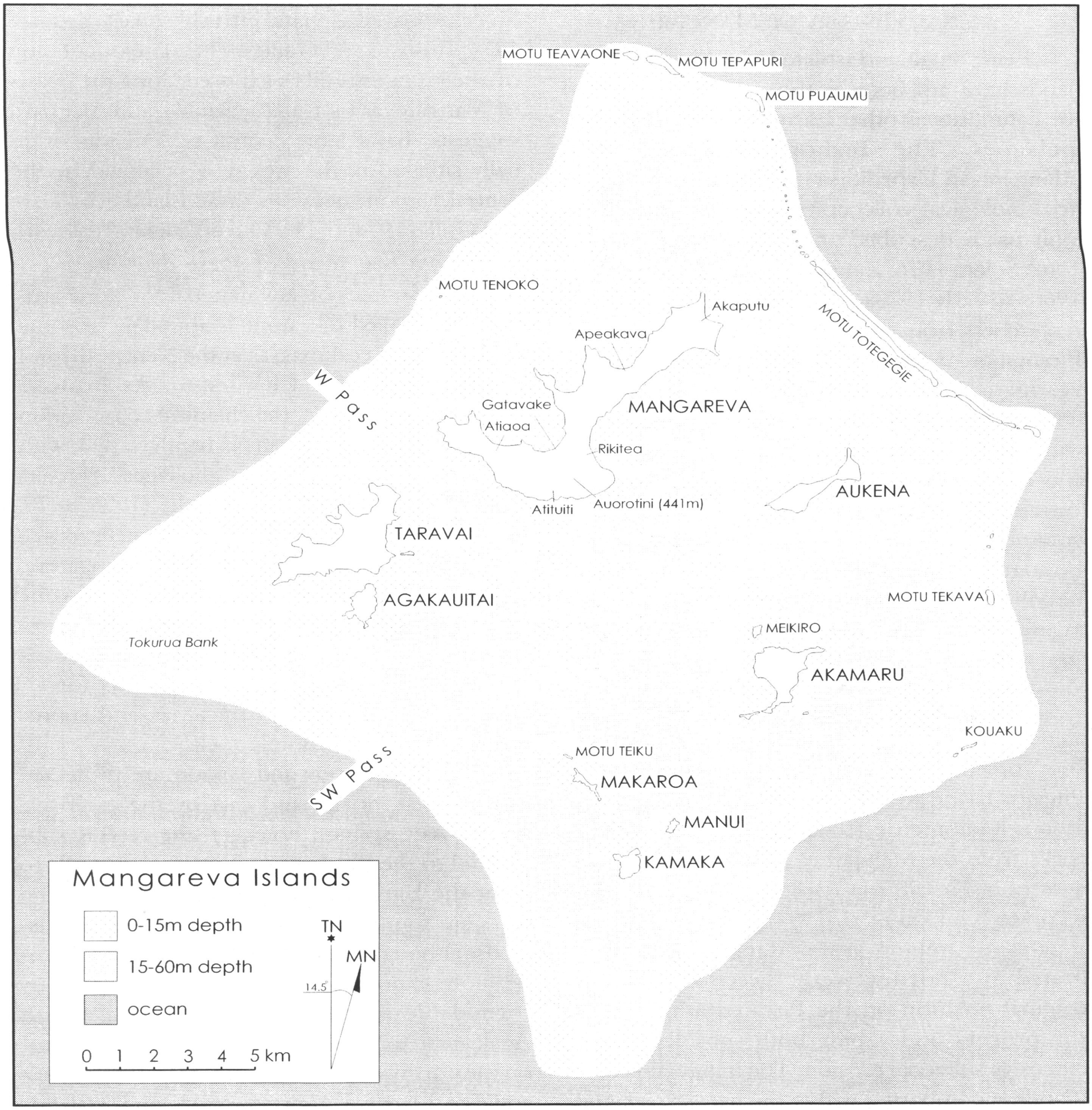


FIGURE 2.1 Map of the Mangareva Islands showing the principal high islands and *motu* of the barrier reef, and submarine topography of the lagoon. (Map after *Atlas de la Polynésie Française*, ORSTOM, 1993, plate 16).

the littoral and marine resources adjacent to particular localities, as is reflected in the results of our faunal analyses from three rockshelter sites (see Chapter 5).

The topography of the Mangarevan high islands is dissected and rugged, with steeply ascending, shallow valleys (Figs. 2.2, 2.3). Only the largest valleys have permanent water courses (as

TABLE 2.1 Geographic characteristics of the volcanic islands of Mangareva.*

Island	Area (km^2)	Highest point (m)	Comments
Mangareva	14	441	Largest island and administrative center (Rikitea Village); several large valleys and deep, protected bays.
Taravai	5.3	250	One village, nearly abandoned today. Three large bays on the west coast; large valley on the east coast.
Akamaru	2	246	Large coastal plain on the north; one large valley on the west (Tokani).
Aukena	1.5	198	Two peaks with narrow isthmus. Narrow coastal plains.
Agakauitai	0.7	139	Two small valleys on the west side; cliff bound on the south, east, and north.
Kamaka	0.5	166	Privately owned by the Reasin family; beach ridge on the north, rockshelters.
Makaroa	0.2	136	Small valley and beach ridge on the north; otherwise cliff bound.
Mekiro	0.075	58	Small, cliff bound islet.
Manui	0.070	54	Small, cliff bound islet.
Makapu	0.065	~50	Small, cliff bound islet.

*Areas and elevations after Brousse (1974).

at Gatavake on Mangareva, or Aganui on Taravai); others have small drainage channels that flow after heavy rains; small springs or seeps emanate at the base of other valleys. Cliffs occur commonly, with shallow rockshelters formed where strata of softer breccia have been eroded more deeply than the intervening dense lavas.

An important issue for archaeology is the matter of relative sea-levels and shoreline dynamics. Brousse et al. discuss the geomorphological evidence for subsidence over the longer term of geological history: ". . . nous pensons que la subsidence a été le phénomène qui a provoque la disparition de la plus grande partie de l'édifice volcanique dont nous n'apercevons aujourd'hui que le sommet en grande partie démantelé" (1974:90). They do not comment on whether there is active subsidence at the present time. However, Orliac (2002, 2003) reports a number of archaeological features, such as stone walls and platforms along with cultural deposits, which are presently in the subtidal zone at Gatavake and other bays. He contends that these are evidence of as much as 50 cm of subsidence over the past 800 years. As reported in Chapter 3, we also noted such stone structures in the intertidal zone at Atituiti-Raro on Mangareva Island, and along the coasts of Aukena and Akamaru islands. Other observations, such as the frequent presence of wave-cut banks and active erosion of beach ridges, also reinforce our view that the Mangareva Islands are actively undergoing a phase of relative transgression of sea level, with erosion of archaeological sites and deposits. This is a topic that deserves particular geoarchaeological investigation.

CLIMATE

At 23° S. under the Tropic of Capricorn, the Mangareva Islands have a somewhat cooler climate than the Society or Marquesas archipelagoes (Chèvre 1974:144). The trade winds blow predominantly from the east. The annual average temperature is about 24° C., with the period from about May to October being somewhat cooler. Average annual precipitation ranges between about 1,400-1,900 mm, with the heaviest rainfall concentrated in December-January, although the differences between the rainiest

FIGURE 2.2 The Mangareva Islands are characterized by small high islands clustered within a large lagoon and barrier reef system. In the foreground is Aukena Island, with Akamaru, Kamaka, and Makaroa islands in the distance. Photo by P.V. Kirch.

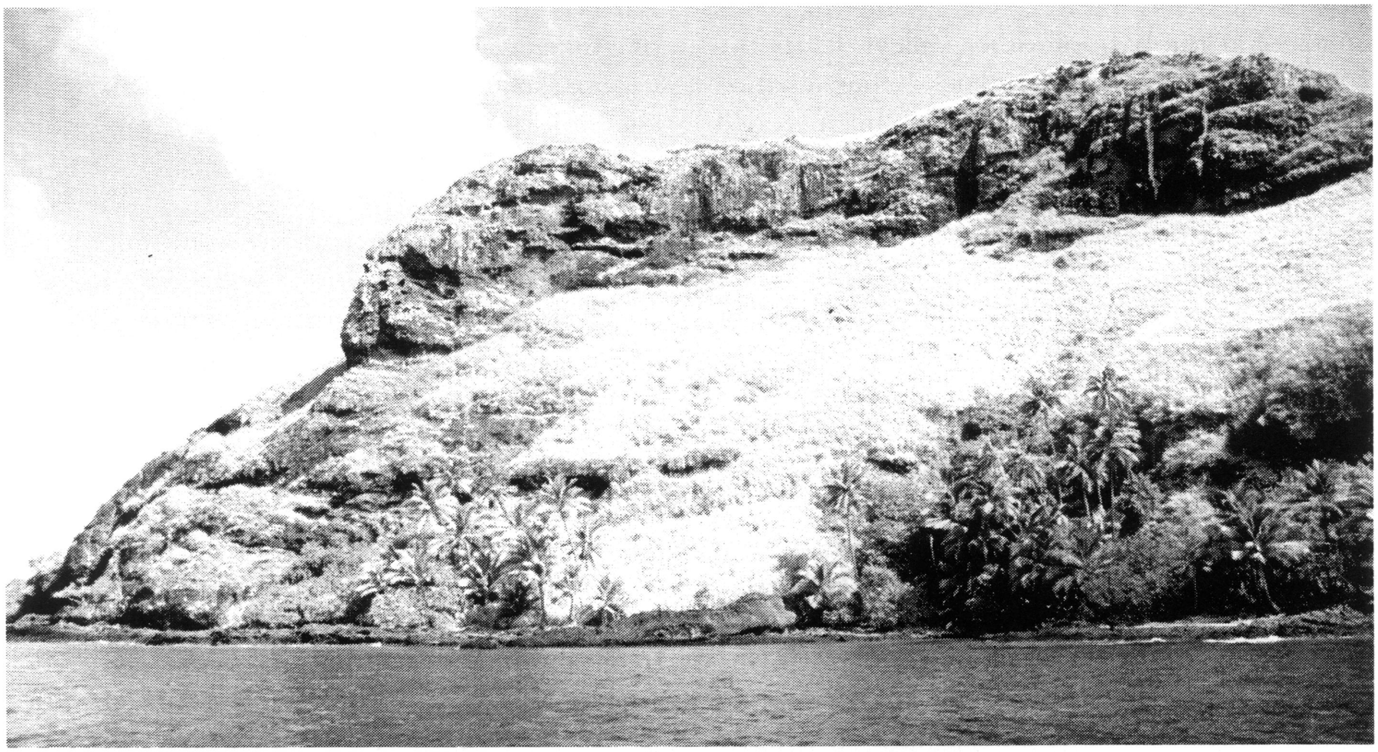


FIGURE 2.3 The topography of the Mangarevan high islands is typically steep, with grass covered slopes broken by ranks of cliffs. Photo by P.V. Kirch.

month (December, 206.2 mm) and the driest month (August, 131.6 mm) are not huge. With this climatic regime, Mangareva is well suited to the cultivation of the suite of tropical cultigens imported by the Polynesians throughout the central Pacific region, including taro, breadfruit, coconut, bananas, and other crops.

SOILS

More limiting for the development of traditional horticultural systems are the Mangarevan soils. Tercinier (1974) classified, inventoried, and mapped the soils of Mangareva Island, which presumably encapsulates the range of edaphic variability in the islands. He defines seven major groups: (1) "sols mineraux bruts d'erosion" (lithosols); (2) "sols peu evolues", including colluvial and alluvial soils; (3) "sols vertiques" (vertisols); (4) "sols calcomagnesimorphes"; (5) "sols brunifies"; (6) "sols ferrallitiques"; and (7) "sols hydromorphes". The lithosols are found mainly on the flanks of Mt. Duff and Mt. Mokoto and have no agricultural significance. The alluvial soils of category (2) are among the most important for the traditional Mangarevan economy, as these comprise most of the lower elevation slopes of the principal valleys, as well as alluvial in-filling of the valley floors. These soils tend to have high organic matter, a slightly acid pH, and are relatively high in available nutrients, such as phosphorus (Tercinier 1974:368). The steeper windward slopes (above the colluvial fans) are dominated by vertisols and are strongly associated with extensive stands of *Miscanthus* cane. The "calcomagnesimorphes" soils are a category of carbonate soils formed on coral sand sediments around the littoral fringes of the island, especially at the mouths of the major embayments (such as Rikitea, Gatavake, or Atiaoa). The ferralitic soils occur extensively on the mountain crests and the leeward slopes (where they replace the vertisols of the windward slopes); exchangeable nutrients are extremely limited, and these soils are essentially worthless for cultivation. The ferralitic soils tend to be associated with *Dicranopteris* (*Gleichenia*) grasslands. Finally, the hydromorphic soils—while restricted in geographic distribution and extent—have considerable economic significance, for these were the main soils used for irrigated taro cultivation. They have abundant organic matter, a pH of around 6, and high available nutrients, including phosphorus. On Mangareva, the largest area of hydromorphic soils is found at Rikitea and along the coastal plain from Atituiti-Raro to Ganoha (very small areas of hydromorphic soils in other valleys do not appear to be mapped by Tercinier [1974: carte]). As we discuss further in Chapter 3, the large area of hydromorphic soil at Rikitea is doubtless a major reason for the early settlement and continued sociopolitical dominance of this locality, as it supported the largest expanse of irrigated taro land in the archipelago.

FLORA AND VEGETATION PATTERNS

Huguenin (1974) provides a checklist of about 200 species of ferns and higher plants in the Mangareva Islands, but there appears to be no definitive study of vegetation patterns. From our own observations, the most striking aspects of the vegetation are: (1) the absence of native forests on the steeper slopes and ridges dominated by degraded fernlands and canelands; and, (2) the strongly anthropogenic character of the vegetation in the valley bottoms and coastal plains, dominated by economically useful plants, many of them Polynesian introductions. We have already referred to the strong associations between fernlands of *Dicranopteris* (*Gleichenia*) *linearis* and the ferralitic soils, and between canelands of *Miscanthus floridulus* and the vertisols (Fig. 2.4). These vegetation associations are maintained by fire, and the low nutrient status of the soils inhibits secondary regrowth. That the degraded fernland and caneland vegetation dominating the Mangarevan high islands was not an artifact of post-European contact changes in land use is made clear by this observation of Captain Wilson of the *Duff* in 1797:

> The tops of the hills, to about half way down, are chiefly covered with sun-burnt grass; and in some

FIGURE 2.4 The vegetation of the high islands is highly anthropogenic. Coastal areas are dominated by *Pandanus odoratissimus* and *Thespesia populnea* trees, with *Hibiscus tiliaceus* on the narrow coastal plains and in the shallow valleys. The higher slopes and ridges are dominated by grasslands of *Miscanthus floridulus*. Photo by P.V. Kirch.

> places there are spots of reddish soil, as on the middle grounds of Otaheite (1799:118).

In our opinion, the expanses of *Dicranopteris* and *Miscanthus* which have covered the higher elevations of the Mangarevan high islands in historic times were not a natural successional state, but rather an artifact of human land use practices during prehistory.[2] We would hypothesize that these fern- and canelands developed in response to burning and forest clearance on slopes with old, nutrient-poor soils, much as was the case in Mangaia (Kirch 1996, 1997b). However, this hypothesis needs to be tested through paleobotanical investigations, such as analysis of microfloral remains (pollen, opal phytoliths) from sedimentary contexts.

The valley bottoms and coastal plains are dominated by a range of economically important plants. Principal tree crops include coconut (*Cocos nucifera*), breadfruit (*Artocarpus altilis*), Tahitian chestnut (*Inocarpus fagiferus*), candlenut (*Aleurites moluccana*), and *vi* apple (*Spondias dulcis*). The narrow upper valley watercourses tend to be choked with dense stands of *Hibiscus tiliaceus*, while along the coastal strand one commonly encounters *Pandanus tectorius*, *Hernandia peltata*, *Calophyllum inophyllum*, *Barringtonia asiatica*, *Cordia subcordata*, *Terminalia catappa*, and *Thespesia populnea*. Plants found in the understory of coastal and valley second growth, and which were introduced to the islands by Polynesians, include bananas (*Musa fehi* [*Australimusa*] and *Eumusa* hybrids), Polynesian arrowroot (*Tacca leontopetaloides*), *ti* (*Cordyline fruticosa*), *kape* (*Alocasia macrorrhiza*), and *nono* (*Morinda citrifolia*).

It is difficult to overly stress the huge impact that human activities have had in shaping the historically known flora and vegetation patterns of Mangareva. Not a single endemic species of higher plant is recorded in Huguenin's checklist (1974). Harold St. John, botanist of the 1934 Bishop Museum Mangarevan Expedition, recorded his utter disappointment with the botanical possibilities of Mangareva in a single line of his report: "Mangareva Islands are desolated; their natural flora is more completely exterminated than that of any other part of the world that I have seen" (1935:57). The same view is presented by the 1934 Expedition's leader and malacologist C. Montague Cooke, Jr., who wrote that "all the endemic forests have disappeared... except on the precipitous southern slope of Mount Mokoto, where some of our party found a small remnant of native forest near the base of the cliff. A few scattered native shrubs and small trees were growing on the ledges above" (1935:41).[3]

TERRESTRIAL FAUNA AND RESOURCES

Cochereau (1974) inventories the terrestrial fauna of Mangareva, which is dominated by invertebrates, particularly insects, among which one does find a number of endemic species (e.g., Zimmerman 1936). Terrestrial molluscs are today represented by only six taxa, three of which are widely dispersed pulmonates thought to have been transported inadvertently by the Polynesians (*Tornatellinops variabilis*, *Elasmias apertum*, and *Lamellidea oblonga*; see Kirch [1984:137]). Subfossil deposits (including our own excavations), however, have yielded other taxa such as several endemic genera and species of endodontids (Solem 1976) which are evidently now extinct. We discuss these further in Chapter 5. The only terrestrial crustacean listed by Cochereau (1974:489) is the small *Talitrus alluaudi*. Conspicuously absent from his list is *Cardisoma carnifex*, the burrowing land crab so common on most atolls and in the coastal regions of Polynesian high islands. We did not observe *Cardisoma* during our own fieldwork, and informants told us it is not present in Mangareva. In the basal levels of the Onemea dune site (Taravai Is.), however, we recovered pincers and carapace fragments that we have tentatively identified as being of this taxon (see Chapter 5). Aside from birds, the only vertebrates listed by Cochereau (1974:516-17) are three species of lizard, including the Polynesian-dispersed gecko (*Gehira oceanica*), a freshwater eel found in taro pondfields (*Anguilla megastoma*), and the European introduced *Rattus rattus* (which has evidently eliminated the Polynesian-introduced *Rattus exulans*).

In view of this extremely impoverished terrestrial fauna, birds provided the only significant terrestrial resource from the viewpoint of subsistence economy. Lacan and Mougin (1974) review the extant avifauna, listing 23 species in total (including the domestic chicken, *Gallus domesticus*), the list being heavily dominated by sea birds. There is a native kingfisher (*Halcyon gambieri*) of a species found also in the Tuamotus; the only other land birds are a reed-warbler (listed as *Conopoderas caffra*, although this species is supposed to be endemic to Tahiti and Mo'orea) and the common rock dove (*Columba livia*). Lacan and Mougin (1974:537) stress the uneven geographic distribution of seabirds among the high islands and coral islets (*motu*), especially the nesting and reproducing populations, which are heavily concentrated on three small, high islands in the southern part of the lagoon (Makaroa, Manui, and Motu Teiku). They regard this distribution as directly related to the relative lack of human presence on these small and difficult-to-access islets.

Based on zooarchaeological and paleontological studies on other Polynesian islands (Steadman 1989, 1995, 1997a), one may predict that the Mangareva Islands originally had a more diverse avifauna, including other land bird species as well as a larger population of breeding seabirds. Hiroa (1938a:9) provides a list of Mangarevan bird names that includes a *kuku* (pigeon) and *moho* (probably a rail), both said to have been extinct by 1934. Indeed, in Chapter 6 we present evidence for a more extensive prehuman avifauna, based on the results of our test excavations at the Nenega-Iti and Onemea sites.

MARINE ENVIRONMENT AND RESOURCES

In contrast with the circumscribed, limited land area and correspondingly impoverished terrestrial resources of the high islands, the lagoon and reefs of Mangareva are extensive and furnished an abundance of marine resources. Brousse et al. (1974) describe the range of variation in the reef systems, which include the barrier reef which bounds the lagoon on the west, north, and east sides, fringing reefs around most of the high islands, and a diversity of patch reefs within the lagoon. This diversity of reef forms provides habitats for a range of fishes and invertebrates. Further environmental variability derives from the presence of rocky shores or sea cliffs along the exposed southern coasts of such islands as Agakauitai, Makaroa, and Kamaka, offering habitats for particular invertebrates such as limpets.

Fourmanoir et al. (1974) cataloged 246 species of fishes in the Mangareva Islands, and offerred important comments on biodiversity and fishing methods used by the Mangarevan people. In particular, they note the importance of certain types of algae which flourish in the slightly colder waters of Mangareva (as opposed to the situation in the Tuamotu archipelago) and provide the major food resource for phytophagous fish:

> L'importance des Algues aux Gambier doit être mise en avant pour expliquer le grand nombre de poisons phytophages que l'on rencontre ici. Il existe en effet en abondance en particulier deux genres mieux représentés par le nombre des individus que partout ailleurs dans les Tuamotu. C'est le genre *Siganus*, Paua, et le genre *Kyphosus*, Nanue (1974:543).

Parrotfish (Scaridae) are particularly prevalent in certain bays where there are extensive coral formations, such as those around Taravai, an observation we also confirmed during our circumnavigations of this island by small boat (1974:544).[4] Likewise, certain *Caranx* species are abundant around some of the banks in the lagoon. Bonitos (*Euthynnus* spp.) also occur within the lagoon. Among the families of fishes with several taxa represented, and which may have been important food resources in prehistory, are Muraenidae, Holocentridae, Serranidae, Carangidae, Lutjanidae, Mullidae, Labridae, Scaridae, Acanthuridae, and Balistidae.

One cannot refer to fish resources in Mangareva without mentioning the extent to which ciguatera poisoning is prevalent, a phenomenon mentioned by Laval (1938) and other early visitors, and which appears to be due to the concentration of certain algae (Bagnis 1974). Bagnis's study indicates that the fishes most susceptible to ciguatera are the Scaridae and Serranidae, although the toxin also occurs in other taxa, such as Carangidae, Acanthuridae, and Labridae. The Mangarevans are particularly adept at identifying which fish are poisonous and know from experience that fish caught in particular locations must be rejected.

The molluscan biota of Mangareva is briefly discussed by Salvat (1974) and by Richard (1974). In his study of the bays of Gatavake, Kirimiro, and Apeakava on Mangareva, Richard found 20 species in the families Neritidae, Littorinidae, Planaxidae, Cerithiidae, Muricidae, Conidae, Pyramidellidae, Acteonidae, Ellobiidae, Mytilidae, Isognomonidae, Pteriidae, Veneridae, and Tellinidae. Our study of invertebrate faunal remains from archaeological sites confirms that many of these taxa were exploited in pre-European times (see Chapter 5).

MANGAREVAN ETHNOGRAPHY

SOURCES FOR MANGAREVAN ETHNOHISTORY

We turn now from natural history to a brief overview of selected aspects of traditional Mangarevan society and culture, as these were recorded by early European voyagers, missionaries, and anthropologists. Initial contact with Europeans (in this case the missionary ship *Duff* in 1797), followed by missionization and colonization in the 19th century, led to a tumultuous progression of often wrenching cultural change. By the time that famed Bishop Museum ethnographer Te Rangi Hiroa (Peter H. Buck) attempted a comprehensive account of Mangarevan culture in the 1930s, this had to be accomplished primarily through recourse to explorers' and missionaries' accounts, along with some important 19th-century "native manuscripts," augmented by such limited information as Hiroa's informants could provide. In his popular book on Polynesia, *Vikings of the Sunrise*, Hiroa described his disappointment at the degree of acculturation he witnessed in Mangareva in 1934:

> I had hoped that in volcanic islands so far east as Mangareva, the people had been conservative enough to preserve their native culture. Alas! the change was even greater than in the Tuamotu. The old type of house had been completely displaced by structures of sawn timber and corrugated iron; even the oldest inhabitant had not seen the original native pattern. The rafts that were so plentiful on Beechey's visit in 1824 had been discarded for small outrigger canoes of the Tahitian model. Nets and fish traps that were abundant in the old culture had long since disappeared, and the only hand nets seen were in the houses of settlers from the Tuamotu. Our hopes were shattered, for we had come to a barren land (1938b:200-201).

Fortunately, we do have important—if limited—sources for the reconstruction of Mangarevan society and culture prior to the major transformations of the early-to-mid 19th century (see Hiroa 1945:81-83 for a succinct summary). The most important firsthand accounts prior to the extensive changes introduced by the missionaries are those of Beechey (1831) and Moerenhout (1837), supplemented by Lesson (1844).[5] The Roman Catholic missionaries of the Congregation des Sacrés-Coeurs arrived in 1834, led by Père Honoré Laval. Laval and his compatriot Père Caret introduced sweeping changes, doing away not only with the traditional religion but also altering aspects of Mangarevan life ranging from housing and settlement patterns to political organization and village governance. Fortunately for posterity, however, Laval made important observations of indigenous culture and in 1856 began writing a manuscript entitled "Mémoires pour servir à l'histoire de Mangareva." After Laval's death in Tahiti, the manuscript found its way to the Archives of the Maison des Pères des Sacrés-Coeurs in Braine-le-Comte, Belgium, where it languished until, in 1936, the Belgian ethnographer Alfred Métraux brought it to the attention of Te Rangi Hiroa, then director of the Bernice P. Bishop Museum (Hiroa 1938a:14). Hiroa arranged for the Bishop Museum to assist in the costs of publication, and that portion of the manuscript dealing with the pre-mission culture was published under the title *Mangareva: L'Histoire Ancienne d'un Peuple Polynésien* (Laval 1938).

In addition to Laval's *Histoire*, there is an important but still unpublished "native manuscript" evidently composed by Mama Taira Putairi, a young Mangarevan of chiefly birth who had studied with Laval. Indeed, this manuscript was presumably a major source used by Laval in compiling his own account. There are several holograph versions of Putairi's manuscript, one of which resides in Braine-le-Comte, and these were also used extensively by Hiroa in compiling his own ethnographic account of Mangareva (Hiroa 1938a:13-14). We hope that it will someday be possible for an edited version of Putairi's important manuscript to be published.

The most important and comprehensive account of Mangarevan culture is surely Hiroa's own *Ethnology of Mangareva* (Hiroa 1938a), which attempts to deal systematically with all aspects of Mangarevan culture including oral traditions, material culture, social and political organization, and religion. To a large extent, it is a work of "reconstruction," following the classic "salvage ethnography" or "memory culture" approach in vogue in the first half of the 20th-century. As noted, Hiroa drew heavily on the Putairi and Laval manuscripts, although he was able to add much new material of his own.[6] The following paragraphs draw primarily from Hiroa's synthesis.

POPULATION

Captain Wilson, who was the first European to come upon the Mangareva Islands in May 1797, observed "about fifty natives armed with spears" on a *motu* of the northern barrier reef. However, as Wilson did not enter the lagoon or attempt to land, he made no overall population estimate. Beechey, who did land and spent some time making observations in 1826, estimated the population at 1,500, "from the number and size of the villages" (1831:191). This is probably a reasonable estimate of the population prior to major depopulation due to European-introduced diseases.[7] The total land area of the high islands is 24.4 km^2, which would give an overall population density of 61 persons/km^2, well within the documented range for Polynesian high islands (Kirch 1984, table 10). However, when we take into account that as much as two-thirds of the land surface consists of either steep, degraded *Miscanthus/Dicranopteris* land, or of cliffs, the actual population density per area of arable land was likely to have been as high as 180 persons/km^2. Such a high density accords well with the ethnographic evidence for intense competition over limited land and terrestrial resources.

Material Culture

As in all Polynesian societies, much of the material culture was manufactured from perishable materials such as wood, bark, leaves, husk, and so forth. Kirch and Green (2001:164, table 7.l) estimate, on the basis of several ethnographic cases, that on average "about 82 percent of the range of material objects used in a traditional Polynesian culture would not be expected to survive in a normal open-site archaeological context." This is certainly the case for Mangareva where, to date, the archaeological record is dominated by basalt adzes and shell fishhooks, with only occasional traces of other kinds of objects.

Hiroa (1938a) provides an overview of Mangarevan material culture, based largely on 19th century accounts and on examination of such specimens as survive in museum collections. He classified the stone adzes available to him for study into three main types: Type 1, quadrangular section; Type 2, quadrangular with rounded edges and reduced polls; and Type 3, thick, long adzes with triangular sections. He also recognized the presence of another type, which he termed 'ax heads', with "the cutting edge formed by two equal bevels" (1938a:269). Hiroa observed that these axes with symmetrical bevels were quite frequent in the collections available to him, accounting for as much of 32 percent of the adze-axe totals (1938a, table 10). He comments that this is a "unique feature" of Mangarevan material culture, and offered a hypothesis for its existence:

> Some simple cause must have accounted for the prevalence in Mangareva of the heavier cutting tools in ax form, and this cause was most likely associated with a local peculiarity in the technique of woodcraft. . . . Mangareva was unique in using rafts as the ordinary means of transport between the islands of the group. . . . Is it too much to postulate a function association between these two unique features of Mangarevan culture, between the object made and the tools used, between the raft and the ax? An ax is a more convenient implement for felling trees and cutting them into lengths, whereas an adze is better suited for hollowing out a tree trunk and preparing planks. It is fair to assume that as the raft came into more use, axes increased accordingly, and the relatively high percentage of ax heads in the Mangarevan material supports this assumption (1938a:277).

Hiroa also discussed fishhooks (1938a:290-294), based on museum specimens available for study, and on some whole and incomplete hooks collected by Emory during his unsystematic "excavations" in 1934. Hooks were called *matau*, and made of pearl shell, coconut shell, and wood. Hiroa classified one-piece fishhooks into two forms, U-shaped and circular. Of particular note is the absence of the compound bonito trolling hook.

Sociopolitical Organization and Land Tenure

Mangarevan social organization was complex, involving cross-cutting categories based on male primogeniture, on affiliation through descent or adoption with an eponymous land-holding group, on success or failure in wars over land, and on acquired statuses (such as warriors, experts, or priests). People were categorized as either elites or "nobles" (*togo‘iti*), or as commoners (*‘urumanu*) based on birth, the latter performing the bulk of subsistence labor. Hiroa writes that "the nobles had power (*ao*), land (*kaiga*), a superior type of house (*‘are*), a tribe or people (*‘u*), and a freshwater spring (*vai*)" (1938a:144). While commoners could not become *togo‘iti*, they could through acquisition of particular skills become specialists, such as warriors (*‘aretoa*), master craftsmen (*tu‘uga*), or priests (*taura*). Hiroa writes also of a "middle class" (*pakaora*), which included junior lines of noble families, and of commoners who had been elevated to that status through "grants of land for services in war" (1938a:146). Those who held large blocks of land were referred to as *ragatira*.

The Mangareva Islands seem not to have been politically integrated under a single ruler but rather were divided into several independent and frequently warring polities, each encompassing a principal island or in the case of Mangareva Island, one of the two districts into which this larger island was subdivided (Taku and Rikitea). The high chief who headed up such a polity was called the *‘akariki*, an interesting variant of the Proto-Polynesian term for chief (PPN **qariki*), formed by combining the causative prefix *‘aka* (PPN *haka*) with the term for chief (*ariki*). Hiroa reads considerable historical significance into this linguistic construction, suggesting that it "implies that the *ariki* position had to be created in Mangareva at some period when a hereditary *ariki* did not exist" (1938a:151). However, the term is cognate with Marquesan *haka‘iki* (a parallel construction), and following Fischer (2001) it may simply be a loan word into Mangarevan from Marquesan.

The *‘akariki* of Rikitea, who at times also held sway over the whole of Mangareva Island, was supposed to be born on the *marae* of Te Kehika, the most sacred temple in the islands, located on the lower slopes of Auorotini (Mt. Duff). After undergoing the *igogo* ceremony to put him "under the direct protection of the gods" (Hiroa 1938a:151), the child was taken to a "house of seclusion" situated on a high flanking ridge of Auorotini, where he would be cared for until he was about twelve or fourteen years of age. Emory (1939:22-23) refers to these houses as the "royal nurseries" and describes two stone pavements that mark these sites (see Chapter 3). Following his descent from the mountain nursery, at puberty, the young chief would be installed in "a royal residence at Marau-tagaroa" (Hiroa 1938a:152). Hiroa notes that the house of the *‘akariki* was larger and better constructed than those of other chiefs and that it contained a stone bench upon which the chief seated himself.

Beechey (1831:193) offers a description of Mangarevan houses prior to the major changes in house type initiated by Laval, and draws a clear distinction between the small houses of the common people ("in length from eight or ten feet to fifteen") and "the larger houses of the *areghe* [chiefs]." This latter dwelling was described in greater detail:

> The large house, or that of the *areghe*, was about thirty-nine feet in length by eighteen or twenty in width; the pitch of the roof was about twenty-five feet in height, and that of the perpendicular sides of the house about ten feet; but these dimensions were obtained by estimation only, the natives appearing to have an objection to our pacing the ground for the purpose of measurement. The south side of the house was left open . . . On that part of the house where the side was deficient, there was a foundation for the wall about three feet in height thrown up, composed of large blocks of coral, shaped in a very workmanlike style, similar to those mentioned by Cook at the Friendly Islands, and well put together: it stood about three feet within the outer part of the roofing, and served as a seat for the chiefs as well as for many others (Beechey 1831:193-94).

Land tenure was a complex matter in Mangareva, involving both hereditary rights of descent groups ("tribes") to particular ancestral estates (*kaiga*) and the rights acquired by victors in wars of conquest. Conquered lands were called *kaiga riro*, ‘lands taken' (Hiroa 1938a:162). Many small landholders held cultivated parcels through a right of usufruct (Hiroa calls these "leased lands," *kaiga 'akareva*), in turn providing regular tribute to their overlords, including first fruits of breadfruit. Both hereditary and usufruct rights to land were, however, apt to be overturned as an outcome of war.

Goldman (1970:164) astutely recognized the parallel developments in the breakdown of traditional hereditary land-holding groups as a response to increased competition over scarce, and frequently degraded, land resources that can be seen in the traditional histories and sociopolitical structures of the Marquesas, Mangaia, Rapa Nui, and Mangareva. Writing of the Marquesas, Kirch (1991) has termed this historical process 'competitive involution', and it likely applies as much to Mangareva as to the former. As Goldman suggests:

> Mangareva reveals the familiar cycle of rivalries that starts among kin, divides them, and finally turns them to seek one another's subjugation or destruction. It is out of desperation at conditions into which they have driven themselves that the chiefs and their allies are compelled to abandon revered traditions and submit themselves to the uncertainties of open combat. They may not have welcomed the consequences, but the choice of endowing risk with honor was surely voluntary. What is distinctive about the Mangareva cycle of rivalries is little more than its intensity (1970:164).

THE TRADITIONAL ECONOMY

In Mangareva, the traditional economy was closely shaped by the fundamental environmental contrast between the small high islands with their limited potential for agricultural development and the vast lagoon and reefs which supplied an abundance of marine foods. In emic terms, this contrast is encapsulated by a lexical distinction between cultivated foods, which were called *kaikai 'akariki* (foods of kings or high chiefs), and wild foods, called *kaikai a te oge* (foods of the hungry) (Hiroa 1938a:199). Thus, the basic starch staples, especially breadfruit which was the core crop, were closely associated with the ruling elite and land-holding families. Hiroa elaborates on these economic distinctions:

> Fish formed the principal food supply. The area of cultivable land was small in comparison with the size of the islands, and lands and their produce were held by the ruling families and landowners who had been rewarded for services rendered in war. A large number of the common people having no cultivable land at all were thus denied direct access to vegetable foods. . . . A large portion of the commoners depended for the necessities of life on fish, shellfish, crustaceans, and such edible wild plants as grew on the promontories and hillsides beyond the boundaries of the cultivable lands. The landholders, while they enjoyed the produce of the land, also depended for this staple flesh food on the produce of the sea (1938a:197).

Goldman teases out additional nuanced social relationships encapsulated in this dichotomy between sea and land resources and those who controlled them:

> The great antithesis was between crop and wild plant. Crop and fish entered into a more complementary balance. The traditions derive the present population from fishermen, acknowledging that even chiefs once fished. Later, high honor shifted to land, and commoners alone became professional fishermen. Since fish were exchanged for crop, the fishermen were only partially reduced. While they were under obligation to trade, they could dare to withhold their fish. The chief who could not compel the fisherman to trade with him had lost his power. The fisherman as a commoner had thus the honor of leverage: he could extract crop and he could weaken the sources of power. This aspect of command stands as a counterpoise to agrarian authority. Its power, however, was circumscribed by the inability of fishermen ever to command a following. If a fisherman could upset a rule by demonstrating its inner weaknesses, he could not establish one. Only land could draw followers as dependent workers, renters, or leaseholders and as recipients of ceremonial distributions (1970:159).

Hiroa (1938a:202) calls breadfruit (*Artocarpus altilis*) "the most valued vegetable food" in Mangareva, in part owing to the fact that it could be preserved for indefinite periods through the widespread Polynesian technique of semi-anaerobic pit fermentation (see Kirch 1984:132-134 on pit fermentation). Breadfruit groves were distributed throughout the coastal flats and into the lower valleys, wherever soil conditions permitted. However, it seems that taro (*Colocasia esculenta*) was an equally important food, raised wherever possible in small spring-fed irrigated pondfield systems situated in the valley bottoms. The status accorded both breadfruit and taro is evident in the following song recorded by Hiroa:

> Puputa 'ao mai
>   Mixed puddings of breadfruit and taro
> Turoro 'ao mai
>   With sauce of cooked coconut cream,
> Kaikai 'akariki
>   Food fit for a king
> Ka to ragatira i ana.
>   To him, the owner of land (1938a:199).

As in other parts of tropical Polynesia such as the Marquesas, pit fermentation of breadfruit was the principal means of preserving and storing surplus food, and thus an extremely important cultural buffer against crop failure and famine. The fermented fruit, called *ma*, was stored in pits (*rua ma*) on average "six feet in diameter and a foot and a half in depth" (Hiroa 1938a:206). Larger pits "were owned by the chiefs of districts commanding a large quantity of fruit." The district pits, which had proper names, were filled in seasons of plenty (*'ou*) "to build up a reserve for important social occasions." The chief Te Mateoa is said to have commanded the construction of an "exceptionally large pit" for the high priest Iakopo for "use in connection with religious ceremonies" (1938a:208). *Rua ma* pits are structural features that archaeologists may expect to encounter during excavation of Mangarevan habitation, and also ceremonial, sites.

Taro cultivation required permanent modifications of the local topography and landscape, in the form of stone-faced terraces holding the small irrigated pondfields. Emory (1939:17) mentions the presence of taro terraces "faced with stones roughly laid up" in places where there was "sufficient water to flood the ground occasionally by means of ditches," but he was of the opinion that these systems were not common. This is contradicted by Hiroa's statement that "in olden times every trickle of water was utilized, and disused terraces are to be seen high up on the hillsides" (1938a:226). Hiroa gives useful ethnographic details of a taro irrigation system which he examined, probably in the Atituiti-Raro area of Mangareva Island:

> In a cultivation examined, a spring of water issued from below a low cliff on the hillside and in the course of time had cut down a rocky water course. A channel had been cut at the source of the stream to lead the water some yards downhill to the first terrace cut out of the side of the hill with the outer edge built up with stones to form a retaining wall (*kato*). The main channel was termed a *tairua*, which is also the general term for a stream or channel. Two smaller channels (*ka'iraga-vai*) were cut toward either end through the raised outer edge of the first terrace to lead the water down to the second terrace formed like the first. The small channels were blocked with earth or grass to flood a terrace when required, but the channels were sufficiently high above the main level to keep the terraces wet. The channels carried off the overflow. A third terrace completed the series, and a side channel carried the overflow back into the old stream bed (1938a:226).

The Mangarevan term for a taro cultivation is *repo taro*. Clearly, if Hiroa is correct that taro cultivation was an important component of the Mangarevan horticultural complex, then structural remains of former pondfield terrace complexes should be regularly evidenced in the archaeological record.

The Mangarevans appear to have placed unusual emphasis upon the cultivation of *ti* (*Cordyline fruticosa*), which in many parts of Polynesia is regarded more as a famine food and is a common component of secondary growth. Beechey commented on the Gambier Islanders' chewing of the cooked root. "The natives collect the fibres in their mouths, and spit them out in round balls" (1831:195), evidently referring to quids of the inedible pith. Hiroa says that *ki* was the appropriate accompaniment or relish (*kinaki*) to go with breadfruit paste, and that "the plant grew wild and was also cultivated" (1938a:211). The cooking of *ti* was a communal event utilizing a special, large earth oven (*umu ti*), the opening of which required a feast. In our 2003 reconnaissance trip to Makaroa Island, we noted dense stands of *ti* in small sheltered niches on the otherwise nearly barren cliff slopes of nearby Motu Teiku islet. This suggests that *ti* was planted wherever possible and that its ability to grow where other crops would not made it a particularly useful plant in resource-limited Mangareva.

In contrast to other parts of tropical Polynesia, where the domestic pig was a significant flesh food, supplemented to some extent by dogs and chickens, both the pig and dog were absent at the time of European contact. Pigs, however, were mentioned in oral traditions and had evidently been present at one time (Hiroa 1938a:194-95). The only large mammal that provided flesh food, therefore, was humans themselves: "The Mangarevans had no hypocrisy about eating human flesh to which native history contains frequent references" (1938a:195). Hiroa discusses Mangarevan cannibalism at some length, citing specific historic traditions; he attributes the prevalence of cannibalism to "the basic urge of hunger" due to chronic food shortage. Whether cannibalism was indeed pervasive in precontact times is a question that may be amenable to archaeological testing. Regular consumption of human flesh, and processing of human corpses, should produce a characteristic zooarchaeological signature, as in Mangaia (Steadman et al. 2000).

With terrestrial flesh foods being so limited, the emphasis was on fish and other marine foods, which were abundant in the extensive lagoon, and on the fringing, patch, and great barrier reefs. In addition to fish, Hiroa lists *Tridacna* clams, *Turbo* snails, rock oysters, limpets, other bivalves, crayfish, octopus, and small land crabs as commonly eaten items (1938a:197-98). Fishing methods included angling with one-piece hooks, netting with several kinds of nets, using leaf sweeps, torch fishing, spearing, poisoning using traps, and walled fish weirs. The walled fish weirs (*pa-kirikiri* or *pa-toka*) were constructed on reef flats in shallow water (Hiroa 1938a:300) and should be archaeologically recognizable as they are in other parts of Polynesia. A curious omission in the list of Mangarevan fishing methods is trolling with the compound lure, so common elsewhere in Polynesia. This is likely to be a cultural loss at some point in the Mangarevan sequence, possibly linked to the abandonment of outrigger canoes and their replacement with rafts.

Food preparation processes in Mangareva can be expected to leave a number of regular traces in the archaeological record. The most ubiquitous should be the typical Polynesian earth oven, called *umu* in Mangareva as elsewhere, a pit (sometimes lined with stones) in which fire is ignited and basaltic stones heated (Hiroa 1938a:216). Indeed, quite predictably, we encountered several of these features during our test excavations (see Chapter 3). Much food preparation equipment was of perishable materials (wooden bowls, woven baskets), but taro and breadfruit puddings were concocted using pounders made of basalt, coral, or limestone (Hiroa 1938a:218-22). Coconut meat was grated using a pearl shell grater, an example of which Emory recovered from his digging in the floor of a rockshelter on Agakauitai Island (Hiroa 1938a:201, fig. 9). Such tools should be archaeologically recoverable.

RELIGION AND RITUAL

Mangareva exhibited its own distinctive version of the Eastern Polynesian religious pattern, with an extensive pantheon of deities, including the principal gods Tagaroa, Rogo, and Tu, along with a host of lesser gods and deified ancestors. Tu was the "principal functioning god" (Hiroa 1938a:422) and was the deity of breadfruit, although Rogo was also associated with rain and the production of food. High priests (*taura tupua*), who officiated at the principal *marae* and represented Tu and Te Agiagi (god of war), were members of high-ranking families. Spirit mediums and sorcerers (*taura nanati-ka'a*) were of commoner stock.

The *marae* were formal ritual spaces where priests conducted seasonal rituals associated with the breadfruit harvest, the initiation of priests and chiefs, and other cult activities. All of the principal *marae* were substantially robbed of their stone foundations, or completely destroyed, during the time of the Catholic missionaries, the stones being used to construct a series of large cathedrals and other European style structures. Hiroa (1938a:454) provides a list of ten major *marae* on Mangareva, Aukena, Akamaru, Taravai, and Agakauitai islands, while Emory (1939) describes the locations of some of these where they were known to his informants. The most sacred *marae* was doubtless Te Kehika, situated on the lower slopes of Mt. Duff. Emory (1939:19) says that all of the stones making up Te Kehika were removed, but in 2001 we were shown some large boulders arranged in two massive courses which were evidently a remnant of this structure (see Chapter 3). Along the coast in Atituiti-Raro is the location of another *marae*, Te Mata-o-Tu, which also appears to haye remnants of its coral slab foundations still intact.

The annual ritual cycle in Mangareva, linked to the horticultural cycle (especially the breadfruit harvest), was regulated through a typical Polynesian lunar calendar of 13 months. As elsewhere in Eastern Polynesia, the heliacal rising of Pleiades (*Matariki*) in June divided the year into two seasons and was used to keep the lunar cycle in sync with the solar year (Hiroa 1938a:411-14). However, the Mangarevans developed a unique innovation to the calendrical system, the regular observation of the solar solstice. Laval (1938) describes the practice of solar observation in some detail and notes that specific localities in Taku, on Akamaru, and at Atituiti on Mangareva were designated as observation posts (*'akano'oga ra*). Moreover, pairs of upright stones are said to have been used to mark the solstice position, raising the likelihood that these "observatories" had some structural modifications associated with them. In Chapter 3 we present evidence that a large *paepae* platform at Atituiti-Ruga may be part of a solstitial observatory mentioned by Laval.

* * *

In the above pages we have summarized a range of environmental and ethnographic information on Mangareva and its culture at the time of European contact, to the extent that this can be ascertained from the available sources. Environmentally, the key features are the small size of the individual high islands, which combined with their geological age and degree of weathering, greatly limit the terrestrial resource base. Moreover, the islands show considerable evidence of severe anthropogenic modifications over the course of human occupation, especially in the elimination of native forest cover from the upper ridges and valley slopes, and its replacement with a terminal vegetation association dominated by *Miscanthus* cane, *Dicranopteris* fern, and scrub *Pandanus*. There are reasons to think that the decimation of native forests and significant alteration of the terrestrial landscapes also resulted in impacts to terrestrial biota, including molluscs and avifauna. In stark contrast, the marine resources of Mangareva are diverse and bountiful, thanks to the large lagoon and the semi-enclosing barrier reef. These salient environmental features are closely reflected in the traditional cultural patterns, such as the economic system in which cultivable land was closely held and defended, and in which marine foods provided the bulk of the non-starch subsistence intake. The Mangarevan sociopolitical system displayed considerable fluidity, the apparent outcome of tensions between a traditional land-holding descent-group system and an emergent class structure reflecting the pervasive role of war and tributary relationships. In this, Mangareva exhibits many parallels with certain other mid-scale Eastern Polynesian societies, especially Mangaia, Rapa Nui, and the Marquesas.

CHAPTER 2 ENDNOTES

[1] Brousse et al. (1974:10) state that the islands had previously been sighted by Fernandez in 1572 and by Quiros in 1606, but given the vague accounts of these Spanish voyages, and high degree of inaccuracy in their navigation and positions given to islands, it cannot be certain that Mangareva was actually the group sighted.

[2] It is certainly the case, however, that the introduction of goats in historic times has greatly exacerbated the situation and helped to maintain the degraded state of vegetation on the hills.

[3] In August 2003, PVK climbed to the summit of Mt. Duff and observed what he believes to be a single, stunted plant of the genus *Metrosideros* clinging to the top of the sheer cliff. This may also be a last remnant of once extensive native forest. Cochereau (1974:483) also mentions the possibility of some remnant native vegetation at the base of the cliffs of Mt. Duff and Mokoto.

[4] Fourmanoir et al. (1974:546) observe that the indigenous Mangarevan classification of the parrotfish is accordingly rich in terminology.

[5] Taylor (1965:169-173) provides a comprehensive bibliography of other early sources on Mangareva.

[6] An unexploited source of ethnographic information on Mangareva remains is the manuscript fieldnotes of Katherine Routledge (Van Tilburg 2003), who spent more than a year working in Rikitea roughly a decade prior to Hiroa.

[7] It has been claimed (e.g., Egron 1974:138) that the pre-contact population of the Mangareva Islands was as high as 5-6,000, a figure we believe to be completely unfounded. While there may have been some depopulation prior to Beechey's visit, a collapse of this magnitude seems improbable. Moreover, a population of 5-6,000 would mean a population density on the order of 750 persons/km^2 of arable land, much higher than that known to have been achieved anywhere in Polynesia under traditional economies.

CHAPTER 3

ARCHAEOLOGICAL FIELD INVESTIGATIONS

E. Conte, P.V. Kirch, M.I. Weisler, and A.J. Anderson

For reasons made clear in Chapter 1, our approach to fieldwork in the Mangareva Islands during our first two field seasons has been extensive rather than intensive. Our strategy has been to sample—through both surface reconnaissance and test excavation—a diversity of locales on most of the major volcanic islands. Intensive studies of particular localities and extensive excavations at specific sites are anticipated for future phases of the project. In this chapter, we present the results of surveys and test excavations in 2001 and 2003, organized geographically so as to integrate observations on surface sites, relevant environmental features, and the results of tests in selected sites. We begin with the largest and central island, Mangareva, and proceed to the smaller islands within the lagoon.

FIELD METHODS

Field methods followed procedures widely applied in Polynesian archaeology. Sites were located whenever possible using a Garmin XL12 GPS receiver, with Universal Transverse Mercator Projection (UTM Zone 8) coordinates referenced to the WGS84 datum. Sites on Mangareva, Aukena, and Akamaru were plotted on a set of advance sheets of the new topographic survey of French Polynesia (1:50,000 scale) kindly made available to us by the Service de Urbanisme, Pape'ete. (Unfortunately, such topographic maps are not available for Taravai or Agakauitai.) In Atiaoa Valley and at Atituiti Ruga, on Mangareva, we used plane table and telescopic alidade to map architectural features in detail. Other maps were made using compass, tape, and hand level. Structures were cleared, described, and photographed using both black-and-white (120 roll film, 35 mm), color slide (35 mm), and color digital cameras.

Coring operations were designed to investigate whether there were cultural deposits present in coastal beach ridges on Mangareva and Akamaru islands, especially at depth. The equipment consisted of a Dormers Hand drilling rig with 6 m of aluminum rods, a 75 mm sand auger, and a 75 mm Jarret loam auger.

Test excavations (typically 1 m^2) were carried out following cultural and natural stratigraphy, and all sediment was screened through 5 mm and 3 mm mesh for recovery of small faunal and floral elements. We systematically collected: (1) flaked stone; (2) invertebrate remains; (3) bone; and, (4) charcoal or other carbonized plant remains from both the 5 and 3 mm screens. Stratigraphy was drawn and described after the completion of each test unit, with Munsell soil color charts used to record soil color. Sediment samples were taken of each stratigraphic unit for laboratory analyses. Standardized recording forms were used during excavation, and all samples were both uniquely numbered and referenced to layer (*couche*) and level (*niveau*). Excavations were documented with black-and-white photographs, color slides, and color digital images. All materials from excavations or surface finds have been deposited in the collections of the Service de la Culture et du Patrimoine at Punaru'u, Tahiti.

INVENTORY OF SITES

Emory did not number his sites, and usually referred to *marae* by their Mangarevan toponyms. Weisler (1996) numbered sites by island, using a three-letter code for each island. The Service de la Culture et du Patrimoine of the Ministry of Culture, French Polynesia, has implemented a Territory-wide site inventory system (Conte 1991). In this volume we have applied this site numbering system, with numeric codes indicating archipelago (190), island (e.g., 01 for Akamaru), district (e.g., ATU for Atituiti), and site. The specific codes are given in Appendix A. Appendix B lists all known sites, including those reported by Emory (1939) and Weisler (1996). It has been necessary to renumber some of Weisler's sites to conform to the new Territorial numbering system.

MANGAREVA ISLAND

Mangareva is by far the largest island in the group, with a total land area of 14 km^2. Auorotini (Mt. Duff) rises to a height of 441 meters, the highest peak in the archipelago. A steeply rising central ridgeline separates the windward and leeward coasts, and is traversed at Manu-kahu (inland of Rikitea) by a road (formerly a foot trail) that passes over the ridge to Gatavake. The southeastern coastline is the most protected and incorporates the principal bay and valley of Rikitea, where the administrative center is located. Rikitea's centrality extends back into traditional times, as the site of the most important *marae* (Te Kehika) and residence of the high-ranked chiefs. Rikitea is sheltered by the towering cliffs of Auorotini, and the colluvial slopes offer good agricultural soil; ample freshwater makes the low-lying, hydromorphic terrain behind the Rikitea beach ridge suitable for taro irrigation (Tercinier 1974). There is as well a protected harbor and landing. On the opposite side of the island, the valleys of Gatavake and Atiaoa open to a deep bay. These districts (Rikitea, Gatavake, and Atiaoa) along with Atituiti, Ganoha, Kokohue, and Gahutupuhipuhi all made up the traditional Rikitea polity. Opposed to Rikitea was Taku, which included a number of smaller valleys on the northeastern limb of the island, such as Kirimiro, Apeakava, Agakuku, Gahututenohu, Akaputu, Gaheata, and Atirikigaro. In late prehistory, all of Mangareva Island was united under the Rikitea polity.

Emory (1939) had reported that most, if not all, of the "important" stone structures such as *marae* formerly present on the main island had been destroyed by the missionaries. He did, however, mention a number of places where pavements or terraces were extant, such as at Atituiti Ruga (1939:24). Emory also reported two stone platforms on the summit spurs of Auorotini, which correspond to traditional accounts of the "royal nurseries" where the children of high-ranking chiefs of Rikitea were sequestered (1939:22-23, fig. 8). Along with a number of other sites (see listing in Appendix B), Emory describes and provides a sketch plan of a large platform at Te Rauriki, the Paepae o Uma (1939:25-26, fig. 9).

Green had difficulty finding rockshelters with substantial deposits on Mangareva but did test one site (his site GM-1) in Taku. The results were summarized as follows: "a homogeneous refuse deposit 90-100 cm thick accumulated in this shelter during the prehistoric period largely as the result of cooking activity. While it contained few artifacts, the midden reflected the local marine ecology" (Green and Weisler 2000:30). Weisler (1996) reported a few surface structures and buried deposits based on a brief reconnaissance of Mangareva.

Despite the somewhat disappointing results of prior researchers, the large size and traditional importance of Mangareva Island in the sociopolitical system underscored the importance of including this island within the scope of our investigations. Our work on Mangareva Island was concentrated on the following localities: (1) Rikitea Village and its environs; (2) the Atituiti area; and (3) Atiaoa Valley. Major areas of archaeological survey and the locations of key sites are shown on Figure 3.1. We also took advantage of opportunities to carry out reconnaissance surveys in several other places and report the results briefly below.

RIKITEA VILLAGE (RIK) AREA

By expending the effort to hike the steep, knife-edged ridge that ascends the summit of Auorotini, one is rewarded by a spectacular view over the valley and village of Rikitea (Fig. 3.2). From this vantage point, it is not hard to understand why Rikitea was the seat of power in traditional Mangareva, and the location of its most ancient and revered temples. The broad arc of sloping colluvium behind the village offers the largest expanse of good agricultural soil in the archipelago, while the springs at the base of the slopes feed freshwater into a zone of hydromorphic soils well suited to wet taro cultivation (Tercinier 1974). The broad sandy beach, well-suited to landing large canoes, slopes away to the deeper, multi-hued waters of the lagoon with all its resources.

Beechey, who landed at Rikitea in 1826, called it the "principal village" of the group, and offers a glimpse of some features of its settlement pattern:

> This village is situated in a bay, at the eastern foot of Mount Duff, and is rendered conspicuous by a hut of very large dimensions, which we shall describe hereafter, and by a quadrangular building of large blocks of coral erected in the water, at a few yards' distance from the shore, which appeared to us to be a morai [*marae*]. Upon its northern extreme stood a small hut, planted round with trees, which it was conjectured contained images and offerings; but, as the door was closed, and the natives were watching us, we would not examine it (1831:163).

> Further on we came to an open area, partly paved with blocks of coral, and divided off from the cultivated land by large slabs of the same material very evenly cut, and resembling those at the Friendly Islands. At one end of this area stood the large hut which had before excited our curiosity: it was about thirteen yards in length by six or seven in width, and proportionably high, with a thatched roof. On the south side it was entirely open . . . Beneath the roof on the open side, about four feet within the eaves, there was a low broad wall well constructed with blocks of coral, hewn out and put together in so workmanlike a style, and of such dimensions, as to excite our surprise how, with their rude implements, it could have been accomplished . . . Upon this eminence was seated a venerable looking person about sixty years of age, with a long beard entirely grey; he had well-proportioned features, and a commanding aspect; his figure was rather tall, but lassitude and corpulency greatly diminished his natural stature; he was entirely naked except a maro, and crown made from the feathers of the frigate bird, or black tern; his body was extensively tattooed . . . He was introduced to us an areghe [*ariki*] or chief . . . (1831:171-72).

> The bay in which this village is situated lies on the N. E. side of Mount Duff; it is bordered by a sandy beach, behind which there is a thick wood of breadfruit and cocoa-nut trees; above it, to the left, there is a second or upper village, where the natives retreat in case of necessity (1831:178-79).

According to Hiroa, the person who received Beechey was Ma-Puteoa, the last *'akariki* or high chief of Mangareva (Hiroa 1938a:95-96, 230), and the house described was at Marae Tagaroa, on the coastal flat where the modern

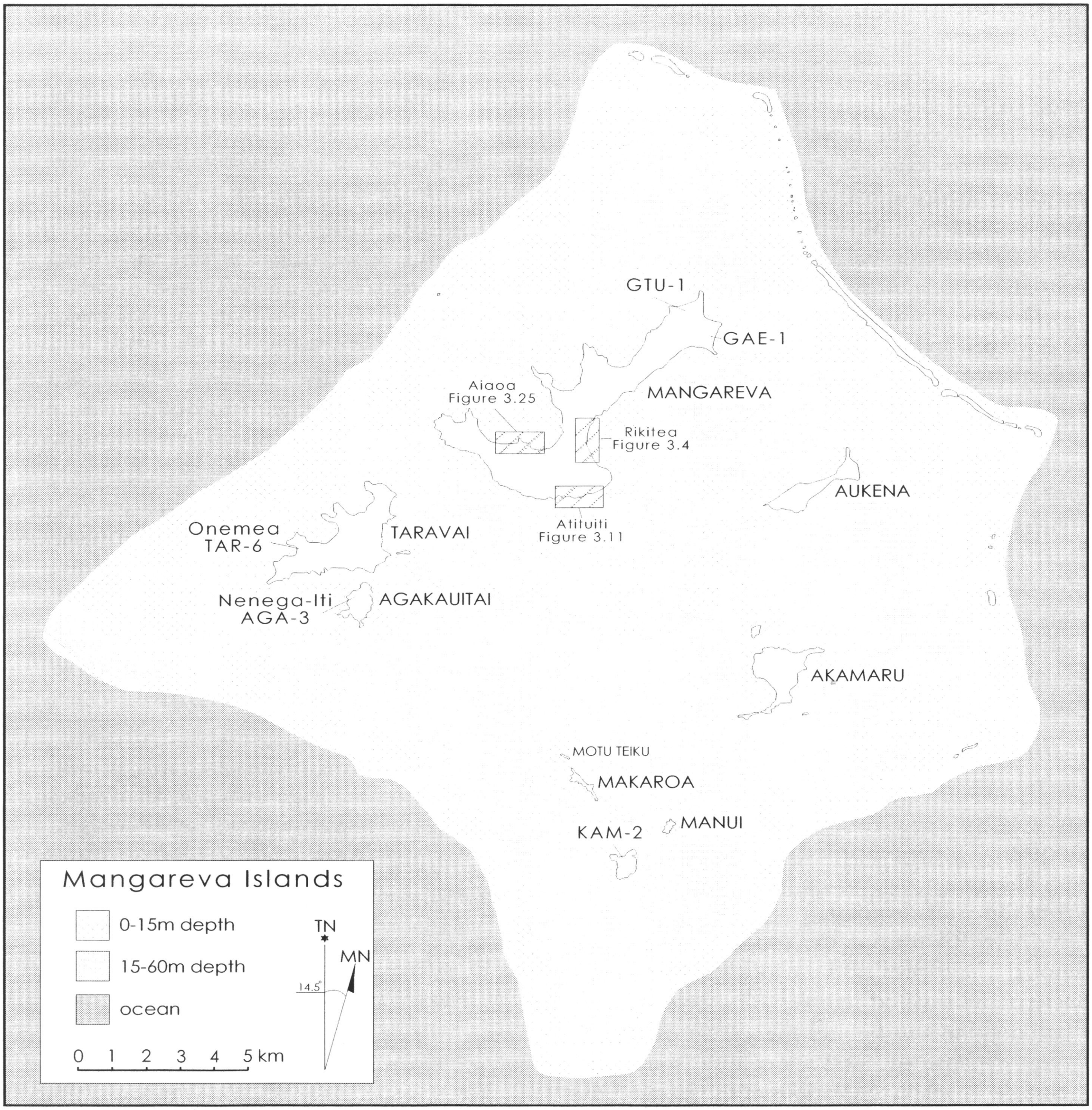


FIGURE 3.1 Map of the Mangareva Islands, showing the areas of archaeological survey and major sites. Shaded rectangles refer to more detailed area maps.

school is located, below the large cathedral (Fig. 3.3). Beechey's remark about a "second or upper village" is noteworthy, as this suggests a substantial area of houses on the higher slopes below Auorotini. His account also makes it clear that the colluvial slopes inland of the coastal plain were heavily covered in tree crops, especially breadfruit and coconut.

Emory (1939, fig. 7) provides a rough sketch map of the Rikitea area, depicting the

FIGURE 3.2 View of the Rikitea area from the summit of Auorotini (Mt. Duff). Photo by P.V. Kirch.

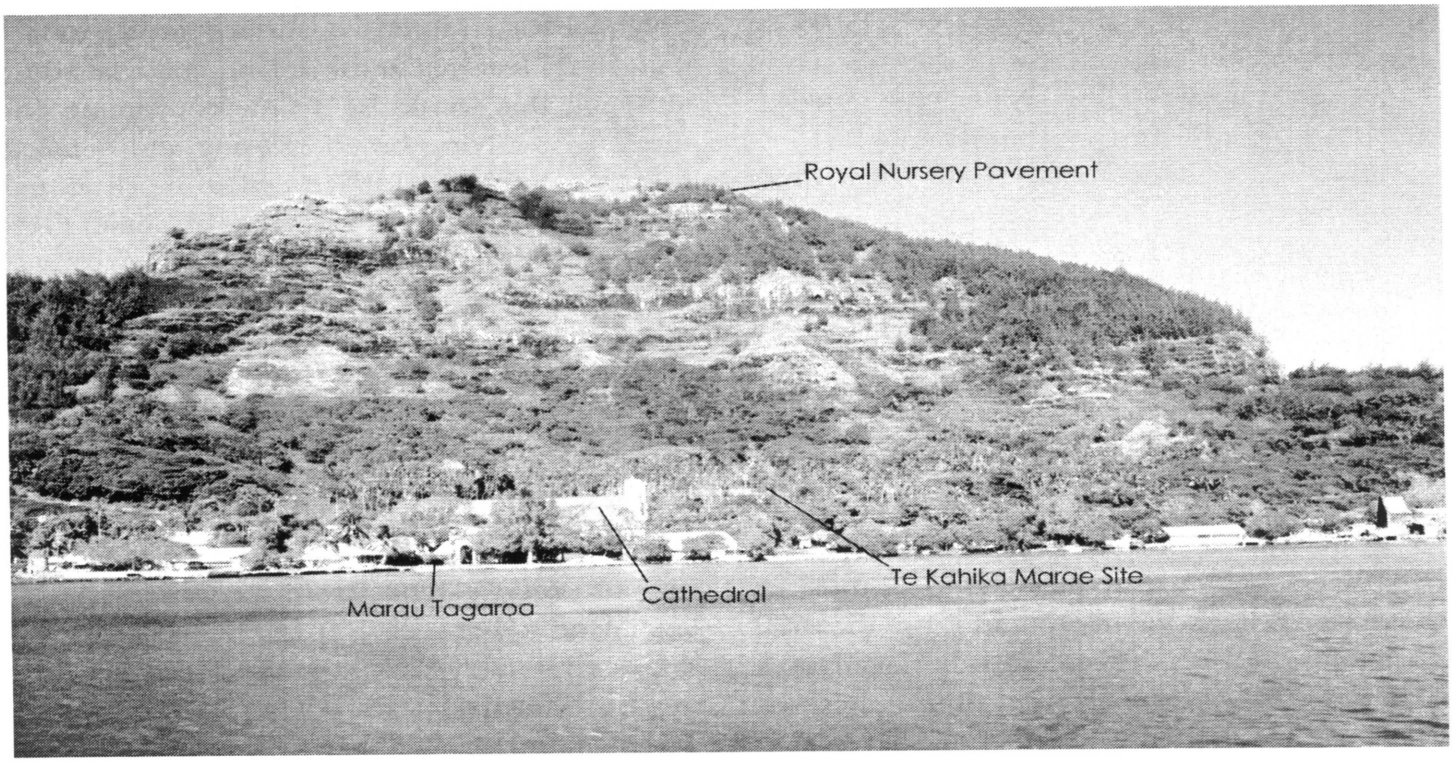


FIGURE 3.3 View of Auorotini (Mt. Duff) and Rikitea Village from the lagoon. The traditional residence of the high ranking chiefs of Rikitea was at Marau Tagaroa. The approximate locations of Marae Te Kehika and the site of the royal nursery are also indicated. Photo by P.V. Kirch.

approximate locations of a number of important sites, including four *marae* (Hiriga-tapu, Te Tehito, Te Kehika, and Te Hau-o-te-Vehi). All of these were heavily modified or destroyed by the Catholic missionaries, although as we report below, portions of the foundation of Te Kehika still exist. The great communal meeting house (*'are tapere*) which stood just inland of the chiefly residence (Marau Tagaroa), became the foundation for Rikitea's cathedral. The approximate locations of these traditionally important sites are shown on Figure 3.4.

Because Rikitea Village continues to be the island's main zone of human occupation, and due to the extensive building projects of the missionaries during the 19th century, the coastal plain is fairly densely covered in houses, roads, churches, schools, and other administrative buildings, making it difficult to survey archaeologically. Our work was limited to a reconnaissance survey of portions of the colluvial slopes and to several subsurface tests for buried cultural deposits on the coastal plain using transect coring and test pits, as shown in Figure 3.4. Our limited work has convinced us that there is still much of archaeological importance in the Rikitea area, but it will require a long-term project to fully tap these resources.

STONE STRUCTURAL SITES

Emory (1939:19) reports that all of the important sites located in the Rikitea area, such as the *marae* Te Kehika and Te Hau-o-te-Vehi, had been destroyed by the missionaries, with "all stones [having] been removed." We found that contrary to his report, not all traces of these structures have been obliterated, although it is true that the main structures are gone, most of the stone having been incorporated into the large cathedral, royal residence, and other structures built under missionary auspices during the 19th century. However, as seen in Figure 3.5, we were shown traces of what appear to be the foundation of *Marae Te Kehika* (site 190-06-RIK-1) consisting of a two-course high facing, ~2 m high and 5-6 m long, built of massive basalt boulders (average diameter ~1 m) (GPS position 503034E 7442770N). Between the two boulder courses we observed pieces of branch coral (*Acropora* sp.), which may have been placed there as ritual offerings. Unfortunately, the higher terrace supported by these foundation boulders had recently been bulldozed and evidently other stones taken from the site (B. Schmidt, pers. comm., 2001).

Reconnaissance survey likewise demonstrated that there are a variety of stone constructions still extant in an arcuate zone extending across the colluvial slopes inland of Rikitea Village. These include terraces of varied size, retaining walls, pavings, free-standing walls, and other constructions made of basalt boulders. In one area (Teva'a), where modern gardening had exposed a complex of features, a dark charcoal-rich cultural deposit with basalt flakes could be seen, and the landowner showed us several basalt adzes which had been uncovered during the course of his gardening activities. There is much potential for an intensive surface survey of architectural features in this inland colluvial zone, although this would be a time-consuming enterprise, involving brush clearing and detailed mapping. Table 3.1 lists several stone structural remains for which we were able to obtain GPS positions.

RIKITEA BEACH RIDGE CORING

The major focus of our work in Rikitea was not surface structural remains but the coastal beach ridge, which we wished to sample, by means of transect coring and test excavations, for evidence of buried cultural deposits. The Rikitea beach ridge, formed of fine-grained calcareous sands, extends from the current shoreline inland to between 100-150 m, where it then slopes down very slightly to the zone of hydromorphic, gleyed alluvial soil described by Tercinier (1974). This zone of hydromorphic soil was the principal area of wet taro cultivation. The beach ridge is low (height above sea level ranges from 1.5-3 m) and, being protected by the lagoon, has been constructed largely through

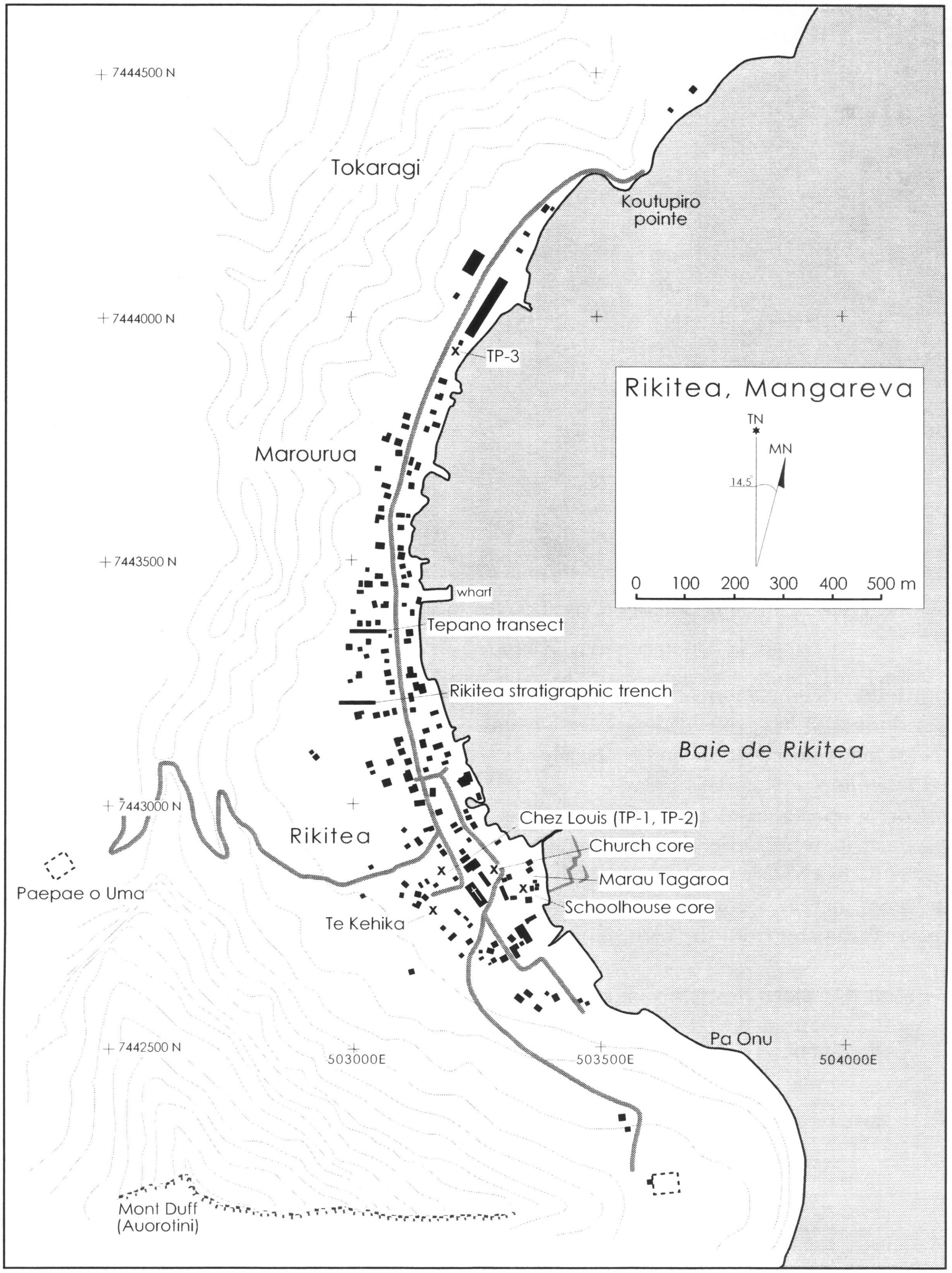


FIGURE 3.4 Map of the Rikitea area, showing the locations of coring transects and test excavations carried out in 2001 and 2003. The approximate locations of some important traditional sites are also indicated, based on Emory (1939).

FIGURE 3.5 View of the remnant two-course boulder facing said to be part of the foundation for Marae Te Kehika.

low-energy accumulation of medium to fine-grained sands. It has probably long been a main zone of human occupation, and is densely covered by houses and gardens today.

Coring operations to search for buried cultural deposits were carried out at several locations in Rikitea Village, as shown in Figure 3.4. The cores include a complete transect (Chez Tepano Paeamara) from the base of the colluvial slopes to the lagoon shore (at 20 m intervals), another partial transect (Chez Louis), and various individual cores sampling other places or features along the coastal plain. Attempts to core in three places near the Boutique Hinarau bottomed out on solid rock. Individual core results are summarized below, and stratigraphic diagrams are provided in Figure 3.6.

1. *Mound near Magazin Muriel.* A low but dis-

TABLE 3.1 Stone structural remains on the slopes inland of Rikitea Village.

Site Number	GPS Easting	GPS Northing	Stone Structure Type
190-06-RIK-7	502909	7442801	Stone-faced terrace, ca. 10 x 10 m; locality named Teva'a; stone adzes found here by landowner.
190-06-RIK-8	502917	7442801	Stone pavement (under heavy brush).
190-06-RIK-9	502933	7442732	Stone-faced terrace.
190-06-RIK-10	502954	7442696	Stone-faced terrace.
190-06-RIK-11	502980	7442684	Massive stone-faced terrace retaining wall ca. 20 m long, 2-3 courses high.
190-06-RIK-12	502954	7442653	Stone-faced terrace.

tinct mound occupies the open land between the road and the lagoon shore north of the Magazin Muriel. A core 25 m seaward of the road and 20 m from the lagoon shore on top of the mound encountered 100 cm of stiff clay and stone, from which it was concluded that the mound had been a secondary deposit of material from modern construction activities.

2. *Chez Tepano Paeamara.* This series of core holes provides a transect across the center of the Rikitea coastal flat. Core hole 3 was about 10 m seaward of the base of the steep, but narrow (20 m wide) hill slope deposits. It sampled 55 cm of hill-slope material lying upon medium-coarse grained carbonate sand and grit which, at 95 cm total depth, lay at an abrupt transition upon a fine marine sand deposit containing some small pelecypods and branch coral. A shell lying at the transition was collected for radiocarbon dating. With the admixture of hill-slope material (stiff volcanic clay and basalt clasts) decreasing seaward, the stratigraphy in the remaining core holes was similar, except that the marine sand was not reached in holes 4 and 5 where the water table lay within the overlying unit. A core hole 20 m seaward of the road and approximately 20 m from the lagoon shore found only medium-to-coarse grained sand and grit to the water table, at about 40 cm.

3. *Frenchman's House.* This core, in an area close to Tepano Paeamara and about 80 m inland from the road, shows similar stratigraphy to the cores at Tepano Paeamara except that the clay admixture was deeper and the core reached the water table before sampling marine sand.

4. *Chez Louis.* This series was cored to sample the land adjacent to the major Rikitea taro swamp, the seaward edge of which was located about 27 m inland from the road. Core 2 at 15 m from the road shows a fairly deep cultural layer, containing charcoal which was sampled for radiocarbon dating, overlying a coarse carbonate sand and grit. Holes 1, 3, 4, and 5 were positioned along a 3 m strip of the edge of the taro swamp, about 1 m back from

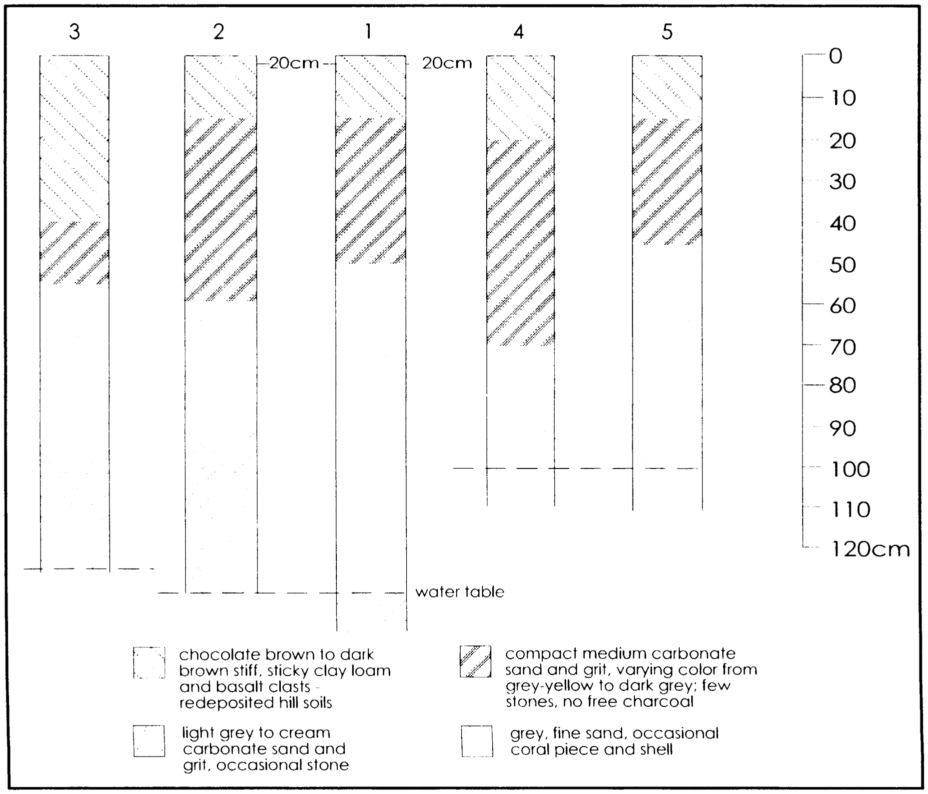


FIGURE 3.6 Stratigraphic diagram of coring transects in Rikitea Village (after Anderson 2001a). (A) Chez Tepano Paeamara.

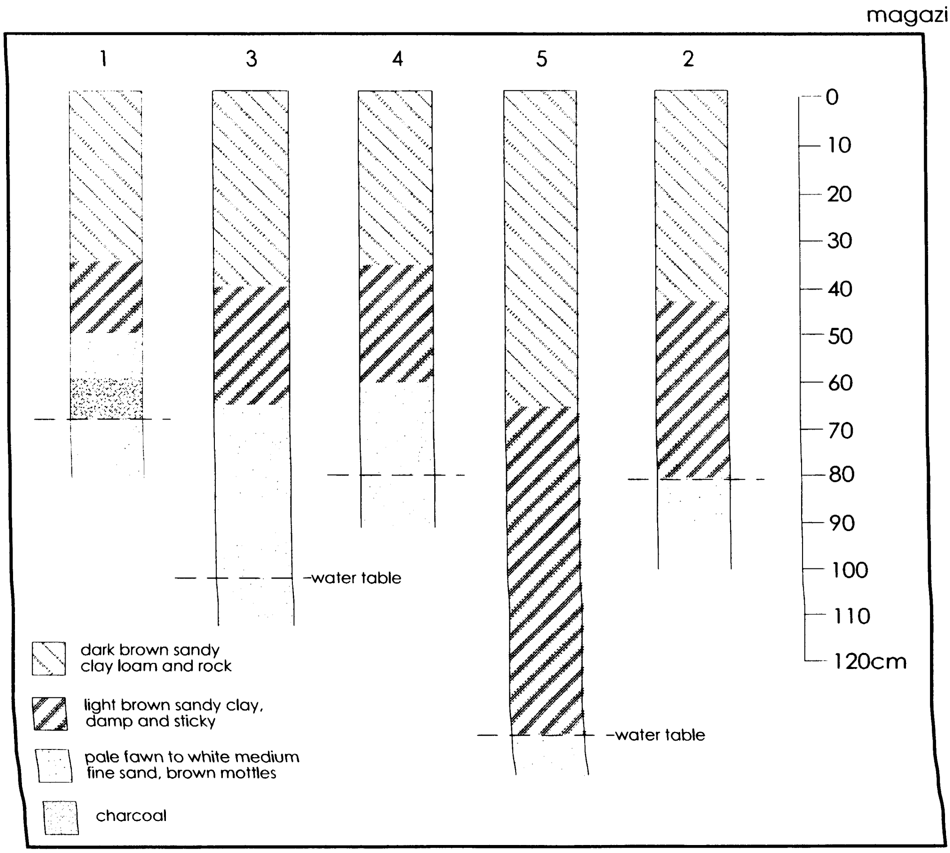


FIGURE 3.6
Stratigraphic diagram of coring transects in Rikitea Village (after Anderson 2001a).
(B) Chez Louis.

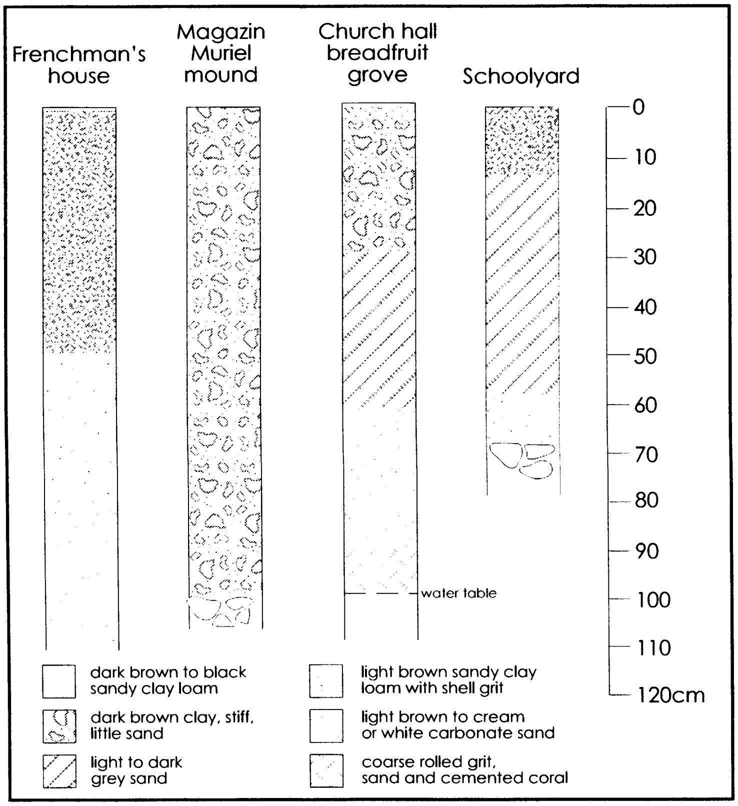


FIGURE 3.6
Stratigraphic diagram of coring transects in Rikitea Village (after Anderson 2001a).
(C) Miscellaneous cores.

the lip of the depression. Holes 3 and 4, at each end of the sample strip, had similar stratigraphy to hole 2, but holes 1 and 5 located something different. Hole 1 recorded charcoal down to the water table at 68 cm. A duplicate hole (5) 20 cm closer to the lip of the taro swamp recorded black sandy clay loam and sand down to 135 cm, at which point some free charcoal was recovered and retained for radiocarbon dating. The feature in hole 5 may be a ditch, or a former edge of the taro swamp, although a modern pit cannot be ruled out since we do not know from which level the feature was cut. A charcoal sample from core hole 2, at a depth of 55-60 cm, was submitted for radiocarbon dating, yielding a calibrated age of A.D. 1160-1220 (Anderson et al. 2003a). This is among the earliest dates from Mangareva, and hence in 2003 we returned to this locality for additional test excavations (see below).

5. *Church Hall Breadfruit Grove.* At the corner of the main road where it turns up the hill below the Rikitea church hall there is a grove of breadfruit trees. A core in the grove, 5 m west of the flat part of the road and 8 m north of the rising part, located a cultural deposit under 30 cm of hill-slope material. Charcoal was recovered for radiocarbon dating.

6. *Schoolyard.* At about 40 m from the lagoon edge and 25 m from the school buildings, along a fence between the school and pre-school, a core disclosed a cultural deposit containing charcoal that was sampled for radiocarbon dating. The core bottomed out on solid coral rock.

CENTRAL RIKITEA STRATIGRAPHIC TRENCH

An unexpected opportunity to observe a stratigraphic section cutting across much of the coastal beach ridge was provided by a trench more than 75 m long, which had been dug by heavy machinery to help correct drainage problems in the village. As shown in Figure 3.7, this trench cut across the zone of water-saturated, gleyed soil which had been identified by Tercinier (1974) and represented the largest area of taro cultivation on the island. The trench started at the base of the colluvial slope, ~175 m inland from the sealed road that runs through Rikitea, and ran perpendicular to the shoreline exposing the buried gley ~1 m below surface. We took advantage of this situation and recorded the stratigraphy ~10 m seaward of the base of the cliffs inland from the Mairie. The stratigraphic section was drawn and photographed (Fig. 3.8). The characteristics of each layer are described below.

Overburden. A dark brown (10YR3/3) sticky clay back dirt, ~20 cm thick, displaced from mechanical excavations of the trench. Similar characteristics to Layer II described below, but overburden was displaced from an unknown distance.

Layer I. Black (10YR2/1) silty clay, ~20 cm thick, with occasional charcoal flecks. Moderate crumb structure; firm, sticky consistency; plastic; abundant roots and pores; a clear and irregular boundary.

Layer II. A dark yellowish brown (10YR3/4) silty-clay with yellowish brown (10YR5/8) mottles, dispersed small flecks of charcoal, no stone or shell. A moderate crumb structure; plastic, with abundant roots and pores. The boundary is gradual and not discernible. A sample of dispersed charcoal was collected from the upper portion of the layer (Fig. 3.8) ~30 cm below the ground surface prior to accumulation of the recent spoil overburden.

Layer III. The ~25 cm thick gley layer consisting of a black (N2.5/2.5) clay-silt-gravel without large stones, but gritty. Very little dispersed charcoal some of which was collected for radiocarbon age determinations (Wk-10901; Beta-168443). The layer is structureless; sticky and very plastic with few roots. The boundary was very abrupt and smooth—characteristic of a gley layer.

Layer IV. A very pale brown (10YR8/3) sterile, well-sorted, coarse coralline beach sand with a gritty texture; no charcoal, stone or whole shell; non-sticky, non-plastic with few roots.

A sample of dispersed charcoal recovered from Layer III (GAM-16) was cleaned and split into three subsamples, each being sent to a dif-

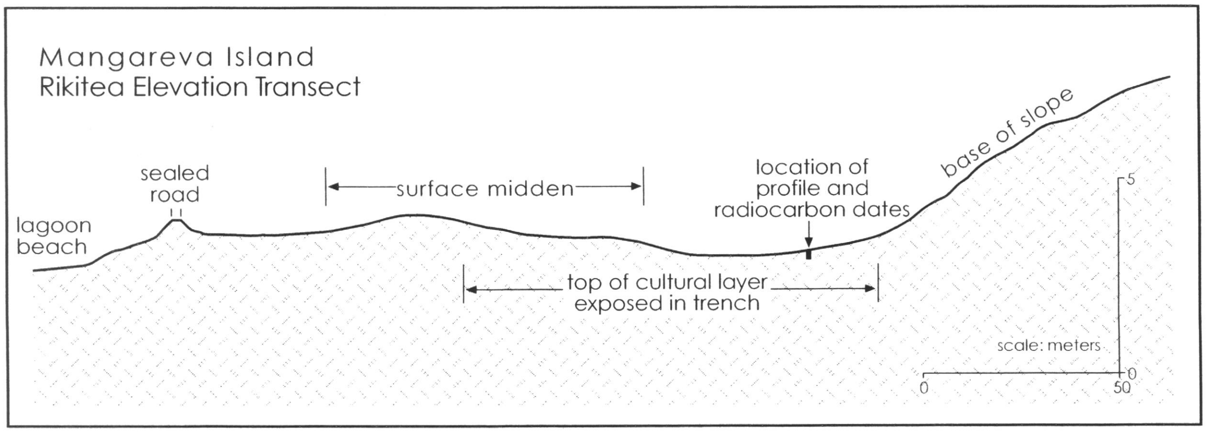


FIGURE 3.7 Elevation transect across the Rikitea beach ridge and taro swamp.

ferent laboratory for radiocarbon dating. One subsample (NZA-15383, GAM-16b) yielded a "modern" age, while the other two subsamples yielded ages of 450 ± 40 and 320 ± 180 B.P. (Beta-168443, GAM-16c; ANU-11927, GAM-16a). We believe that sample Beta-168443 provides the best estimate for the deposition of the gley layer. Calibrated to A.D. 1430-1460, this date suggests that the Rikitea taro swamp was in use as an agricultural system by at least this time period. Additional excavations of the buried gley layer at Rikitea will be needed to define the boundaries of the archaeological site, locate buried *in situ* cultural deposits (artifacts, midden, combustion features) and date multiple samples from the entire length of the site. Based

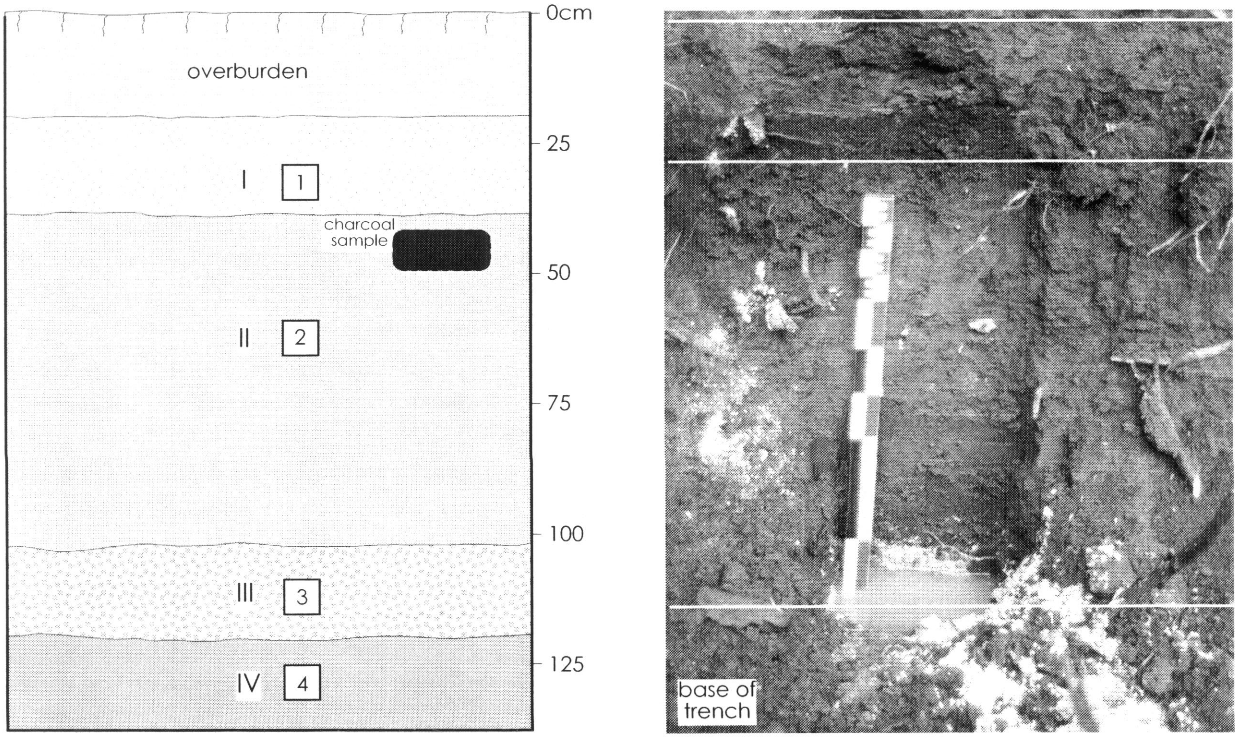


FIGURE 3.8 Stratigraphic section through the hydromorphic zone inland of the Rikitea beach ridge. Photo by M. I. Weisler.

on the geomorphological setting of the site it is likely that early cultural deposits may be found there, especially just seaward of the base of the slope.

TEST EXCAVATIONS IN RIKITEA VILLAGE (CHEZ LOUIS)

From the 2001 coring at Chez Louis (see above), we submitted a charcoal sample which yielded a calibrated radiocarbon age of A.D. 1160-1220 (Anderson et al. 2003a). As this is among the earliest obtained from any sites in Mangareva, in 2003 we decided to carry out a test excavation in the vicinity of the core hole, to explore the nature of the deposits which yielded the dated charcoal. Two test pits, each 1 m^2, were excavated along an east-west transect which crossed a narrow, swampy depression formerly used for taro cultivation (Fig. 3.9A).

Our first *sondage* (TP-1) was situated in the grassy flat to the south of Chez Louis, some 13.6 m inland (west) of the concrete road running through Rikitea Village (GPS coordinates 0503136E, 7442984N). The uppermost deposit, which was excavated by shovel, consisted of a compact sandy-clay loam containing recent (historic age) cultural materials such as rusted iron. At about 45 cm below surface, the top of a traditional Polynesian earth oven (*umu*) was exposed in the SW corner of the unit; soon after, a pit-like feature began to appear across the entire northern part of the square (between 55-70 cm below surface). These features made the excavation of the cultural deposit complex and difficult. Clean, culturally sterile beach sand was reached between 55-90 cm, and the water table appeared at 90 cm, making further excavation impossible. After completion of excavation, the exposed stratigraphy was recorded as follows (see Fig. 3.9B):

Layer I. 0-25 cm. Dark reddish brown (5 YR 3/2) sandy clay loam (about 5% sand grains); quite hard and compact. The upper 10 cm contained some rusted iron nails and partially burned wood. The earth oven (Feature 1) is associated with Layer I.

Layer II. 25-48/55 cm. Strong brown (7.5 YR 4/6), slightly mottled, cultural deposit with some shellfish (*Pinctada*, *Turbo*, *Gafrarium*, and other species noted), charcoal, and one piece of burned fishbone. The sediment is a mixture of clay and calcareous sand (~20% sand). The contact with Layer III is fairly sharp but irregular. A large pit runs along the north side of the unit, containing Layer II fill.

Layer III. 48/55-90 cm. White (7.5 YR N8) calcareous sand with some dark red mottling (2.5 YR 3/6) which may derive from decomposed organic matter. Sand is medium-to-fine-grained with small marine shells, including one bivalve in intact death position. Several small branch coral fragments were also noted, along with scattered pieces of decomposed organic material (rotted wood fragments?). The water table was reached at 90 cm, but much of the deposit immediately above this is also wet. Layer III has the appearance of being a low-energy beach deposit.

After TP-1 was completed, we decided to open a second *sondage* (TP-2) inland of the taro swamp depression, at the base of the colluvial slope, to determine whether the beach deposit represented by Layer III in TP-1 continued inland under the colluvium. It was our hope that we might also find an intact cultural deposit on an old beach surface, if such existed. TP-2 (1x1 m) was located by GPS at 0503097E and 7442962N. Because of the dense and compact clay and rock making up the sediment in TP-2, it was excavated by shovel and iron bar and could not be screened. There was little difference in stratigraphy from top to bottom, the entire deposit consisting of colluvial material until the water table was reached at 125 cm below surface. With some difficulty we continued to dig below the water table to a depth of 145 cm, but no calcareous sand deposit was encountered. At this depth we were somewhat below the level of the calcareous beach sand deposit (Layer III) in TP-1. The stratigraphy of

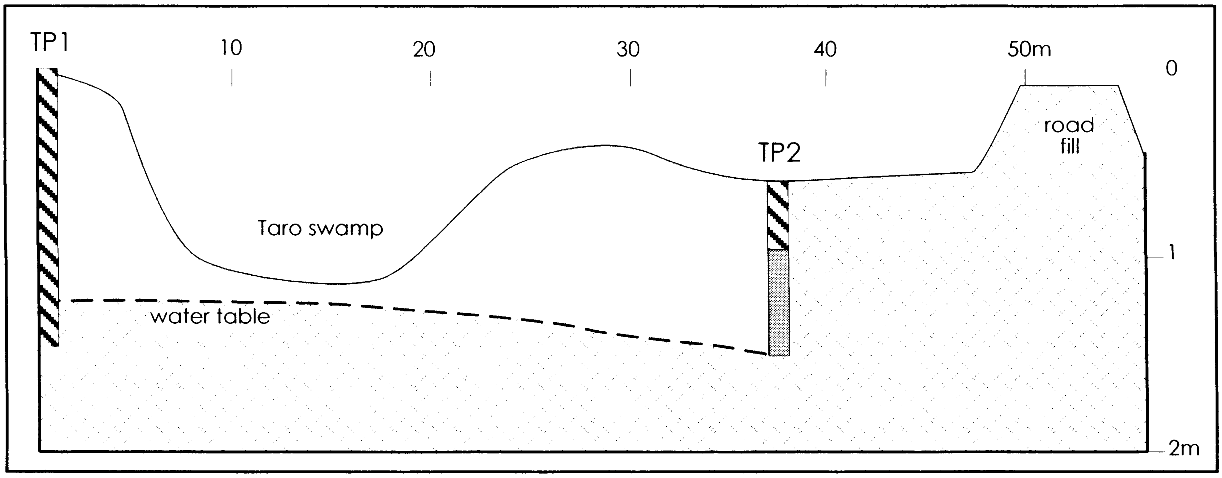


FIGURE 3.9A Elevation transect at Chez Louis, showing the relative positions of TP-1 and TP-2.

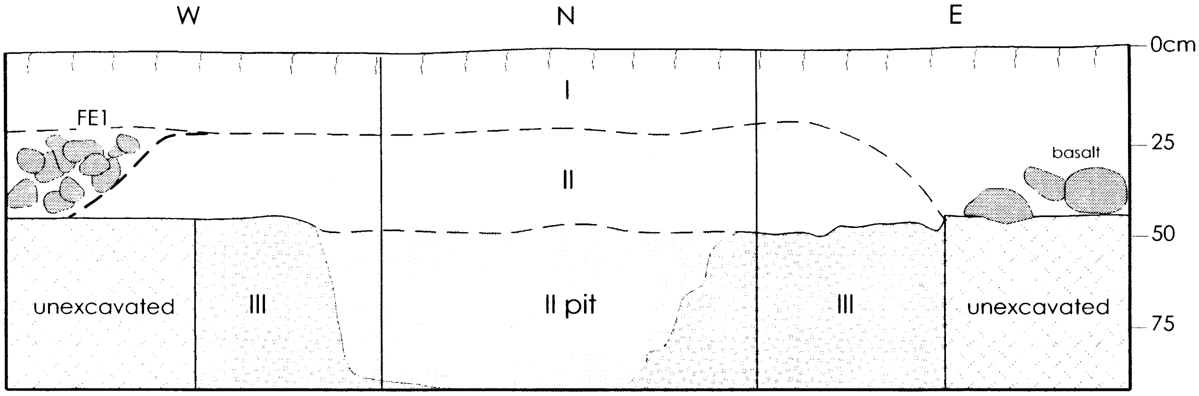


FIGURE 3.9B Stratigraphic section of TP-1, Chez Louis.

TP-2 was recorded as follows:

0-30 cm. Dark reddish brown (5 YR 3/2) clay (lacking sand inclusions); stiff and compact.

30-80 cm. Dark reddish brown (5 YR 3/2) clay with a dense concentration of fist-sized rounded basalt cobbles. Charcoal pieces scattered throughout, indicating burning.

80-100+ cm. Very dark gray clay mixed with much smaller volcanic gravel (subangular shape).

In sum, these test excavations failed to reveal the presence of a substantial cultural deposit in the vicinity of Chez Louis, despite the early ^{14}C date from the 2001 coring. However, the test pits and transect leveling did provide some detail on the geomorphological context. Specifically, it appears that TP-1 sits on the inland slope of a former low calcareous sand beach ridge, upon which early Polynesian occupation was located. A natural depression inland of the beach ridge and at the base of the colluvial slope provided an excellent locality for taro cultivation. Most likely, the primary zone of habitation was slightly seaward of TP-1 itself, in the vicinity of the present elevated concrete roadway. Further test excavations between TP-1 and the present shoreline might succeed in locating more promising cultural deposits.

RIKITEA, TEST PIT 3

In 2001 we dug one 1 m^2 test excavation on the property of T. Reasin in Rikitea (near the NE end of the village), in a location where construction for a house and water line had led to the discovery of a pearlshell fishhook. The excavation was carried to a depth of about 120 cm, although the water table was encountered at 100 cm below surface. No prehistoric artifacts were recovered, although some historic-period objects were found in the upper levels. The stratigraphy of the south face of the excavation unit is shown in Figure 3.10, and can be summarized as follows:

Layer IA. Compact sandy-clay loam, with basalt rocks and coral debris (includes historic-period artifacts). Color 10 YR 2/2.

Layer IB. Lens of reddish mottled material mixed with large pieces of semi-burnt wood and charcoal, coral rubble. This deposit possibly relates to a recent period of charcoal production in the vicinity, as described by T. Reasin.

Layer II. A deep, structureless, uniform deposit of gray-brown sandy-clay loam (color 10 YR 3/2), with some dispersed charcoal flecks. The contact between layers II and III is fairly sharp but slightly irregular.

Layer IIIA. Zone of mottled sand, stained (7.5 YR 8/6-7/8).

Layer IIIB. White, sterile beach sand (10 YR 8/2). Water table reached at 103 cm below surface (3:30 pm, high tide).

Summary of the Rikitea Area

The transect cores, test pits, and stratigraphic section through the drainage trench all indicate the presence of subsurface cultural deposits in the beach ridge underlying Rikitea Village. In the case of Chez Louis, a radiocarbon date of A.D. 1160-1220 (calibrated) suggests that some of these deposits are of considerable age. At the same time, no deeply stratified deposits were encountered, and it is likely that the beach ridge is characterized by "horizontal stratigraphy" rather than deep, vertically stratified deposits. Thus, a far more extensive program of coring and test excavations will be required to identify localities that may be worthy of intensive excavation. Moreover, it is likely that some of the oldest deposits underlie the complex of structures including the cathedral, parish house, and school, near the southern end of the village, making them difficult or impossible to access. Our reconnaissance forays onto the colluvial slopes inland of the beach ridge also demonstrated that an array of stone structural features remain extant on these slopes, and would repay efforts at intensive settlement pattern survey.

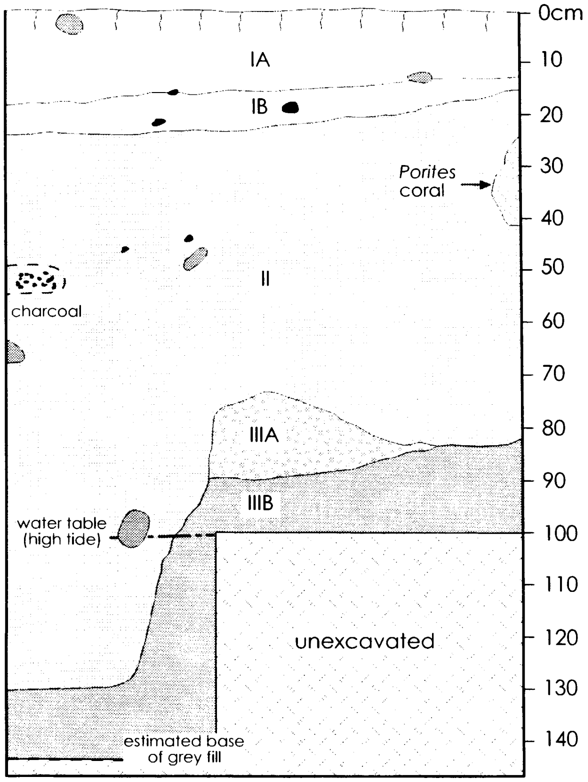


FIGURE 3.10 Stratigraphic section of TP-3, Rikitea Village.

Atituiti (ATU) Area

The Atituiti district lies on the southern part of Mangareva, to the southwest of Rikitea, and consists of a calcareous coastal plain (Atituiti Raro), and a kind of plateau or shelf (Atituiti Ruga) situated about 100 m above sea level and below the steep cliff of Auorotini. Access from the plateau (Atituiti Ruga) to the coastal plain (Atituiti Raro) is provided by a partly stone-paved path which descends from just west of the ruins of the Catholic convent at Rouru.

Emory (1939:23-24) hints at the presence of stone terraces and platforms in the Atituiti area and mentions a *marae* (Te Mata-o-Tu at Tai-o-te-Avarua), on the coast at Atituiti Raro, which he described as consisting only of a "rough pile of basalt and coral stones, covering an area 9 feet square." A general map of the Atituiti area is provided in Figure 3.11.

STRUCTURAL COMPLEX AT ATITUITI RUGA
(SITE 190-06-ATU-1)

In his monograph, Emory (1939:23-24) briefly noted that "back of the coastal plain on which is situated the little village of Atituiti is a high, heavily wooded shelf known as Atituiti *ruga* (above), along which are a number of old pavements and terraces." Hiroa (1938a:226) alludes to the remains of taro irrigation systems at Atituiti, although he does not give detailed descriptions. During a reconnaissance foray, Kirch noted the presence of numerous stone-faced terraces and other features situated on either side of the dirt road running west from the abandoned convent across the Atituiti shelf referred to by Emory. From November 27 to 29, 2001 these features were mapped with plane table and alidade at scale of 1:300, with contour intervals at 1 m. The location of our mapped area is shown in Figure 3.11, while Figure 3.12 is a digitized version of the detailed plane table map.

As indicated by the features within our mapped area, Atituiti Ruga preserves a largely undisturbed settlement landscape, with a diversity of stone structures including a large *paepae*, smaller pavements, and both dry and irrigated agricultural terraces. It is one of the few remaining areas of Mangareva Island where there appears to be an intact settlement pattern which has not been destroyed either by the 19th century mission or more recent construction and land modification.

Major features shown in Figure 3.12 are designated by letters, for which we provide brief descriptions or comments:

Feature A. A large *paepae*, described in further detail below.

Feature B. A rough retaining wall of large boulders, partly disturbed by recent bulldozing. The wall marks the edge of a large terrace.

Feature C. A partly disturbed free-standing stone wall about 2 m wide (there has been some collapse), which seems to have defined the east and south edges of a flat "court" to the east of the large *paepae*, Feature A. The area to the west of the wall is very flat and possibly paved.

Feature D. An upright slab of basalt 0.9 x 0.15 m across and standing 0.95 m high, set on edge. The slab is surrounded by three other angular volcanic stones. This feature may possibly have been associated with the large Feature A *paepae* in a sighting alignment.

Feature E. Area of pavement with well-set volcanic slabs (30-40 cm diameter), laid flat. Disturbed at the south and west sides by recent bulldozing.

Feature F. Two or possibly three shallow depressions, each 1-1.5 m in diameter, with stone rims, evidently associated with the Feature E pavement. These may possibly be subterranean storage pits for breadfruit paste (*rua ma*).

Feature G. A small, well-set pavement of volcanic slabs on a knoll overlooking the large Feature A *paepae*.

Feature H. A crude terrace of large boulders with what appears to be a heap of dark-colored earth on top of it.

Feature I. A well-faced terrace or retaining wall, four courses high (1.0 m). The terrace retains sloping ground behind it and was probably a dryland horticultural feature.

Feature J. A free-standing stone wall 0.3-0.7 m high of stacked cobbles and boulders. This possibly served as a land division or boundary marker.

Feature K. A large, relatively flat area about 20 x 20 m with low retaining walls on the east and south, possibly a habitation terrace.

Feature L. A worked (cut and dressed) block of tuff or breccia 0.35 x .40 m, 0.55 m high, which stands upright in the middle of a dryland terrace.

Feature M. A set of terraces defined by retaining walls 0.3-0.6 m high. One terrace has a

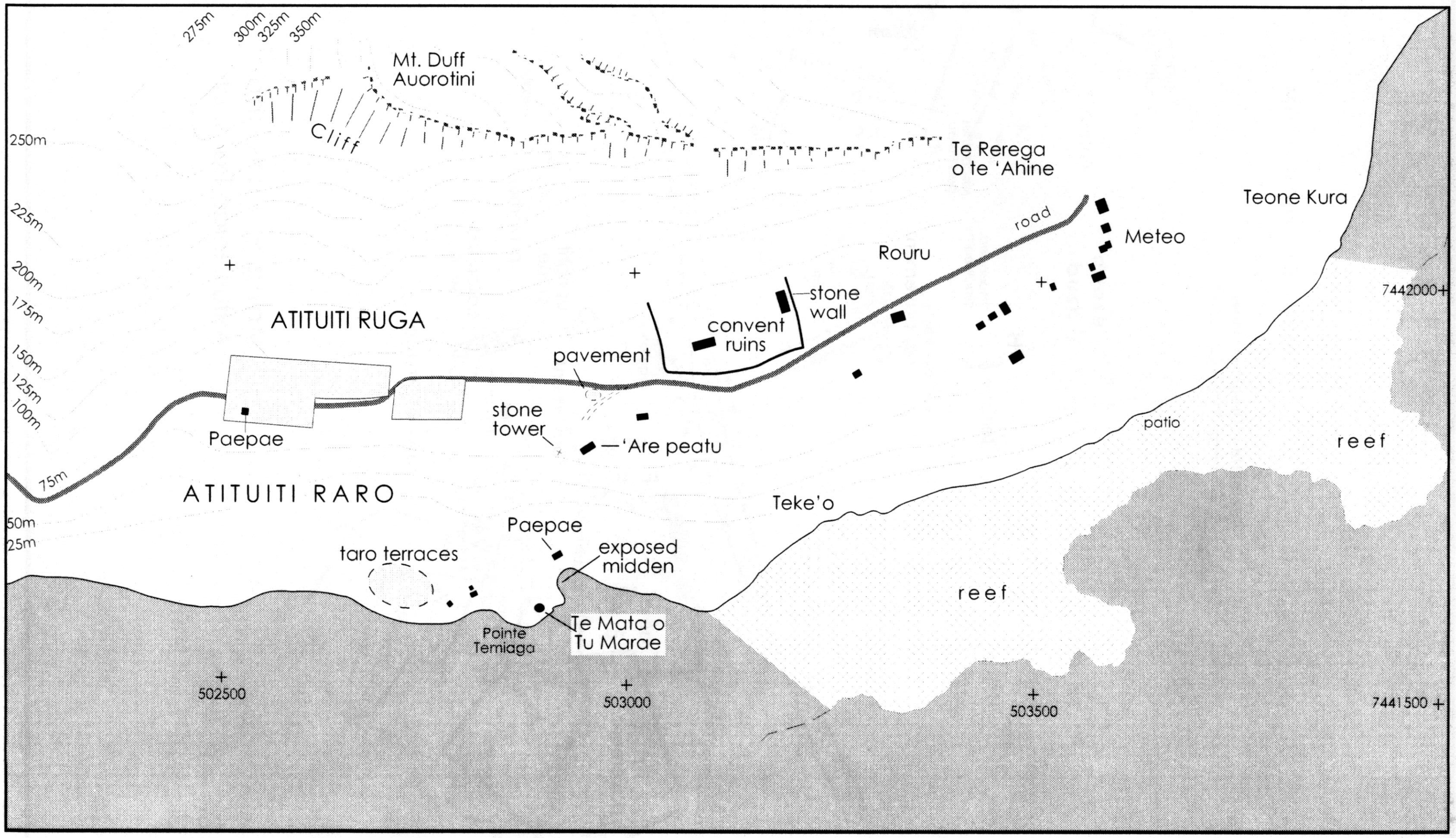


FIGURE 3.11 General map of the Atituiti area, Mangareva Island. Shaded area indicates detailed mapping shown in Figure 3.12.

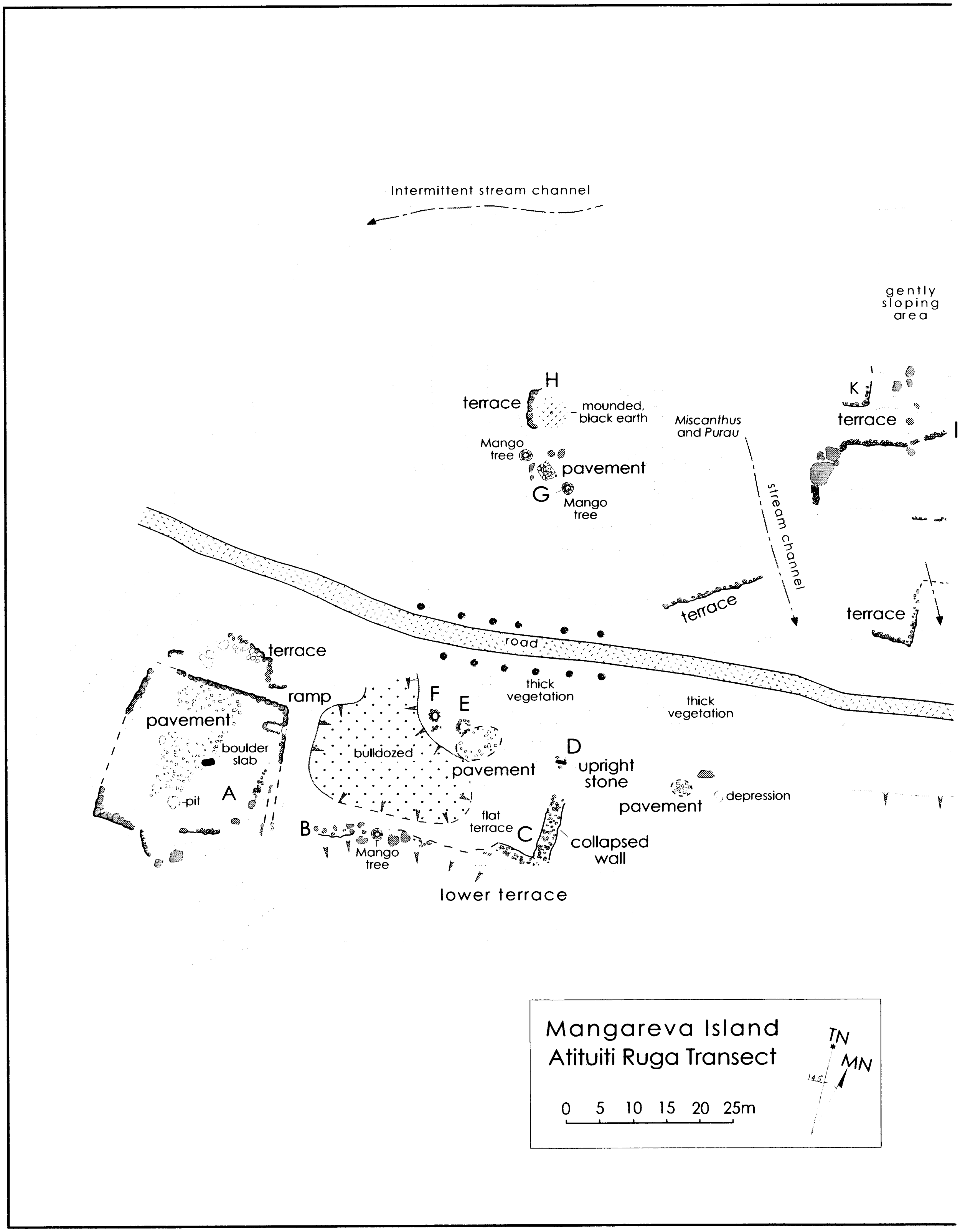
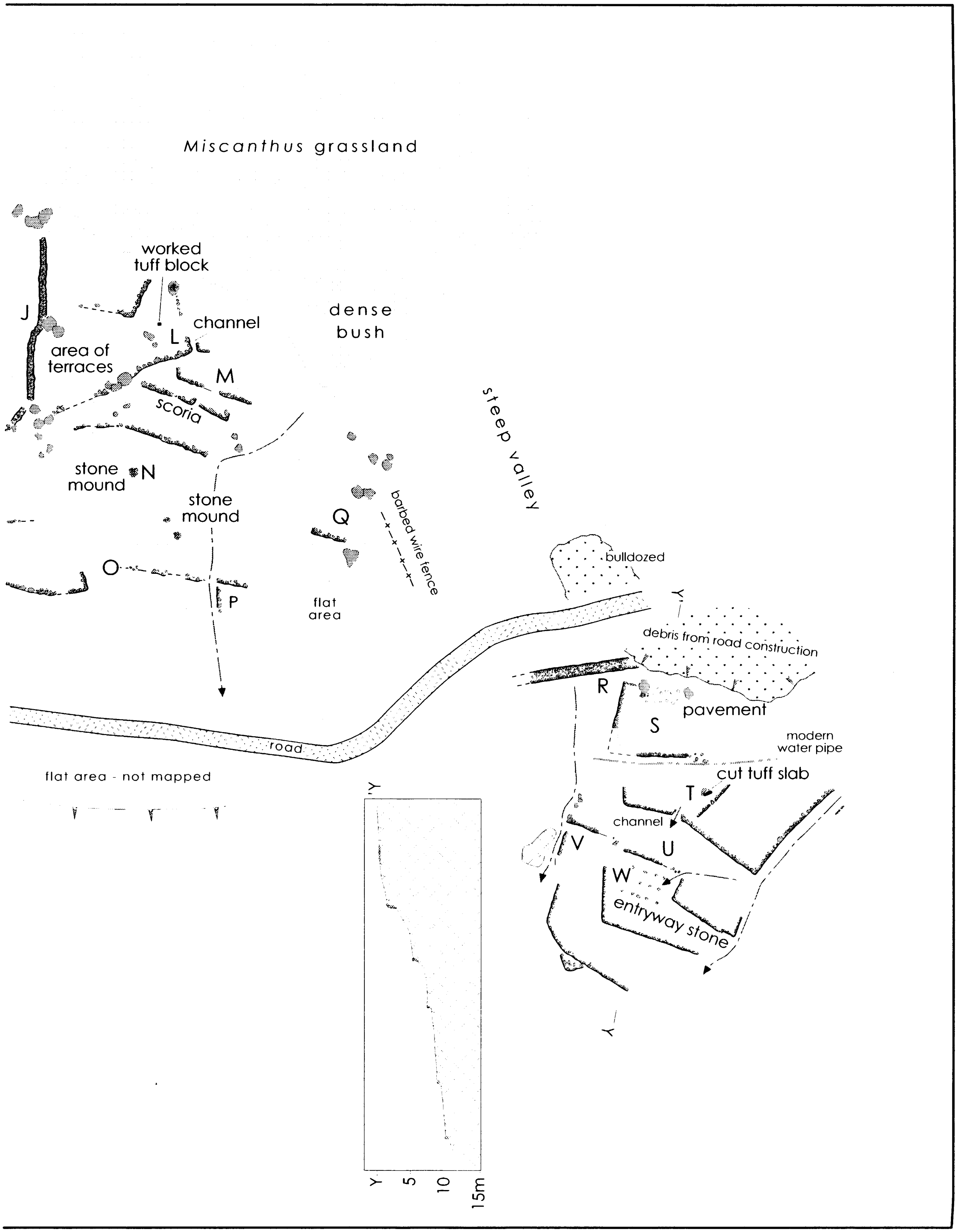


FIGURE 3.12 Plane table map of stone structures in the Atituiti Ruga area, Mangareva Island. See text for description of lettered features.


Miscanthus grassland
worked tuff block
channel
dense bush
J
L
area of terraces
M
scoria
steep valley
stone mound
N
stone mound
Q
barbed wire fence
O
P
flat area
bulldozed
Y
debris from road construction
R
pavement
S
modern water pipe
road
flat area - not mapped
cut tuff slab
T
channel
V
U
W
entryway stone
Y
Y
5
10
15m

red scoria stone in its facing. A distinct stone-lined channel cuts through one terrace, probably for drainage. The terraces have sloping, rather than flat, surfaces and hence were probably used for dryland horticulture, rather than being irrigated.

Feature N. Three stone mounds with diameters of ca. 1 m, and ranging from 0.5-0.75 m high.

Feature O. Stone-faced terraces, probably for dryland horticulture.

Feature P. Part of a small drainage which has been channelized by a rock wall lining.

Feature Q. A flat area on the ridge with a low stone retaining wall (0.4 m high), possibly a habitation terrace.

Feature R. Part of an elevated stone pathway or road, destroyed in part by the construction of the modern road and by bulldozing. The well-built feature has facing heights of 0.7 to 1.1 m. This may be part of a system of stone-paved trails constructed during the missionary period.

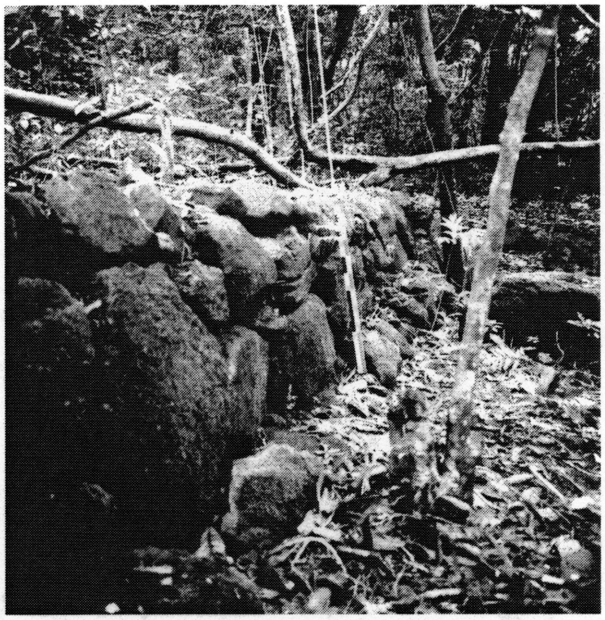
Feature S. A well-built, high stone-faced terrace with a retaining wall up to 1.7 m high. There is a stone pavement of flat volcanic slabs at the rear of the terrace. The feature is probably a habitation terrace.

Feature T. A cut-and-dressed slab of tuff or breccia, rectangular in shape and measuring 1.15 x 0.4 m, 0.5 m high. The stone has a grooved indentation on its upper surface, and may have been intended for use as a lintel stone. It probably dates to the missionary period, when extensive stone working was undertaken both for religious and secular constructions.

Feature U. A complex of six well-constructed, stone-faced terraces with retaining walls ranging from 0.3-0.9 m high. The terrace surfaces are flat, and the complex appears to represent a small irrigated system for taro cultivation, as mentioned by Hiroa. Figure 3.13 shows a view of one of these irrigation terraces.

Feature V. An area where the small stream has been channelized between a large outcrop boulder and a well-constructed boulder retaining wall 0.7 m high.

Feature W. Three parallel alignments of four boulders each, making up the foundation stones for a house structure. Informants indicated that a frame house stood here earlier in the 20th century.



3.13. View of stone-faced terrace (Feature U) probably for pondfield cultivation of taro, at Atituiti Ruga.

PAEPAE SITE 109-06-ATU-1A

The largest structure within the mapped zone at Atituiti Ruga is the platform or *paepae* designated site 190-06-ATU-1A. A Garmin XL12 GPS receiver was used to determine a position of 0502521 E, 7441801 N for the center of the platform, although reading quality was poor due to overhead trees. This structure is shown in plan view in Figure 3.14, based on a detailed theodolite map made by E. Conte; north-south and east-west sections through the platform are provided in Figure 3.15. The platform was constructed on a low knoll or natural rise, and is perched on the edge of the steep bluff descending some 90 m to the coastal flat of Atituiti Raro. This topographic setting gives the platform a magnificent view across the Mangareva lagoon to the east, south, and west, including the islands of Aukena, Akamaru,

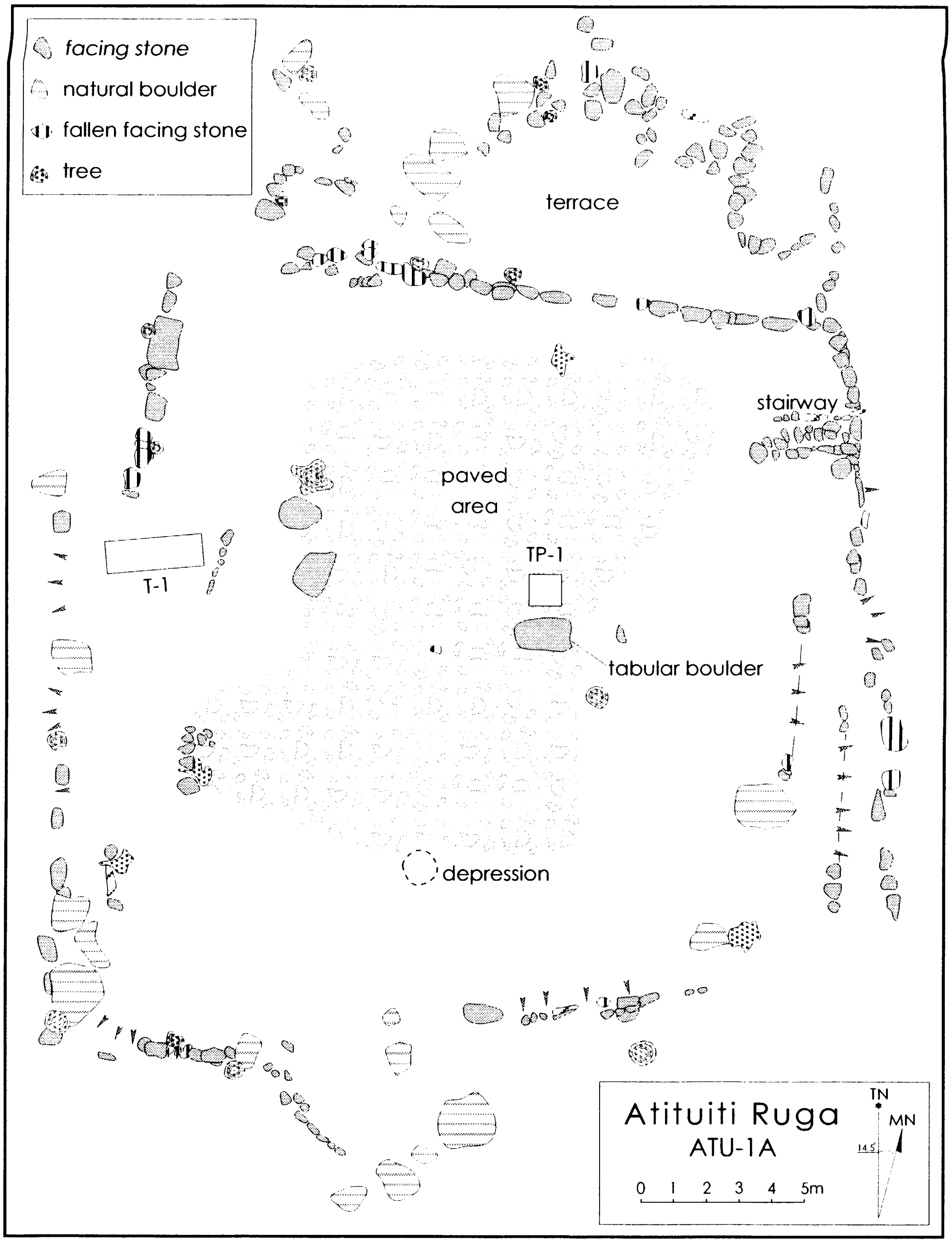


FIGURE 3.14 Plan of *paepae* Site 109-06-ATU-1A at Atituiti Ruga.

Kamaka, Makaroa, Agakauitai, and Taravai.

The platform is well faced with one to two courses of large basalt boulders, up to 70 cm high, on its northern side (Fig. 3.16), and was apparently similarly well faced on the east, but unfortunately much of the eastern façade was damaged during the bulldozing associated with construction of the nearby road. The western side of the platform has a lower, discontinuous facing of boulders and cobbles. On the southern side, there are only low facing walls, but the platform's southern edge is nonetheless well defined by the sharp break and in slope, and drop off to the natural bluff. North-to-south as well as east-to-west the platform measures roughly 23 m. On the northern side, there is a separate, slightly lower terrace (partly paved) about 6 m wide; on the eastern end of this terrace a sloping ramp descends to the natural ground level. A well-constructed stairway, faced with cobbles

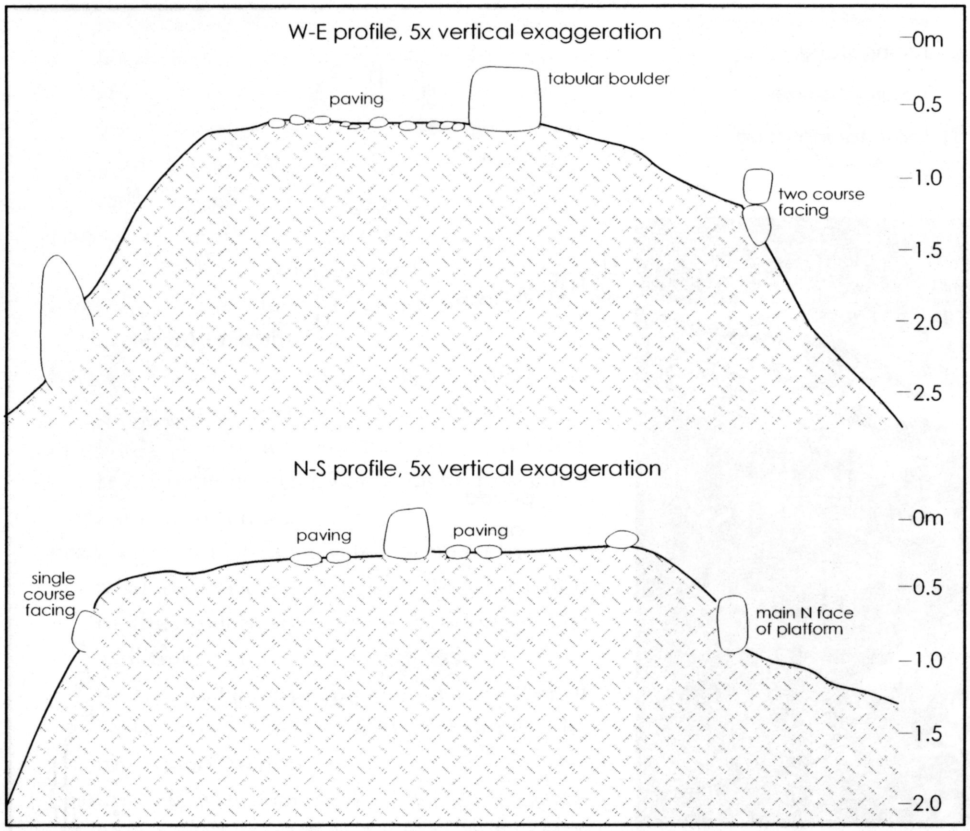


FIGURE 3.15 Cross sections through the 109-06-ATU-1A *paepae* (vertical exaggeration x5).

FIGURE 3.16 View of the northeast corner and part of the northern façade of the ATU-1A *paepae*, showing large boulders used in its construction. Photo by E. Conte.

on either side, ascends the platform from ground level on the eastern façade about 3 m from the northeast corner. At the approximate center of the platform is a large, flat table-shaped boulder, 1.75 m long and 0.45 m high, with its long axis oriented about 86° (Fig. 3.17, 3.18). Adjoining this boulder on the west and extending over a rectangular area some 8 by 18 m is a pavement of flat basalt cobbles, carefully placed. Two large flat boulders are situated near the western edge of the pavement. Just to the south of the pavement is a circular depression 1.6 m in diameter which may be a filled-in pit or earth oven.

The large tabular boulder in the center of the *paepae*, and adjacent to the paved area, is a feature of some interest. During his 1826 visit to Mangareva, Beechey mentions a similar large stone in the middle of a paved area, which served as the seat of the *'akariki* or high chief: "We had not remained many minutes in the hut where we were first introduced, when the areghe rose, and, taking me with him, went to a large stone, in the centre of the paved area, where we both sat down, and were immediately surrounded by some hundreds of his subjects" (1831:173). Emory (1939:14) discusses stone seats in Mangareva, which he says were called *'akapua*, and were "actual seats and not slab back rests." The tabular boulder on the ATU-1A *paepae* is presumably such a seat.

As can be seen in the plan (Fig. 3.14), the ATU-1A *paepae* is very nearly square and is moreover closely aligned to cardinal directions. Bearings taken with a Suntoo sighting compass-clinometer (all readings corrected for magnetic declination of +14.5°) indicate that the well-defined north face is oriented 96.5°, while the somewhat disturbed eastern façade seems to have been oriented approximately 178.5°. The stairway ascending the eastern face has an orientation of 90.5°. The large tabular boulder in the center of the platform has its long axis oriented about 86.5°. The discontinuous facings on the western side have orientations of 189.5° and 181.5°. In sum, the platform is oriented so that its sides are essentially due east-west and north-south, with a deviation of no more than 9° from true cardinal directions. The stairway feature is precisely oriented due east. A sight line was also taken from the large tabular boulder to the upright slab about 22 m east of the platform, with a bearing of 82.5°.

TEST EXCAVATIONS AT PAEPAE *SITE ATU-1A*

In 2003, Conte and Kirch returned to the ATU-1A *paepae* to carry out test excavations with the principal objective of obtaining datable charcoal. As noted above, a large tabular basalt slab sits on the *paepae* in a central position, with a basalt cobble paving extending out from this slab towards the north. We began by carrying out a *décapage* of the humic soil overburden partially obscuring this pavement, over an area of about 3 x 3 m. Some charcoal flecks were noted and collected, along with a number of thin, tabular basalt spalls which had clearly "popped off" of the north face of the large tabular slab (evidenced by negative spall scars on the slab surface). These suggest that at one time a fire was lit directly in front of the tabular slab, generating sufficient heat to cause the spalling.

After the *décapage* was completed, we laid out a 1 x 1 m test excavation (designated TP-1) about 1.5 m north of the face of the tabular slab. The paving slabs were carefully lifted and the earth between and underneath the pavement excavated by trowel (Fig. 3.19). Although charcoal was not abundant, we recovered a large piece of carbonized candlenut shell (*Aleurites moluccana*), a carbonized *Pandanus* fruit key, and what appeared to be burned coconut husk but was later identified as carbonized *Cordyline fruticosa* stem (see Chapter 4), along with other flecks of unidentified wood charcoal. A small flake of basalt dikestone was also recovered. One sample of charcoal in secure context under a paving slab was submitted for radiocarbon dating (Beta-190115) and yielded a calibrated age of A.D. 1430-1470 (see Chapter 4 for details).

Our second test excavation consisted of a

FIGURE 3.17 View of the paved surface of the ATU-1A *paepae*, with the large tabular boulder. Photo by E. Conte.

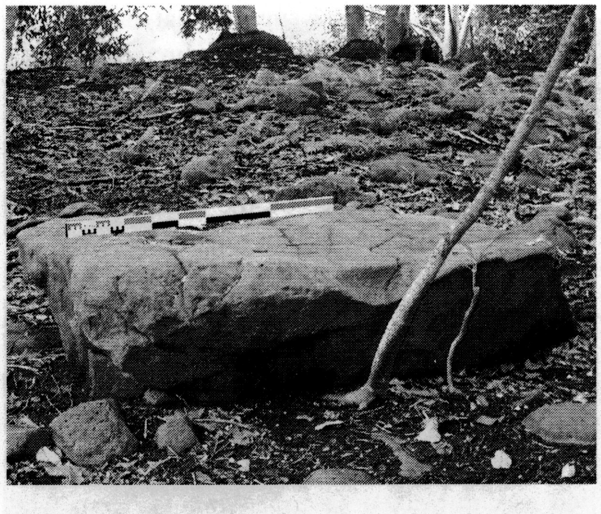


FIGURE 3.18 Close-up of the large tabular boulder in the center of the ATU-1A *paepae*. Photo by E. Conte.

1 x 3 m trench (designated T-1) situated on the western slope of the *paepae*, in an area where there is no visible stone facing. Our goals here were first to determine whether buried traces of facing existed, and second to see if we could obtain datable charcoal either in the *paepae* fill, or on the original landscape surface beneath the *paepae*. A number of basalt cobbles exposed in the excavation do appear to be the remains of a stone facing which has tumbled and collapsed. The stratigraphic section exposed by the trench (Fig. 3.20) was described as follows:

Layer I. Humic clay loam, A-horizon; color 5 YR 3/2 dark reddish brown. Many large and small rootlets from nearby Java plum trees. This layer appears to be the natural forest soil which has built up after abandonment of the site. The contact with Layer II is gradational and irregular.

Layer II. A reddish brown (5 YR 4/4) volcanic clay with some subangular gravel inclusions, which appears to be the *paepae* fill. This deposit overlays several highly weathered, large saprolithic boulders, which appear to be on the old landscape surface. The presence of these boulders prevented us from digging down into the pre-*paepae* land surface.

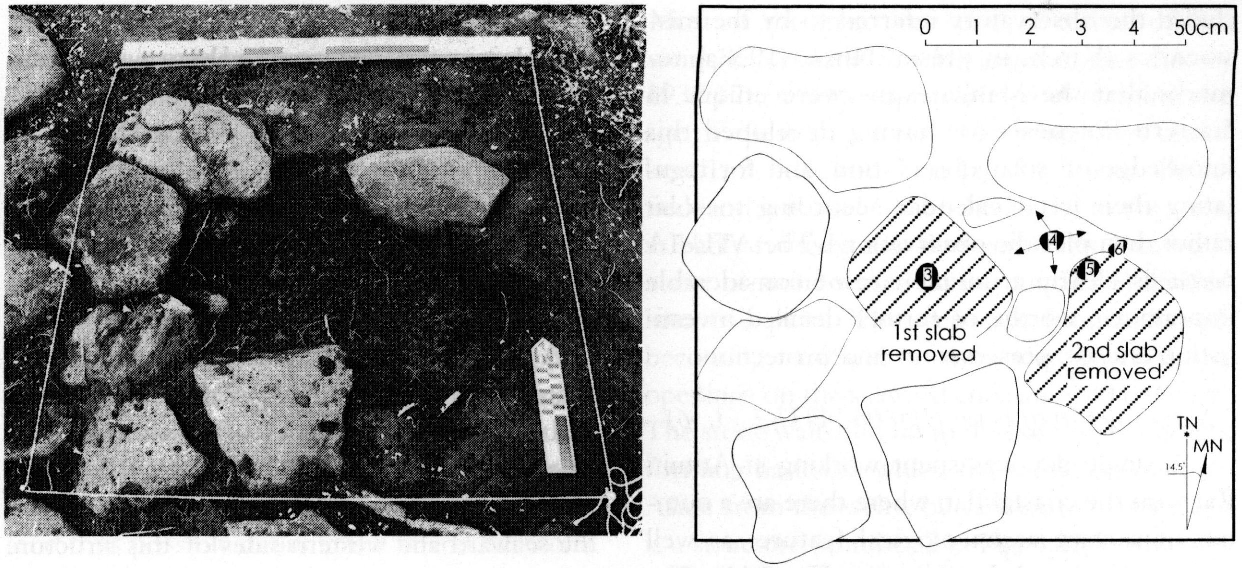


FIGURE 3.19 View and plan of the TP-1 excavation in the pavement in front of the large tabular boulder at ATU-1A. Two paving stones have been removed in order to search for charcoal for radiocarbon dating. Photo by E. Conte.

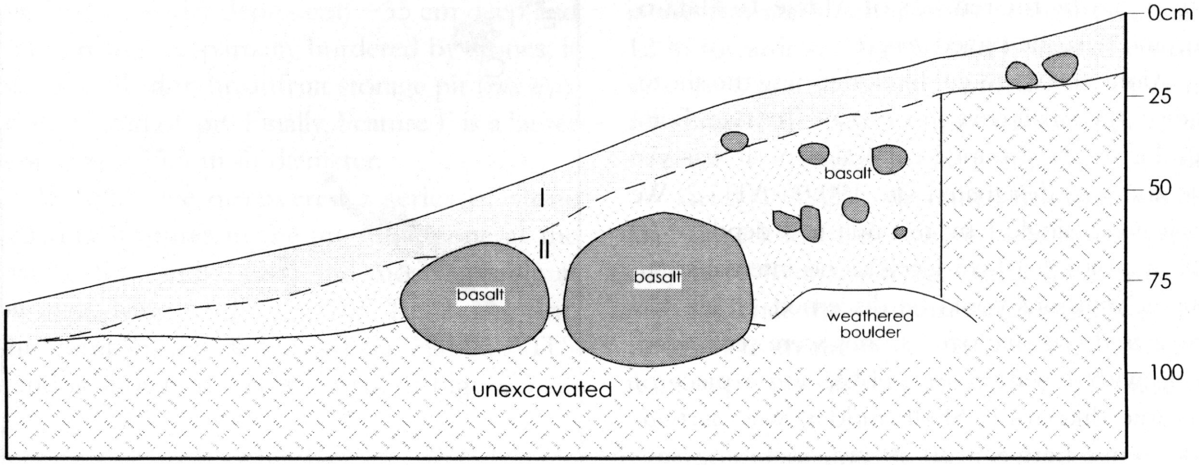


FIGURE 3.20 Stratigraphic section of the T-1 trench at the ATU-1A *paepae* site.

Unfortunately, no charcoal was observed, making it impossible to date the *paepae* fill deposit.

The ATU-1A *paepae* site may correspond with early 19th-century descriptions of a solar observatory in the Atituiti area (Laval 1938). According to the missionary sources, the Mangarevan priests observed the solstice rising and settings from Atituiti in order to make predictions concerning the breadfruit harvest. Computer retrodiction (for A.D. 1834) of the solstice setting azimuth from the position of the *paepae* confirm that this would have corresponded with a point on Agakauitai Island (Te Ana Tetea), as described by Laval (1938). Given that the platform, situated on the edge of the Atituiti Ruga plateau with a superb view over the lagoon, would have been the best locality to observe this solar solstice setting, and given that the facings of the *paepae* are oriented precisely to cardinal directions, we believe it is likely that the platform is either the observatory itself, or part of a former complex of structures which included the observatory referred to by the missionaries (Kirch, in press). Hiroa (1938a) remarks that the Mangarevans were unique in Eastern Polynesia for having developed this knowledge of solar observation, and for regulating their lunar calendar according to solar rather than pleiadic observations. The ATU-1A *paepae* is clearly a unique site of considerable importance, worthy of further detailed investigation and of preservation and protection.

SITES AT ATITUITI RARO (190-06-ATU-2, -3, -6)

A single day was spent working at Atituiti Raro, on the coastal flat, where there are a number of surface archaeological features as well as buried cultural deposits (see Fig. 3.11). The surface features include the remains of stone-faced irrigated pondfields for taro cultivation, a slab pavement and associated coral foundations which may be the remains of Marae Te Mata-o-Tu, and a stone-paved *paepae*.

Along the wave-cut bank defining the shoreline of the small cove just east of Temiaga Point (see Fig. 3.11), a buried cultural deposit was visible and was designated site 190-06-ATU-2. We excavated a single 1 m^2 test unit to a depth of 60 cm, in arbitrary 10-cm levels as no internal stratigraphic divisions could be discerned. In all, 119 fire-altered volcanic oven stones were recovered, along with 1 waterworn pebble and a piece of volcanic dikestone. Shell midden was particularly dense between 20-30 cm, including several whole pearlshell valves. A sample of wood charcoal collected at 52 cm below surface was submitted for radiocarbon dating (Beta-174779, GAM-3), yielding three calibrated age ranges: A.D. 1650-1680, 1770-1800, and 1940-1950. The last age can be ruled out based on the absence of any modern materials; it seems likely that the deposit dates to the late pre-contact era.

To the southwest of our ATU-2 test pit, on the coastal flat just inland of Temiaga Point, we discovered a pavement and associated features (designated site 190-06-ATU-3) that may be the remains of Marae Mata-o-Tu, reported by Emory (1939:24). The thick coastal vegetation (dominated by coconut palms, *tumu'au*, and *Pandanus*), badly disturbed nature of the site, and the limited time at our disposal restricted us to a rapid observation of the site, and preparation of a rough compass-and-tape plan (Fig. 3.21). The structure which makes us think that this may be the remains of Marae Mata-o-Tu is what appears to be a badly disturbed *ahu*, shown as A in Figure 3.21. It consists of a slightly elevated, more-or-less rectangular space (~8 x 14 m), with numerous blocks of basalt and coral. The thick vegetation which covers this structure make clear observations impossible, but on the seaward and western sides of this structure

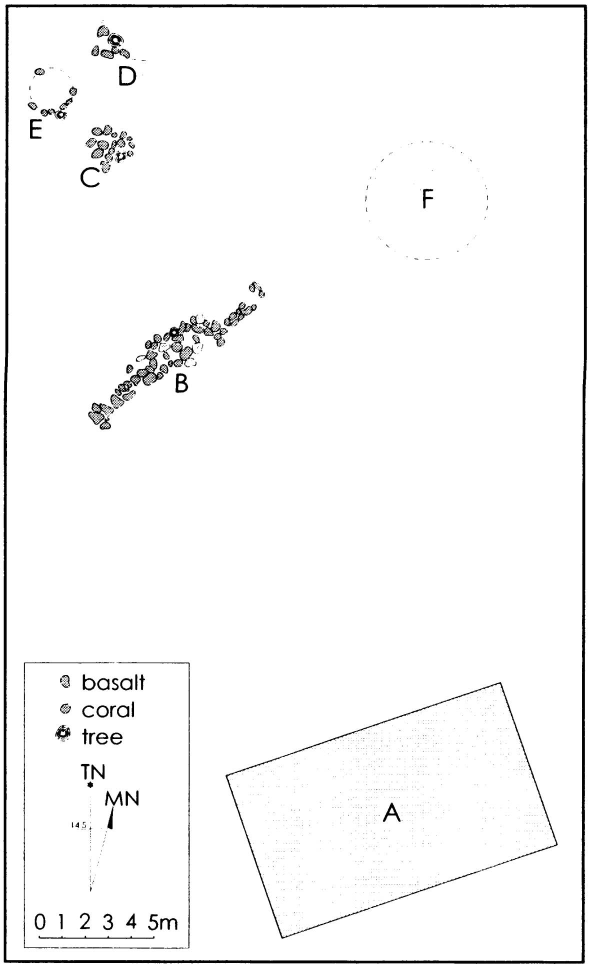


FIGURE 3.21 Plan of features at Temiaga Point, Atituiti Raro, which may be the remains of Marae Te Mata-o-Tu.

we noted basalt stones and coral slabs set on edge which may be remnant facings of the *ahu*. On the inland side of the *ahu* (and hence in the area which may have been occupied by the court of the *marae*) we noted several other features, which should eventually be studied in detail after thorough clearing and excavation. While they may be associated with the putative *ahu*, we cannot yet rule out the possibility that they could be more recent constructions (dating perhaps to the 19th century). Feature B in Figure 3.21 is a pavement 10 m long and no more than 2 m wide, consisting of basalt and coral stones, with a clearly defined edge facing Feature A (and thus possibly defining the inland edge of a *marae* court). Feature C is a small area (~2 x 2 m) of paving that does not seem to be a continuation of Feature B. Feature D is small area of pavement that appears to be a corner. Feature E is a circular depression ~35 cm deep and 2 m in diameter, partially bordered by stones; it may be a filled-in breadfruit storage pit (*rua ma*), or other kind of pit. Finally, Feature F is a larger depression ~5.5 m in diameter.

In 2003, we discovered a series of stone structural features in the intertidal zone at the base of the sandy beach and mostly visible at low tide, lying to the west of Temiaga Point. This complex was designated site 190-06-ATU-6 and is shown in a sketch plan in Figure 3.22. Most of the structures seem to consist of fish weirs, called *pa ika* in Mangarevan (see Emory 1939:17); it was impossible to determine the age of these structures. Five stone weirs (numbers 1, 3, 4, 6, and 7 on Fig. 3.22) were identified, and it is likely that others exist to the west, in badly ruined state. Between weirs 4 and 6 is a sort of stone-walled basin (number 5) divided into two parts. The weirs are funnel-shaped, becoming narrower on their seaward ends; the openings on the seaward ends are ~80 cm wide. The stone walls run up to the base of the beach, forming basins in which fish could be trapped. Aside from the weirs, but associated with them is a structure (number 2 in Fig. 3.22) both complex and badly disturbed (one of the walls of weir number 3 joins the structure). Along the beach, a 6 m long alignment of blocks defines the edge of a damaged pavement. This feature is incorporated with a larger structure running 12 m towards the lagoon and bordered on two sides by stone alignments, with a zone of stone fill about 4 m wide on the seaward side. This structure is completely submerged at high tide.

Laval (1938:257) described fish traps which, like those known elsewhere in Polynesia, typically have their wider part turned towards the ocean. Hence the structures at Atituiti Raro are reversed from the typical layout. Such weirs or traps were possibly used in the final phase of

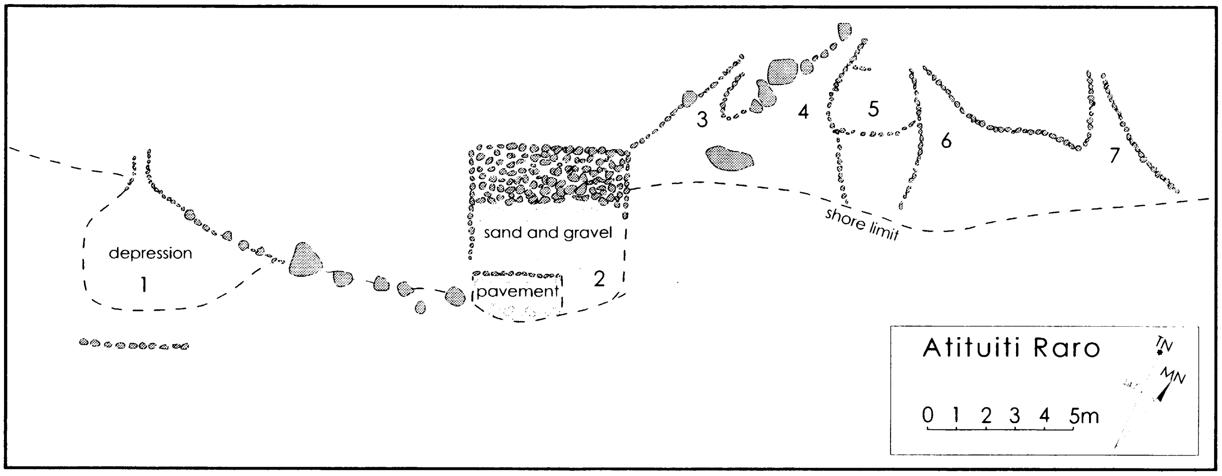


FIGURE 3.22 Plan of stone fish weirs and associated features in the intertidal zone at Atituiti Raro.

fishing with coconut leaf sweeps (*rau*), as described by Laval (1938:255-57; see Hiroa 1938a:297-98), and as existed elsewhere in Polynesia. However, Laval mentioned only the use of nets and did not specially note the presence of stone weirs. The use of the *rau* technique has continued into recent times in Mangareva (Fourmanoir et al., 1974:545). It is equally possible that along this coastline encumbered by coral heads, the Mangarevans attempted to construct a microenvironment which is typically found on atoll fringing reefs. In effect, these structures converged towards the lagoon and opened into basins resembling the natural system of channels and basins on reefs and reef platforms. As on these reefs, fish are able to enter the artificial channels at high tide, and remain in the basins where they may be captured by use of nets. This recalls a fishing method observed by Conte (1988) at Rurutu (Austral Islands), and at Napuka (Tuamotu Islands) where it is called *tuki tuki*. If this system functioned regularly, it would have been intended for a variety of species, but it is equally possible that it served intermittently for the capture of seasonal prey such as *ature* (*Selar crumenophtalmus*).

ATIAOA (ATA) VALLEY

Atiaoa is one of the main valleys on the northwestern side of Mangareva Island and has been relatively undisturbed by the earth-moving and construction activities which have modified major parts of the low-lying areas of the island in recent years.[1] A general location map of the Atiaoa and Gatavake areas is shown in Figure 3.23, including the locations of two areas mapped in detail with plane table and alidade. Four sites were designated in the Atiaoa area:

109-06-ATA-1, a small rockshelter;
109-06-ATA-2, a complex of stone structures in the valley;
109-06-ATA-3, a stone *paepae* near the coast; and,
109-06-ATA-4, an extensive midden deposit situated within the coast plain.

ATIAOA ROCKSHELTER (SITE 190-06-ATA-1)

Our main focus of work in Atiaoa was a small rockshelter (site 190-06-ATA-1) which had been noted previously by Weisler and Conte during prior reconnaissance surveys and which appeared promising for excavation. This site (GPS location 0500512E, 7443204N) lies a few meters off the main road where a large outcrop of volcanic breccia with an overhanging cliff protects an area of about 8 by 4 m. The rockshelter had recently been used as a pig pen, resulting in some disturbance to the uppermost cultural deposits; this disturbance also revealed the presence of shell midden and an ashy cultural deposit. Also, an adze fragment was found on the surface. Prior to excavation, the site was mapped with plane table and alidade, with contour intervals at 25 cm, as shown in Figure 3.24. A fixed datum point was established on the rock outcrop face at the southern end of the rockshelter, and a metric grid was laid out for horizontal control, as shown in Figure 3.25.

We excavated a single 1 m^2 test unit (grid unit F11) into the rear central part of the rockshelter floor; all sediment was fine-screened through 5 and 3 mm mesh for faunal and floral materials (Fig. 3.26). Much fine fishbone and some birdbone, along with shellfish remains, were noted during screening (see Chapter 5).

The stratigraphic profile of the north face of unit F11 is shown in Figure 3.27, and the stratigraphy was described as follows:

Layer I. Black (5 YR 2.5/1), compacted, silty-clay loam with some minor admixture of calcareous sand, much disturbed by recent pig rooting. The deposit contains shell (*Gafrarium* shell especially abundant) and bone midden, along with artifacts of historic age (glass, iron, etc.). The contact with Layer II is straight but gradational over about 5 cm.

Layer II. Very dark gray (5 YR 3/1), silty clay with about 25% calcareous sand admixture (sand grain size is fine, 0.43-.08 mm range); the deposit readily breaks into peds.

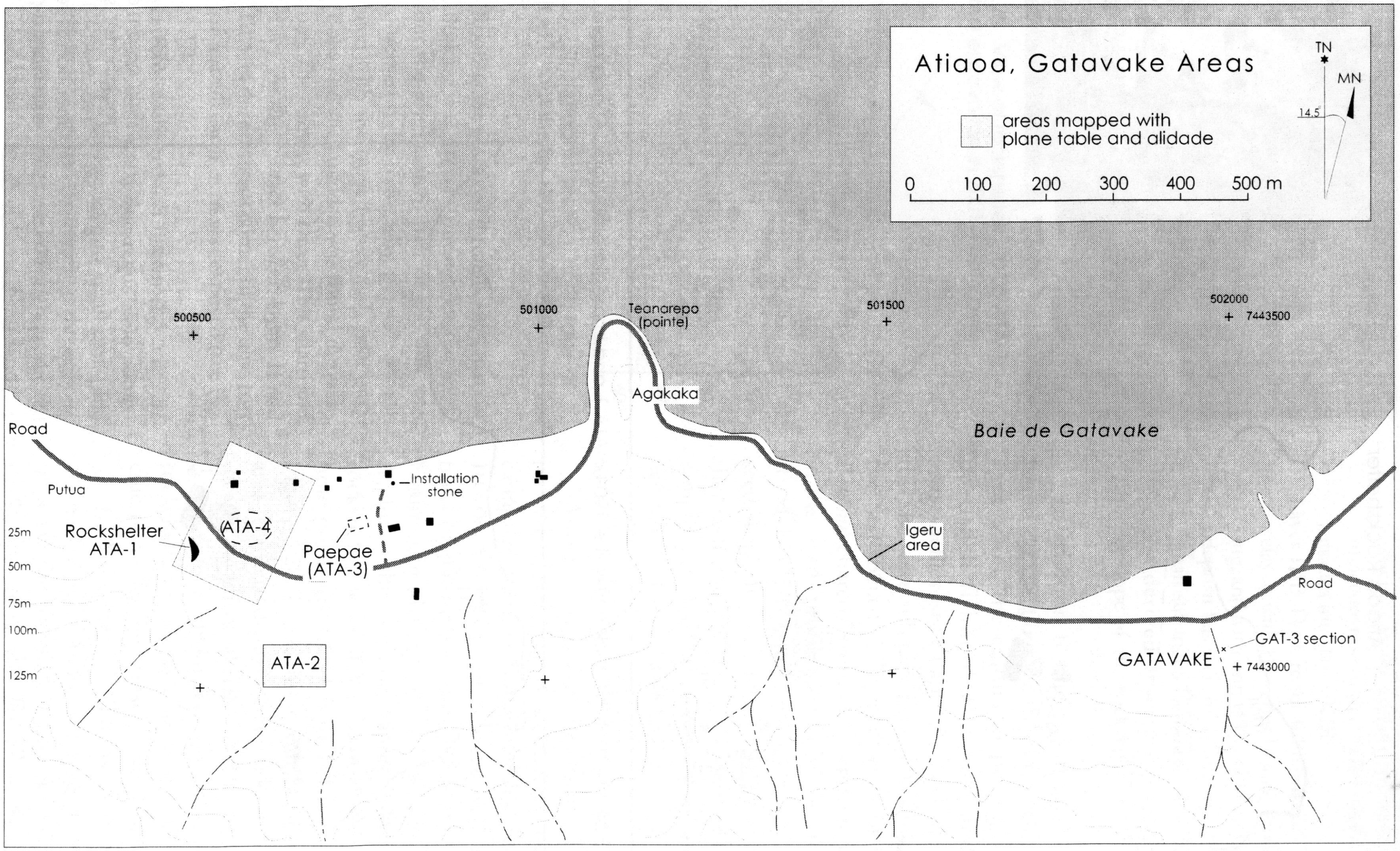


FIGURE 3.23 General map of the Atiaoa and Gatavake areas, Mangareva Island, showing site locations and mapped areas.

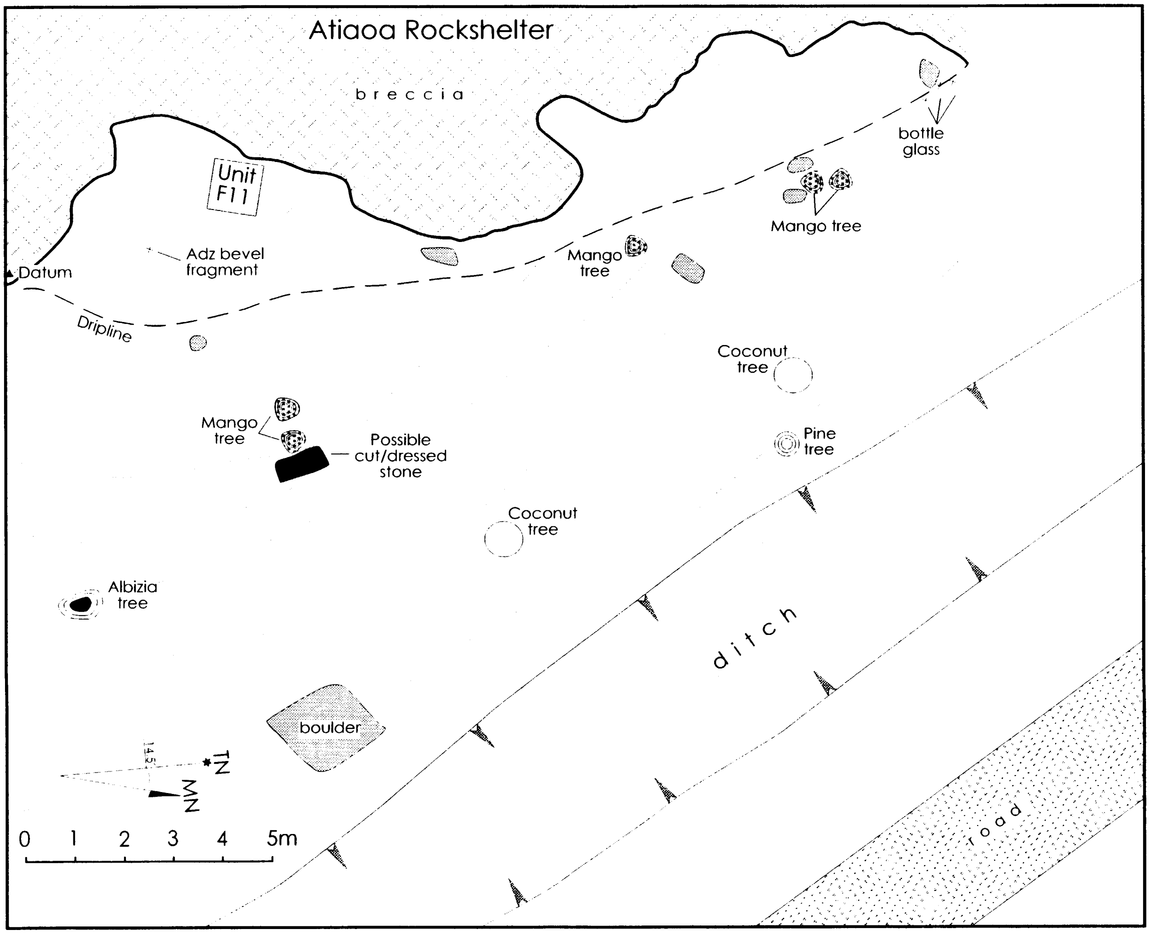


FIGURE 3.24 Plan of the rockshelter site 190-06-ATA-1 and immediate environs, Atiaoa area.

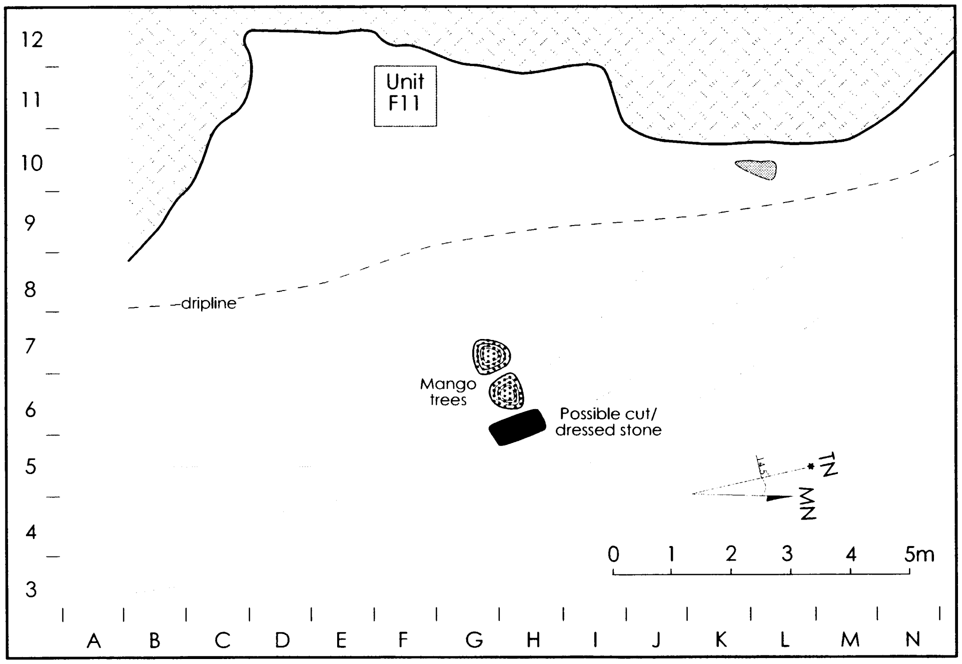


FIGURE 3.25 Grid system at the rockshelter site 190-06-ATA-1 and location of test excavation grid unit F11.

FIGURE 3.26 View of rockshelter 190-06-ATA-1 during test excavation in 2001. Photo by E. Conte.

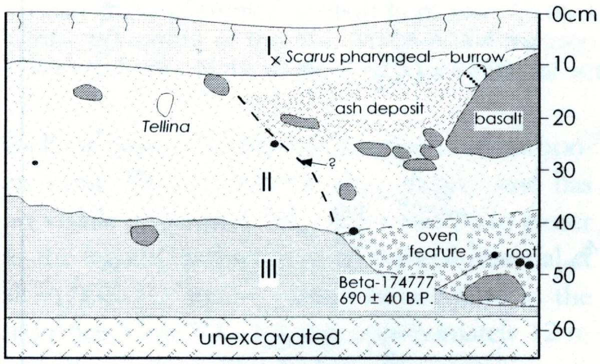


FIGURE 3.27 Stratigraphic section, north face of grid unit F11, rockshelter site 190-06-ATA-1.

Rootlets are scattered throughout. Charcoal flecking was present throughout the layer, but the northeastern part of the unit was observed to be more ashy, possibly associated with the oven feature (ash rake out). Bone and shell midden was found throughout. The contact with Layer III is sharp and wavy. At the contact between layers II and IIIA, in the northeast corner of the unit, part of a small earth oven was exposed (see Fig. 3.27).

Layer IIIA. Dark reddish brown (2.5 YR 2.5/4) clay with <5% calcareous sand admixture. The clay breaks into small peds, and there are angular volcanic clasts throughout. Charcoal was dispersed throughout the deposit, and is likely derived from land-use activities in the vicinity of the shelter prior to occupation of the shelter itself. Layer IIIA grades into layer IIIB.

Layer IIIB. Dark reddish brown (2.5 YR 2.5/4) clay as with IIIA, but lacking charcoal flecking, and with only <1% sand inclusions. The deposit has a crumbly texture, and contains small subangular volcanic clasts which may be derived from a saprolithic source upslope of the rockshelter.

In addition to the basalt adze fragment found on the floor of the rockshelter prior to excavation, the cultural deposit yielded one pearlshell fishhook fragment and several *Acropora* files (see Chapter 7). Two samples from this site were submitted for radiocarbon dating, the first (Beta-174777) consisting of wood (cf. *Bauhine*) charcoal from the oven feature exposed in the north profile (see Fig. 3.24), the second (Beta-174778) consisting of an unidentified seed from the top of Layer IIIA. The latter of these samples yielded a modern age, but the sample from the earth oven yielded a calibrated age range of A.D. 1280-1300.

SITE 190-06-ATA-4 COASTAL MIDDEN

Across the road (seaward) from the rockshelter, we carried out transect corings, locating an extensive buried midden deposit (site 109-06-ATA-4) in the coastal flat. The locations of the transect core holes are shown on Figure 3.28 (designated T.C. 1-n and T.C. 2-n). A plot of the elevation transect taken from the rockshelter site ATA-1 through transect core hole positions T.C.-1-5 to 1-4 is provided in Figure 3.29. From this it can be seen that the area of inferred subsurface midden deposit (indicated by charcoal-rich midden deposit in the cores) extends from the slope in front of the rockshelter as far as core hole T.C. 1-1. Specific notes on the transect cores follow:

1. Atiaoa Transect 1. This is the main transect across the ATA-4 site, running from the gate opposite the rockshelter (site ATA-1) down to the lagoon shore, with core holes at about 20 m

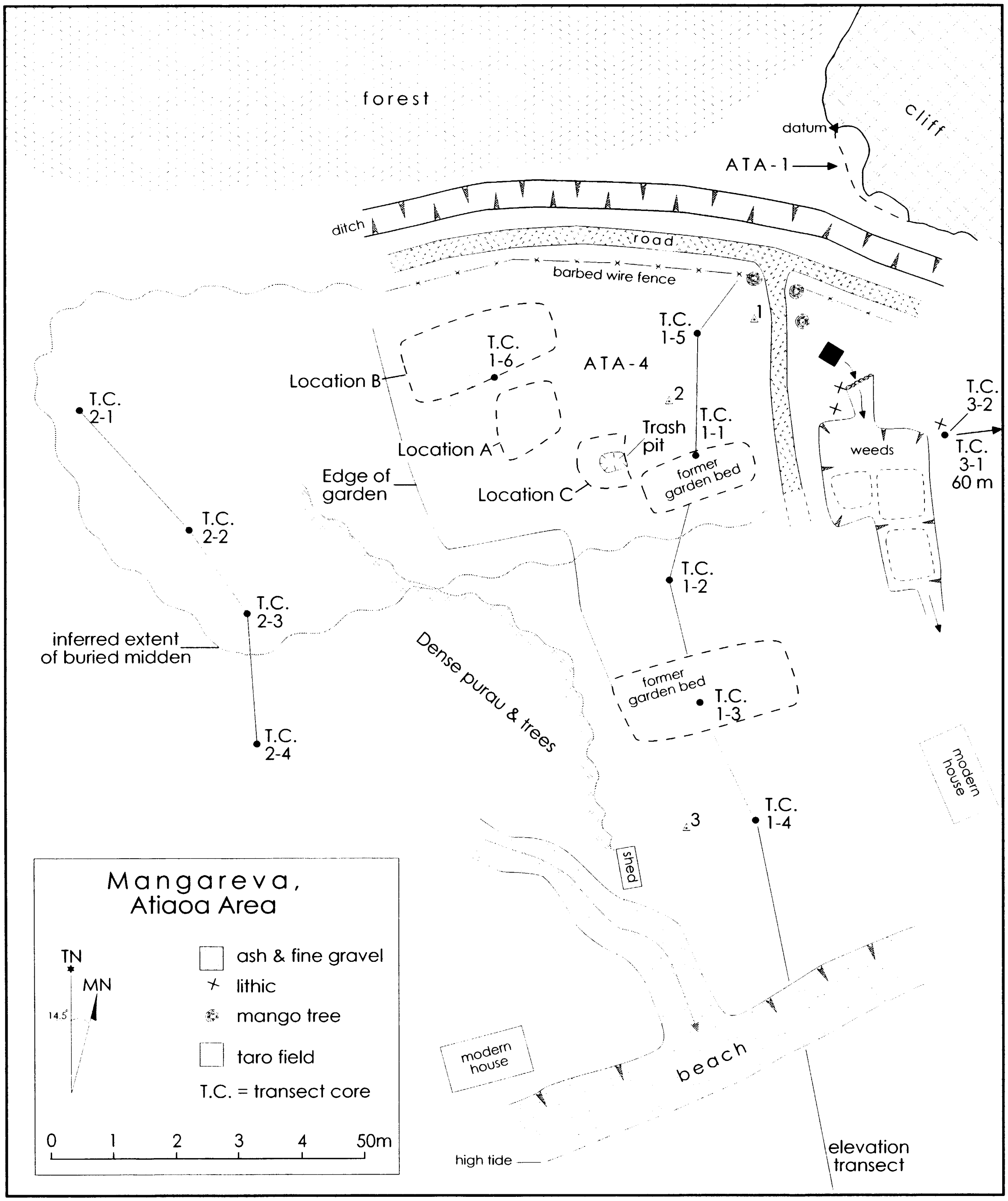


FIGURE 3.28 Plane table map of the coastal plain at Atiaoa showing the location of transect cores and inferred extent of buried midden at site 190-06-ATA-4.

intervals, and some cores offset at a right angle to the main transect. The main transect begins with T.C.-1-1 situated 32 m towards the lagoon from the edge of the road. It has a shallow and weakly developed topsoil of hill-slope materials over a calcareous sand layer, approximately 60 cm thick, varying from gray to black and containing abundant charcoal but no evident stone,

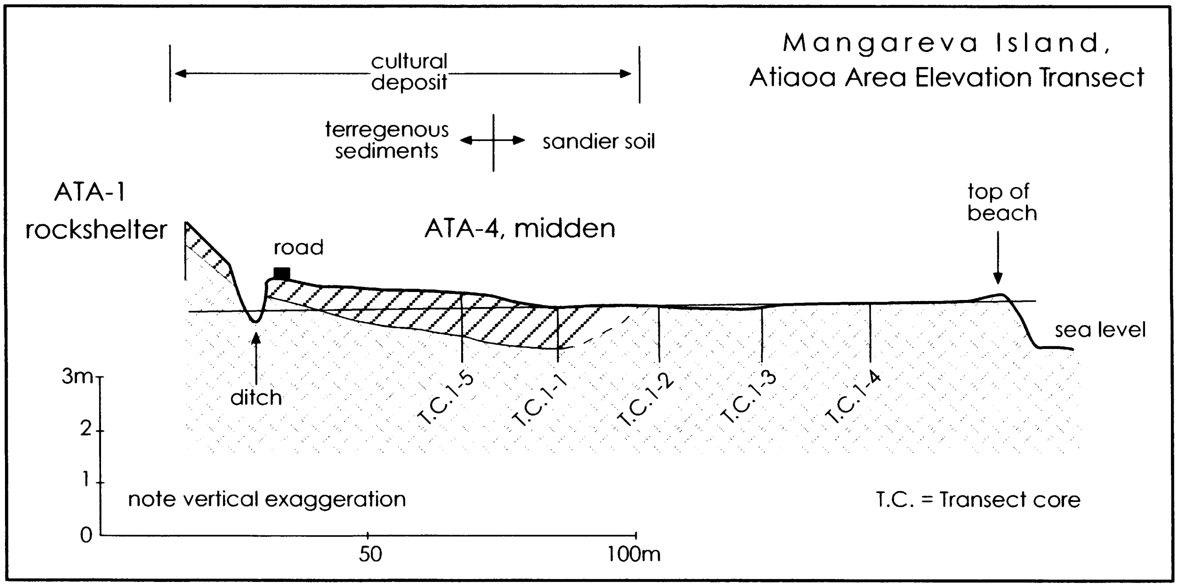


FIGURE 3.29 Elevation section from site 190-06-ATA-1 through the coastal plain, showing the inferred extent of the site 190-06-ATA-4 midden deposit. See Figure 3.28 for location of the transect line. Note vertical exaggeration of scale.

shell, or bone. This deposit overlies clean carbonate sand. The cultural deposit is thinner and has no visible charcoal in T.C.-1-2, some 20 m closer to the lagoon, and there is no cultural material at all in T.C.-1-3 and -4 further lagoonward in the sequence. Core T.C.-1-5 was approximately 12 m from the road but offset 7 m from the main transect line to avoid an area of exposed coral rock. The cultural layer was weakly apparent in this core, with some free charcoal. A further 30 m eastward on the same line at a right angle to the main transect was T.C.-1-6 which disclosed the cultural layer, including fire-altered stone and charcoal. Charcoal samples were recovered for radiocarbon dating from the base of the cultural layer in T.C.-1-1, -5, and -6.

2. *Atiaoa Transect 2.* This lies on the coastal flat, seaward of the road, and begins 110 m eastward along the road from the gate opposite the rockshelter. T.C.-2-1 had an upper sand layer which contained a small fraction of finely comminuted charcoal. Black sand and possibly fire-cracked rock occurred sparsely in T.C.-2-3. Cores -2 and -4, however, showed no clear sign of cultural material beyond a gray tinge to the upper sand layer. This transect seems to be the approximate location of one margin of the cultural deposit on the Atiaoa flat (site ATA-4).

3. *Atiaoa Transect 3.* This transect began 85 m along the road to the west of the gate opposite the rockshelter. The coastline pinches in closer to the road from this point for some distance to the west, i.e., forming the western edge of the Atiaoa coastal flat. At 20 m north (seaward of the road and equidistant from the high tide mark) core T.C.-3-1 disclosed no obvious cultural traces, just light gray-brown sand over orange-stained carbonate sand, lightening to white with depth. A further 8 m to the west the wall of a modern drainage ditch, cleaned down, displayed the same stratigraphy. Core T.C.-3-2 is about 35 m west of the gate opposite the rockshelter. It is 25 m west of the covered spring and 10 m seaward from the road on a slight rise west of the small taro swamp. The cultural layer is evident here in black sand and cracked rock with some flecks of charcoal. A large basalt adze flake was found on the surface adjacent to the core hole, and other flakes were found nearby.

In sum, the coring operations demonstrate that a subsurface cultural deposit of substantial dimensions exists within the Atiaoa coastal flat seaward of the road. The site extends, at least from core hole T.C.-3-2, an east-west distance of about 150 m, and it extends 40-60 m seaward of the road. Although the site has been disturbed by gardening, our observations and collections of surface materials indicate some areal differentiation in the distribution of material. Two samples (from core holes 5 and 6) were submitted for radiocarbon dating. The sample from core hole 5 (74 cm depth; Beta-174789) of unidentified wood returned a modern age, but the sample from core hole 6 of candlenut endocarp (60 cm depth, Beta-174790) yielded an age range of cal A.D. 1280-1300, identical to that from the nearby rockshelter. This cultural deposit would probably warrant extensive areal excavation in the future.

Surface collections in a sweet potato garden within the 190-06-ATA-4 area yielded a diversity of flaked volcanic stone, worked pearl shell, and fire-altered rock. A sample of 44 basalt flakes has been analyzed morphologically and geochemically, and results are presented in Chapter 7.

Stone Structures at Atiaoa

Also in the seaward sector of Atiaoa, we recorded the remains of an extensive pavement (called Taupapa) said to have been the former residence of the *ari'i vahine* Meriga Teipo; the pavement has GPS coordinates 500736E and 7443216N. The site was designated 109-06-ATA-3. The pavement of large basalt slabs extends about 26 by 30 m, with a few larger stones which may have been uprights. Dark soil and scattered midden were noted in the vicinity of the *paepae*, suggesting the presence of buried cultural deposits. According to local residents, a large basalt "installation stone" used during chiefly investiture ceremonies formerly stood on or near the pavement. This stone was recently moved to the house of the landowner, where it has been incorporated into the contemporary landscaping. The stone was photographed, and measures 2.4 m long, 0.85 m wide, and 0.33 m high.

A small structural complex at Atiaoa, about 100 m inland of the road, was mapped with plane table and alidade at 1:400 scale and designated site 190-06-ATA-2 (GPS coordinates of mapping station 1, 055772E 7442963N). The complex is situated at the foot of a steep hillside, on the gently sloping valley floor. The area consists of terrigenous clay sediment and was very muddy at the time of our mapping. Modern vegetation consists of mango trees with scattered older coconut palms. Some stands of *tumu'au* (*Hibiscus tiliaceus*) are located between the site complex and the road. This site complex includes a substantial *paepae* pavement and the remains of what appears to have been a small irrigated pondfield system for taro cultivation. A map of the site is shown in Figure 3.30 and the following notes pertain to individual structures indicated on the map.

Feature A. A stone-faced, earth-filled terrace about 10 x 16 m in area, with a retaining wall constructed of medium-sized boulders (40-70 cm size), one to two courses high. The top of the terrace is fairly level and dry. A low, single-course alignment lies about 15 m back of the front retaining wall. Feature A has the appearance of being a house platform.

Feature B. Between 15-50 m west of Feature A, at the foot of the hillslope, are a series of alignments and retaining wall segments that appear to be the remnants of a small terraced horticultural system (possibly irrigated taro pondfields given the proximity of the small stream). The highest and largest terrace segment has two to three courses with a facing height of 65 cm, constructed of cobbles ca. 30-80 cm in size.

Feature C. A well-constructed *paepae* some 18.5 m long by 9 m wide (estimated area ~166 m^2), defined on the north by a retaining wall one to two courses high, about 45 cm high, made of boulders 40-60 cm in diameter. The northeast corner of the *paepae* appears to have been robbed of stones. The *paepae* is well paved over the northern part with flat basalt slabs (averaging ~30 cm diameter) and may in fact be paved over the entire surface, but this is

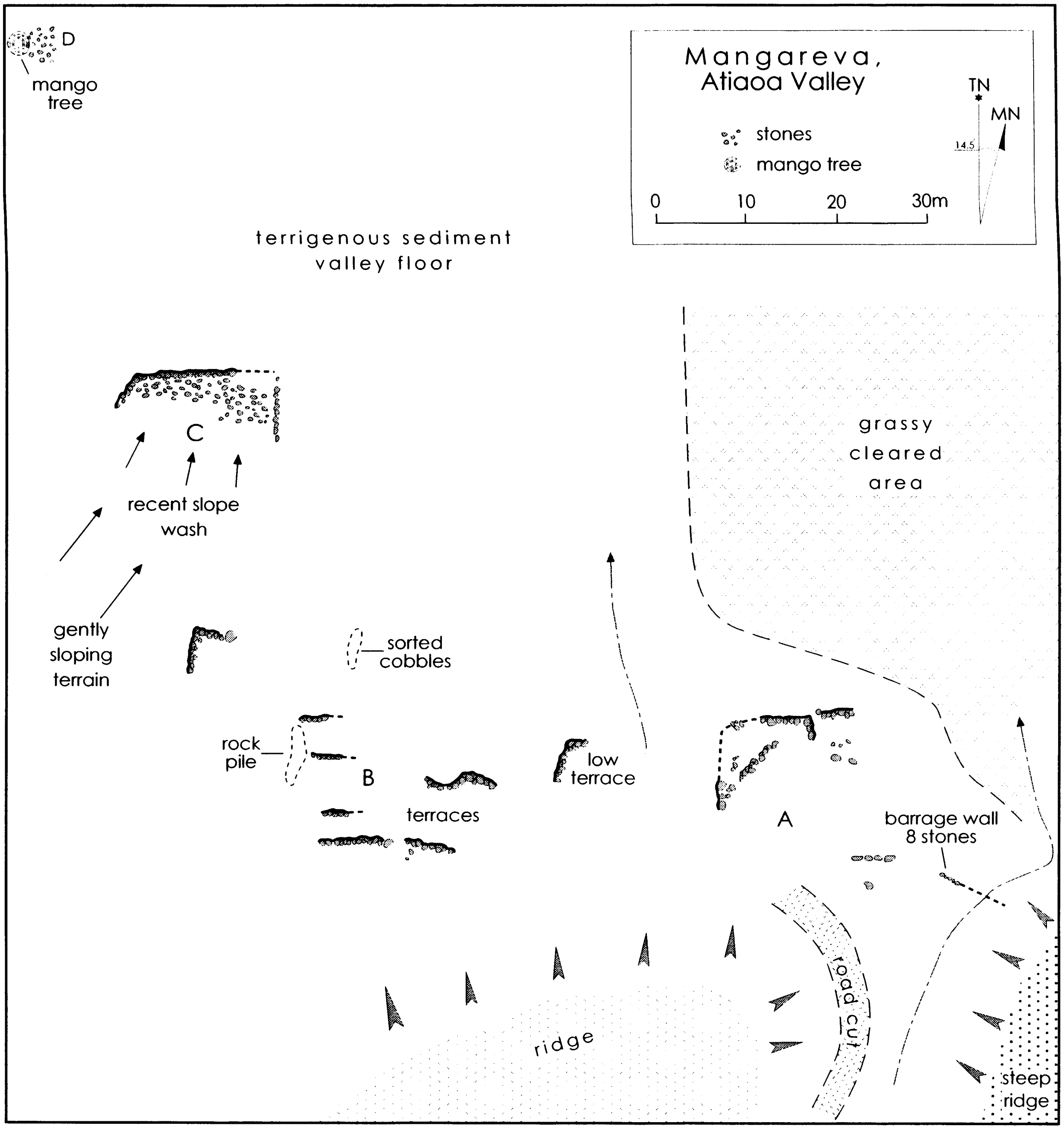


FIGURE 3.30 Plane table map of stone structures in Atiaoa Valley, comprising site 190-06-ATA-2. See text for description of Features A through D.

not certain as the southern part is covered by muddy sediment. A detailed plan of this *paepae*, made by compass and tape, is shown in Figure 3.31.

Feature D. A small pavement of basalt boulders, about 4-5 m in diameter, much disturbed by the roots of a large mango tree.

SUMMARY OF THE ATIAOA AREA

The Atiaoa Valley incorporates a number of features illustrating what may be a fairly typical Mangarevan settlement pattern. Within the coastal zone (beach ridge) there is both a *paepae* site associated with a chiefly lineage (ATA-3) and an extensive subsurface cultural deposit

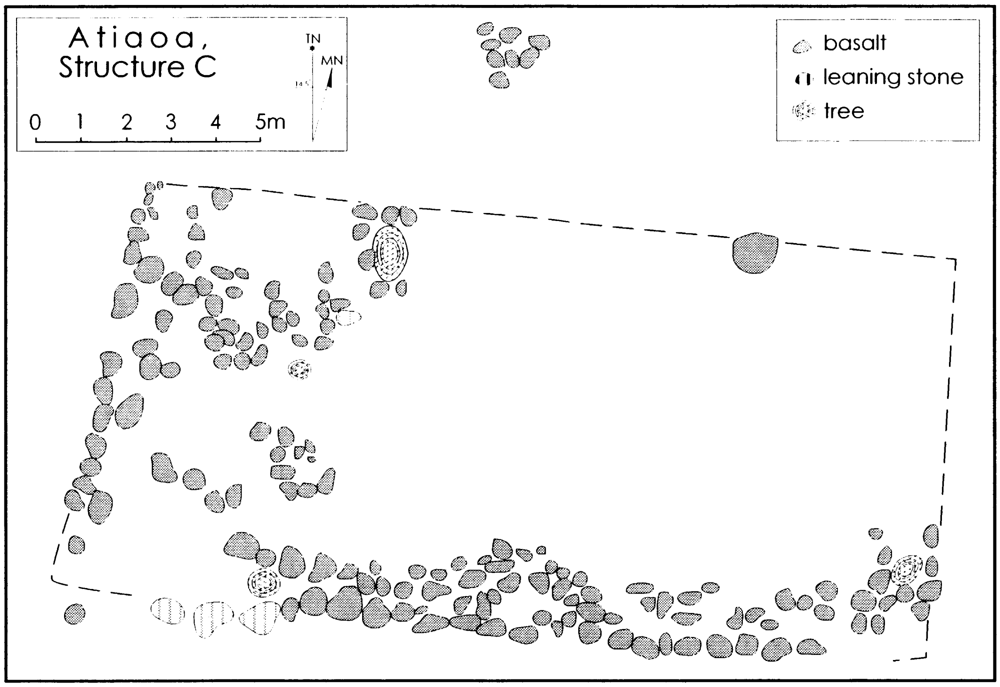


FIGURE 3.31 Plan of *paepae* Feature C at site 190-06-ATA-2.

(ATA-4), suggesting that the beach ridge has been a major focus of habitation. Inland, one finds additional residential *paepae* associated with the remains of a small irrigated taro terrace system. Radiocarbon dates from both the rockshelter (ATA-1) and the coastal midden indicate that the Atiaoa Valley has been occupied since at least the 13th century.

GATAVAKE (GAT) VALLEY

The valley of Gatavake, across the low pass from Rikitea, was formerly a major area of settlement, as indicated by oral traditions. A small, intermittent stream channel had cut to a depth of about 160 cm into terregenous sediments in the middle of the valley, exposing cultural deposits about 50 m inland of the road (Fig. 3.32). This locality had previously been noted by Weisler (1996:72) as his MAN-5 site and was redesignated site 190-06-GAT-3. The location of the stream cut is shown on Figure 3.23. We took the opportunity provided by this exposed stream cut to record the stratigraphy and collect samples for radiocarbon dating. As seen in Figure 3.33, three main strata were identifiable in the section:

Layer I, 0-80 cm. Dark yellowish brown (10 YR 3/6) deposit of silty-gravelly clay, very plastic and sticky, incorporating large basalt and coral boulders that appeared to be part of an artificial structure (possibly a platform or pavement) that had been buried by deposition of the clay layer. Within the deposit we could distinguish individual lenses of roughly-sorted gravel, suggesting that deposition had been incremental over time, probably as a result of erosion of formerly exposed slopes up-valley. A slightly developed A-horizon was also identifiable in the middle of Layer I, superposed above a distinct gravel lens; this A-horizon indicates a hiatus in the deposition of the clay deposit, possibly associated with the use of the artificial stone structure. Within the A-horizon we observed dispersed charcoal flecks, and a sample was taken for radiocarbon dating. A basalt adze section was found ~10 cm above the contact with Layer II, some 4 m from the boulder concentration. The contact with Layer II is abrupt and smooth.

Layer II, 80-120 cm. Black (10 YR 2/1) anthropogenic soil horizon which has developed on the underlying Layer III parent material.

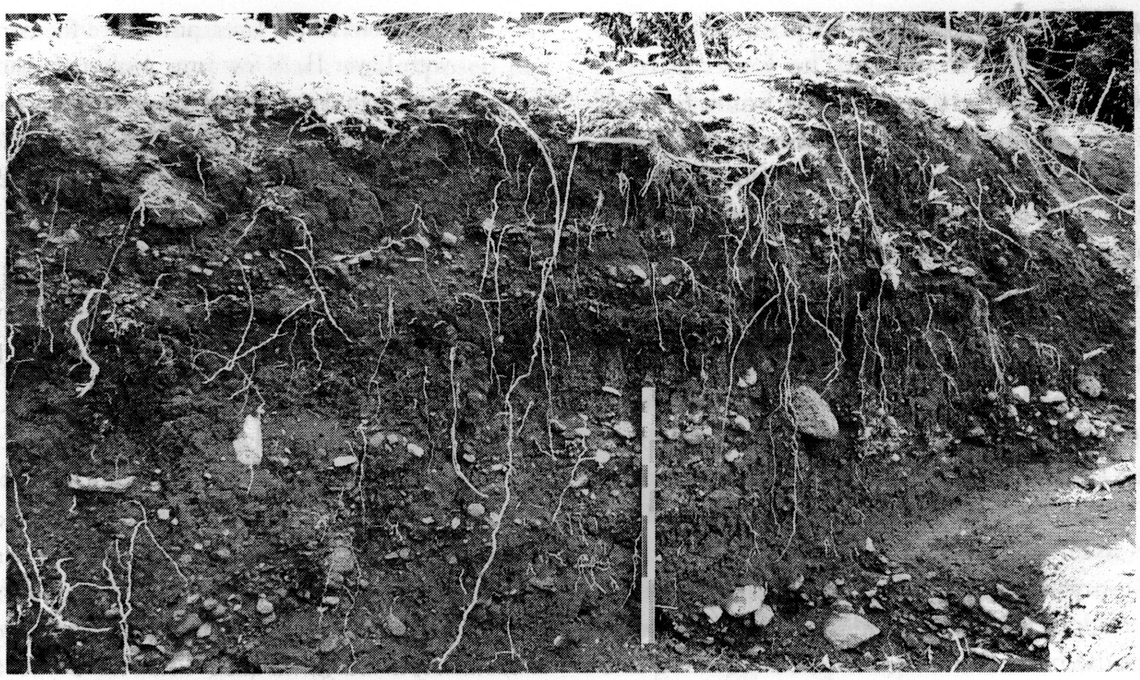


FIGURE 3.32 View of the stream cut in Gatavake Valley showing the buried cultural deposit. Photo by E. Conte.

The texture is that of a silty-clay loam with some gravel clastics; moderate structure with distinct peds and a sticky, friable consistency. The boundary with Layer III is abrupt and irregular, with visible root casts penetrating down into Layer III. There is much dispersed charcoal throughout the lower part of Layer II, and a sample was taken for radiocarbon dating.

Layer III, 120-170 cm. Dark brown (10 YR 3/3) gravelly clay, with lenses of gravel to cobble-sized clastics, and a few boulders. Structure is blocky. The deposit consists of poorly to moderately sorted alluvium. No charcoal flecking was observed, and the deposit appears to represent a pre-human alluvial surface within the valley.

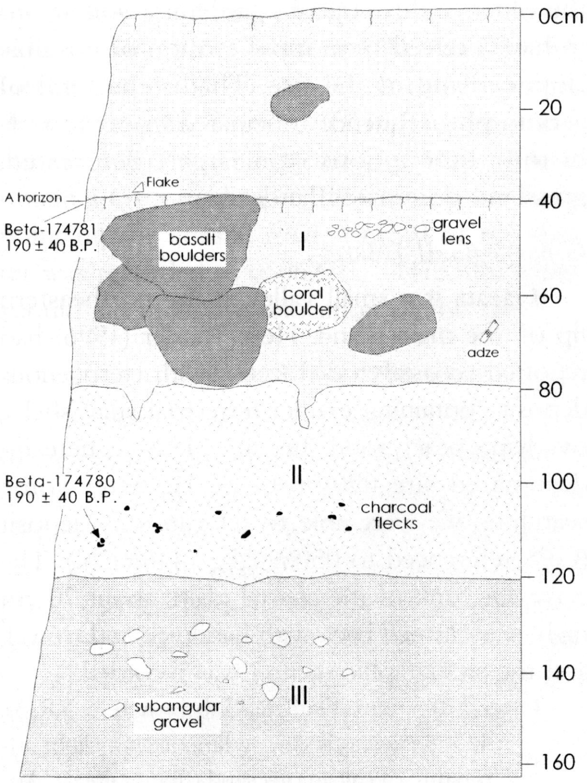


FIGURE 3.33 Generalized stratigraphic section at site 190-06-GAT-3, Gatavake Valley, Mangareva Island.

Our tentative interpretation of this stratigraphic section is as follows: Layer III represents the pre-human landscape surface. Following human settlement of the valley, Layer II developed on this alluvial surface primarily through the action of horticultural activities, including forest clearance and burning of woody vegetation, resulting in the deposition of considerable wood charcoal. The lower part of Layer I includes what is probably some form of domestic habitation (or possibly ritual) structure, constructed of basalt and coral boulders. The presence of basalt flakes and an adze section supports the interpretation of domestic activities at this locale. The change in depositional regime, to a yellowish-brown clay material, is probably correlated with vegetation changes and landscape transformation up-slope.

Charcoal samples were submitted from both Layer I (Beta-174781) and from Layer II (Beta-174780), and returned essentially identical results after calibration: A.D. 1660-1680, 1740-1810, and 1930-1950, at 1σ. The absence of any evident historic-period artifacts leads us to reject the most recent age range, suggesting that the cultural deposits here are of late prehistoric age (17-18th centuries). It is worth noting that the thick clay deposit (Layer I) which covers the older anthropogenic gardening soil seems to have derived from rapid erosion of unstable slopes inland of the site. This is the kind of geomorphic sequence anticipated from the early historic descriptions of a largely deforested, grassland dominated landscape.

GAEATA (GAE) AREA

Gaeata is a small valley at the northeastern tip of the main island. Here Weisler (1996) had reported a coastal eroded section with a terrigenous deposit containing extinct terrestrial snail shells, overlying beach sand (his site MAN-7, here redesignated site 090-06-GAE-1). After some searching we were able to relocate this deposit (GPS referenced to 0506942E, 7446802N). The wave-cut bank of the coastal plain, about 70 cm high, was cleaned back with handpick and trowel, and the stratigraphic section was recorded.

Layer I, 0-55 cm. Dark reddish brown (5 YR 3/4/3) terrigenous clay sediment with slight admixture of calcareous sand (fine-grained). Angular volcanic clasts (2-5 cm diameter) dispersed throughout. Terrestrial gastropod snail shells are found in low frequency in the lower 10-15 cm of the layer, just above the contact with Layer II. A few large pieces of charcoal were found just above this interface and collected for radiocarbon dating. The interface between layers I and II is irregular, mottled, and with what appear to be root casts descending down into Layer II.

Layer II, 55-70 cm. Red (2.5 YR 4/8) very fine-grained calcareous sand that appears to have been colored red by admixture of clay particles. At 70 cm a layer of water-rolled volcanic cobbles (5-15 cm diameter) was encountered.

A sample of terrestrial gastropod shells collected from the lower part of Layer I contained two taxa. The first consists of a species of prosobranch snails of the family Assimineidae *Omphalotropis margarita* (see Chapter 5 for further discussion). The second taxon is *Lamellidea oblonga*, a pulmonate snail known to have been widely dispersed by the Polynesians, and often found in association with gardening activities (Christensen and Kirch 1981).

A single piece of dicotyledonous wood from the base of the clay deposit was submitted for dating (Beta-174791), yielding calibrated age ranges (1σ) of A.D. 1650-1670, 1770-1800, and 1940-1950. We reject the last range on independent evidence, indicating that the burning and erosion which resulted in the deposition of the clay layer occurred sometime during late prehistory (17-18th centuries).

MISCELLANEOUS RECONNAISSANCE SURVEY ON MANGAREVA ISLAND

Several brief reconnaissance forays were also made on Mangareva Island, adding to our knowledge of various archaeological features. The Paepae o Uma platform site, previously recorded by both Emory (1939:25-26, fig. 9) and Weisler (1996:70-71) was visited twice. We were able to obtain a GPS position of 0502415E and 7442815N for the platform. It should be noted that the compass bearing shown in Weisler's plan (1996, fig. 4) is in error; the main facing of the platform bears approximately 70°E (magnetic), not due N as indicated on Weisler's sketch. We noted that dark gray to black soil exposed just below the terrace facing also contained some shell fragments, indicating the possibility of cultural deposits worth future excavation. There are other structural features in the vicinity of the *paepae*, such as low stone alignments and terrace facings, though most of these are obscured by dense *tumu'au* vegetation. The presence of these features suggests that the Paepae o Uma may be part of a more extensive, intact settlement landscape which would deserve detailed mapping and study in the future.

A brief reconnaissance was also made to the summit of Auorotini during which Kirch was able to check for the location of one of the "royal nurseries" reported by Emory (1939:23). On the ridge leading to the summit, at a GPS-determined elevation of 1,354 ft and position of 0502632E and 7442333N, there is a small plateau where the ridge widens to about 5 m (see Fig. 3.3). Four flat basalt boulders, clearly artificially placed in an alignment, could be seen where the trail passed through the dense vegetation. This is presumably the feature corresponding to Emory's site 2 as shown in his sketch plan. It would be worth clearing and reinvestigating this site in the future.

A brief reconnaissance was made in 2001 to the Gahututenohu district of Mangareva to follow up on a report of a large rockshelter with excavation potential. We were able to locate the shelter which lies at the base of a prominent cliff on the eastern side of the narrow ridge leading to Teoneai Pt. and at the top of a talus slope about 4 m above the coastal plain (GPS position 508700E, 7447650N). We estimated that the shelter has a width of about 12 m, is 6-8 m deep, and has a ceiling height ranging from 1-3 m. The shelter had a dry interior, sloping back towards the rear, with ashy gray deposit visible on the surface. We observed fragments of pearlshell (one cut piece) and *Turbo* shell on the surface. In 2003 Kirch and Conte made a second trip to re-assess the excavation potential of this site. According to Engui Guifford, who accompanied us, the old foot trail between Agakuku and Gahututenohu passed close to this shelter, which makes it probable that this is the site referred to by Emory (1939:26) as Te Ana-o-Mea-Hiti. If so, it is likely that Emory and/or his associate Garwood "excavated" the shelter's deposits with shovels in 1934; indeed, the sloping interior of the present floor looked as though it had been shoveled out to form the present "berm" at the shelter mouth.

We continued our reconnaissance in Taku around the ridgeline into Agakuku Valley, where we reconnoitered the cliff face inland of the valley for possible rockshelters. One large, airy shelter was located, with some shell midden (*Turbo*, *Pinctada*, *Tridacna*) on the surface. A concrete slab covers part of the floor, but otherwise no significant disturbance was noted. Subsequent discussions with Roger Green (pers. comm. 2003) indicate that this rockshelter is the same one designated GM-1 by him and test excavated in 1959 (Green and Weisler 2000:30). Green found that the 90-100 cm thick cultural deposit contained few artifacts. The overhanging cliffs and vegetation made it impossible to obtain a GPS reading at the shelter itself, but a point on the coastal road seaward of the shelter was recorded as 050627E, 7447330N which should aid in future relocation of the site.

AKAMARU ISLAND

Akamaru Island, lying to the southeast of Mangareva, is the third largest high island in the group, with an area of 2 km^2 and a maximum elevation of 246 m (Fig. 3.34). On the northern side of the island is an extensive coastal plain, formed by a succession of low, calcareous beach ridges. Emory describes this as the "most favorable" portion of the island and says that two *marae* were situated here (1939:31). This coastal plain was also the location of a major village in historic times, including a large church and the residence of Père Laval. The village is abandoned today, but there are several ruins of

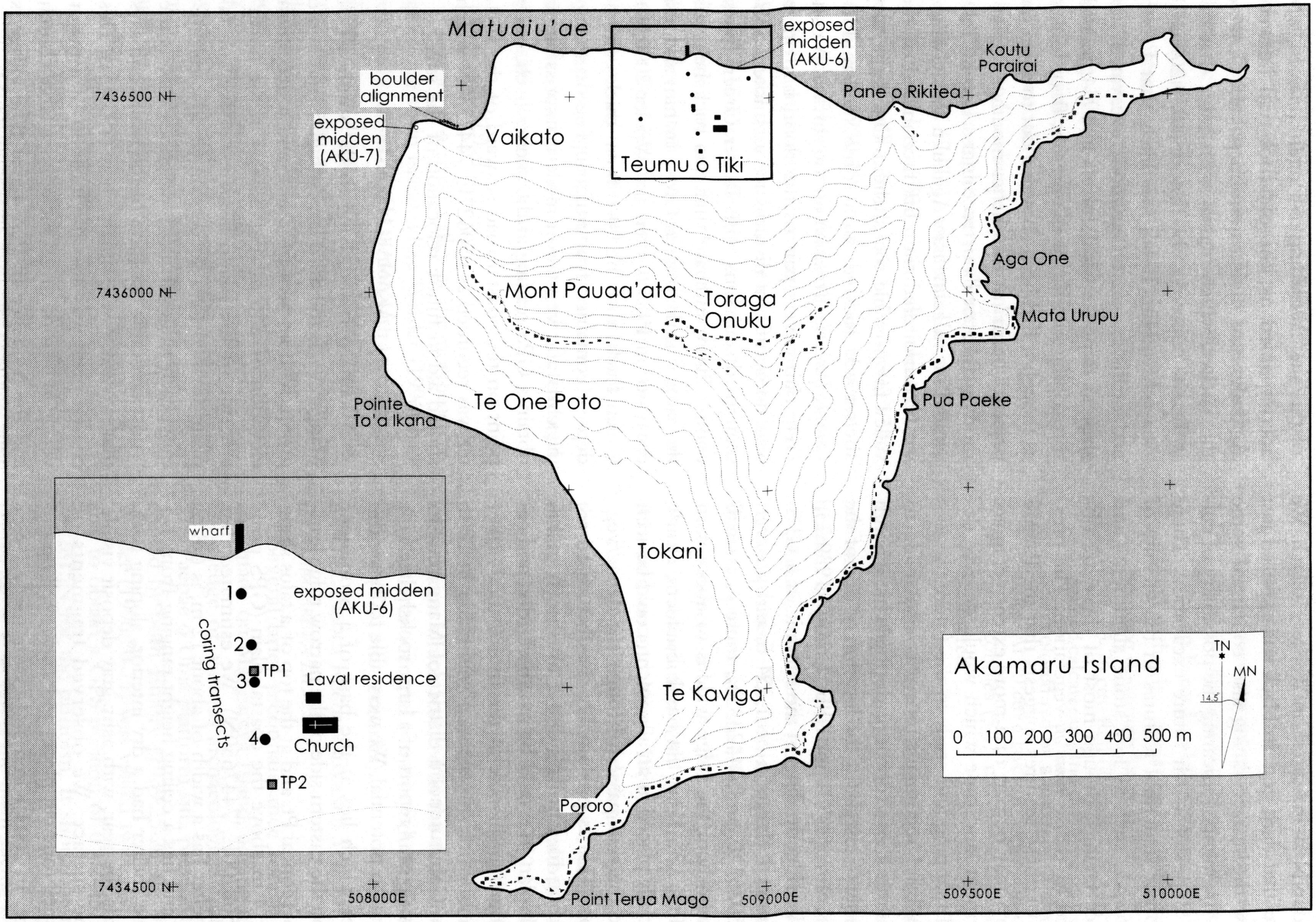


FIGURE 3.34 Map of Akamaru Island. Inset shows the location of transect cores 1-4 and the two test pits.

19th century houses built of cut-and-dressed coral slabs (Fig. 3.35), lying in the bush to either side of an elevated roadway running west from the church. This historic village site has great potential for historic archaeology and culture-contact studies. On the eastern spur of the mountain overlooking the coastal village is the burial cave of the chiefs of Akamaru, named Te Ana-o-Porotutu (Emory 1939:31), which was visited and photographed by the Templeton Crocker Expedition in 1934.

The other major area of former settlement is on the southwestern part of the island, at Tokani Bay, where there is a large valley with flat alluvial coastal plain. Emory (1939:32) mentions a number of sites here and gives a sketch plan of a large paved platform. In 1959, Green mapped an extensive complex of stone structures in Tokani Valley (Green and Weisler 2000:7-10, fig. 2).

Our work on Akamaru Island was confined to two days in 2001, carrying out a reconnaissance survey to the Vaikato area on the south side, coring for buried deposits on the northern coastal flat, and excavating a 1 m^2 test pit offset along the main path leading to the church.

AKAMARU TRANSECT CORING

Coring was carried out along two transects across the extensive coastal flat situated on the northern side of the island, an area identified with the place name Vai-kato by Hiroa (1938a).[2] Much of this coastal flat consists of sand, with a slight beach ridge formation notably expressed in a low fore dune. Other parts of the coastal plain consist of hill-slope clays and basaltic debris deposited as low colluvial fans where the short, steep valleys open into the bay towards its eastern and western ends. The main sand flats are thus in the central part of the bay.

Akamaru Transect 1. This transect begins where the concrete pier stands and extends along the southwest side of the missionary-era road which strikes directly inland, approximately southward, to meet an east-west road joining the remains of missionary houses with the Akamaru Church and the Père Laval house and

FIGURE 3.35 Ruins of a 19th century house, constructed of cut-and-dressed coral blocks, on the northern coastal plain of Akamaru Island. Photo by E. Conte.

associated structures. An elevation profile along this transect is provided in Figure 3.36, which shows the inferred extent of buried cultural deposit based on the coring results. More remains of stone houses are situated in the forest still further north again. Core hole 1 was on the top of the fore dune, about 35 m inland. There was sparse cultural evidence in blackened sand down to about 60 cm, but nothing beneath for approximately 1.5 m to the water table. Core holes 2 and 3, at succeeding 50 m intervals, were very similar. Close to hole 3, a test excavation (TP-1) was undertaken to further investigate the nature of these cultural deposits, as described below. Hole 4, another 50 m on and located 7 m south of the intersection with the east-west road, encountered hill wash materials mixed with sand and some charcoal. As the coring apparatus could not readily penetrate hillslope clay and rock, we hand excavated a test unit (designated TP-2 on Fig. 3.34) approximately 50 m further south of core hole 4. Charcoal was obtained in terrigenous sediments at a depth of 120-128 cm below surface and was submitted for radiocarbon dating. Unfortunately, the material (which may have been decomposed roots) returned a "modern" age date.

Akamaru Transect 2. This transect was started about 150 m to the northeast of Transect 1, where the forest comes down to the shore. Core hole 1 is on the fore dune at 20 m from the shore and about 2.5 m above sea level. The surface layer was cultural and contained one piece of fishbone, but there were no cultural traces below this. Core hole 2 at 30 m inland has a stratigraphy exclusively of hill-slope materials, at least as far as the coring equipment could penetrate. Core holes were attempted at intervals through the forest eastward on a line which terminated about 100 m north of the church. Penetration was difficult and only hill-slope materials were encountered. An additional core was taken at 188 m southwest from the church and immediately west of the road in a gardened area near some derelict missionary-era houses. No cultural traces were observed in stratigraphy that exhibited considerable admixture of clay and sand. Southwest beyond this point, clay soils are increasingly apparent on the surface.

EXCAVATION OF TEST PIT 1

The TP-1 unit (GPS position 508813E, 7436469N) was excavated just north of core hole 3 on the N-S transect, in order to gain a better idea of the cultural deposits in this coastal plain. The pit yielded faunal materials, charcoal, and a single pearlshell fishhook in a low-den-

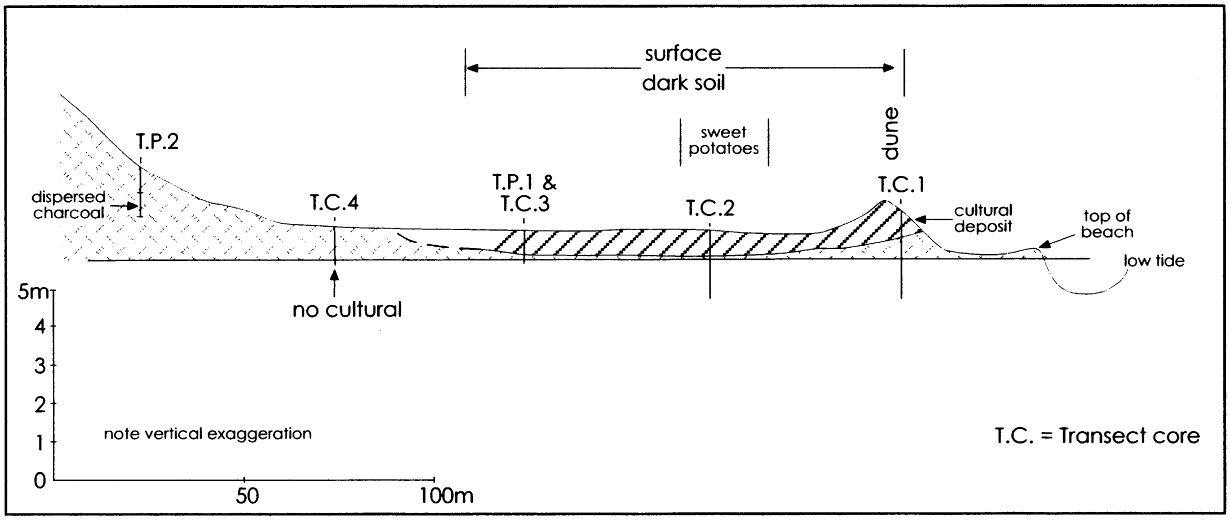


FIGURE 3.36 Elevation section through site 190-01-AKU-1, Akamaru Island, showing the inferred extent of the buried midden deposit situated in the coastal plain.

sity midden deposit, with a total depth of about 50 cm. The simple stratigraphy can be described as follows:

> Layer IA, 0-20 cm. Black (10 YR 2/1) sandy loam, fine-grained calcareous sand with charcoal admixed, coconut and other rootlets. Some historic period artifacts were present. The deposit has a loose consistency, is slightly plastic and slightly sticky, and easily excavated.
>
> Layer IB, 20-45 cm. Very dark gray (10 YR 3/1) fine-grained calcareous sand, lighter colored than IA; loose consistency, slightly plastic, slightly sticky. Toward the base of this deposit a small earth-oven feature was encountered, from which a charcoal sample was taken.
>
> Layer II, 50+ cm. Grayish brown (10 YR 5/2) loose, non-plastic, non-sticky calcareous sand, culturally sterile. Texturally, fine to coarse-grained sand, with loose $CaCO^3$ cementation occurring from 60 cm below surface. Slightly compact.

An unidentified carbonized seed from the earth oven feature in Layer IB was submitted for radiocarbon dating (Beta-174782), yielding calibrated age ranges (1σ) of A.D. 1450-1520 and 1590-1620. This date confirms the presence of occupation deposits within the northern coastal plain of Akamaru Island dating to approximately the 15-16th centuries. Much of the northern coastal flat appears to have buried cultural deposits, but it would take extensive transect testing to determine whether there are areas of midden concentration that would repay extensive areal excavation.

COASTAL MIDDEN DEPOSITS (190-01-AKU-6, -7)

On the northern side of Akamaru Island, about 100-150 m due east from the small wharf, Conte and Kirch in 2003 observed an eroding midden deposit (GPS position 508942E, 7436578N), designated site 190-01-AKU-6. The eroding wave-cut bank was 0.4-0.5 m high, exposing sandy gray-colored sediment. The lag deposit fronting the bank included much fire-cracked volcanic stone (oven stones) and large *Lambis truncata* shells with their dorsa cracked open for meat extraction. Two fragments of wave-worn 19th-century bottle glass were also observed, suggesting that the midden deposit may date to the missionary period.

While rounding the northwestern point (Vai-o-Koukaveka) of Akamaru Island in 2001, we observed another eroding coastal midden deposit (designated site 190-01-AKU-7) on a small shelf of flat land (GPS position 0508125E, 7436429N). The shell midden included *Turbo* and pearlshell, and there were a number of flakes of fine-grained basalt, as well as one file of *Acropora* coral. To the east of this midden, in the small bay, we noted an alignment or wall of large basalt boulders, within the intertidal zone.

KAMAKA ISLAND

Kamaka, with a land area of only 0.5 km^2 (maximum elevation 166 m), is one of the smaller islets in the Mangareva lagoon, and the most southerly, exposed to storm swells from the southwest. Cliff-bound on its southern side, it has a semi-protected sandy beach ("Sancho's Cove") and restricted calcareous beach ridge on the northern side. The island is privately owned and is the residence of the Reasin family.

At the base of the steep slope that rises from the coastal beach ridge are several overhanging rockshelters or niches, two of which were excavated by Green in 1959 (Green and Weisler 2000, fig. 4), yielding adzes, fishhooks, and other portable artifacts. From these deposits, Green obtained charcoal which was radiocarbon dated, with the oldest dates from sites GK-1 and GK-2 being 850 ± 60 B.P. and 890 ± 70 B.P., respectively (Green and Weisler 2000, table 2). In addition, Green excavated the structural remains of a *marae*, constructed of slabs of concreted beach rock, located in the beach ridge (designated site GK-3). Green's sites are here redesignated 190-04-KAM-1 to -3 in the new site inventory system for French Polynesia (see Appendix B).

Test Excavation at Rockshelter Site 190-04-KAM-2

Because the KAM-1 and -2 rockshelters had yielded the oldest known radiocarbon dates for the Mangareva Islands, we decided that further work on Kamaka would be warranted. In particular, we wished to obtain additional samples for AMS radiocarbon dating, to check the chronology obtained by Green, and to sample the midden deposits using fine-meshed sieves (not used by Green in 1959), particularly for possible extinct bird bones or other evidence for former environmental conditions on the island. With the permission and encouragement of Mr. Tihoni Reasin, we were able to carry out a limited re-excavation of KAM-2 (Green's GK-2) rockshelter site over a three-day period.[3] We had originally hoped to test the larger KAM-1 shelter, but due to unusually heavy rains that shelter had flooded, making excavation impossible. Shelter KAM-2, however, had a more protected floor and was relatively dry (the shelter was georeferenced by GPS to UTM coordinates 0504191E, 7429850N). We were able to discern the outlines of Green's partly back-filled square Z-1 and proceeded to dig out the backfill with a spade (Fig. 3.37). This allowed us to expose the unexcavated section of the west face of square Z-1, which could be compared with the stratigraphic section recorded by Green and presented in Green and Weisler (2000:fig. 14). Proceeding from this cleaned face, we excavated a unit 1 x 0.5 m (area of 0.5 m^2) into the shelter floor, as shown in Figure 3.38. All sediment was screened through 5 and 3 mm mesh, most of it by wet-screening in the ocean; all screen contents were bagged for later sorting in the laboratory. The sediments were rich in small faunal remains (mostly fishbone) and charcoal, including recognizable macroscopic plant parts such as the carbonized keys of *Pandanus* fruit.

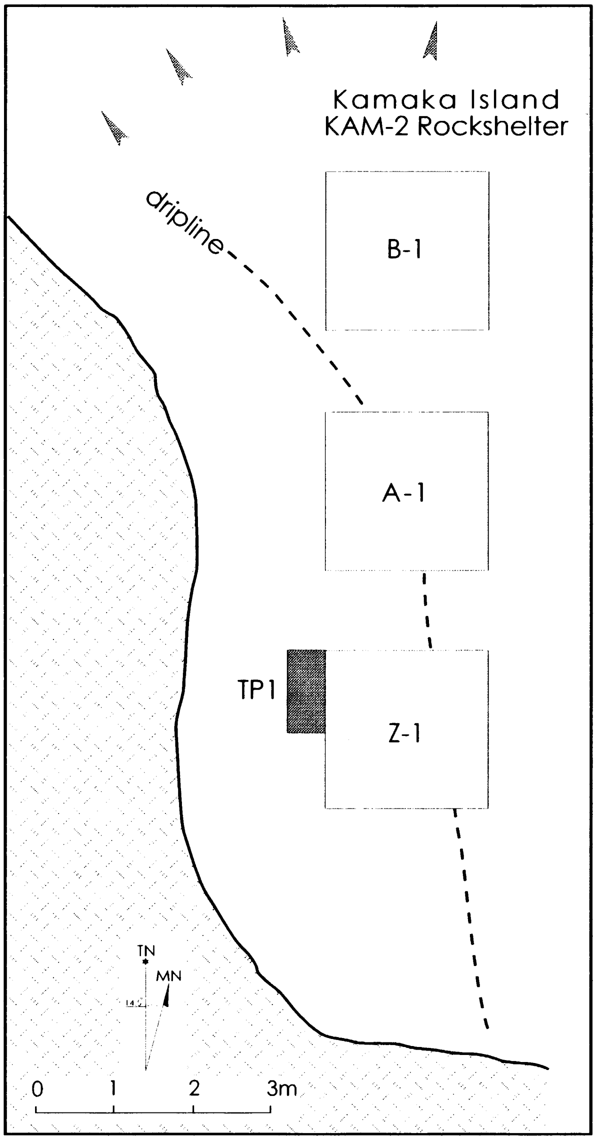


FIGURE 3.37 Plan of rockshelter site 109-04-KAM-2, showing the location of Roger Green's 1959 excavation units and the position of our 2001 test excavation unit TP-1.

The stratigraphy was complex, with five main layers and numerous finer lenses. The upper layers consisted of finely-lensed midden alternating with lenses of beach sand (Layers II and III). At the base of Layer III, part of a structure made of slabs of concreted beach rock was exposed, as shown in Figure 3.39. Two vertical slabs oriented N-S formed an alignment, with what appeared to be three horizontally positioned paving slabs to the east side of it. This structure appears to correlate with Green's "bed 4" deposit where he found a "limestone slab" (Green and Weisler 2000:21). After lifting the paving stones, a uniform gray-black midden

FIGURE 3.38 P. Kirch, foreground, excavating TP-1 at KAM-2. Kirch is standing in Green's 1959 unit Z-1, which has been cleaned out. Photo by E. Conte.

appeared, which proved to be the fill from several large, intercutting oven pits (Layer V). Because the ovens continued to the base of the unit, we were not able to sample the deepest cultural deposits exposed by Green.

The stratigraphic section of the west face of TP-1 is shown in Figure 3.40 and can be summarized as follows:

Layer I. Loose sand and vegetative matter (ironwood needles, etc.).

Layer II. Dark brown (10 YR 3/3), fairly compact, silty clay with a small admixture of coarse calcareous sand. Easy to excavate, loose when excavated.

Layer III. Alternating lenses of dark reddish brown (5 YR 3/2) and black (10 YR 2/1) deposit, some lenses having considerable admixture of calcareous beach sand. The darker lenses were rich in charcoal.

Layer IV. Large *in situ* slabs of beach rock (sandstone).

Layer V. Matrix of dark gray (5 YR 4/1) coarse, sandy midden with a great deal of charcoal flecks and pieces. Intercutting this deposit are several large earth ovens, marked at their bases by deposits of white ash and pinkish gray (5 YR 6/2) burned soil.

As Green had dated only a single sample from the base of this important site, we obtained additional samples that might indicate the time span for the entire stratigraphic sequence. Four samples were selected, beginning with a fragment of *Artocarpus* wood from Layer III (Beta-174784), followed by *Cocos* wood from Layer

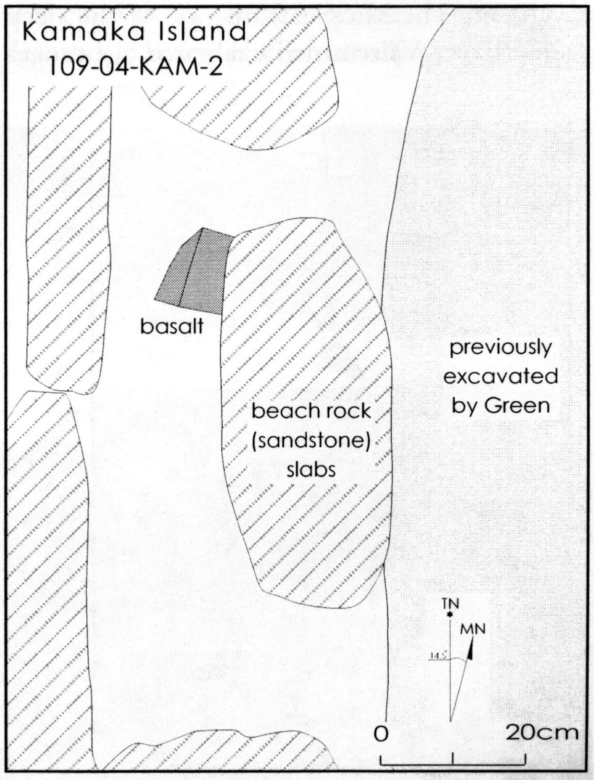


FIGURE 3.39 Plan of TP-1 in rockshelter site 109-04-KAM-2 at Layer IV showing the position of beach rock slabs.

IV (Beta-174785), *Pandanus* wood from Layer V (Beta-174786), and finally a *Pandanus* fruit ("key") from one of the deep ovens, Layer V (Beta-174787). As reported in detail in Chapter 4, the results are fairly consistent with stratigraphy. The Layer III sample has calibrated age ranges of A.D. 1650-1680, 1770-1800, and 1940-1950; the latter can be rejected on the total absence of recent historic materials from the deposits. The underlying Layer IV sample has a calibrated age range of A.D. 1640-1670. These two dates indicate that the beach rock pavement and the midden deposit which developed on top of it were deposited in a time frame encompassing the 17-18th centuries, i.e., the proto-historic period prior to European contact. The Layer V midden underlying the pavement yielded a significantly older age range of A.D. 1420-1450. This raises the possibility of a hiatus in use of the rockshelter between the Layer V midden and the construction of the Layer IV pavement. The sample from one of the deep ovens (Layer V) returned calibrated age ranges of A.D. 1450-1510 and 1600-1620. The earlier of these ranges overlaps with the range for Layer V, from which the oven pits were cut. Most likely, both the Layer V midden and the ovens date to a time period of approximately the 13-14th centuries.

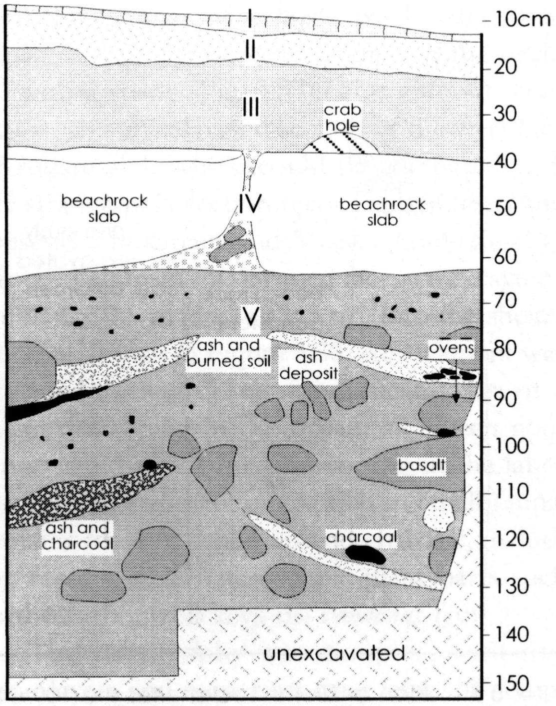


FIGURE 3.40 Stratigraphic section of the west face of TP-1 in rockshelter site 109-04-KAM-2.

As noted above, the presence of the large, inter-cutting ovens prohibited us from obtaining a good *in situ* charcoal sample from the true basal cultural deposits (Green's Layer G, see Green and Weisler 2000, fig. 14). We have no reason to doubt the validity of the date obtained by Green from this deposit, calibrated to A.D. 1025-1292, as this is reinforced by a date of almost identical age from the nearby KAM-1 rockshelter (Green and Weisler 2000, table 2). Our expanded range of radiocarbon dates from site KAM-2 would suggest the following temporal sequence: (1) initial occupation in the 11-13th centuries, followed by a possible hiatus; (2) continued occupation in the 13-14th centuries, including the use of the shelter for cooking, as evidenced by the large ovens; (3) a possible hiatus in use of the site in the 15-16th centuries; and (4) construction of a beach rock pavement and edging, and subsequent re-occupation in the 17-18th centuries.

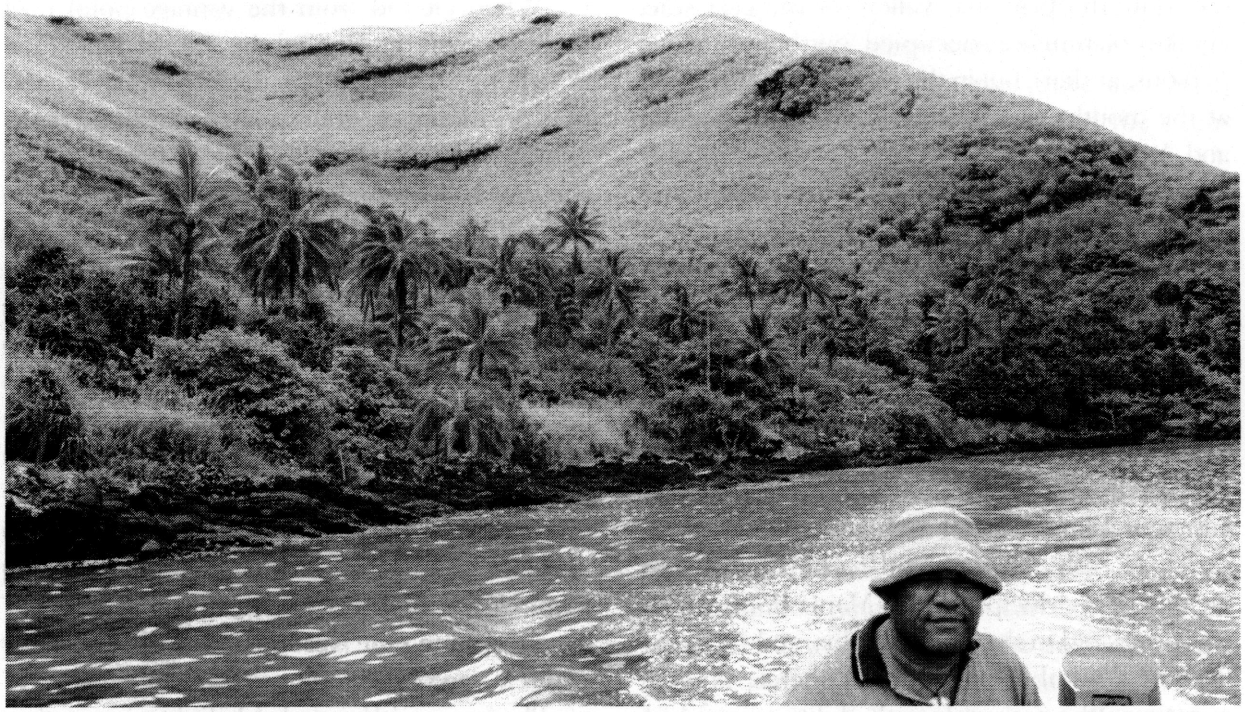
Our 2001 excavations did not yield any formal artifacts, but the rich array of faunal and floral materials should provide important data on subsistence economy and on changing environmental conditions on Kamaka Island over several centuries.

TARAVAI ISLAND

The most westerly of the volcanic islands within the Mangareva lagoon, Taravai is the second largest, with a maximum length of 5.8 km and width of 2.4 km (land area, 5.3 km^2), and maximum elevation of 256 m above sea level. It has a spine-like ridgeline of peaks and outcrops running the length of the island from northeast to southwest, from which a number of valleys descend, opening onto deep bays with calcareous sand beaches (Fig. 3.41). Today only the principal valley on the east side, Agakono, remains occupied (with only three persons, at that), but in the past villages also stood at the mouths of the large bays named Gahutu and Aganui on the west coast. Agakono probably enjoys the best combination of terrestrial and marine resources, siting in an analogous location to that of Rikitea Village on Mangareva (protected location, good water sources, rich colluvial and alluvial soils, extensive fringing reefs adjacent), and we would predict that early occupation deposits should be present here. However, as with Rikitea this village was the center for missionary activity on Taravai, with construction of a large coral limestone church and adjunct structures. The church was said to be built in the vicinity of a principal *marae* (Marae Popi) which was destroyed in the process. This, and the presence of a number of modern concrete houses, constrains the archaeologist's ability to conduct test excavations or corings; nonetheless, subsurface prospection would be worthwhile carrying out in the future.

When viewed from the vantage point of a small boat on the lagoon, the Taravai landscape is striking for the absence of arboreal vegetation on its upper slopes, all of the trees being confined to the narrow valleys and coastal plains (Fig. 3.42). The higher elevations—where they are not in vertical rock faces—are cloaked in dull brown dense thickets of *kakao* grass (*Miscanthus floridulus*), dotted here and there with scrub ironwood (*Casuarina equisetifolia*) and *Pandanus*. Taravai has had much less recent planting of exotic trees (such as *Pinus* and *Albizia*) than Mangareva, so its open and frequently fired-scarred landscape remains much like that recorded photographically by the Bishop Museum's Mangarevan Expedition in 1934 (see Kirch 1984, fig. 41). When travelling close to the shore along the west coast, we observed the arboreal vegetation to consist almost exclusively of *Pandanus*, with scattered *Thespesia populnea* (*miro*) trees in pockets where freshwater is probably close to the surface; thickets of *kakao* cane descend in many places virtually to the sea. At

FIGURE 3.41 View of Taravai Island, from the east. Photo by P.V. Kirch.



3.42. Typical vegetation of Taravai Island. The coastal strand exhibits scattered *miro* (*Thespesia populnea*), coconut (*Cocos nucifera*) palms, and *Pandanus*, with stands of *tumu'au* (*Hibiscus tiliaceus*) in the ravines. The higher slopes are covered in thick *kakao* grass (*Miscanthus floridulus*). Photo by P.V. Kirch.

the mouths of the larger bays and in their valleys, one finds coconut palms (*Cocos nucifera*), a few large *Calophyllum inophyllum* trees (an important indigenous timber resource), and some *Pandanus*, amidst dense stands of *tumu'au* (*Hibiscus tiliaceus*) that often choke the valley bottoms. (The *tumu'au*, especially, greatly impedes one's progress inland past the immediate strand.)

Previous archaeological work on Taravai has been very limited. Emory seems not to have spent as much time on Taravai as on Agakauitai, although he says he "skirted the barren south and west coasts of Taravai by canoe," landing "at all promising places along here in search of adzes and fishhooks" (1939:28). Evidently he did not find any "bluff shelters" which he regarded as of sufficient promise to "excavate." Weisler (1996:73-74), based on a rapid canoe survey, reported five sites: two coastal middens, a rockshelter, a possible dikestone quarry site, and a "major village complex."

RECONNAISSANCE SURVEY

Taking advantage of unusually calm weather, Conte and Kirch were able to reconnoiter the entire coastline of Taravai by small boat on August 14, 2003, revisiting Weisler's sites and discovering a number of others. A complete list of sites seen by us is provided in Table 3.2. While several rockshelters are present, none appeared to us to be especially promising in terms of deep stratification. Rather, the beach ridge ("dune") sites situated at the mouths of Onemea, Aganui, and Gahutu bays seem to have greater possibility for occupation deposits with good stratigraphy. For this reason, we sampled the Onemea dune site (190-12-TAR-6) with two test excavations (see below). Another promising site is the extensive coastal plain at Agakauiuta, where buried midden deposits have been exposed along the shoreline.

It should be stressed that all of the survey work on Taravai carried out to this point (by

TABLE 3.2 Archaeological sites of Taravai Island.

Site No.	GPS Easting	GPS Northing	Site Description
190-12-TAR-1	Not determined	Not determined	Cave site inland of Agakono Village, at the base of the steep slope. The cave is quite large and deep, but the floor is covered with a thick deposit of clay and rock which has washed in from up-slope, obscuring any occupation deposit which may be present.
190-12-TAR-2	0497000	7439417	Small overhang rockshelter (entrance 4-5 m wide) on the point facing Motu-a-Vari islet. Several dikes are exposed here, making this a possible source of dikestone. The shelter floor may have excavation potential.
190-12-TAR-3	0496389	7439264	Coastal plain at Agakauiuta, former village site. This is site TAR-5 of Weisler (1996:74). We examined a wave-cut bank, extending for perhaps 100 m, with midden deposit eroding out. At one point, we sketched a stratigraphic section with two distinct strata extending to 60 cm below surface; two earth oven or combustion features were partially sectioned by the wave-cut bank. Much shellfish, dikestone flakes, and fire-altered oven stones litter the beach slope in front of the bank. Here we collected part of an unfinished pearlshell fishhook, 4 *Acropora* coral files, worked pearlshell, and 7 basalt flakes (adz production debitage). Weisler reports *paepae* and a small taro irrigation system in the valley immediately inland.
190-12-TAR-4	0496129	7439222	A very small rockshelter in a rocky headland next to a protected, sandy beach. Our informant said that human bones had been seen here.
190-12-TAR-5	0493865	7439368	A large rockshelter on the island's W coast, just S of Onemea Point. The shelter has a flat floor, but it is not well protected. No surface midden was seen.
190-12-TAR-6	0494534	7439897	Onemea Bay. Site TAR-3 of Weisler (1996:73) is situated at the N end of the bay and consists of a sand dune or beach ridge with a wave-cut bank 1-2 m high. Shell midden and flaked dikestone litter the beach in front of the bank. Two test excavations were dug here (see text). The S end of Onemea Bay may also contain buried midden deposits in the sand dune there.
190-12-TAR-7	0495284	7440061	A small rockshelter on the rocky coast S of the Aganui Bay sandy beach; some surface midden noted. The shelter is close to the sea and may be washed out during high surf.
190-12-TAR-8	0495784	7440507	Aganui Bay; site TAR-2 of Weisler. Where the intermittent stream cuts through the low sandy beach ridge, some midden, charcoal, and oven stones were noted in the exposed stream cut. Weisler (1996:73) describes a "buried midden layer" some 50 cm thick, and says that there are "numerous *paepae*" on the flat inland. Immediately N of the stream mouth we observed a *paepae* facing of basalt and coral cobbles in the intertidal zone.
190-12-TAR-9	0497011	7442024	A spacious rockshelter ~30 m long with a high ceiling. There appears to be some deposit, but no surface midden was observed, except in a small niche near the W end of the shelter where there were several pieces of branch coral and a large piece of *Turbo* shell. The site was probably used as a fishermen's camp.
190-12-TAR-10	0497085	7441998	A rockshelter just W of Toku Tokuku Point, described by Weisler (1996:73) as site TAR-1.
190-12-TAR-11	0497446	7441690	Rockshelter with a sand dune flanking it. No midden observed.
190-12-TAR-12	0497457	7440936	Te Kumete o Matane. A natural rock formation on the wave-cut basalt shelf, said to resemble a bowl (*kumete*). There is an oral tradition associated with this feature.

Emory, Weisler, and ourselves) has been limited to the coastal zone; the valley interiors, in particular, remain to be investigated. Emory (1939:28) hints of the presence of *marae* and *paepae* in several locations, such as at Onemea, Agarei, and Aganui. In future work we plan to carry out intensive surveys of one or more of these valleys, in conjunction with continued excavations in the dune midden deposits.

TEST EXCAVATIONS AT THE ONEMEA SITE (190-12-TAR-6)

During our coastal reconnaissance, the midden deposit at the north end of Onemea Bay (Fig. 3.43), exposed in a wave-cut bank between 1-1.5 m high, seemed to offer the best possibility for a well-stratified cultural sequence. We thus returned to the site for two days of test excavations, completing two 1 m^2 *sondages.*

The site consists of a high beach ridge deposit made up of very fine-grained calcareous sand; the uniformly fine sediment size suggests that the dune was built up primarily through aeolian deposition. Today the beach ridge surface is covered in a mix of *tumu'au* (*Hibiscus tiliaceus*), coconut palms, and scattered *Calophyllum inophyllum* trees (one large tree is about 20 m south of our TP-2 unit). As noted, active wave erosion has cut an embankment between 1-1.5 m high along the front of the dune, exposing shell and bone midden (Fig. 3.43). About 4 m seaward of this bank there is a shelf of exposed beach rock (cemented calcareous sand) which indicates that the dune formerly extended up to 10 m seaward of its present edge. Fallen coconut trees and an exposed alignment of basalt cobbles now in the inter-tidal zone also testify to the active nature of coastal erosion. The narrow beach directly in front of the wave-cut bank consists of a kind of deflated "pavement" of volcanic cobbles (many of which appear to have been used as oven stones) and dikestone flakes, most of which is probably cultural in origin.

A transect was cut with machete and chain saw up the beach ridge slope through the coastal

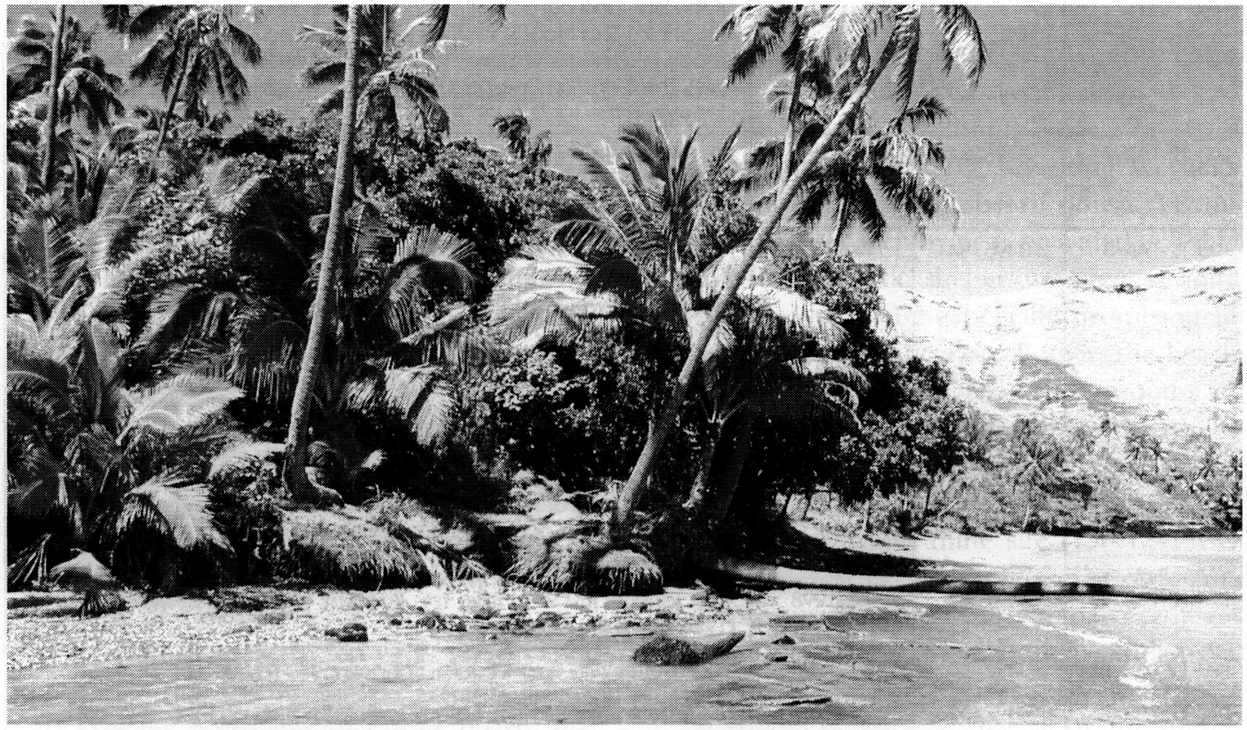


FIGURE 3.43 View of the Onemea dune site (190-12-TAR-6). Photo by E. Conte.

forest, extending from the wave-cut bank inland up to the crest of the slope, and two test excavation units were laid out, designated TP-1 and TP-2 (Fig. 3.44). TP-1 was situated 1.5 m inland of the bank, while TP-2 sits atop the dune crest some 18 m inland of TP-1. The elevation difference between TP-1 and TP-2 is 3 m. All excavated earth was screened through 5 mm mesh, and all shell, bone, and worked stone retained. Oven stones (fire-altered rock) and other manuports were counted and discarded. In the deeper deposits of TP-2, when a high frequency of bird bones appeared near the base of Layer II, we shifted from 5 to 3 mm mesh for screening to ensure full recovery of small bones.

The stratigraphy of TP-1 (north face) was described in the field as follows, with the stratigraphic section shown in Figure 3.45 (depths below surface from the NE corner):

Layer IA. 0-30 cm. Dark reddish gray (5 YR 4/2) sandy loam, comprised of very fine-grained calcareous sand mixed with organic inclusions. Many rootlets from coconuts and other plants in the upper 10-15 cm. Structureless, massive deposit. Much bone, some shell midden, and lithics (dikestone); oven stones present. The contact with Layer II is sharp but irregular; some disturbances and possible mixing.

Layer IB. 30-32 cm. A lens of light brown (5 YR 6/4) sandy loam separating the upper cultural deposit from a lower stratum (Layer II). This lens-like deposit contains some charcoal.

Layer II. 32-50 cm. Dark reddish gray (5 YR 4/2) sandy loam, virtually identical to Layer IA, but containing a number of thin ashy lenses noted during excavation, probably deriving from combustion features. Layer II varies considerably in thickness, up to 16 cm in the W part of the unit. Contact with Layer III sharp and fairly regular.

Layer III. 50-85+ cm. Reddish yellow (5 YR 7/6), very fine-grained calcareous sand. Culturally sterile except for a 2-cm thick band of charcoal and burned material (black color, 5 YR N2-3/) running across the unit ~3-4 cm below the contact with Layer II; this feature was sampled for ^{14}C dating.

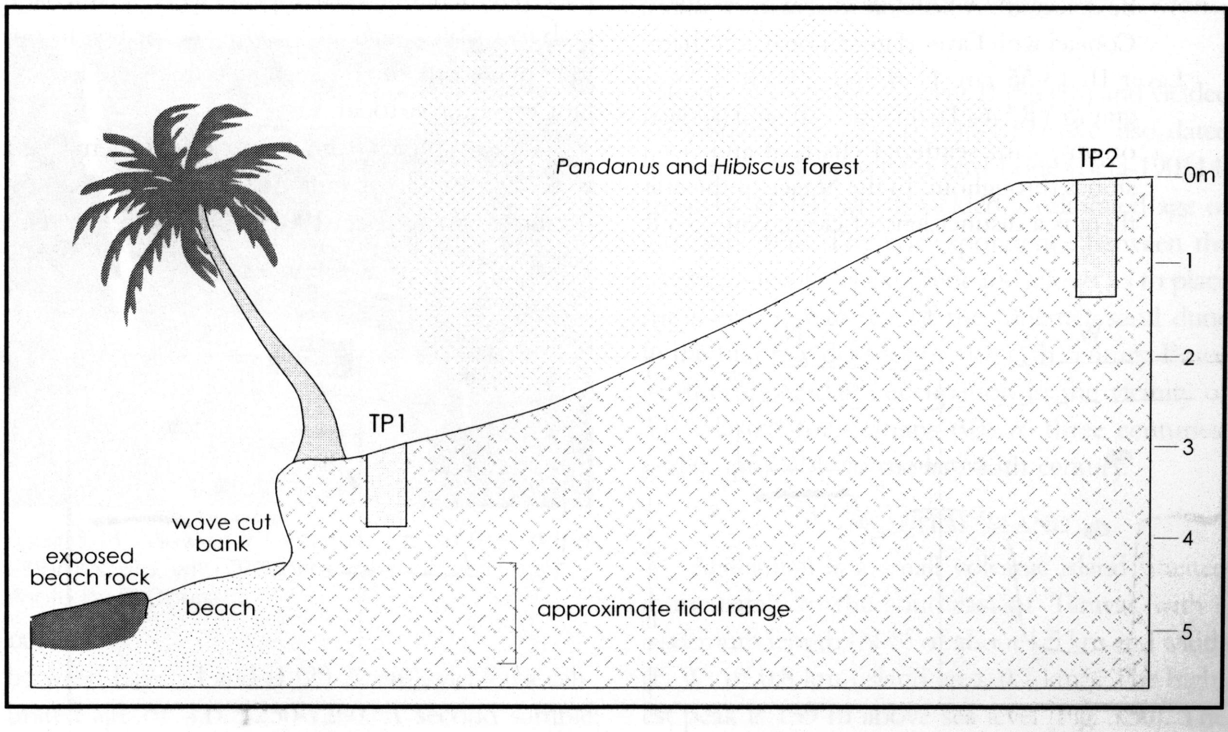


FIGURE 3.44 Elevation profile through the Onemea beach ridge showing the relative positions of TP-1 and -2.

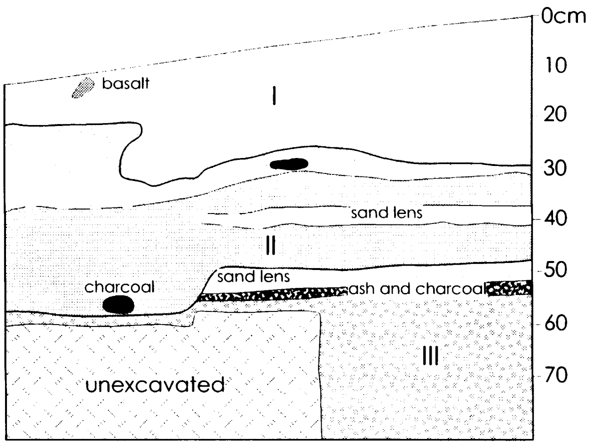


FIGURE 3.45 Stratigraphic section of the north face of TP-1 at the Onemea site.

TP-2, situated atop the dune crest some 18 m inland of TP-1, produced a slightly deeper stratigraphic sequence, as described below and shown in Figures 3.46 and 3.47 (depths below surface given from the SW corner of unit):

Layer I. 0-15 cm. Dark reddish brown (5 YR 3/2) sandy loam, consisting of very fine-grained calcareous sand with organic enrichment (no volcanic clay component could be detected). A horizon with many rootlets. Contact with Layer II gradational, not sharp.

Layer II. 15-55 cm. Dark gray (5 YR 4/1) to gray (5 YR 5-6/1), fine-grained sand (aeolian origin), with scattered charcoal and oven stones throughout. In the N face of the unit there is a distinct lens of clean, pink (5 YR 7/3) sand, truncated by a pit, designated Feature 1. The Feature 1 pit contained an entire valve of pearl shell (*Pinctada margaritifera*), as shown in Figure 3.48. Layer II is the main cultural deposit. The contact with Layer III is sharp, distinct, and clear.

Layer III. 55-175+ cm. Reddish-yellow (5 YR 7/6), very fine-grained aeolian sand. Lacking shell midden or artifacts, but containing large quantities of bird bones down to ~115 cm. This deposit was excavated to 125 cm, and shovel tested down to 175 cm.

The high frequency of bird bones, which began to appear near the base of Layer II and continued into Layer III (down to 115 cm), is of particular interest for its paleoecological implications (Fig. 3.49). While Layer III does not appear to be an in-situ occupation deposit, it does have indications of human presence, such as the presence of three volcanic manuports, several bones of the Pacific rat (*Rattus exulans*), and the shells of a terrestrial gastropod (*Allopeas gracile*) thought to have been transported by the Polynesians. Also noteworthy in Layer III are numerous pincers and carapace fragments of what appears to be a large land crab (possibly *Cardisoma carnifex*); according to our informant Simeon Tu, such land crabs are not extant on Taravai today.

Three samples from TP-2 of the Onemea site were submitted for radiocarbon dating. The uppermost sample (Beta-190119), from the interface

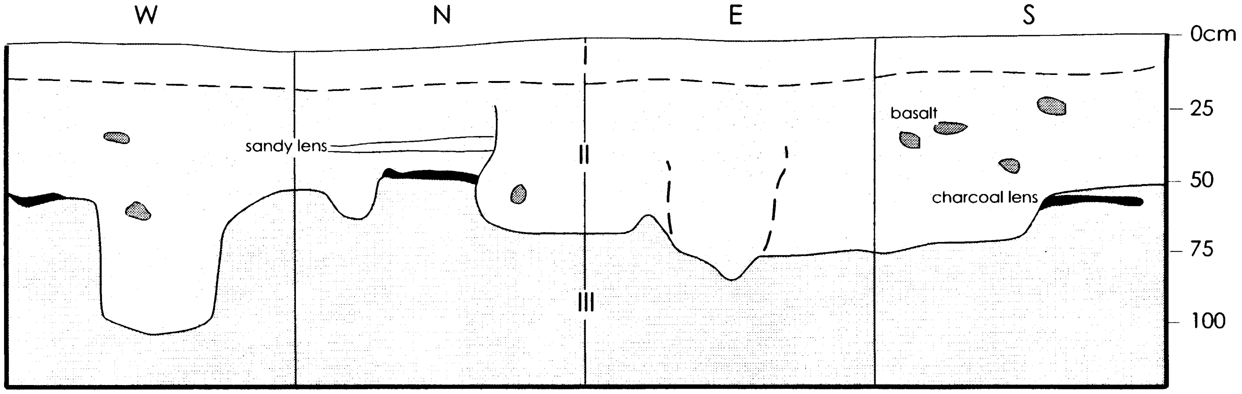


FIGURE 3.46 Stratigraphic section of TP-2 at the Onemea site.

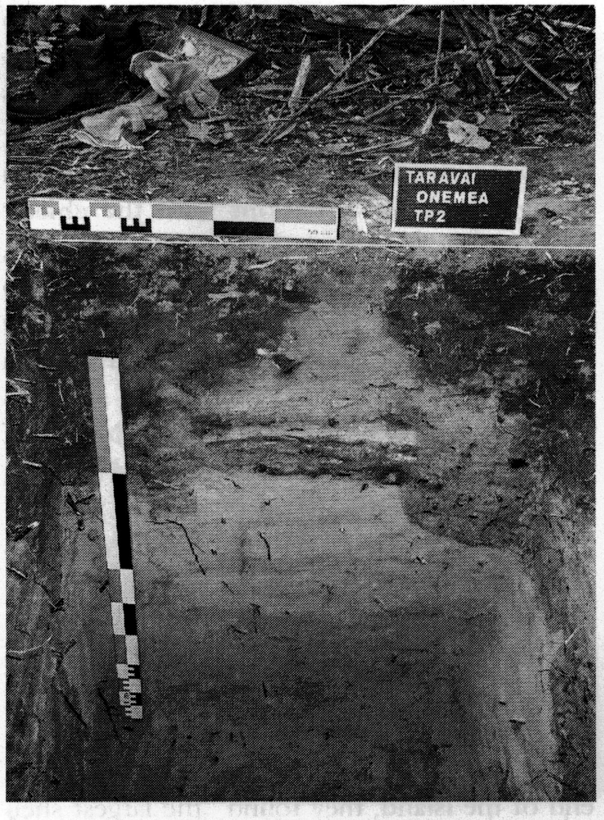


FIGURE 3.47 View of the completed TP-2 excavation at the Onemea site. Photo by E. Conte.

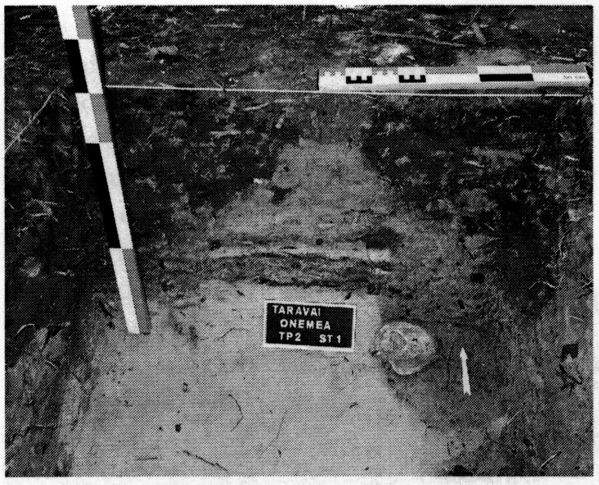


FIGURE 3.48 View of the Feature 1 pit in TP-2 at the Onemea site, with an entire valve of pearl shell. Photo by E. Conte.

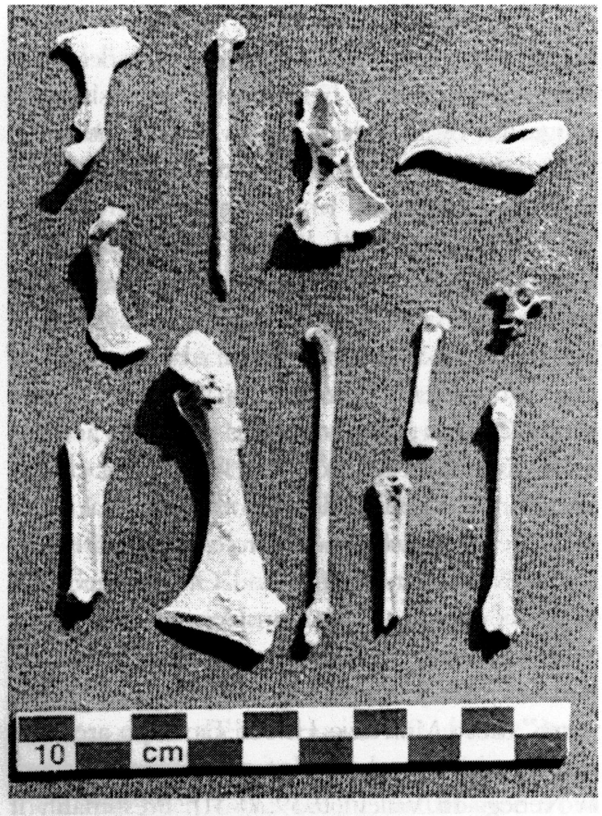


FIGURE 3.49 Sample of bird bones recovered from the base of the TP-2 excavation. Note excellent preservation of beak and bones in calcareous sandy sediment. Photo by P.V. Kirch.

between Layers I and II (20-22 cm), yielded a calibrated age of A.D. 1250-1280. A second sample (Beta-190118) was removed from a charcoal and ash lens at the base of Layer II (58 cm) and yielded a calibrated age of A.D. 945-1030. We also dated an entire, well-preserved bird bone (Beta-190114) from Layer III, which yielded a calibrated age of A.D. 945-1030. The correspondence between the last two samples is excellent and allows us to place the initial human use of the Onemea sand dune in the first few decades of the 11th century. Based on the upper date, occupation in the vicinity of TP-2 lasted for perhaps two to three centuries, ending probably in the late 13th century.

AGAKAUITAI ISLAND

Agakauitai is a small volcanic island situated immediately to the southeast of Taravai, with a maximum length (N-S) of about 1.5 km and width (E-W) of 0.8 km (island area, 0.7 km^2). The highest peak is 139 m above sea level (Fig. 3.50). The narrow strait between Taravai and Agakauitai consists of shallow reef flat, and it is possible to wade between the two islands at low tide. Indeed, the intimate connection between the two islands is suggested by the place names Agakauiuta ("Inland Agakau") which designates the coastal flat facing Agakauitai on Taravai Island, and Agakauitai ("Seaward Agakau"). The only level terrain on Agakauitai is found in two small valleys on the west side of the island, named Nenega-Iti and Nenega-Nui; the rest of the island consists of steep slopes (largely covered in *kakao* grass) and cliffs. Whereas the west coast is protected and has a long, sandy beach excellent for landing canoes at high tide, the coastline south of Kauai Point and extending along the entire east side of the island is exposed and cliff-bound. Obtaining potable water would have been a problem on Agakauitai, as there are no permanent watercourses. Emory, however, notes the presence of "a spring of fine water" called Murivai-o-Hue at Taputapu-aroa and also mentions "a number of ancient taro patches" in Nenega-Iti Valley (1939:30-31). Presumably it would have been possible to dig shallow wells to tap the Ghyben-Herzberg aquifer in the shallow valley floors near the coast in Nenega-Iti or Nenega-Nui. Otherwise, water would have to be brought to the island from nearby Taravai.

Agakauitai is closely associated in Mangarevan oral traditions with the chiefly brothers Te Akariki-tea and Te Akariki-pagu, who were raised on the island by Toa-Maikao and her husband Te Makoeko, during the rule of the usurper king Teiti-o-Tuou (Hiroa 1938a:73). The royal brothers were at times sequestered in a small cave near the N end of the island, called Rua-o-Pou (Hiroa 1938a:73; Emory 1939:30, fig. 10).

Emory devoted considerable time to Agakauitai during his 1934 expedition, camping out on the island for several days and exploring it "thoroughly" with his local expatriate guide Garwood (Emory 1939:28). In particular, Emory and Garwood sought out "bluff shelters" that might yield artifacts. Near the north end of the island, they found "the largest shelter seen on the island, called by the natives Te

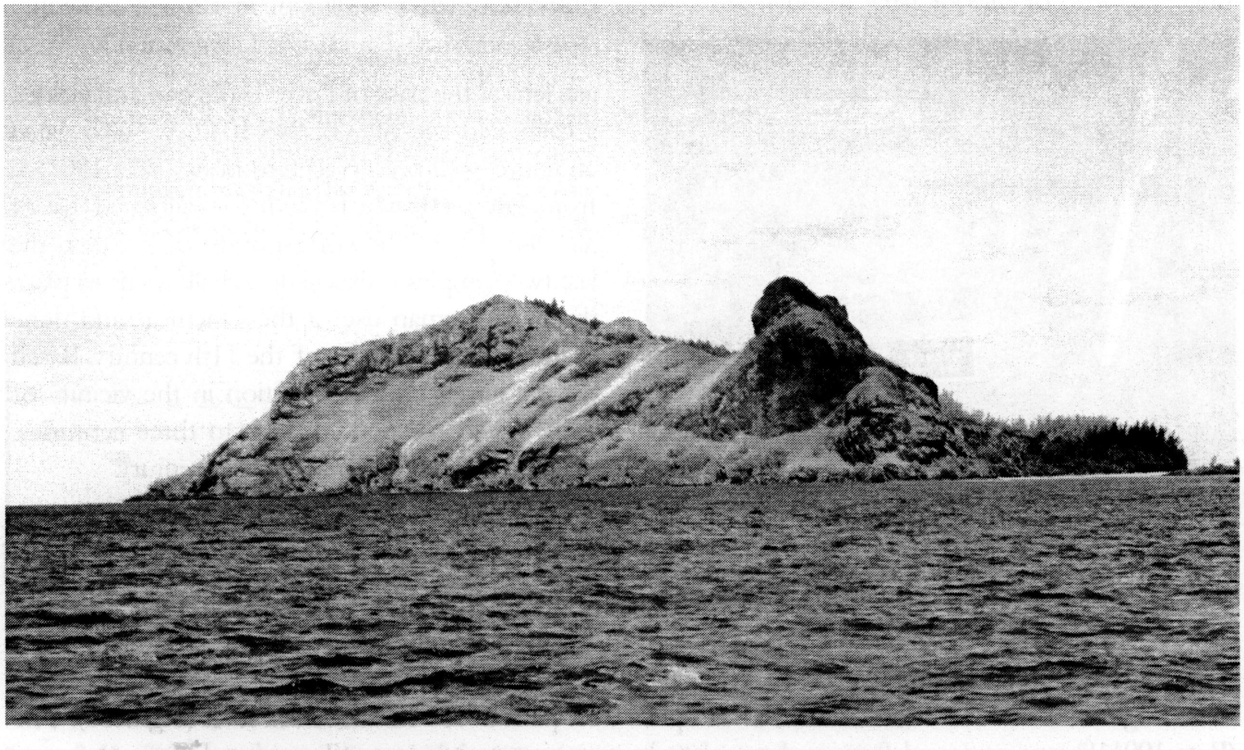


FIGURE 3.50 View of Agakauitai Island from the north. Photo by P.V. Kirch.

Ana-vehivehi," where they found a pearlshell fishhook on the floor (1939:30). This prompted Emory and Garwood to dig the entire floor deposit. We did not relocate this site, although it should be easy to find on a ledge south of the Rua-o-Pou cave; we have designated Te Ana-Vehivehi as site 190-02-AGA-12.

The only site reported by Weisler on Agakauitai is a "large rockshelter" which he designated AUG-1. No coordinates are given for this site, and it is not certain whether it corresponds to site 190-02-AGA-1, or to Emory's Te Ana-Vehivehi rockshelter. The dimensions given by Weisler are too large to correspond with 190-02-AGA-3.

RECONNAISSANCE SURVEY

On August 14, 2003 Kirch and Conte were able to reconnoiter all of Agakauitai by boat, taking advantage of fine, calm weather to search for any evident coastal rockshelters, and making reconnaissance forays into Nenega-Iti and Nenega-Nui valleys. We also attempted to relocate several of the sites reported by Emory (1939). Several sites were found, including the 190-02-AGA-3 rockshelter in Nenega-Iti Valley, which showed promise for test excavation. Returning to dig a *sondage* in this shelter, we were able to record several other surface sites in Nenega-Iti Valley, including a number of small shelters under talus boulders and what may be remains of Marae Te Aga-o-Tane. Most archaeological sites seem to be tightly clustered on the northwestern part of the island, where the small valleys of Nenega-Iti and Nenega-Nui provide the best land for cultivation and where the protected coast and the broad reef flat provides good opportunities for net fishing. In all, 12 sites have been recorded for Agakauitai, and these are enumerated in Table 3.3, with GPS positions given where these could be determined.

TEST EXCAVATION OF NENEGA-ITI ROCKSHELTER (SITE 190-02-AGA-3)

During our reconnaissance survey, this narrow rockshelter at the back of Nenega-Iti Valley appeared to offer the best prospects for an undisturbed deposit which might contain a stratified cultural sequence (Fig. 3.51). There was no evidence that Emory and Garwood had located this site in 1934 when they searched the island for "bluff shelters," several of which were crudely "excavated" with shovels. We therefore decided to excavate a 1 m^2 *sondage* (TP-1) within the protected overhang space in the northern part of the shelter floor, which was conducted over three days.

The Nenega-Iti Rockshelter is formed in a cliff of volcanic breccia which rises steeply at the back of Nenega-Iti Valley (Fig. 3.52). The area of the shelter which lies beneath the overhanging cliff has a maximum length of ~16 m, and depth of ~2-2.5 m. The rear wall of the shelter rises steeply, so that it is easy to walk around upright in most of the protected area (maximum ceiling height ~4-5 m). The interior surface of the shelter consists of an ashy, dark-gray soil with some shellfish remains visible; there had been some recent disturbance from pigs, but this was limited to the uppermost 10 cm. Three or four basalt cobbles formed a low alignment oriented north-south just within the dripline in the northern part of the site. The shelter's floor is elevated ~0.5-1 m above the valley floor immediately to the west, suggesting some accumulation of occupation deposits within the site. A fragment of a coral food pounder (*tuki*) was found on the surface ~15 m northwest of the shelter. As noted above, a number of other archaeological sites are found in the vicinity of this rockshelter, including a cluster of small overhang shelters under talus boulders to the N and a low *paepae* to the west.

Vegetation in the vicinity of the rockshelter is thoroughly anthropogenic. Immediately upslope, above the overhanging cliff, is dense *Miscanthus* grassland, while the valley floor in front of the site is dominated by young mango trees under coconut palms. Scattered about are *Pandanus* trees, *Cordyline* plants, and some *tumu'au* (*Hibiscus tiliaceus*). Trees found along the strand to the west include *Casuarina equisetifolia*,

TABLE 3.3 Archaeological sites of Agakauitai Island.

Site No.	GPS Easting	GPS Northing	Site Description
190-02-AGA-1	0496563	7438800	A narrow rockshelter at the base of a high cliff near the N end of the island, elevated ~5 m above sea level. Some shell midden on surface; also glass bottle fragments indicating historic-period use. Probably the same shelter called Te Ana-o-raveika ("Fishermen's Cave") by Emory (1939:29, fig. 10), and partly "excavated" by him in 1934. May correspond with site AUG-1 of Weisler (1996:66).
190-02-AGA-2	0496299	7438512	A small bluff shelter at the interior of Nenega-Iti Valley; no surface artifacts or midden but possible buried deposit.
190-02-AGA-3	0496472	7438630	Rockshelter in the interior of Nenega-Iti Valley at the base of the steep slope. Area under the dripline ~16 m long by 2.5 m deep. Basalt cobble alignment, flakes, and shell midden noted on the surface. Site was tested with a 1x1 m sondage (see text for description).
190-02-AGA-4	0496438	7438578	Low platform (*paepae*) with terraced facing of basalt cobbles 9 m long and 4 m wide, maximum elevation 1.5 m above surrounding ground surface. The *paepae* lies on gently sloping terrain in Nenega-Iti Valley, between the rockshelters and the coast.
190-02-AGA-5A	0496472	7438680	On the coastal plain of Nenega-Iti, a short distance N of rockshelter site 190-02-3. Several large (5-6 m diameter) talus-fall boulders form a small shelter with a low cobble wall built up across the entrance. Appears to be some deposit with shell midden on the surface.
190-02-AGA-5B	0496482	7438681	Similar to site 190-02-5A, a small shelter formed under a large talus boulder (boulder diameter 8 m); some surface midden and evident deposit.
190-02-AGA-5C	0496458	7438717	On the W (seaward) side of a large talus boulder (7-8 m diameter), a small overhang shelter about 1.5 m deep with some evident deposit, partly disturbed by pig rooting. Noted pearl shell, a large conch shell (*putara*), and *Turbo* (*maoa*) shell on the surface.
190-02-AGA-5D	0496508	7438730	Two small shelters under the seaward side of a huge talus boulder (8-10 m diameter). Shell midden (*Turbo*, patellid) and basalt flakes on the surface; ashy deposit evident.
190-02-AGA-6	0496538	7438728	A small cave site known as Te-Rua-o-Pou and said in Mangarevan tradition to be the hiding cave of Te Akariki-tea. The site was reported by Emory (1939:30). The cave entrance is at the base of a cliff, with an opening 2.5 m wide and less than 1 m high. Inside, the cave is dome-shaped, with a ceiling height of ~2 m and floor area of ~4 x 5 m. The floor is covered with reddish-brown clay which has washed in through the entrance; there may be cultural deposit buried under this in-washed clay.
190-02-AGA-7	0496527	7438741	Several large basalt slabs on the coastal plain seaward of site 190-02-6. These may be remnants of the *marae* site called Te Aga-o-Tane mentioned by Emory (1939:28).
190-02-AGA-8	0496408	7438661	A slightly elevated earthen terrace with at least one basalt slab present; probably a house foundation.
190-02-AGA-9	Not determined	Not determined	Several small, niche-like rockshelters immediately S of the rocky point separating Nenega-Iti from Nenega-Nui Valley. The shelters contain debris from recent occupation but may also have older cultural deposits.
190-02-AGA-10	0495923	7437868	Overhang rockshelter in the bluff at Kauai Point. Shelter is 3 m long and 1.5 m deep, elevated ~6 m above the rocky shoreline.
190-02-AGA-11	0496633	7438757	Te Ana Tetea. An exposed shelter formed by the dramatic cliff which rises ~40 m or more. Emory (1939:30) reports this to have been the burial place of Te Akariki-tea and Te Akariki-pagu, and was told that the Routledge Expedition visited the site in 1921.
190-02-AGA-12	Not determined	Not determined	Te Ana-Vehivehi. Excavated by Emory and Garwood in 1934 (Emory 1939:30). Not revisited by us.

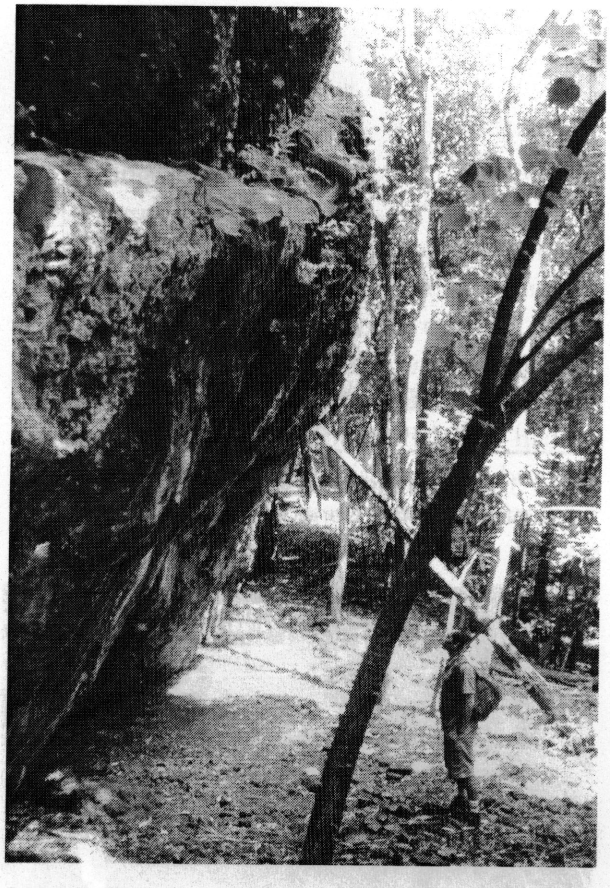


FIGURE 3.51 View of the Nenega-Iti rockshelter site (190-02-AGA-3) prior to excavation. Photo by P.V. Kirch.

Terminalia catappa, and *Calophyllum inophyllum*.

Our *sondage* (designated TP-1) was laid out between the single-course alignment of basalt cobbles and the rear wall of the shelter, in the northern part of the site. Excavation was entirely by trowel, following natural stratigraphy (Fig. 3.53). All deposit was passed through double sieves of 5 and 3 mm mesh size, and all bone, shell, charcoal, lithics, and non-carbonized candlenuts shells were retained for analysis.

Aside from some minor disturbance of the uppermost deposit due to recent rooting by pigs, the cultural deposit appears to be intact and well stratified, with three distinct cultural layers and some minor charcoal and ash lensing. The stratigraphic profile of the north face of TP-1 is shown in Figures 3.54 and 3.55, and was described in the field as follows (depth measurements below

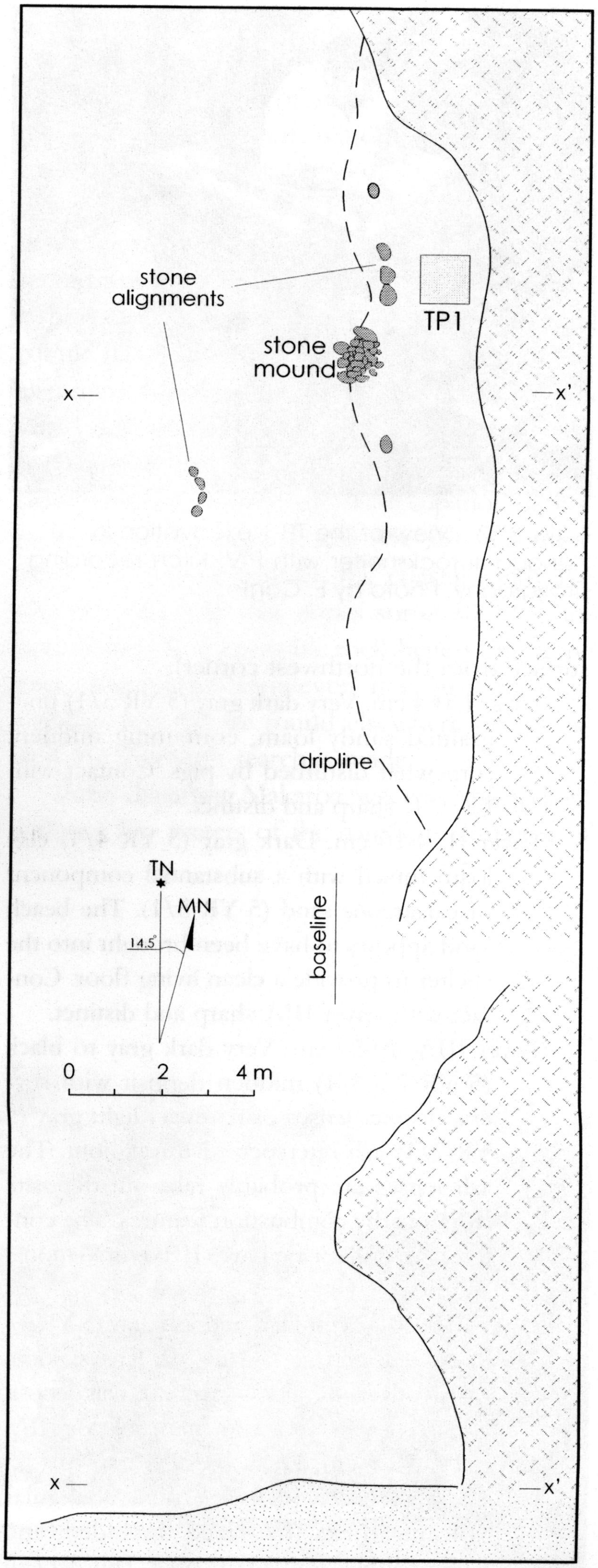


FIGURE 3.52 Plan and cross section of the Nenega-Iti rockshelter.

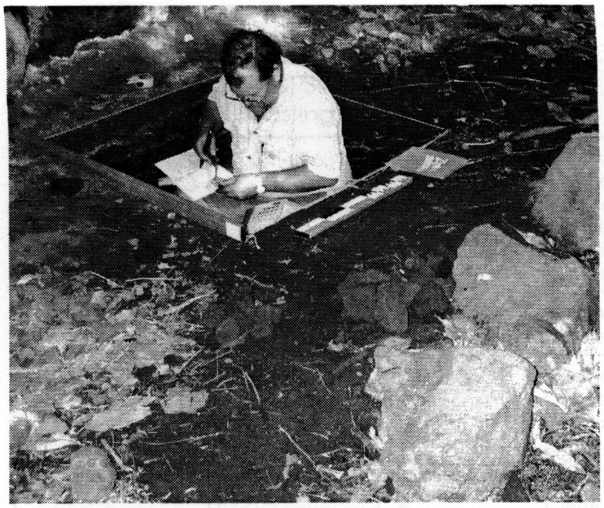


FIGURE 3.53 View of the TP-1 excavation in Nenega-Iti rockshelter with P.V. Kirch recording stratigraphy. Photo by E. Conte.

surface from the northwest corner):

Layer I. 0-4 cm. Very dark gray (5 YR 3/1) fine-grained sandy loam, containing midden; somewhat disturbed by pigs. Contact with Layer II sharp and distinct.

Layer II. 4-10 cm. Dark gray (5 YR 4/1) clay loam mixed with a substantial component of calcareous sand (5 YR 8/1). The beach sand appears to have been brought into the shelter to provide a clean living floor. Contact with Layer IIIA sharp and distinct.

Layer IIIA. 10-50 cm. Very dark gray to black (5 YR 2.5-3/1) midden deposit with several distinct lenses of compact light gray (5 YR 7/1) ash interspersed throughout. The ash lenses are probably rake-out deposits from nearby combustion features. The contact with underlying Layer IIIB is gradational and not distinct.

Layer IIIB. 50-72 cm. Dark reddish gray (5 YR 4/2) cultural deposit lacking ash lenses; some calcareous sand grains intermixed. This deposit contains a higher clay content than Layer IIIA.

Layer IV. 72+ cm. Dark reddish brown (2.5 YR 3/4) clay with numerous subangular volcanic rocks (fist-sized) included, and larger cobbles toward the base. This deposit appears to be the natural ground surface in the shelter prior to human occupation.

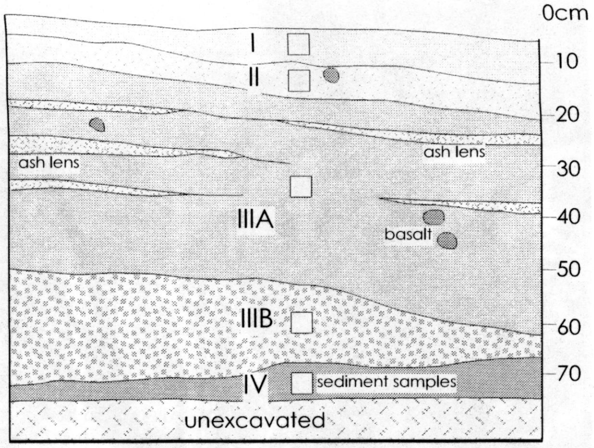


FIGURE 3.54 Stratigraphic section of the north face of TP-1 at the Nenega-Iti rockshelter.

FIGURE 3.55 View of the north face of TP-1 at the Nenega-Iti rockshelter after completion of excavations. Photo by E. Conte.

Excavation of TP-1 yielded a number of artifacts, including pearlshell fishhooks, *Acropora* coral files, worked pearlshell, and flaked dikestone lithics, as described in Chapter 7. Faunal materials recovered from the excavation are discussed in Chapter 5.

Two samples from the Nenega-Iti site were submitted for radiocarbon dating. One sample (Beta-190116) from the interface of Layers I and II yielded a calibrated age of A.D. 1430-1460. The second sample (Beta-190117), from the base of Layer III, yielded a calibrated age of A.D. 1260-1290. These dates suggest that the deposits within the Nenega-Iti rockshelter span a time period from the 13th through the 15th centuries.

MAKAROA AND MOTU TEIKU ISLANDS

During the 2001 field season, while passing Makaroa on the way to landings on Kamaka Island, we noted that the northern side of Makaroa, which is relatively sheltered from the predominant swell, seemed to have a small beach ridge which might be worthy of investigation for possible archaeological features (Fig. 3.56). On August 23, 2003 Conte and Kirch had an opportunity to land on the island for a brief reconnaissance. As there is no beach, but only an exposed shelf of beach rock, we had to make a "wet landing" and did not take any cameras or equipment ashore with us. Our reconnaissance was limited to less than one hour, while the small boat waited for us offshore. Nonetheless, our observations were sufficient to demonstrate that there are indeed archaeological features on the beach ridge at the base of the small valley on the island's northern side, which would likely repay more systematic investigation in the future.

The beach ridge—formed of unconsolidated calcareous sands—is presently exposed by a 1-3 m high wave-cut bank which shows traces of midden deposits in places. Climbing this bank and walking inland across the narrow flat (covered in dense *tumu'au* with some coconut trees), we observed a surface alignment of basalt cobbles, and a short distance to the east, a low *paepae* with coral rubble fill. A fallen coconut tree just west of the alignment had exposed a dark gray, charcoal-rich sandy midden deposit including fire-altered basalt oven stones and shellfish remains. These features clearly indicate the presence of occupation deposits in the beach ridge system. We also reconnoitered the contact between the coastal sandy flat and the steep volcanic slopes some 30-40 m inland, searching for possible rockshelters, but none were discovered. However, it is possible that rockshelters may be found elsewhere on the island if a thorough search is made.

After departing Makaroa, we were able to pass within a few meters of the southern shoreline of

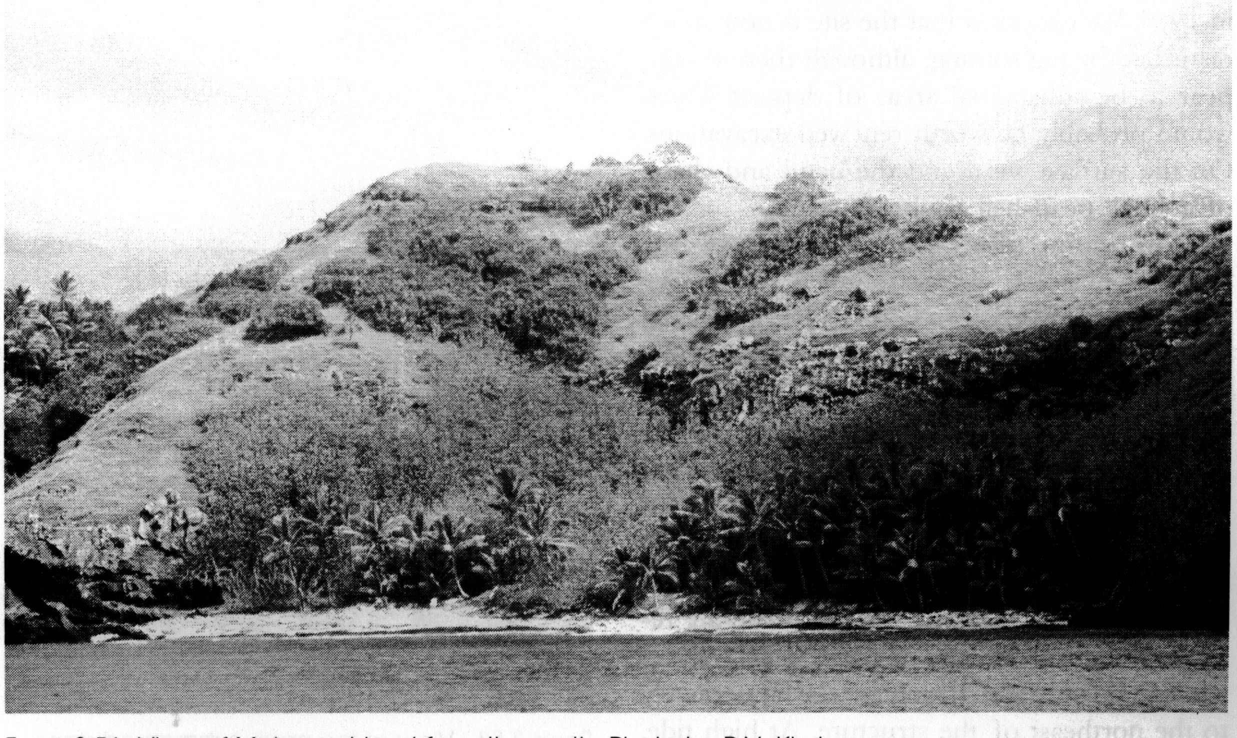


FIGURE 3.56 View of Makaroa Island from the north. Photo by P.V. Kirch.

Motu Teiku Island, a small rocky pinnacle islet to the west of Makaroa. As the island has no trees and is very exposed to storm swells, we were rather surprised to see two dense stands of *Cordyline fruticosa* plants growing in small pockets on ledges only about 7 by 3 m in area, between 15-20 m above sea level. Some narrow overhang rockshelters are situated near these *Cordyline* stands. As Eastern Polynesian *Cordyline* is a sterile plant which must be vegetatively propagated (Hinkle 2004), there can be no doubt that these stands were originally planted on the islet by humans, as a food resource (the *Cordyline* root is an excellent source of carbohydrate and sugar, the leaves are used for wrapping foods for cooking). We hope at a later date to be able to land on Motu Teiku and examine these *ti* features more thoroughly.

AUKENA ISLAND

On 18 November 2001, Conte and Kirch were able to spend a few hours carrying out a reconnaissance survey along the southern coast of Aukena Island. We first visited Te Ana Pu, the large rockshelter excavated by Roger Green in 1959. We observed that the site is now much disturbed by pig rooting, although there do appear to be substantial areas of deposit which would probably be worth renewed excavations. On the surface we found the bend and shank of a small pearlshell fishhook.

Continuing along the coastline towards Terua Kara point, we encountered a rectangular stone structure which was either constructed out on the reef flat, or more likely has become exposed due to coastal erosion (GPS position 509643E 7441323 N). A sketch plan of the structure is shown in Figure 3.57. The walls are constructed of stacked basalt boulders ca. 30-60 cm in size, stacked in 2-3 courses up to 60 cm high. The walls continue into the wave-cut bank, suggesting that more of the structure remains buried within the coastal beach terrace. A small fresh-water spring issues immediately to the northeast of the structure. At high tide, the tops of the walls are submerged (Fig. 3.58).

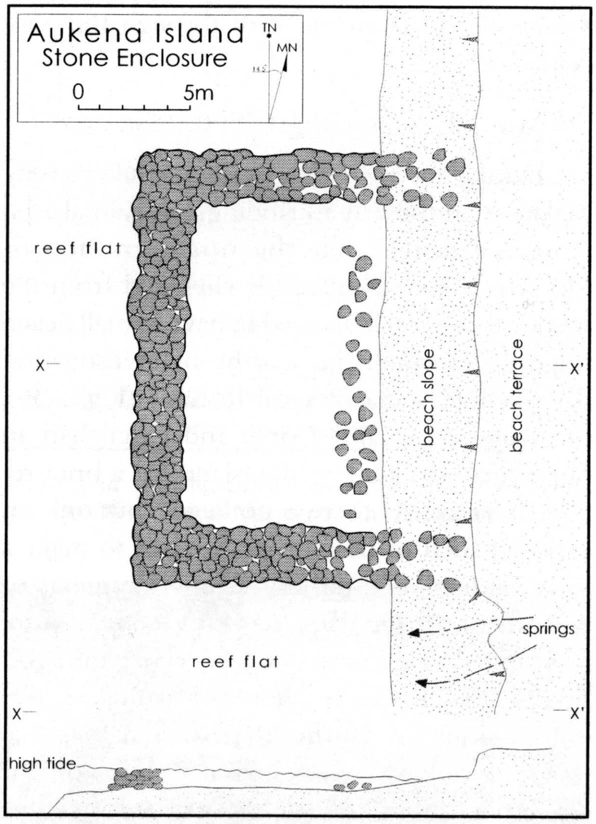


FIGURE 3.57 Sketch plan of stone enclosure along the shoreline of Aukena Island.

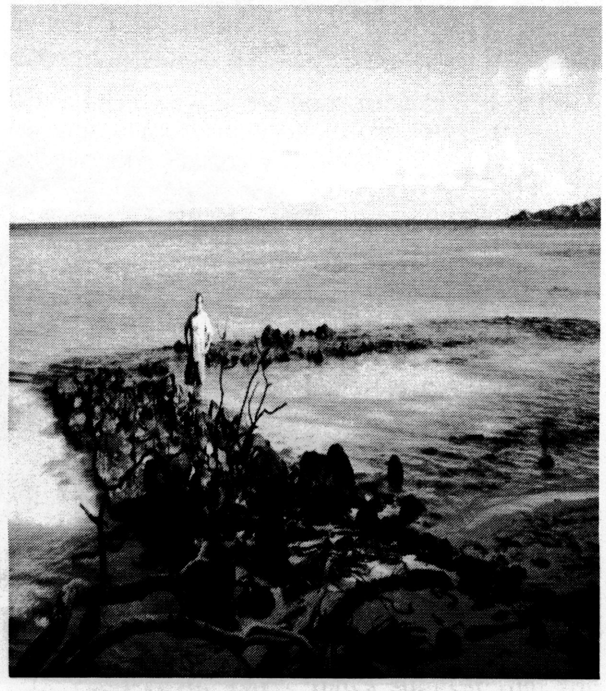


FIGURE 3.58 View of the partly submerged stone enclosure at Aukena Island. Photo by E. Conte.

CHAPTER 3 ENDNOTES

[1] We take this opportunity to note that with the arrival on the island of several pieces of large earth-moving equipment, the pace of landscape transformation has quickened remarkably, with a doubtless unintended consequence of hastening the destruction of remaining vestiges of ancient settlement. Several small valleys on the northern coast of the main island were recently bulldozed in their entirety, leaving only remnant vestiges of cultural deposits at the margins. This pace of modern landscape transformation heightens the urgency of completing an archaeological survey before important sites are irretrievably destroyed.

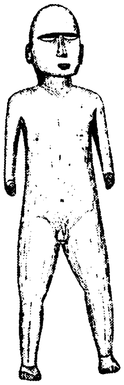
[2] In his preliminary report on coring in the Gambier Islands, Anderson (2001a:4) mistakenly reports that these transects were located at Tokani Bay. Tokani is the large bay on the southwestern side of the island, which was briefly visited by Kirch and Conte on a reconnaissance survey but which was not cored during our work on the island.

[3] Mr. Reasin, the landowner of Kamaka Island, had participated in the original 1959 excavations as a member of Green's expedition, and thus was very familiar with the specific location of the original trenches. We appreciate his willingness to share his knowledge, as well as his help in arranging transport and logistics on the island.

CHAPTER 4

RADIOCARBON DATING AND SITE CHRONOLOGY

P.V. Kirch, J. Coil, M.I. Weisler,
E. Conte, and A.J. Anderson



Prior to the commencement of our project, a prehistoric chronology for the Mangareva Islands rested upon eight radiocarbon dates, all from samples obtained during Green's 1959 excavations at four rockshelter sites on Kamaka and Aukena islands (see Chapter 1). Five of these dates came from Green's site GK-1 (redesignated KAM-1). The oldest date from this site (850 ± 50 B.P., Beta-109018) along with a single date from the base of the nearby GK-2 (KAM-2) rockshelter (880 ± 70 B.P., Beta-109019) suggest initial occupation of Kamaka Island by the early 13th century A.D. (Green and Weisler 2000).[1] As Kamaka is one of the smallest high islands in Mangareva, with limited terrestrial resources, it would not be expected to have been among the first localities colonized by early Polynesians. For this and other reasons, Green and Weisler (2000, 2002) hypothesized that the initial discovery and settlement of the Mangareva Islands probably occurred two or more centuries prior to the oldest dates from Kamaka.

As stated in Chapter 1, one of our primary objectives in the Mangareva Archaeological Project has been to obtain new empirical evidence to refine the prehistoric chronology of the Mangareva Islands, including establishing an age for initial Polynesian discovery and colonization. Within the somewhat limited financial resources available to us, we have attempted to date as many samples from good stratigraphic contexts as possible. Here we report in detail on the AMS (accelerator mass spectrometry) dating of 24 samples from five islands.

SELECTION OF RADIOCARBON SAMPLES

During fieldwork, samples for radiocarbon dating were collected directly into aluminum sample tins from features or contexts where the samples could be closely related to particular stratigraphy and associated cultural materials. A much larger number of such samples was collected than could be dated within the project budget (these have been retained for future analyses), and a selection of 24 samples was chosen for dating. In this pioneering phase of research, samples were chosen to represent as many different sites as possible to give a broad indication of the temporal framework for a Mangarevan cultural sequence. As research in Mangareva continues, it will be necessary to run multiple samples from the same contexts in order to test for chronological variability within specific sites.

Several recent articles have drawn attention to the need for improving "chronometric hygiene" in Polynesian radiocarbon dating programs (e.g., Anderson 1991; Spriggs and Anderson 1993; Dye 2000). While considerations of sample stratigraphic contexts are a critical component of such an approach, the composition of radiocarbon samples can also affect the degree to which radiocarbon dates accurately reflect the true calendar dates of cultural events of interest (the "target date" of Dean [1978]). Although charcoal is generally considered to be a good material for radiocarbon dating because of its inert chemistry and the relatively simple pretreatment necessary to remove modern contaminants (Bowman 1990:29, Taylor 1987:43), archaeological wood charcoal can also contain inbuilt age if it has been derived from the burning of heartwood from long-lived tree taxa (Bowman 1990:15, Taylor 1987:45), or from wood that has been burned after a significant period of preservation, as with driftwood (Dye 2000:204). Dating of samples with inbuilt age can result in radiocarbon ages that are somewhat older than the time period when the wood was actually burned and deposited in its archaeological context (e.g., Anderson 1991:fig.7). In his critical analysis of the New Zealand archaeological radiocarbon corpus, Anderson (1991:792) concludes that "dates on charcoal of minimal inbuilt age should be closest to the actual calendrical period; dates on marine shell and moa bone collagen are less predictable but broadly in agreement; unidentified charcoal is the most problematic sample type."

To address these issues, radiocarbon samples from Mangareva sites were examined at the U.C. Berkeley Oceanic Archaeology Laboratory prior to submission of samples to Beta Analytic for sample pretreatment and AMS radiocarbon measurement. Using methods based upon those described by Leney and Casteel (1975), charcoal fragments were individually examined using two reflected light microscopes: a Wild M5a stereoscopic for low-magnification and an Olympus BHS metallurgical scope for higher magnifications. Archaeological materials were compared with modern reference materials consisting of Pacific Island wood thin sections, experimentally carbonized charcoal samples, and economic plant materials curated at the Oceanic Archaeology Laboratory. Whenever possible, charcoal fragments derived from short-lived plant taxa or from short-lived plant parts such as seeds or twigs, were isolated from the selected dating samples to minimize the potential for inbuilt age to affect the resulting dates.

Table 4.1 lists the provenience, sample weight, laboratory identifications, and an assessment of the likelihood of an inbuilt age factor for all AMS dated fragments. Unfortunately, it was not possible to eliminate the potential for some inbuilt age to exist in many of the dated samples. In some cases, where samples were small, fragile, degraded, or otherwise unidentifiable against available reference materials, dated fragments could be identified only as "wood" or "dicotyledonous wood," while one sample (GAM-7) contained questionable semi-carbonized material and one (GAM-20) contained unidentified lumps of carbonized plant matter mixed with sand. Those samples which could be securely identified were primarily derived from economic plant genera including *Aleurites, Artocarpus, Cocos, Cordyline, Hibiscus, Pandanus*, and *Thespesia.* All of these taxa occur commonly throughout the Mangareva Islands today (see Chapter 2).

Because ideal materials could not be isolated from all of the dating contexts, Table 4.1 includes estimations of the potential for inbuilt age for each of the radiocarbon results obtained.

Table 4.1. Mangareva radiocarbon dating samples: provenience and identification.

Laboratory & Field Codes	Site No.	Provenience	Sample Weight (g)	Botanical Identification	In-built Age Potential
Beta-174777, GAM-1	190-06-ATA-1	Unit F11, Layer II, Level 3, 50-60 cmbs (oven)	8.8	Dicotyledonous wood, cf. *Bauhine*	High
Beta-174778, GAM-2	190-06-ATA-1	Layer III, Level 1	29.6	Unident. seed tissue	Low
Beta-174779, GAM-3	190-06-ATU-2	Layer I, Level 5, 52 cmbs	0.2	Dicotyledonous wood	High
Beta-174780, GAM-4	190-06-GAT-3	Layer II	3.4	Dicotyledonous wood, cf. *Bauhine*	High
Beta-174781, GAM-5	190-06-GAT-3	Layer I, horizon A	0.4	Dicotyledonous wood, twig morphology	Low
Beta-174782, GAM-6	Akamaru, TP1	Layer IB, Level 2, 30-39 cmbs, oven	2.9	Unident. seed tissue	Low
Beta-174783, GAM-7	Akamaru, TP2	120-128 cmbs, soil + charcoal	0.1	Semi-carbonized material	?
Beta-174784, GAM-8	190-04-KAM-2	Layer III, Level 3 (no. 59)	8.1	*Artocarpus* wood	Medium
Beta-174785, GAM-9	190-04-KAM-2	Layer IV, Level 2 (no. 70)	5.7	*Cocos* wood	Medium
Beta-174786, GAM-10	190-04-KAM-2	Layer V, Level 2 (no. 80)	3.5	*Pandanus* wood	Medium
Beta-174787, GAM-11	190-04-KAM-2	Layer VI, Level 6 (no. 99)	16.3	*Pandanus* fruit (key)	Low
Beta-174788, GAM-12	Rikitea Transect	Chez Louis, Core 2, 55-60 cmbs	0.1	Unident. wood	High
Beta-174789, GAM-13	190-06-ATA-4	Core hole 5, 74 cmbs	0.3	Dicotyledonous wood	High
Beta-174790, GAM-14	190-06-ATA-4	Core hole 6, 60 cmbs	0.2	*Aleurites* endocarp	Low
Beta-174791, GAM-15	090-06-GAE-1	Erosional deposit with terrestrial gastropods	0.2	Dicotyledonous wood	High
ANU-11927, GAM-16a (split)	Rikitea trench	Gley layer, 90 cmbs		"Creeper twig" charcoal	Low
NZA-15383, GAM-16b (split)	Rikitea trench	Gley layer, 90 cmbs		"Creeper twig" charcoal	Low
Beta-168443 GAM-16c (split)	Rikitea trench	Gley layer, 90 cmbs		"Creeper twig" charcoal	Low
Beta-190115 GAM-17	190-06-ATU-1A *paepae*	TP-1, under pavement	0.1	*Cordyline fruticosa* stem	Medium
Beta-190116 GAM-18	190-02-AGA-3	TP-1, interface of Layers I and II	0.4	*Pandanus* sp. wood	Low
Beta-190117 GAM-19	190-02-AGA-3	TP-1, base of Layer III, 59 cmbs	0.5	*Hibiscus tiliaceus* wood	Medium
Beta-190118 GAM-20	190-12-TAR-6	TP-2, base of Layer II, 58 cmbs	4.4	Unknown carbon in sand clumps	?
Beta-190119 GAM-21	190-12-TAR-6	TP-2, interface of Layers I/II	0.5	Cf. *Artocarpus* wood	Medium
Beta-190114 GAM-22	190-12-TAR-6	TP-3, Layer III, 103 cm	0.3	Seabird bone, cf. Procellariidae	Low

Of the 24 dated samples, five were considered to have low potential for inbuilt age (<50 years), seven were judged to have potential for a medium degree of inbuilt age (~50-100 years), and seven were considered to have significant potential for inbuilt age (>100 years). Two samples (GAM-7 and GAM-20) were difficult to evaluate based on their unusual nature (given as "unknown" in Table 4.1). These should conservatively be considered as potentially containing a high degree of inbuilt age. These estimations need be taken into account when interpreting the calibrated date ranges. For samples with "medium," "high," or "unknown" inbuilt age potential, the dates obtained should be seen as providing a *terminus ante quem*, or "date before which," cultural events of site formation occurred. It is also possible, however, that samples with potential medium, high, or unknown inbuilt age are actually free of such bias and that their dates do in fact accurately reflect the calendar period when the wood was burned.

DATING METHODS AND RESULTS

Samples GAM-1 to -15 and -17 to -22 were submitted to Beta Analytic Inc. for pretreatment and AMS radiocarbon dating. The same pretreatment procedure was applied to all charcoal samples in order to eliminate contaminants such as carbonates and secondary organic acids, along with modern rootlets. The samples were gently crushed and dispersed in de-ionized water, followed by hot HCl acid washes and alkali (NaOH) washes; this was followed by a final acid rinse to neutralize the solution prior to drying (Darden Hood, pers. comm., Feb. 4, 2003). For GAM-22, a sample of bird bone, bone collagen was extracted with alkali pretreatment.

Three additional samples (GAM-16a, b, c) consist of subsamples ("splits") from a single bulk sediment sample taken from a buried gleyed clay horizon in Rikitea Village. Three separate subsamples were sent to Beta Analytic, to the radiocarbon dating laboratory at the Australian National University, and to the University of Waikato for independent dating. All three dates are AMS dates, and pretreatment methods were comparable with acid/alkali washes.

The results of AMS dating on the 24 samples are provided in Table 4.2. Somewhat surprisingly, five samples yielded ages which are reported in Table 4.2 as 'pMC' or 'percent modern carbon'. These samples are <50 years old, meaning that there was a greater concentration of ^{14}C in the sample than in the A.D. 1950 reference standard (95% of the ^{14}C content of the National Bureau of Standards Oxalic Acid). Remaining fragments of these samples were returned by Beta Analytic to U.C. Berkeley for reexamination after AMS dating. One of these (GAM-7), a sample that originally appeared to be semi-carbonized, may represent stratigraphically intrusive modern root material. The initial identification of the other two samples, originally identified as carbonized seed tissue (GAM-2) and unknown dicotyledonous wood charcoal (GAM-13), were reconfirmed. The reasons that these two samples returned modern ages remains unclear.

For the 19 other samples listed in Table 4.2, we have provided the results in terms of the measured ^{14}C age (calculated using the Libby ^{14}C half-life of 5568 yrs), the ratio ($\delta^{13}C$) between ^{13}C and ^{12}C (calculated relative to the PDB-1 international standard), the "conventional radiocarbon age" (as defined by Stuiver and Polach 1977), and the calibrated age range at 1 standard deviation (68% probability). Calibration follows the calibration database and methods of Stuiver et al. (1998) and of Talma and Vogel (1993). All charcoal samples were calibrated using the atmospheric calibration database INTCAL98, while a sample of seabird bone from the Onemea site was calibrated using the marine calibration curve MARINE98 with a ΔR value of 0 ± 0. We now turn to a brief discussion of the various dates reported in Table 4.2 in terms of their stratigraphic and archaeological contexts. The first five localities discussed below are situated on Mangareva Is-

TABLE 4.2 Mangareva radiocarbon dating samples: results.

LABORATORY & FIELD CODES	MEASURED ^{14}C AGE (B.P.)	^{13}C/^{12}C RATIO (°/oo)	CONVENTIONAL ^{14}C AGE (B.P.)	CALIBRATED AGE RANGE (1σ) A.D.
Beta-174777, GAM-1	670 ± 40	-23.9	690 ± 40	1280-1300
Beta-174778, GAM-2	113.8 ± 0.6 pMC	-25.5	113.9 ± 0.6 pMC	------
Beta-174779, GAM-3	210 ± 40	-24.9	210 ± 40	1650-1680, 1770-1800, 1940-1950
Beta-174780, GAM-4	190 ± 40	-25.2	190 ± 40	1660-1680, 1740-1810, 1930-1950
Beta-174781, GAM-5	100.1 ± 0.5 pMC	-12.6	190 ± 40	1660-1680, 1740-1810, 1930-1950
Beta-174782, GAM-6	430 ± 40	-28.2	380 ± 40	1450-1520, 1590-1620
Beta-174783, GAM-7	120.7 ± 0.8 pMC	-27.9	121.4 ± 0.8 pMC	------
Beta-174784, GAM-8	230 ± 40	-26.1	210 ± 40	1650-1680, 1770-1800, 1940-1950
Beta-174785, GAM-9	240 ± 40	-25.3	240 ± 40	1640-1670
Beta-174786, GAM-10	460 ± 40	-25.1	460 ± 40	1420-1450
Beta-174787, GAM-11	330 ± 40	-21.2	390 ± 40	1450-1510, 1600-1620
Beta-174788, GAM-12	860 ± 40	-24.6	870 ± 40	1160-1220
Beta-174789, GAM-13	109.3 ± 0.5 pMC	-28.2	110.0 ± 0.5 pMC	------
Beta-174790, GAM-14	650 ± 40	-23.2	680 ± 40	1280-1300
Beta-174791, GAM-15	220 ± 40	-23.2	220 ± 40	1650-1670, 1770-1800, 1940-1950
ANU-11927, GAM-16a (split)	------	-24.0 (estimated)	320 ± 180	1400-1850, 1900-1950
NZA-15383, GAM-16b (split)	98.7 ± 0.7 pMC	-25.8	180 ± 57	------
Beta-168443, GAM-16c (split)	410 ± 40	-22.3	450 ± 40	1430-1460
Beta-190115, GAM-17	450 ± 40	-26.3	430 ± 40	1430-1470
Beta-190116, GAM-18	480 ± 40	-26.7	450 ± 40	1430-1460
Beta-190117, GAM-19	760 ± 40	-26.3	740 ± 40	1260-1290
Beta-190118, GAM-20	1010 ± 40	-24.7	1010 ± 40	1000-1030
Beta-190119, GAM-21	740 ± 40	-24.0	760 ± 40	1250-1280
Beta-190114, GAM-22	1170 ± 40	-12.2	1380 ± 40	1000-1050

land, followed by those on Akamaru, Kamaka, Taravai, and Agakauitai islands (see Chapter 3 for stratigraphic details of all sites).

DISCUSSION OF RADIOCARBON DATING RESULTS

RIKITEA VILLAGE AREA

Weisler (1996:70) and Green and Weisler (2000:32; 2002:232) argued, on environmental grounds, that the area of Rikitea Village on Mangareva Island was likely to have been "an ideal locale for initial occupation of the Mangarevan group." Rikitea offers a sheltered bay and canoe landing, along with one of the largest valleys with many freshwater springs at the base of Auorotini watering a swampy alluvial basin which in historic times contained the most important zone of intensive taro (*Colocasia esculenta*) cultivation. The ritual and political significance of this locality also suggests a long history of settlement (see Chapter 2). As described in Chapter 3, one component of our field strategy involved stratigraphic coring along multiple transects running from the shoreline inland, cross-cutting the low accretionary beach ridge which separates the taro swamp from the sea, and which has likely been a major locus of habitation throughout prehistory. At one transect in particular ("Chez Louis") a fairly deep cultural layer, containing charcoal and overlying a coarse carbonate sand and grit, was encountered in Core 2 about 15 m inland of the road and on the margins of the taro swamp. A charcoal sample of unidentified wood from 55-60 cm depth was radiocarbon dated (Beta-174788, GAM-12), with a result of cal A.D. 1160-1220. This date corresponds closely with two dates obtained by Green and Weisler (2000, table 2) from the GK-1 (190-04-KAM-1) and GK-2 (190-04-KAM-2) rockshelters on Kamaka Island (with 2σ ranges of cal A.D. 1065-1294 and 1025-1292). The Rikitea date offers strong support for the hypothesis that early habitation deposits are located here, although an expanded test excavation at Chez Louis in 2003 failed to locate a substantial cultural deposit.

The low-lying basin-shaped depression between the coastal sand beach ridge and the base of the colluvial slopes at Rikitea was formerly a major zone of wet taro cultivation. This area was originally identified from a buried gley soil layer that formed through continuous fresh water saturation (Tercinier 1974). As described in Chapter 3, we took advantage of a 75 m long drainage trench to record the stratigraphy at a locality about 10 m seaward of the base of the cliffs inland from the Mairie. The key stratigraphic unit here was the 25 cm thick gley layer containing small amounts of finely dispersed charcoal (see Fig. 3.8).

Charcoal dispersed in sedimentary deposits that accumulate gradually over time—such as that represented by the Rikitea gley layer—can be difficult to date reliably. This is because the origin of the sediments—and charcoal particles—can change over time and the depositional environment can be disturbed and reworked centuries after first deposition. Roots of shrubs and trees can penetrate soil layers adding more recent carbon to ancient sediments. This is especially problematic when vegetation burns and follows the roots well below the surface, thus adding younger charcoal to old. Mindful of these potential problems, we removed a bulk sediment sample from the gley layer 90 cm below surface and processed it in the field. The sediment was placed on a 3.2 mm sieve and washed with fresh water. Charcoal was collected with forceps and placed in a plastic bag. The single sample (GAM-16) was then split into three subsamples, each being sent to a different laboratory as described above. One subsample (NZA-15383, GAM-16b) yielded a "modern" age, while the other two subsamples yielded ages of 450 ± 40 and 320 ± 180 B.P. (Beta-168443, GAM-16c; ANU-11927, GAM-16a). The latter date has a rather large standard deviation but overlaps with the Beta-168443 date which we take to be a best estimate for the deposition of the gley layer. Calibrated to A.D. 1430-1460, this date suggests that the Rikitea taro swamp was in use as an agricultural system by at least the mid-15th century A.D.

Atituiti Area

Another area with significant ethnohistorically documented settlement is Atituiti, to the south of Rikitea in the lee of Auorotini. A number of important sites are located here, including the large 190-06-ATU-1A *paepae* and associated structures on the natural terrace called Atituiti Ruga. The ATU-1A *paepae* site is not only a unique example of monumental architecture within Mangareva, but as suggested in Chapter 3, may also be the site of solstitial observations by the Mangarevan priests, as described by the early Catholic missionaries (Laval 1938). In our 2003 test excavations at ATU-1A, we were able to obtain several charcoal specimens from a sealed stratigraphic context under the basalt paving stones in front of the large tabular boulder "seat" on the *paepae* platform (see Fig. 3.19). A fragment of *Cordyline fruticosa* stem was submitted for dating (Beta-190115, GAM-17), with a result of cal A.D. 1430-1470. Given the stratigraphic context, this sample probably post-dates the actual construction of the *paepae* (although possibly not by a very long interval) and should yield a good estimate of the period when the present paved surface was in use. The 15th century date falls into the later part of the Mangarevan sequence, corresponding to the period of intense inter-tribal competition and rivalry for political power so amply documented by Hiroa (1938a) in his summary of Mangarevan oral traditions.

On the coastal flat called Atituiti Raro we also test excavated a buried midden deposit (site 190-06-ATU-2) exposed by coastal erosion. Our single 1 m^2 test unit into this cultural deposit extended to 60 cm below surface; no artifacts were found, but faunal materials and charcoal were encountered to the bottom of the sandy deposit. A sample of wood charcoal collected at 52 cm below surface was submitted for dating (Beta-174779, GAM-3), yielding three age ranges: cal A.D. 1650-1680, 1770-1800, and 1940-1950. The last age can be ruled out based on the absence of any modern materials; it seems likely that the deposit accumulated in the late pre-contact era.

Atiaoa Valley Sites

In the Atiaoa Valley, on the northwestern side of Mangareva Island, we tested a small rockshelter (site 190-06-ATA-1) and carried out transect coring operations across the coastal flat, locating a buried cultural deposit (site 190-06-ATA-4). Both sites were radiocarbon dated. Two samples from the rockshelter were submitted for dating, the first (Beta-174777, GAM-1) consisting of wood (cf. *Bauhine*) charcoal from an oven feature exposed in the north profile (see Fig. 3.27), the second (Beta-174778) consisting of an unidentified seed from the top of Layer IIIA. The latter of these samples yielded a modern age, but the sample from the earth oven yielded an age range of cal A.D. 1280-1300. Transect coring revealed buried cultural sediments containing charcoal in a zone extending about 50 m seaward of the rockshelter (see Fig. 3.29). Two samples were submitted for radiocarbon dating. One sample (Beta-174789, GAM-13) of unidentified wood returned a modern age, but the second sample of candlenut (*Aleurites moluccana*) endocarp (Beta-174790, GAM-14) yielded an age range of cal A.D. 1280-1300, identical to that from the nearby rockshelter. These two acceptable dates from Atiaoa sites ATA-1 and -4 (GAM-1, -14) are only slightly younger than our oldest dates from Rikitea and the Kamaka Island rockshelters, and suggest that the Atiaoa Valley has been occupied since at least the late 13th century A.D.

Gatavake Valley

Gatavake Valley, directly across the low mountain pass from Rikitea and east of Atiaoa, was another major locus of settlement, as indicated by oral traditions. We did not excavate here but recorded buried cultural deposits exposed in the banks of a narrow, intermittent stream, at the locality designated site 190-06-GAT-3 (see Fig. 3.33). Charcoal samples were submitted from both Layer I (Beta-174781, GAM-5) and from Layer II (Beta-174780, GAM-4) and returned essentially identical results after calibration: A.D. 1660-1680, 1740-1810, and 1930-1950, at 1σ. Again, the absence of any evident recent historical artifacts leads us to reject the most recent age range, suggesting that the cultural deposits here are of late prehistoric age (17-18th centuries). The thick clay deposit (Layer I) which covers the older anthropogenic gardening soil seems to have derived from rapid erosion of unstable slopes inland of the site. This is the kind of geomorphic sequence anticipated from the early historic descriptions of a largely deforested, grassland dominated landscape.

GAEATA LANDSNAIL DEPOSIT

In the Gaeata Valley at the northeastern tip of Mangareva Island, we recorded an eroded coastal bank with a terrigenous deposit containing endemic and Polynesian-introduced terrestrial gastropod shells. A single piece of dicotyledonous wood from the base of the clay deposit containing these gastropods was submitted for dating (Beta-174791, GAM-15), and yielded age ranges (1σ) of cal A.D. 1650-1670, 1770-1800, and 1940-1950. Again, we reject the last range on independent evidence, indicating that the burning and erosion which resulted in the deposition of the clay layer occurred sometime during late prehistory (17-18th centuries).

AKAMARU ISLAND

Akamaru, the third-largest volcanic island in the Mangareva group, is notable for a broad, protected coastal flat nearly 200 m wide on the island's northern side. We cored this coastal plain for possible buried cultural deposits, finding low concentrations of charcoal and other cultural materials throughout the area. At the location of Core 3, 100 m inland of the beach ridge, a 1 m^2 test pit revealed a small earth oven and also yielded a fragment of a pearlshell fishhook (Fig. 3.36). An unidentified carbonized seed from this oven was submitted for dating (Beta-174782, GAM-6), yielding age ranges (1σ) of cal A.D. 1450-1520 and 1590-1620. This date confirms the presence of occupation deposits on Akamaru Island dating to approximately the 15-16th centuries; however, there is no reason to believe that this sample dates the earliest use of this fairly large and relatively resource-rich high island.

A second sample of carbonized material (Beta-174783, GAM-7) was submitted from a test pit (TP-2) excavated through the edge of the fan of colluvial detritus down to the contact with the underlying calcareous sand flat, near the base of the island's volcanic ridge. Unfortunately, this sample returned a "modern" age; re-examination of the remaining, undated portion of the GAM-7 sample suggested that it may consist of stratigraphically intrusive, modern root material.

KAMAKA ISLAND ROCKSHELTER

At Kamaka Island, we re-sampled the smaller of two rockshelters (GK-2, now redesignated 190-04-KAM-2) originally excavated by Roger Green in 1959. This overhang shelter had produced a radiocarbon date (Beta-109019) of 890 ± 70 B.P. (cal A.D. 1025-1292 at 2σ) on charcoal originally collected by Green (Green and Weisler 2000, 2002). Prior to our project, this was the earliest radiocarbon date known for Mangareva. As Green had dated only a single sample from the base of this important site, we wished to date additional samples that might indicate the time span for the entire stratigraphic sequence. Four samples were selected, beginning with a fragment of breadfruit (*Artocarpus*) wood from Layer III (Beta-174784, GAM-8), followed by coconut (*Cocos*) wood from Layer IV (Beta-174785, GAM-9), *Pandanus* wood from Layer V (Beta-174786, GAM-10), and finally a *Pandanus* fruit ("key") from one of the deep ovens (Beta-174787, GAM-11).

As can be seen in Table 4.2, the results are fairly consistent with stratigraphy. The Layer III sample has 1σ age ranges of cal A.D. 1650-1680, 1770-1800, and 1940-1950; the latter can be rejected on the total absence of recent historic materials from the deposits. The underlying Layer IV sample has an age range of cal A.D. 1640-1670. These two dates indicate that the beach rock pavement and the midden deposit which developed on top of it were deposited in a time frame encompassing the 17-18th centuries, i.e., the proto-historic period prior to European contact. The Layer V midden underlying the pavement, however, yielded a significantly older age range of cal A.D. 1420-1450. This raises the possibility of a hiatus in use of the rockshelter between the Layer V midden and the construction of the Layer IV pavement. The sample from one of the deep ovens returned age ranges of cal A.D. 1450-1510 and 1600-1620. The earlier of these ranges overlaps with the range for Layer V, from which the oven pits were cut. Most likely, both the Layer V midden and the ovens date to a time period of approximately the 13-14th centuries.

The presence of the large, inter-cutting ovens prohibited us from obtaining a good *in situ* charcoal sample from the true basal cultural deposits (Green's Layer G, see Green and Weisler 2000, fig. 14). We have no reason to doubt the validity of the date obtained by Green from this deposit, calibrated to A.D. 1025-1292, as this is reinforced by a date of almost identical age from the nearby GK-1 (= KAM-1) rockshelter (Green and Weisler 2000, table 2). An Oxcal plot of the probability distributions of all five available dates from the KAM-2 rockshelter is provided in Figure 4.1. Our expanded range of radiocarbon dates from site KAM-2 suggests the following temporal sequence: (1) initial occupation in the 11-13th centuries, followed by a possible hiatus; (2) continued occupation in the 13-14th centuries, including the use of the shelter for cooking activities as evidenced by the large ovens; (3) a possible hiatus in use of the site in the 15-16th centuries; and, (4) construction of a beach rock pavement and edging, and subsequent re-occupation in the 17-18th centuries.

ONEMEA SITE, TARAVAI ISLAND

Located along the shore of the smallest of three large bays on the northwestern coast of Taravai Island, the Onemea site (190-12-TAR-6) did not yield many artifacts from the two test pits excavated but nonetheless is remarkable for the high concentration of bird bones found at the base of TP-2, both in the lower part of the cultural deposit (Layer II) and in the immediately underlying sand (Layer III; see Fig. 3.46). Elsewhere in Polynesia, similar high concentrations of bird bones have typically proved to be associated with the earliest phases of human colonization on islands (Steadman 1989, 1995; Steadman and Kirch 1990). Hence, it seemed possible that the Onemea site incorporates cultural deposits dating to the initial period of human occupation on Taravai Island.

Three samples were submitted for dating, all from the deeper TP-2 unit at Onemea. The uppermost sample (Beta-190119, GAM-21), consisting of wood tentatively identified to the genus *Artocarpus* (breadfruit), came from the interface of Layers I and II, at 20-22 cm below surface. This sample yielded an age of cal A.D. 1250-1280, roughly the same age as the base of the Kamaka Island rockshelters and of the sample from Chez Louis at Rikitea Village. A second sample (Beta-190118, GAM-20) was collected directly from the cleaned south face of the stratigraphic profile after the completion of excavations, from a thin lens of carbonized material at 58 cm below surface (see Fig. 3.46). This sample appeared to represent burning of vegetative matter directly on top of the Layer III sand deposit containing the high density of bird bones, and immediately prior to the accumulation of the Layer II cultural deposits. While we could not botanically identify the carbonized material, it did not appear to consist of mature wood; rather, it is likely to have derived from some kind of leafy or soft vegetative mat-

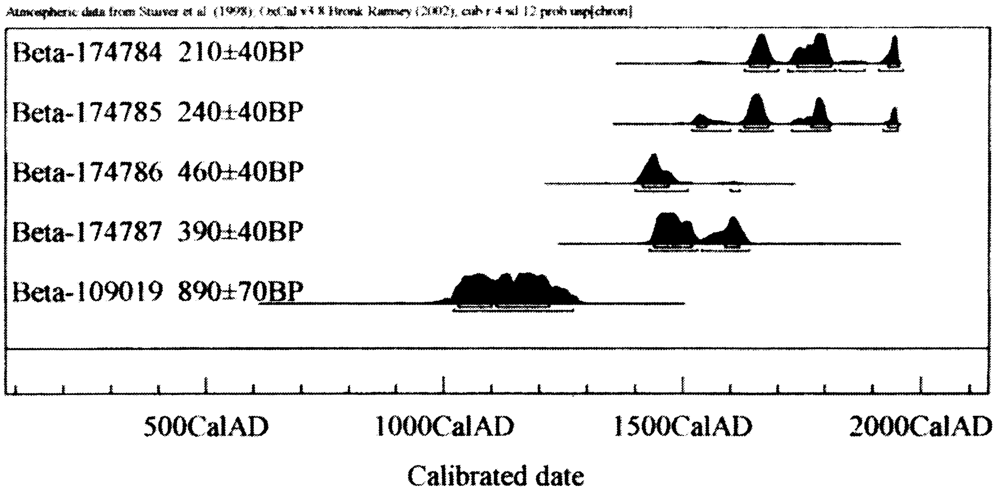


FIGURE 4.1 Oxcal plot of five radiocarbon dates from Site 190-04-KAM-2.

ter. This sample yielded an age of cal A.D. 1000-1030. The third sample (Beta-190114, GAM-22) consisted of a complete long-bone shaft of a seabird (probably a petrel species of the family Procellariidae) from Layer III at 103 cm; the $\delta^{13}C$ value of -12.2 obtained for this sample is consistent with what would be expected for a seabird subsisting on a marine diet. Using the marine calibration curve with a ΔR value of 0 ± 0, this sample returns an age of cal A.D. 1000-1050, essentially identical to the charcoal date from the lens immediately overlying Layer III.

Calibration of a sample such as GAM-22, using the marine (rather than atmospheric) calibration curve is affected by the value chosen for the ocean reservoir effect, the so-called ΔR value. Since the world's oceans are a "sink" or reservoir for older carbon, marine-grown samples typically yield ages somewhat older than their true age (Stuiver and Braziunas 1993; Stuiver et al. 1986). The MARINE98 calibration curve uses a "model ocean surface" which is essentially a smoothed version of the atmospheric curve (INTCAL98) offset by an average age of 400 years. However, since the local reservoir effect can vary greatly—partly as an effect of substantial upwelling of deep ocean water—the calibration of a ^{14}C date can be adjusted by application of a ΔR correction factor. In Pacific archaeology, much debate has ensued over what ΔR values should be applied to marine samples for particular areas (see Kirch 2001 for discussion of the reservoir problem with respect to Lapita archaeology). Much may depend on the local marine topography and environment, such as the presence of extensive reefs and lagoons where there is apt to be considerable exchange of CO_2 between the upper ocean layer and the atmosphere, or the presence of steeply shelving islands where upwelling may be significant.[2] Unfortunately, no empirical measurements of the local reservoir effect are available for Mangareva. For the Society Islands, a ΔR value of 45 ±30 has been reported (Stuiver et al. 1986). Recent dating of a series of 23 coral samples from Rapa Nui (Easter Is.), perhaps a better fit for Mangareva, indicated an average surface ocean reservoir value of 355 ± 71 years (Beck et al. 2003: 102-104, table 2). This would imply a ΔR value of approximately -45. Mangareva, with its extensive lagoon, may be analogous to the Mussau situation, although we have no idea whether the diet of the seabird dated in sample GAM-22 was primarily fish grown in the lagoon or open-ocean pelagic fish. Calibrating the GAM-22 date using a ΔR of -45 yields a range of A.D. 945-1030 at 1σ, overlapping with GAM-20, but suggesting an age perhaps a decade or two older than the latter. This is indeed the result one would predict from the stratigraphic and archaeological evidence.

As noted in Chapter 3, the Layer III deposit at Onemea is not an *in situ* occupation but nonetheless shows signals of human presence. These include two fire-altered volcanic stones (probably oven stones) and a number of shells of a Polynesian-introduced garden snail (*Allopeas gracile*). The closely consistent results obtained for samples GAM-20 and GAM-22 indicate that Polynesians were present on Taravai Island by the close of the 10th century or first few decades of the 11th century A.D., some 150-200 years earlier than the initial occupation of the Kamaka Island rockshelters. This accords well with the prediction of Green and Weisler (2000, 2002) that the first part of the Mangarevan cultural sequence was not evidenced in the Kamaka sites. Based on the GAM-21 date, the occupation on the Onemea beach ridge did not extend after the mid-to-late 13th century, although it is expectable that there are later sites elsewhere within the Onemea Valley. In short, Onemea is a good candidate for a site dating to the pioneering phase of Polynesian settlement in the Mangareva Islands.

NENEGA-ITI ROCKSHELTER, AGAKAUITAI ISLAND

The Nenega-Iti rockshelter (190-02-AGA-3) on Agakauitai Island contains a well-stratified, undisturbed cultural deposit extending to a depth of about 60-70 cm (see Fig. 3.54). Although our test excavations were limited to a single square meter, the site yielded the richest material culture assemblage from any of the sites we sampled, with nine fishhooks or hook fragments, 11 coral files, much worked pearl shell, and several other artifacts. Two samples were submitted for AMS dating. The first consisted of a sample of *Pandanus* wood from the interface between Layers I and II (Beta-190116, GAM-18) and returned an age of cal A.D. 1430-1460. The second sample, of *Hibiscus tiliaceus* wood, came from the base of cultural Layer IIIB, just above the contact with the underlying reddish sediment of Layer IV, at 59 cm below surface. This sample (Beta-190117, GAM-19) yielded an age of cal A.D. 1260-1290. Taken together, these two dates suggest that the cultural deposits in the Nenega-Iti rockshelter accumulated over a period of about 200 years, from the late 13th to the mid-15th centuries A.D. Expanded excavations at this site should therefore provide a good sample of materials dating to the middle phase of the Mangarevan cultural sequence.

CONCLUSIONS

The radiocarbon dates obtained as a result of our 2001 and 2003 excavations now expand the Mangarevan radiocarbon corpus by a factor of three. Figure 4.2 provides an Oxcal plot of all 20 calibrated dates (excluding those with modern ages) and shows their probability distributions. As can be seen, the Mangarevan sequence now spans a full eight centuries. The full implications of this corpus for outlining a prehistoric cultural sequence for the archipelago will be developed in Chapter 8. Here we conclude with a few key observations. (1) Initial Polynesian discovery and settlement of the Mangareva Islands occurred no later than the end of the 10th century A.D., or opening decades of the 11th century, based on the new dates from the Onemea site. (2) By the 13th century, we have evidence for widely dispersed occupation—in both rockshelters and open sites—on Mangareva (at both Rikitea and Atiaoa), Taravai, Agakauitai, and Kamaka islands. (3) Monumental architecture, as evidenced by the *paepae* at Atituiti, was being constructed by the 15th century. (4) A major episode of erosion and deposition of terrestrial sediments, as evidenced at Gatavake and Gaeata, was in effect by the 17-18th centuries (if not earlier), indicating considerable environmental degradation and instability by the late phase of the Mangarevan sequence.

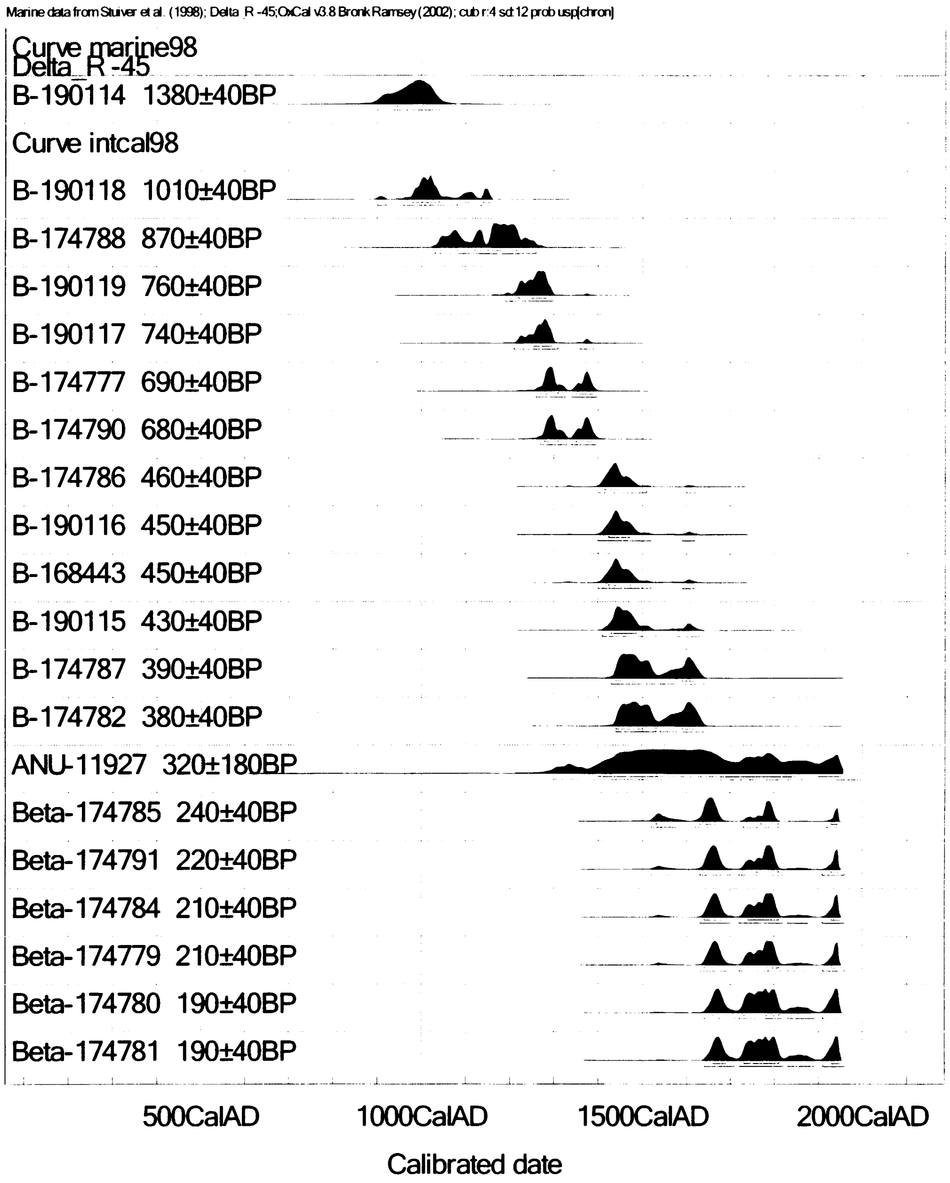


FIGURE 4.2 Oxcal plot of radiocarbon dates from the Mangarevan Islands, showing probability distributions.

CHAPTER 4 ENDNOTES

[1] In 2001, just prior to our own expedition, M. Orliac (2003:159) carried out investigations at Gatavake, obtaining an additional radiocarbon date of 830 ± 70 B.P. (Beta-160931).

[2] For example, in the Mussau Islands of the Bismarck Archipelago (where there are extensive shallow lagoons), direct comparison of paired marine shell and wood samples from Lapita contexts strongly indicates that the reservoir effect is very slight, requiring a ΔR correction of -350 years to bring the sample pairs into agreement.

CHAPTER 5

ZOOARCHAEOLOGICAL ANALYSIS OF FAUNAL ASSEMBLAGES

N.M. Howard and P.V. Kirch

The rockshelter sites at Atiaoa, Kamaka, and Nenega-Iti (Agakauitai Is.), as well as the beach ridge midden site at Onemea on Taravai Island, all produced assemblages of invertebrate and vertebrate faunal remains.[1] In this chapter, we present the results of a preliminary analysis of this material; a detailed analysis of bird bones from these sites is provided in Chapter 6. We stress that this is a preliminary analysis in that available reference collections have limited to some degree the identifications possible, especially of the vertebrate remains.

SAMPLING AND METHODS

As noted in Chapter 3, 0.5 and 0.3 mm sieves were used during all test excavations to recover faunal remains. In the field, faunal remains recovered at each site were loosely sorted into shell and bone and bagged by layer and level; contents of features such as hearths or pits were bagged individually as well. Each bag was assigned a unique identification number. In the laboratory, the contents of these field bags were rinsed with water to remove excess dirt and sand and cleaned using a solution of equal parts of distilled vinegar and water. After air drying, the clean faunal remains were fine sorted and identified to the lowest taxonomic category possible.

Shell identification and taxonomy follows Salvat and Rives (1975). Whole shells and most larger fragments could be identified to genus and species, but smaller unidentifiable fragments were designated as "miscellaneous shell." After sorting and identification, all of the specimens for each taxon were weighed to determine a total weight per excavation level. Shells were also counted, with the number of identified specimens (NISP) determined by counting the total number of specimens present for each molluscan taxon in each level.[2] The minimum number of individuals (MNI) was estimated by counting specific diagnostic elements for each species. For bivalves, the umbo (the apex or beak of the shell) was used as the diagnostic element to determine MNI. The apex (the tip or point) was used for all gastropods (snails), except for *Drupa*, *Nerita*, *Cypraea*, and those of the Cymatiidae family for which the intact aperture was used instead. The aperture was selected as the diagnostic element in the determination of MNI for these species because the apertures were less fragile than the apex and therefore less likely to break. However, the apertures had to be at least 75% intact to be counted as a viable individual representative. For all *Latirus nodatus* specimens, the intact columella (the solid central column around which the gastropod shell spirals) was chosen to determine MNI, and for all operculae the central portion was selected (although at least half of the nucleus had to be present to be counted).

Three shell species were abundant enough to be measured for possible size changes between stratigraphic units: *Gafrarium pectinatum*, *Cellana taitensis*, and *Turbo setosus* as represented by operculae. All specimens of these three taxa were measured, provided that they were intact enough to accurately record their size. Dial calipers were used and the lengths recorded in millimeters. The *Gafrarium pectinatum* shells were measured transversely to the hinge (umbo). The maximum length diameter was measured for both *Cellana taitensis* and *Turbo* operculae.

All vertebrate specimens were first sorted into categories of mammal, bird, and fish. After initial sorting to category, certain diagnostic specimens were identified to family and when possible to genus and/or species. Most of the vertebrate material consisted of fishbone, which was identified with the aid of the comparative reference collection of Pacific fishes in the Oceanic Archaeology Laboratory at U. C. Berkeley, and by consulting Fowler (1955) and Barnett (1978). Once identified to the lowest taxonomic level possible, the bone specimens were counted and the NISP established. Bone was not weighed nor did we attempt to determine the MNI, given that a large number of specimens could not be identified to a level other than basic class. However, the vertebral centra of both Teleost fish and Elasmobranchii (sharks and rays) were measured as a proxy for fish size, following Reitz and Wing (1999). Assuming that the available samples of vertebrae come from a cross section of the identified species, this allows one to determine whether size changes occurred across different stratigraphic layers. Dial calipers were used to measure the maximum centrum diameters of each intact vertebra, and these were recorded in millimeters.

INVERTEBRATE REMAINS

By weight, invertebrate remains constituted the bulk of the faunal materials recovered at all three sites, and these were dominated by marine mollusks. Smaller quantities of echinoderms and crustacea were also found. Several sites also yielded the shells of terrestrial gastropods; the latter were not food sources but do provide significant information on local environmental conditions.

MARINE MOLLUSKS

Salvat and Rives (1975:64) indicate that the Gambier archipelago is depauperate in molluscan taxa when compared with the Society, Tuamotu, and Marquesas islands of Eastern Polynesia. The decline in species richness from west to east across French Polynesia reflects both increasing distance from the primary Indo-Pacific source area and local ecological conditions, especially the cooler waters of Mangareva (average seawater temperature in August 21.5°, compared with 26° in the Marquesas). Moreover, as Richard (1974) demonstrates in his study of littoral species on Mangareva Island, the number of molluscan taxa which are both abundant and suitable for gathering as food is even more restricted.

Table 5.1 lists the marine molluscan taxa represented in the faunal assemblages from the three sites, with notes as to habitat. Several taxa are typical of rocky shores, either volcanic platforms or cliffs within the surge zone, or coralline rocks: *Cellana taitensis* and *Nerita plicata* with other nerites are the most typical of this zone. Other mollusks are typically found on the outer crests of fringing and barrier reefs: *Turbo setosus* and *T. argyrostomus*, *Drupa* sp., *Morula uva* are characteristic of this zone. Still other taxa, such as *Conus* and *Cypraea* spp., prefer the reef platform. With the exception of *Tridacna maxima* and the two *Chama* spp., both of which are sessile and

TABLE 5.1 Molluscan taxa represented in the Mangareva sites.

FAMILY	GENUS AND SPECIES	HABITAT	COMMENTS
GASTROPODS			
Patellidae	*Cellana taitensis*	Exposed volcanic rocky shores.	Prized for food.
Turbinidae	*Turbo setosus*	Frontal zone of barrier reefs, on algal crests, surge zone.	Prized for food; used in parts of Polynesia for fishhook manufacture.
	Turbo argyrostomus	Algal crests of exterior reefs, lagoons.	Considerably larger than *T. setosus* (up to 91 mm diameter).
Neritidae	*Nerita plicata*	Rocky shores, littoral fringe.	
	Nerita picea	Same as *N. plicata.*	
	Nertia morio	Same as *N. plicata.*	
Strombidae	*Lambis truncata*	Subtidal, in sand or gravel patches on lagoon floor.	Large shell obtains up to 170 mm length.
Cypraeidae	*Cypraea* spp.	Fringing and barrier reefs; in crevasses and under stones.	Several species represented, including *Erosaria moneta.*
Cymatiidae	*Cymatium* spp.	Fringing and barrier reefs.	
	Charonia tritonis	Deeper water, lagoon.	Large shell up to 380 mm; used as a trumpet throughout Polynesia.
Muricidae	*Drupa* sp.	Reef platform.	
	Morula uva	Exterior reefs near surge zone.	
Fasciolariidae	*Latirus nodatus*	Reef platforms.	
Mitridae	*Mitra* sp.	Coral sand, lagoon floors or sandy patches.	Large family with many species.
Conidae	*Conus* spp.	Reef platforms and sandy patches.	Some species highly toxic.
BIVALVES			
Arcidae	*Arca* sp.	Lagoon, sandy substrates.	
Pteriidae	*Pinctada margaritifera*	Lagoon.	Shell provided primary material for fishhooks.
Ostreidae	*Crassostrea cucullata*	Rocky substrates.	
Lucinidae	*Codakia* sp.	Lagoon sediments, sandy patches.	
Chamidae	*Chama imbricata*	Rocky substrates.	
	Chama pacifica	Rocky substrates.	
Tridacnidae	*Tridacna maxima*	Reef platforms.	Prized for food.
Veneridae	*Gafrarium pectinatum*	Sandy substrates, lagoon floors.	
Tellinidae	*Scutarcopagia scobinata*	Sandy substrates.	
	Tellina spp.	Sandy substrates.	
Psammobiidae	*Asaphis violaseus*	Sandy substrates.	

require a hard substrate, most of the bivalves listed in Table 5.1 inhabit sandy or lagoon sedimentary substrates. *Gafrarium pectinatum* occurs in quite shallow water where there are sand flats, whereas *Pinctada margaritifera* requires deeper lagoon waters.

Most of the taxa listed in Table 5.1 seem to have been gathered for their food value. However, *Pinctada margaritifera*, the pearl oyster shell, yields not only edible meat but also large valves which were the principal material used to manufacture fishhooks. Much of the *Pinctada* material in our sites shows signs of being worked for fishhook manufacture (see also Chapter 7).

The molluscan assemblage from the Atiaoa rockshelter site (190-06-ATA-1) is tabulated by MNI and weight in Table 5.2. Twelve taxa are represented, deriving from several different habitats. However, the assemblage is overwhelmingly dominated by one species, *Gafrarium pectinatum*, making up nearly 64% by weight. This dominance of *G. pectinatum* probably reflects the extensive sandy, inter-tidal flats found at Atiaoa Bay, an ideal habitat for this bivalve. In all, 1.9 kg of shellfish remains were recovered from the single 1 m^2 test pit, but the density of mollusks varies considerably by stratigraphic layer. In Table 5.2 we give concentration indices (C.I.) expressed as kilograms of shell midden per cubic meter (kg/m^3). From these it can be seen that the density of shellfish rises steadily throughout the deposit. Layer I, with a C.I. of 11.17 kg/m^3, has a density more than four times greater than that of Layer II. This increased density could be the result of several different factors, such as increased intensity of shellfish exploitation in later prehistory or simply a higher rate of midden dumping or utilization within the shelter. The relative composition of the marine molluscan assemblages from the three sites, plotted by major habitat zones, is shown graphically in Figure 5.1.

The molluscan assemblage from Nenega-Iti rockshelter site (190-02-AGA-3) on Agakauitai Island is tabulated in Table 5.3. This is the most diverse assemblage analyzed with 19 taxa represented, again from a diversity of habitats. No single species dominates as at Atiaoa, but the following set of five mollusks accounts for more than 75% of the assemblage: *Cellana taitensis*, *Turbo setosus*, *Nerita plicata*, *Latirus nodatus*, and *Pinctada margaritifera*. Agakauitai is a small island with both exposed rocky substrates on the south and east coasts (providing excellent habitats for *Cellana* and *Nerita*), and reef platforms and sandy flats on the west, in the channel between Agakauitai and Agakauiuta on Taravai Island. Most of the *Pinctada* shell in this rockshelter is presumably related to fishhook manufacture, as the site also yielded a sizeable assemblage of *Acropora* coral files and pearlshell fishhooks (see Chapter 7). The concentration indices in Nenega-Iti are similar to that of Layer II at Atiaoa, with a slightly higher density (C.I. = 5.12 kg/m^3) in Layer IIIA. There is no overall temporal trend evident.

The Onemea site (190-12-TAR-6) assemblages, recovered from two test pits, are tabulated in Tables 5.4 and 5.5. This site has both the least taxonomic richness (7 taxa) and the lowest density values of the three sites studied. There are also considerable differences between the assemblages recovered from the two test pits. In TP-1, *Turbo setosus* and *Lambis truncata* dominate the assemblage, whereas in TP-2 most of the weight is made up by *Cellana taitensis* and *Pinctada margaritifera*. Whether these differences reflect distinct activity areas within the site, or temporal shifts, is not clear (the TP-1 deposits have not yet been dated). The *Turbo* shells were probably obtained from the barrier reef lying to the west of Onemea Bay, whereas the *Cellana* limpets could have been readily collected on the volcanic rock platforms found to either side of the bay.

Intense collecting pressures by human populations have the potential to affect the population structures of marine mollusks (e.g., Kay and Magruder 1977), resulting in a reduction of older (and larger) individuals relative to younger (and smaller) individuals. The ethnohistoric literature

TABLE 5.2 Molluscan fauna from Atiaoa rockshelter (Site 190-06-ATA-1).

Taxon	Layer I		Layer II		Layer IIIA		Total Weight (g)	% Total Weight
	MNI	Weight (g)	MNI	Weight (g)	MNI	Weight (g)		
Turbo setosus	5	10.5	5	60.5			71	3.7
Turbo argyrostomus	2	104.1					104.1	5.4
Turbo operculae	6	25.5	7	31.3			56.8	2.9
Nerita plicata	14	7.79	18	14.5	2	0.9	23.2	1.2
Cypraea spp.	3	10.0	2	15.9			25.9	1.3
Cymatium spp.	5	24.0	2	5.3			29.3	1.5
Drupa sp.	1	2.3	4	6.5			8.8	0.4
Morula uva	1	0.6					0.6	<0.0
Pinctada margaritifera	2	97.0	3	66.1	1	1.6	164.7	8.5
Crassostrea cucullata	2	1.6					1.6	<0.0
Gafrarium pectinatum	152	775.1	87	431.9	5	19.8	1,226.8	63.7
Scutarcopagia scobinata	2	8.9					8.9	0.5
Tellina spp.	5	19.5	9	77	1	3.9	100.4	5.2
Miscellaneous shell	17	30.4	22	67.9	4	5.7	104	5.4
Total	224	1,117.3	159	776.9	13	31.9	1,926.1	
C.I. kg/m^3		11.17		2.59		0.64		

for Mangareva (see Chapter 2) suggests that in late prehistory and protohistory marine resources were extremely important in Mangarevan subsistence economy. In order to assess whether this heavy reliance on marine resources might have had a statistically detectable impact on the population structures of gathered shellfish species, we measured the size ranges of the most abundant taxa in our assemblages.

For the Atiaoa rockshelter site, the most abundant mollusk species present is *Gafrarium pectinatum*. Table 5.6 presents data on mean length and standard deviation for five stratigraphic subsamples of *G. pectinatum* from the Atiaoa site. As can be seen, there is no statistically significant difference from the top to bottom of this stratigraphic column, and therefore no indication of significant human pressure on the population structure of this bivalve. In the Nenega-Iti rockshelter, the most abundant mollusk is the limpet species *Cellana taitensis*. This species is closely related to the Hawaiian *Cellana exarata*, which has been shown to respond dramatically to over-collecting through size reductions (Kay and Magruder 1977). Table 5.7 presents the size data for *C. taitensis* from the Nenega-Iti TP-1 sample. While there is some fluctuation in mean size throughout the stratigraphic column, no consistent pattern of size reduction occurs, and the variations are not statistically significant given sample sizes. We therefore conclude that there was no measurable impact on the local population structure

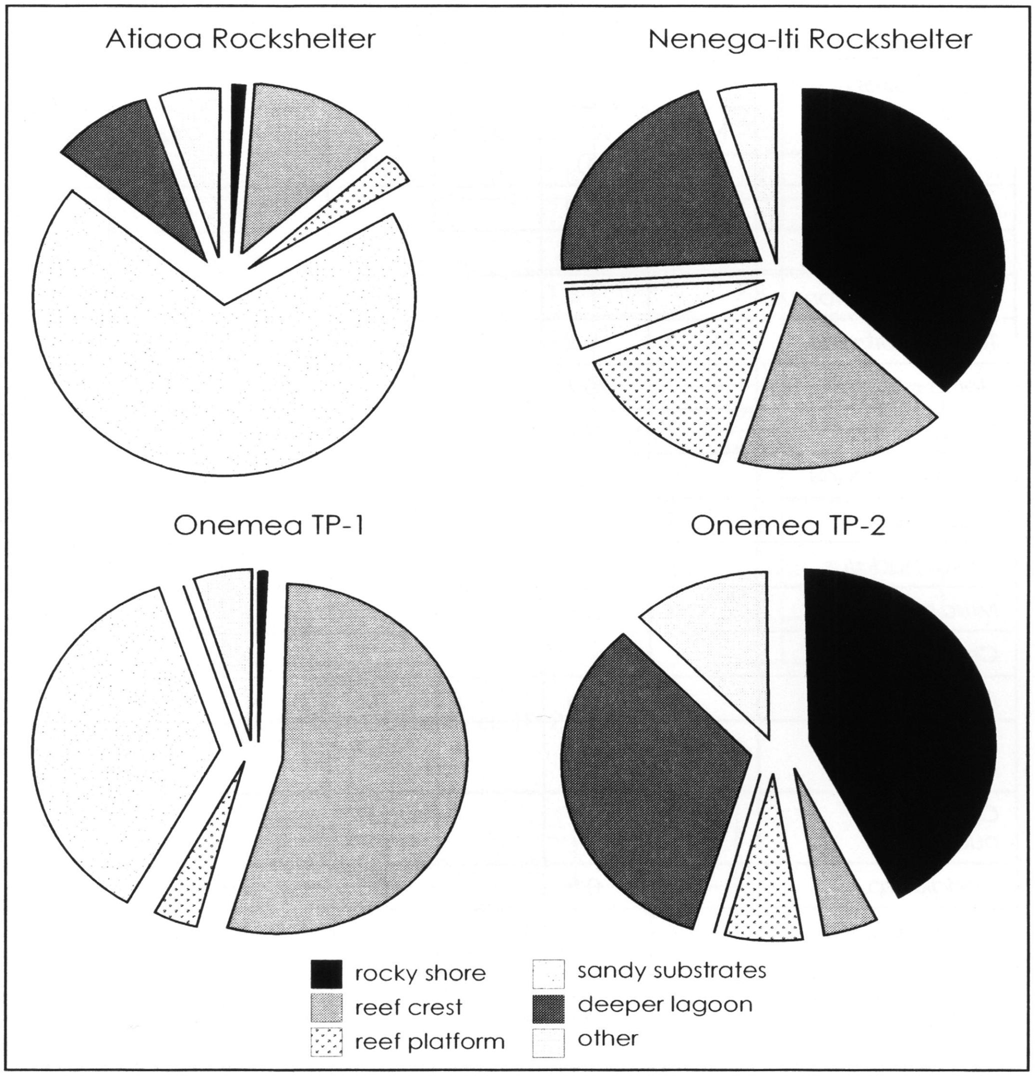


FIGURE 5.1 Pie charts representing the composition of molluscan fauna from Mangareva sites according to major habitat zones.

of *C. taitensis* due to human gathering on Agakauitai. The Onemea site assemblage did not provide sufficiently large samples of any molluscan taxon for measurements to be taken.

ECHINODERMS AND CRUSTACEA

Small quantities of echinoderm (sea urchin) spines and tests were found at all sites, but unlike the situation in other Eastern Polynesian sites, these do not appear in sufficient quantities to represent regular gathering for food. The large slate-pencil sea urchin *Heterocentrotus mammillatus* was represented by a few spines at Nenega-Iti, but none of these showed any signs of use as abraders (as is the case in the Marquesas or Hawaii).

Small quantities of crustacea were also found in the assemblages, but it has not been possible as yet to have these identified to taxon. In the Nenega-Iti site, 49 NISP of crustacea were collected, with 21 of these in Layer IIIB. At Onemea TP-2, 48 NISP of crustacea were found, and many of these tentatively appear to be pincer fragments of a land crab, possibly *Cardisoma* sp. This good sized terrestrial crab is common throughout much of Eastern Polynesia, where it inhabits sandy beach ridges and is often taken as food. In Mangareva, however, *Cardisoma* is not present today (according to informants). If our tentative identification of the specimens from Onemea can be confirmed as representing *Cardisoma*, this may indicate a case of local extinction within the prehistoric period.

TABLE 5.3 Molluscan fauna from Nenega-Iti rockshelter (Site 190-02-AGA-3).

Taxon	Layer I		Layer II		Layer IIIA		Layer IIIB		Total Wt. (g)	% Wt.
	MNI	Wt. (g)	MNI	Wt. (g)	MNI	Wt. (g)	MNI	Wt. (g)		
Cellana taitensis	13	14.2	7	6.6	390	440.0	70	67.6	528.4	20.4
Turbo setosus	4	50.3	2	43.5	10	120.0	2	45.2	259.0	10.0
Turbo argyrostomus					2	30.2			30.2	1.2
Turbo operculae	3	9.6			17	101.0	5	54.3	164.9	6.4
Nerita plicata	17	20.7	4	5.3	220	396.4	9	8.7	431.1	16.7
Cypraea spp.	1	2.1			4	13.4	1	3.2	18.7	0.7
Charonia tritonis			1	28.4	1	4.7			33.1	1.3
Drupa sp.	3	6.4			7	19.4	3	11.0	36.8	1.4
Latirus nodatus	7	48.2	10	44.2	22	135.6	5	50.3	278.3	10.8
Mitra sp.	3	0.9							0.9	<0.0
Conus spp.					1	1.2			1.2	<0.0
Arca sp.	2	0.6	2	0.6					1.2	<0.0
Pinctada margaritifera	1	54.3	1	1.3	4	315.1	2	135.2	505.9	19.6
Crassostrea cucullata	2	0.9							0.9	<0.0
Codakia sp.	2	0.8	1	0.3	1	0.2	1	2.9	4.2	0.2
Chama pacifica					1	20.1			20.1	0.8
Tridacna maxima							1	6.4	6.4	0.2
Gafrarium pectinatum	2	7.7			16	59.0	1	4.2	70.9	2.7
Tellina spp.	2	4.1			7	44.9	2	17.5	66.5	2.6
Asaphis violasceus	3	1.0							1.0	<0.0
Miscellaneous shell	14	18.1	8	5.0	21	92.7	6	10.6	126.4	4.9
Total	79	239.9	36	135.2	724	1,793.9	108	417.1	2,586.1	
C.I. kg/m^3		2.39		1.35		5.12		2.08		

TERRESTRIAL GASTROPODS

Two inter-related biogeographic characteristics of Pacific island faunas are their disharmonic nature with respect to higher-order taxa (i.e., absence of many groups) and remarkable radiation at the species level. The Mangareva Islands appear to have followed this pattern, although the severe degradation of the terrestrial environment—and probable extinction of many species—makes this more difficult to ascertain on the available terrestrial biological inventories (Cochereau 1974). Thanks to the extensive collecting efforts of the 1934 Mangarevan Expedition (Cooke 1935), however, followed by additional collecting in 1997 by Philippe Bouchet (Bouchet and Abdou 2001, 2003; Abdou and Bouchet 2000), we have some idea of the endemic land snail fauna which formerly existed on the Mangareva high islands and islets. This fauna included: six endemic species or subspe-

TABLE 5.4 Molluscan fauna from Onemea, TP-1 (Site 190-12-TAR-6).

Taxon	Layer IA		Layer II		Total Weight (g)	% Weight
	MNI	Weight (g)	MNI	Weight (g)		
Turbo setosus	6	260.9	2	12.5	273.4	47.1
Turbo operculae	7	37.2	1	11.7	38.9	6.6
Nerita plicata	1	1.8	1	1.0	2.8	0.5
Lambis truncata	1	91.1	1	129.9	221.0	37.4
Cypraea spp.	2	6.1			6.1	1.0
Latirus nodatus	3	15.0			15.0	2.5
Miscellaneous shell	5	8.1	3	15.1	23.2	3.9
Total	25	420.2	8	170.2	590.4	
C.I. kg/m³		1.40		0.61		

Table 5.5 Molluscan fauna from Onemea, TP-2 (Site 190-12-TAR-6).

Taxon	Layer II		% Weight
	MNI	Weight (g)	
Cellana taitensis	47	42.0	36.9
Turbo setosus	2	5.3	4.7
Nerita plicata	9	6.0	5.3
Nerita morio	1	0.6	0.5
Cypraea sp.	1	1.3	1.1
Drupa sp.	4	6.5	5.7
Pinctada margaritifera	3	38.2	33.6
Miscellaneous shell	9	13.8	12.1
Total	76	113.7	
C.I. kg/m³		0.28	

cies of the genus *Tubuaia* in the family Achatinellidae (Kondo 1962); three endemic genera (*Anceyodonta*, *Rikitea*, and *Gambiodonta*) and at least 24 endemic species in the family Endodontidae (Solem 1976; Abdou and Bouchet 2000); one endemic species in the family Punctidae (Abdou and Bouchet 2000); two endemic species in the family Euconulidae (Bouchet and Abdou 2001); and two endemic species in the family Assimineidae (Bouchet and Abdou 2003).

Between the 1934 and 1997 malacological expeditions, more than 50,000 specimens of Mangarevan land snails have been assembled in the collections of the Bernice P. Bishop Museum and the Muséum National d'Histoire Naturelle (Abdou and Bouchet 2000:691). What is truly striking about these collections is that—with the

Table 5.6 Mean lengths of *Gafrarium pectinatum* from the Atiaoa Rockshelter (Site 190-06-ATA-1).

Layer and Level	Mean Length	Standard Deviation	N
Layer I, Level 1	22.57	3.73	49
Layer I, Level 2	23.24	2.80	49
Layer II, Level 1	22.72	3.92	40
Layer II, Level 2	21.43	3.10	30
Layer III	22.62	3.68	8

Table 5.7 Mean diameters of *Cellana taitensis* from the Nenega-Iti Rockshelter (Site 190-06-ATA-1).

Layer and Level	Mean Length	Standard Deviation	N
Layer I, Level 1	18.80	2.43	13
Layer IIIA, Level 3	19.44	3.63	36
Layer IIIA, Level 4	22.38	3.15	226
Layer IIIA, Level 5	20.07	2.60	30
Layer IIIA, Level 6	19.62	2.96	82
Layer IIIB, Level 7	19.90	3.61	61
Layer IIIB, Level 8	20.44	2.74	8

exception of historically introduced taxa (such as *Bradybaena similaris* or *Subulina octona*)—none of the endemic taxa are represented by living specimens. With the exception of a very few British Museum specimens dating to collections made by Lesson in 1842 (Bouchet and Abdou 2003:169), all of this material consists of subfossil specimens, much of it obtained from recent sedimentary deposits. As Solem noted of the 1934 Mangarevan Expedition collections, "no living material of endodontids was obtained, but specimens proved to be quite abundant in several cave deposits or road cuts" (1983:280; see also Kondo and Clench 1952:18). All of the endemic species of terrestrial gastropods formerly present in the Mangareva Islands are thus thought to be extinct, the result of an "environmental crisis that has affected the native land snail fauna of this island group" (Bouchet and Abdou 2003:169). The question arises as to the timing and causes of this "environmental crisis," and here the recovery of land snail shells in datable archaeological contexts may be of much value.

Given Kirch's prior research on land snails in Pacific island archaeological sites (e.g., Christensen and Kirch 1981), particular attention was paid during our excavations to the recovery of snail shells. In all, 116 specimens were recovered from four site contexts, as enumerated in Table 5.8. These represent eight species in six families, including both endemic and introduced taxa. Several taxa are illustrated in Figure 5.2.

Four endemic species are present in the assemblages. The most frequent, present at three sites, is *Omphalotropis margarita*, an endemic assimineid formerly distributed throughout the islands and exhibiting remarkable microgeographical variation, as shown by Bouchet and Abdou (2003, fig. 3). This species was particularly common in the Nenega-Iti and Atiaoa rockshelters and is also

TABLE 5.8 Distribution of terrestrial gastropods in Mangarevan sites.

Family	Genus/species	ATA-1	TAR-6 (TP-2)	AGA-3	GAE-1
Tornatellinidae	*Lamellidea oblonga*				7
Endodontidae	*Gambiodonta* cf. *grandis*	4		13	
	Minidonta sp.?		1		
Punctidae	*Punctum* sp.			1	
Subulinidae	*Allopeas gracile*		26		2
	Subulina octona			1	
Bradybaenidae	*Bradybaena similaris*		1		
Assimineidae	*Omphalotropis margarita*	10		46	4

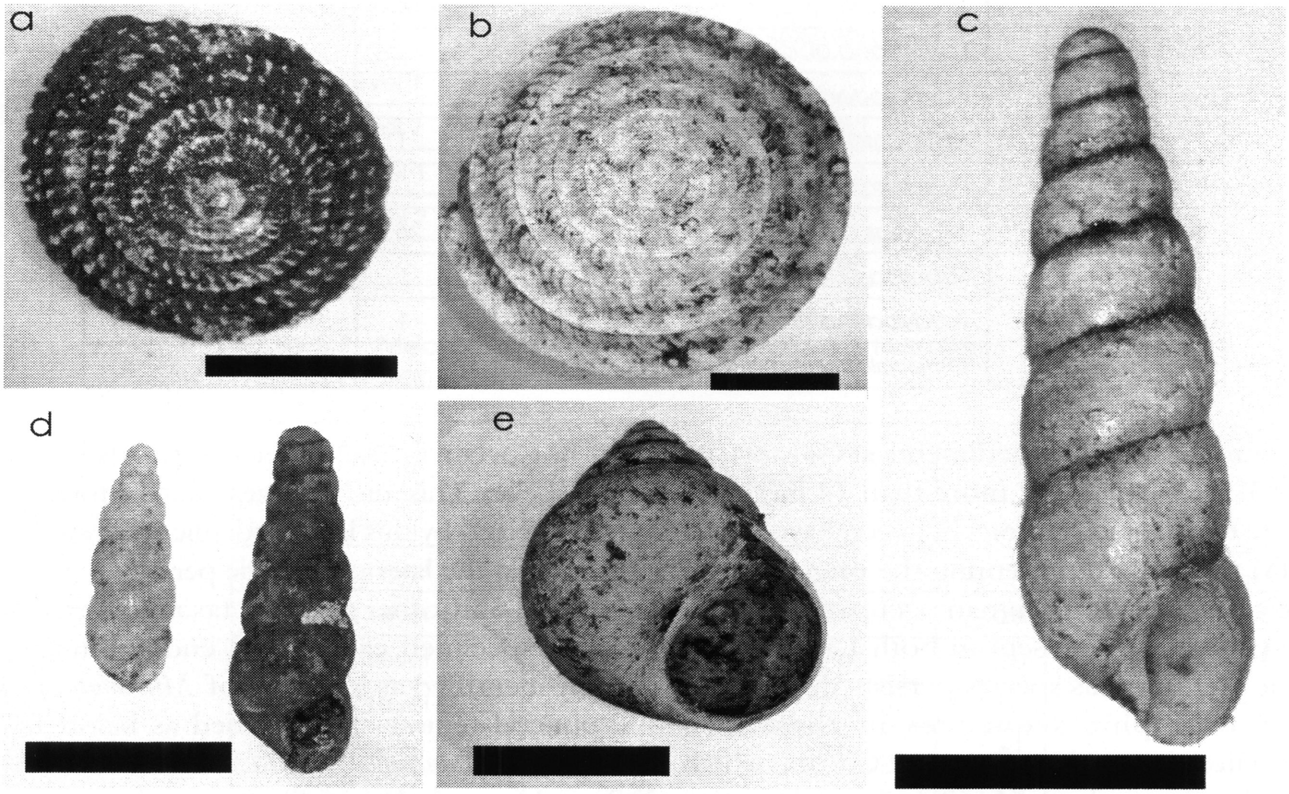
present in the erosional sediments at Gaeata (site GAE-3). In Nenega-Iti, more than 14 individuals were found at the contact between Layers IIIB and IV, probably representing the original landscape surface prior to human occupation. In the Atiaoa site, it was present in both Layers I and II. The fact that this species persists throughout the stratigraphic sequences in these two rockshelter sites and is present at Gaeata, which is ^{14}C dated to cal A.D. 1650-1670, 1770-1800, suggests that it persisted throughout much of the period of human occupation in the Mangareva Islands.

Also present in the Atiaoa and Nenega-Iti sites is an unusually large endodontid snail, tentatively identified as *Gambiodonta grandis* (Solem 1976: 441-44, fig. 189), shown here in Figure 5.2 a and b. Solem reports this unusually large endodontid as being present (based on the 1934 Mangarevan Expedition collections) on only Aukena and Agakauitai islands, but it (or a closely related species, or subspecies) must also have formerly existed on Mangareva Island, based on the material from Atiaoa. The specimens from Nenega-Iti have diameters consistent with the range given by Solem (average 12.3 mm). However, a specimen from the base of Layer II in the Atiaoa rockshelter exceeds this size considerably, with a diameter of 16.5 mm. The specimens of *Gambiodonta* cf. *grandis* are more heavily concentrated in the lower levels of the Nenega-Iti site and do not occur in the uppermost levels of either rockshelter. This might suggest that the forest habitat preferred by this large endemic snail was disappearing in the later prehistoric period.

The only other endemic taxa recovered are a single specimen each of an endodontid tentatively identified as a species of *Minidonta*, and of a punctid tentatively identified as belonging to the genus *Punctum*. Abdou and Bouchet (2000) describe an endemic *Punctum mokotoense*, from Mangareva Island, but our specimen comes from Agakauitai Island.

The introduced land snails are also of considerable interest. A number of anthropophilic snails are known to have been transported between islands and archipelagoes by the Polynesians and other Pacific peoples, probably adhering to crop plants or in soil with crop plants during inter-island voyages (Christensen and Kirch 1981; Kirch 1984:136-37). Two such anthropophilic taxa are present in our assemblages: *Lamellidea oblonga* and *Allopeas gracile*. The former has a geographic distribution over much of the central eastern Pacific, and Cooke and Kondo state that: "There is little doubt that the wide distribution of this species is due, mainly to the frequent voyages of the Polynesians, who transported food plants on their travels, especially between islands only a few hundred miles apart" (1960:201, fig. 85). This snail was found only at the GAE-1 site, where its presence suggests that

FIGURE 5.2 Terrestrial gastropods from Mangareva sites: a, b, large endodontids, *Gambiodonta* cf. *grandis* (a, Nenega-Iti; b, Atiaoa); c, large subulinid, *Subulina octona* (Nenega-Iti); d, *Allopeas gracile* (Onemea site, TP-2); e, assimineid, *Omphalotropis margarita* (Atiaoa). All scale bars = 5mm.



the local environment had already been modified for agricultural purposes, as the snail is found primarily in association with economic plants.

More interesting, perhaps, is *Allopeas gracile* (formerly named *Lamellaxis gracilis*), a small snail in the Subulinidae also known to have been widely transported by Pacific islanders in prehistory (Christensen and Kirch 1981). This snail is also present at GAE-1, but more significantly is relatively abundant at the base of the TP-2 deposits in the Onemea site, extending well down into the basal Layer III, where it was recovered in direct association with the assemblage of indigenous bird bones. As a human-introduced species, the presence of *Allopeas gracile* in direct association with the now extinct or extirpated birds indirectly points to the presence of humans in the immediate vicinity of the Onemea site at this early time period (approximately cal A.D. 1000).

Two other introduced species, *Subulina octona* and *Bradybaena similaris*, are represented each by a single individual and come from the uppermost stratigraphic contexts at Nenega-Iti and Onemea, thus dating to the post-contact period. Both taxa have been widely dispersed as a result of European commerce and the spread of plants and soil in the past two hundred years.

VERTEBRATE REMAINS

Vertebrate remains have been analyzed from the Nenega-Iti rockshelter site and Agakauitai Island, and the Onemea site on Taravai Island; unfortunately, the vertebrate remains from Atiaoa rockshelter were lost in transit to the University of Florida in 2002. The vertebrate assemblage from Nenega-Iti is enumerated by basic faunal categories in Table 5.9, and that from the two Onemea site test pits in Table 5.10. In both sites, fish bones make up the majority of the material, although TP-2 at Onemea also yielded a significant quantity of bird bones from the lowest stratigraphic levels.

TABLE 5.9 Vertebrate remains (NISP) from Nenega-Iti rockshelter (Site 190-02-AGA-3).

Faunal Category	Layer I	Layer II	Layer IIIA	Layer IIIB	Total NISP	% Total
Sus scrofa		1			1	<0.0
Medium mammal	4		1		5	0.2
Rattus exulans	38	3	40	12	93	4.2
Rattus sp.	2	4			6	0.3
Bird			3	10	13	0.6
Fish	201	243	1,116	527	2,087	94.6
Totals	245	251	1,154	549	2,205	

TABLE 5.10 Vertebrate remains (NISP) from the Onemea site (Site 190-12-TAR-6).

Faunal Category	Test Pit 1				Test Pit 2			
	Layer I	Layer II	Total NISP	% Total	Layer II	Layer III	Total NISP	% Total
Homo sapiens	6		6	0.7				
Medium mammal					2		2	0.4
Rattus exulans					5		5	1.1
Bird					21	132	153	33.8
Fish	551	252	803	99.3	177	115	292	64.6
Totals	557	252	809		205	247	452	

MAMMALS

Ethnographically, the only mammals known to be present in Mangareva were the rat and the pig, but the latter had become extinct prior to European contact (Hiroa 1938a:194-95). Green and Weisler (2004), reporting on the faunal remains recovered from Green's 1959 excavations (see Chapter 1), indicate that dog (*Canis familiaris*), pig (*Sus scrofa*), and rat (*Rattus exulans*) were all present at several sites, but that the first two had indeed gone locally extinct prior to European contact. Whereas the rat was fairly common in Green's samples (total of 99 NISP),[3] the pig is represented by only 11 bones and the dog by a mere 5 bones (these from a total of 13,598 NISP).

We recovered only a single unambiguous specimen of *Sus scrofa*, a premolar tooth from Layer II of the Nenega-Iti site. However, a few other fragmentary pieces of post-cranial bone from the two sites were identified as "medium mammal" and most likely also represent either pigs or dogs. The low frequency of pig in our sites thus matches that of Green's earlier excavations, and indicates that while pigs were formerly present, they were never abundant.

The bones of the Pacific rat (*Rattus exulans*) were quite common in the Nenega-Iti rockshelter but rare at Onemea. At Nenega-Iti, we also found 6 NISP of a larger species of rat in the two uppermost levels; this probably represents a European introduction (possibly *R. rattus*). Unlike the situation in the Tangatatau rockshelter on Mangaia Island, where the numerous rat bones showed evidence of burning and chewing (Kirch et al. 1995), none of the rat bones from Nenega-Iti displayed such taphonomic characteristics. This supports Hiroa's contention that rats were not eaten in Mangareva (1938a:194), which is somewhat surprising considering the abundant indications of terrestrial food stress in late prehistory. It may be, however, that the Mangarevan marine resources were sufficient to provide for protein needs, and that food stress was primarily in the realm of terrestrial carbohydrates.

Six NISP of *Homo sapiens* were also recovered from the uppermost stratigraphic level of TP-1 at the Onemea site. It is uncertain whether these derived from a disturbed burial context, or represent food remains.

BIRDS

A total of 166 NISP of bird bones was recovered from the two sites, primarily at TP-2 of Onemea. No bones of the domestic jungle fowl (*Gallus gallus*) were included in this sample, although Green and Weisler (2004:36) report a total of four NISP chicken bones from Green's 1959 excavations. Our sample consists predominantly of several species of sea birds, although an extinct or extirpated pigeon is also represented. It is significant that these bird bones derived from the deepest stratigraphic contexts in both Nenega-Iti and Onemea (especially the Layer III deposit in TP-2 at Onemea). A full report on the bird bones is provided in Chapter 6 by Worthy and Tennyson, who undertook the identification of this collection.

FISH

As was the case with Green's 1959 faunal samples (Green and Weisler 2004), the majority of bone from our sites consists of the bones of teleost fishes or elasmobranches (rays and sharks). Fully 94% of the Nenega-Iti bone sample and 64% of that from Onemea consist of fish bone. Much of this material consists of fragmentary cranial bones, along with abundant post-cranial spines and vertebrae which we have not attempted to identify to a lower taxonomic level. However, using reference collections and published sources available to us, we have been able to identify a proportion of the assemblage to family level. Most of the identified material consists of mouth parts (dentaries, premaxilaries, pharyngeal grinding apparatus), or of distinctive spines (as with the Balistidae) or tangs (Acanthuridae). We consider this a preliminary analysis only, and doubtless additional taxa will be recognized when the collection is analyzed by a zooarchaeologist specializing in Pacific fishes.

Table 5.11 lists the identified fish remains from the Nenega-Iti site. Most prevalent are scarids (parrotfish), probably representing more than one genus, followed by balistids (triggerfish). Also present in large quantities are serranids (groupers). Fourmanoir et al. (1974) list 19 species of Scaridae (in the genera *Scarus*, *Bolbometopon*, and *Hipposcarus*), six species of Balistidae, and 11 species of Serranidae as being present in Mangareva. The high frequency of these taxa in our samples probably reflects the dominance of these fishes in the inshore and benthic habitats of the Mangarevan marine environment. Several other taxa of inshore reef fishes are also present, including moray eels (Muraenidae), convict tangs (Acanthuridae, probably including at least one species of *Naso*), wrasses (Labridae), emperors (Lethrinidae), and the spiny puffer (*Diodon hystrix*). Only one specimen of a pelagic fish was represented, a fragment of dentary tentatively identified as *Acanthocybium solandri*, the wahoo. Sharks and/or rays were represented by some small teeth and by the distinctive vertebrae.

The fish bone assemblage from the Onemea site is both smaller and less diverse than that from Nenega-Iti (Table 5.12). The samples from the two test pits are also very different in composition (as were the molluscan assemblages). The TP-1 sample is heavily dominated by parrotfish, which are indeed abundant in the inshore waters along the western coastline of Taravai Island. In TP-2, the sample is dominated by elasmobranch teeth and vertebrae. Much of this material derives from the Layer III deposit also containing a high density of bird bones. The 98 elasmobranch vertebrae and 23 teeth from Layer III in TP-2 probably derive from a single individual of very small shark.[4]

TABLE 5.11 Identified fishbone from Nenega-Iti rockshelter (Site 190-02-AGA-3).

Taxon	Layer I	Layer II	Layer IIIA	Layer IIIB	Total NISP	% Total
Elasmobranchii vertebrae	1				1	0.7
Lamiformes (shark) teeth	2				2	1.4
Muraenidae			3	1	4	2.9
Acanthocybiidae				1	1	0.7
Serranidae	2	4	11	7	24	17.5
Lethrinidae		1			1	0.7
Labridae	2	2	4	3	11	8.0
Scaridae	2	2	24	23	51	37.2
Acanthuridae			6		6	4.4
Diodontidae			7	2	9	6.6
Balistidae		3	15	8	26	19.0
Ostraciidae				1	1	0.7
Totals	9	12	70	46	137	

TABLE 5.12 Identified fishbone from the Onemea site (Site 190-12-TAR-6).

Taxon	Test Pit 1				Test Pit 2			
	Layer I	Layer II	Total NISP	% Total	Layer II	Layer III	Total NISP	% Total
Elasmobranchii vertebrae	12		12	16.9	21	98	119	78.8
Lamniformes teeth					2	23	25	16.5
Serranidae	2	4	6	8.4	1		1	0.7
Lethrinidae	3		3	4.2				
Labridae	1	1	2	2.8	2		2	1.3
Scaridae	32	14	46	64.8	2	1	3	2.0
Diodontidae	1		1	1.4				
Balistidae		1	1	1.4	1		1	0.7
Totals	51	20	71		29	122	151	

In order to assess whether there were any significant changes in the sizes of fish being taken by the inhabitants of the Nenega-Iti and Onemea sites over time, we measured the vertebral centra from these assemblages. (Following Reitz and Wing [1999], this assumes that the samples of vertebrae provide a representative cross section of fish being taken.) Results are given in Table 5.13. Although there appears to be a slight increase in the size of fish in Layer I of the Nenega-Iti site relative to the lower layers, the sample size is small and statistically not significant. There is no statistically significant difference between the two layers at Onemea TP-1. There is, however, a statistically significant difference between the mean vertebral sizes in the two sites, with the fish at Onemea being generally larger. This may reflect the marine habitats in proximity to the two sites, with Onemea having access to deeper waters and the Nenega-Iti site being fronted by a large expanse of shallow water. In any event, there is no indication from this admittedly small sample for any size reduction in fish over time at either site, which is consistent with the evidence from the molluscan assemblages.

TABLE 5.13 Diameters of fish vertebral centra from Nenega-Iti and Onemea sites.

Site and Layer	Mean Diameter	Standard Deviation	N
Nenega-Iti			
Layer I	6.96	3.40	19
Layer IIIA	5.14	3.33	33
Layer IIIB	5.30	2.86	35
Onemea TP-1			
Layer I	8.61	2.38	64
Layer II	8.57	1.86	105

CONCLUSIONS

While the faunal samples analyzed here are admittedly small in size, they do begin to provide some indication of certain aspects of the pre-contact Mangarevan subsistence economy and environment. One salient conclusion deriving from our analysis, as well as that of Green and Weisler (2004), is the overwhelming emphasis on marine as opposed to terrestrial resources. Only in the deepest layers at Onemea and Nenega-Iti are any appreciable quantities of wild terrestrial resources represented, in this case by a number of indigenous seabirds and a native pigeon. As was the case in many other Pacific islands (Steadman 1989, 1995, 1997), nesting populations of seabirds in Mangareva were probably decimated within a few decades after the arrival of humans, as a consequence of direct predation combined with the effects of human-introduced rats.[4]

Domestic pigs and dogs were clearly present in Mangareva prehistorically but, on the available evidence, were never abundant and seem to have been eliminated prior to European contact. Kirch, drawing upon comparative cases including Tikopia, Mangaia, and Mangareva, suggests that under conditions of small-island resource limitation, high human population density, and competition for resources, "pigs and humans eventually came into a situation of direct *trophic competition*" (2000b:438). On small islands where horticulture is a critical component of the subsistence economy, pigs must be kept penned so that they do not devastate gardens and will need to be fed a certain quantity of carbohydrate foods that otherwise could be consumed by their human keepers. The fact that more than half of the pig bones recovered by Green in 1959 came from a *marae* site on Kamaka Island suggests that pork was an elite or ritually charged food, and not an item of daily consumption. Nonetheless, the ethnographic record makes it clear that pigs had been eliminated from Mangareva by the time of European arrival.

At the same time that the faunal record speaks to the extreme limitation of terrestrial protein sources, there is no indication in our data thus far to support an interpretation of increasing stress on marine resources over time. Samples of measured mollusks and fish vertebrae from our sites do not display statistically significant size reductions over time, as would be expected if there had been appreciable resource depression. It seems likely that the extensive reefs and lagoon of Mangareva—which are vastly greater than the small area of land, especially arable land—were more than sufficient to provide protein resources to the Mangarevan population, even at its maximum level. Thus the small spatial extent of the high islands was most likely the key limiting factor to Mangarevan population growth and density.

The zooarchaeological assemblages have also provided important new data on environmental changes during the period of human occupation of the Mangareva islands. Most significant is the discovery of a rich avifauna from the basal deposits of the Onemea site, from which we now have a good indication of what the islands' bird life may have been like at the time of initial human colonization. As described in detail in Chapter 6, eight species of seabirds (including petrels, shearwaters, the red-tailed tropic bird, white tern, and brown noddy) and an undescribed species of large pigeon (*Ducula* sp.) were recovered from just a single 1-m^2 test pit. Combined with the bird bones identified by Steadman and Justice (1998) from Green's 1959 excavations, we now know that the pre-human avifauna of Mangareva comprised at least 19 species, including seven petrels, two tropic birds, two frigatebirds, one heron, one wading bird, three noddies, and three pigeons (see Chapter 6). Given the still limited sample sizes (and the fact that Green's excavations used large-mesh sieves), it is probable that this list will be expanded through further excavation. Nonetheless, it is now evident that Mangareva shared the same kind of massive avifaunal extinction that occurred on many other central Pacific islands following human colonization.

Other hints of environmental changes also emerge from the faunal record. The presence of what has tentatively been identified as the pincers of a terrestrial crab in the Onemea site, may also represent an extinct species, although this remains to be verified. The land snail record indicates the prehistoric introduction of two species, *Allopeas gracile* and *Lamellidea oblonga*, both known to have been transported by Polynesians on their inter-island voyages. *Allopeas gracile* is present from the basal deposits at Onemea, and thus its introduction may date to the initial human colonization of Mangareva. Reductions in endemic land snails, especially *Gambiodonta* cf. *grandis*, in the upper stratigraphic levels of several sites may be correlated with habitat change and reductions in native forest.

CHAPTER 5 ENDNOTES

[1] Unfortunately, all of the faunal materials from the Kamaka (KAM-2) rockshelter, along with the vertebrate samples from the Atiaoa (ATA-1) rockshelter, were lost during shipment to Dr. David Steadman of the University of Florida (Gainesville) in early 2002. Therefore, the analyses here are limited to molluscan fauna from three sites and vertebrate fauna from two sites.

[2] In this chapter, we present only weight and MNI data for molluscan fauna, and have summarized these by stratigraphic layers corresponding to site stratigraphy as given in Chapter 3. Additional data, including NISP counts by individual excavations levels within stratigraphic units, are provided in Howard (2004).

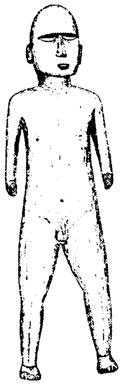
[3] Due to Green's use of larger-meshed screens, the numbers of rat bones are probably under-represented in his samples.

[4] It is not clear that this represents a human-caught shark. Given the small size of the individual represented, it could represent the prey of one of the larger seabirds whose bones are also abundant in this deposit.

CHAPTER 6

AVIFAUNAL ASSEMBLAGES FROM THE NENEGA-ITI AND ONEMEA SITES

T.H. Worthy and A.J.D. Tennyson



This chapter presents the results of identification and analysis of bird bones recovered from archaeological sites on Taravai and Agakauitai islands in 2003. There is one previous study on the archaeological bird bones on the Gambier Islands, from the five sites excavated by R.C. Green in 1959 on the islands of Mangareva, Aukena, and Kamaka (Steadman and Justice 1998). They identified 215 bird bones, representing 15 species of seabird, three species of resident landbird, a migrant shorebird, and the chicken *Gallus gallus* (Linnaeus, 1758). They concluded that of the 18 certain or presumed resident species, at least four and perhaps as many as eight, no longer occurred at the island group.

METHODS

This study examines bones excavated at two sites, Nenega-Iti and Onemea on Agakauitai and Taravai islands, respectively, by P. Kirch and E. Conte in August 2003. Details of the test excavations at these sites are given in Chapter 3.

COMPARATIVE MATERIALS

Bones were identified using comparative material in the Museum of New Zealand Te Papa Tongarewa (MNZ).

Abbreviations: L, left, R right, p proximal, s shaft and d is distal parts of bone, pt part, ant anterior, frag fragment; Elements: cmc carpometacarpus, cor coracoid, fem femora, hum humerus, mand mandible, pmx premaxilla, quad quadrate, scap scapula, tt tibiotarsus, tmt tarsometatarsus, stern sternum, vert vertebra. For coracoids, the humeral end is designated proximal and the sternal end distal, p and d respectively.

The identifications follow: Murphy's Petrel *Pterodroma ultima* (Murphy, 1949): MNZ 24403 Ducie Island; Kermadec Petrel *P. neglecta* (Schlegal, 1863): MNZ 11423 Kermadec Islands; Herald Petrel *P. heraldica* (Salvin, 1888) or Henderson Petrel *P. atrata* (Mathews, 1912): MNZ 24691 Henderson Island; Hawaiian Petrel *P. phaeopygia sandwichensis* (Ridgeway, 1884) MNZ 22367 Hawaii; Black-winged Petrel *P. nigripennis* (Rothschild, 1893): MNZ 13708 North Island, New Zealand; Bulwer's Petrel *Bulweria bulweria* (Jardine & Selby, 1828) MNZ

22145 Laysan Island, Hawaii; Tahiti Petrel *Pseudobulweria rostrata* (Peale, 1848): MNZ 23900 North Island, New Zealand; Wedge-tailed Shearwater *Puffinus pacificus* (Gmelin, 1789): MNZ 27271 New Caledonia; Christmas Island Shearwater *P. nativitatis* (Streets, 1877): MNZ 19307 North Island, New Zealand; Red-tailed Tropic bird *Phaethon rubricauda* (Boddaert, 1783): MNZ 16056 Kermadec Islands; Crested Tern *Sterna bergii* (Lichtenstein, 1823): MNZ 23879 Australia; Brown Noddy *Anous stolidus* (Linnaeus, 1758): MNZ 24593 Henderson Island, MNZ 25348 Niue; Black Noddy *A. minutus* (Boie, 1844): MNZ 24246 Kermadec Islands; White Tern *Gygis alba* (Sparrman, 1786): MNZ 23587 North Island, New Zealand, MNZ 23894 North Island, New Zealand. *Ducula goliath* (G.R. Gray, 1859), New Caledonian imperial pigeon, MNZ 22839, 3 mixed individuals, New Caledonia; *Ducula galeata* (Bonaparte, 1855), Marquesan imperial pigeon, MNZ 26971, cast of selected elements of BMNH S/1975.9.5; *Ducula lakeba* (Worthy, 2001); R tmt, Fiji Museum, Archaeology Dept, bone numbered '197-3-w-1-6, 6', cast of type, MNZ S38899. Henderson Island *Ducula*: MNZ S41609, R tmt; MNZ S41715, dR tmt; MNZ S41653, 1dL tmt.

Specimens the size of, but not definitely referable to, a taxon are prefixed with *magn*. Some elements of *Gygis alba* and *Anous minutus* are very similar, but since all identifiable elements in the Mangareva sample are *Gygis*, the rest are referred to as cf. *Gygis alba*.

RESULTS

The following is a complete listing of all identified and unidentified bird bones from the Onemea and Nenega-Iti sites, listed by field sample number. A summary of all bones, by stratigraphic unit, is provided in Table 6.1.

Onemea Site

Sample 8, Layer II, Level 3, TP (test pit) -2, Onemea site, 19 August 2003. Coll P. Kirch et al.: Procellariid sp. *magn*., *Pt. ultima*: 1 proximal pt R hum.

Sample 14, Layer II, Level 4, TP-2, Onemea site, 19 August 2003. Coll P. Kirch et al. Procellariid sp. cf. *Pseudobulweria*: 1dL fem, 1sR tt.

Sample 20, Layer II, Level 5, TP-2, Onemea site, 19 August 2003. Coll P. Kirch et al. *Ducula* sp.: 1p+sR tmt, 1pL fem. Indeterminate: 7 bone frags.

Sample 22, Layer II, Level 6, TP-2, Onemea site, 19 August 2003. Coll P. Kirch et al. *Gygis alba*: 1pR cor, cf. *Gygis alba* 1 ant stern. Procellariid sp. cf. *Pseudobulweria*: 1pR hum, 1L cor, 1pL tmt. Indeterminate: 2 bone frags.

Sample 28, structure 1, TP-2, Onemea site, 19 August 2003. Coll P. Kirch et al. *Gygis alba*: 1dR tt.

Sample 31, Layer II, Level 7, TP-2, Onemea site, 19 August 2003. Coll P. Kirch et al. *Gygis alba*: 1dL tt, 1L tmt; cf. *Gygis alba*: 1dL2dR cor, 1L1R scap, 1 ant stern. Procellariid sp. cf. *Pseudobulweria*: 1L scap, 1R quad, 1 vert. Indeterminate: 1 bone frag.

Sample 33, Layer III, Level 8, TP-2, Onemea site, 19 August 2003. Coll P. Kirch et al. *Gygis alba*: 1L2R os dentaries, 2R2L articular ends mand., 1L1pL 1R cor, 2dL2dR tt, 1 p+s R tmt; and cf. *Gygis alba*: 2 ant stern, 1 pmx, 1 mand tip, 1L1R scap,. 1dL2dR cor. *Puffinus nativitatis*: 1L cor, 1d+sL tt, 1R scap. Procellariid sp. cf. *Pseudobulweria*: 1 pmx, 1 pt cran, 1 ant stern, 1dL tt, 1L1R 1 pt R cor, 1dL ulna, 1pL fem. *Phaethon rubricauda*: 1L1dR juv fem. *Ducula* sp.: 1L manus phal 2.1. Indeterminate: many bone frags.

Sample 35, Layer III, Level 8 bank, TP-2, Onemea site, 19 August 2003. Coll P. Kirch et al. *Gygis alba*: 1pL hum, 1R tt, 1L1R cor; cf. *Gygis alba*: 1L1R scap, 1 ant stern. *Puffinus nativitatis*: 1d+sR tt, 1R tmt, 1 ant stern, 1R quad. Procellariid sp. cf. *Pseudobulweria*: 1R1sL1dL tt, 1L1R tmt, 1R cor, 1R quad, 1p+sL ulna, 1 pmx, 3L1R artic pt mand, 1L1R os dentaries, 1L palatine. *Phaethon rubricauda*: 1L tmt, 3 vert. Indeterminate: many bone frags.

Sample 39, Layer III, Level 9, TP-2, Onemea site, 19 August 2003. Coll P. Kirch et al. *Gygis alba*: 1L2R cor; cf. *Gygis alba*: 1R scap, 1 ant stern. *Puffinus nativitatis*: 1L2R cor, 2L1R scap, 2 ant stern, 1R tmt, 1dR tt, 1R1d+sL fem. *Puffinus pacificus*: 1R tmt, 1dR tt; cf. *Puffinus pacificus*: 1L1R

TABLE 6.1 Summary of bird bone identifications from Onemea site and Nenega-Iti rockshelter, by stratigraphic unit. In the totals column total number of identified bones for each unit is given followed by, in brackets, the Minimum Number of Individuals represented in each unit. The addition of the specimens listed under 'cf. *Gygis alba*' and '*Puffinus* cf. *pacificus*' are most probably these taxa and do not alter the MNI calculation for those taxa so MNI is not calculated for them.

Taxa	Onemea Site		Nenega-Iti Site	Total Specimens
	Layer II	Layer III	Layer III	
Pterodroma magn. Pt heraldica		5 (2)	2 (1)	7 (3)
Pterodroma magn. Pt ultima	1 (1)			1 (1)
Procellariid sp. cf. *Pseudobulweria*	8 (1)	51 (5)	10 (3)	69 (9)
Puffinus pacificus		2 (1)		2 (1)
Puffinus cf. P. pacificus		3		3
Puffinus nativitatis		19 (3)		19 (3)
Phaethon rubricauda		15 (1)		15 (1)
Gygis alba	4 (2)	22 (4)		26 (6)
Tern cf. *Gygis alba*	6	14		20
Anous stolidus			1(1)	1 (1)

scap, 1pR fem. *Pterodroma magn. Pt. heraldica*: 1L2R cor, 1 ant stern, 1dR fem. Procellariid sp. cf. *Pseudobulweria*: 3L1R cor, 1 ant stern, 3L1R scap, 1L os dentary, 1 fur, 1 pt cran, 2 pmx, 1R1L1dL tt, 3L quad, 1R fem, 2dL1pL tmt. *Phaethon rubricauda*: 1L cor, 1L scap, 6 vert, 1L tmt. Indeterminate: many bone frags.

Sample 41, Layer III, Level 10, TP-2, Onemea site, 19 August 2003. Coll P. Kirch et al. Procellariid sp. cf. *Pseudobulweria*: 1R quad, 1 pterygoid.

NENEGA-ITI SITE

Sample 54, Layer III, Level 4, TP-1, Nenega-Iti rockshelter site, 21 August 2003. Coll P. Kirch et al. Procellariid sp. cf. *Pseudobulweria*: 1L cmc. Indeterminate: 1 bone frag.

Sample 63, Layer III, Level 5, TP-1, Nenega-Iti rockshelter site, 21 August 2003. Coll P. Kirch et al. Procellariid sp. cf. *Pseudobulweria*: 1dL cmc. Indeterminate: 1 bone frag.

Sample 75, Layer III, Level 6, TP-1, Nenega-Iti rockshelter site, 21 August 2003. Coll P. Kirch et al. Procellariid sp. cf. *Pseudobulweria*: 1sL hum

Sample 86, Layer III, Level 7, TP-1, Nenega-Iti rockshelter site, 21 August 2003. Coll P. Kirch et al. Procellariid sp. cf. *Pseudobulweria*: 2pR 1dL hum. *Pterodroma* sp. magn. *Pt. heraldica*: 1L cmc, 1dL tmt. Indeterminate: 12 bone frags.

Sample 92, Structure 2, TP-1, Nenega-Iti rockshelter site, 21 August 2003. Coll P. Kirch et al. Procellariid sp. cf. *Pseudobulweria*: 1pR hum, 1dL ulna, 1dR tmt. Indeterminate: 3 bone frags.

Sample 94, Layer III/IV, interface, TP-1, Nenega-Iti rockshelter site, 21 August 2003. Coll P. Kirch et al. Procellariid sp. cf. *Pseudobulweria*: 1 frag pR tmt. *Anous stolidus* 1pLradius.

SPECIES ACCOUNTS

FAMILY PROCELLARIIDAE

PTERODROMA SP. GADFLY PETREL

The remains of at least four individuals, representing probably two medium-sized species, are represented in the Mangareva archaeological sites. Several medium-sized *Pterodroma* species breed in the eastern tropical Pacific (Pratt et al. 1987; Brooke 1995), most of which are poorly represented in comparative recent skeleton collections, which makes specific identification of fragmentary bones difficult.

From sample 8 at Onemea, a single proximal part of a humerus is from a species the size of Murphy's Petrel *Pterodroma ultima* or Kermadec petrel *P. neglecta*. We suspect that the remains are of Murphy's petrel, which is the only species of *Pterodroma* known to breed at the Gambier Island group (BirdLife International 2000). Other bones from samples 39 and 86 are from a slightly smaller *Pterodroma*—the size of Herald Petrel *P. heraldica*, Henderson petrel *P. atrata* or Phoenix petrel *P. alba* (Gmelin, 1789). Of these, similarly sized species (Murphy and Pennoyer 1952; Brooke and Rowe 1996), Herald and Phoenix petrels have the most widespread breeding distributions in the eastern tropical Pacific, and the Gambier Islands fall within the boundaries of their known breeding ranges (Murphy and Pennoyer 1952; Brooke 1995), while the Henderson petrel is confirmed breeding only at the Pitcairn Group (Brooke 1995; BirdLife International 2000). While it seems most likely that the remains represent one of the two more widespread species, it has been suggested that Henderson petrels could be breeding at the Gambier Islands (BirdLife International 2000). Without further information, we are unable to suggest a specific identity for the smaller *Pterodroma* taxon. Steadman and Justice (1998) recorded "at least two species" of "medium to large-sized forms of *Pterodroma*" in the archaeological remains on Aukena and Kamaka islets.

PSEUDOBULWERIA *SP.* PETREL

The majority of petrel bones (representing at least nine individuals) in the Mangareva sites comes from a single taxon about the size of *Pterodroma heraldica*, which we refer to as cf. *Pseudobulweria*. *Pseudobulweria* is known from three poorly known species in the Pacific: the Tahiti petrel *P. rostrata* a widespread (Solomon to Marquesas) taxon (Murphy and Pennoyer 1952); Beck's Petrel *P. becki* (Murphy, 1928) known from only two specimens taken at sea off the Solomon Islands (Murphy & Pennoyer 1952); and the Fiji petrel *P. macgillivrayi* (Gray, 1859) represented by only three specimens from Gau, Fiji (Watling & Lewanavanua 1985; BirdLife International 2000). *Pseudobulweria becki* and *P. macgillivrayi* are much smaller than *P. rostrata*, and their extreme rarity makes comparison of the Mangarevan bones with them difficult.

The Mangareva bones are referred to *Pseudobulweria* and not to *Pterodroma* on the basis of comparisons with *P. rostrata* because of the following features: skull with relatively narrow frontal-lacrymal complex relative to premaxilla hinge width (hinge relatively narrow in *Pterodroma*), premaxilla hinge without evidence of nasal bar (nasal bar is a centrally placed bone at hinge marked by unfused sutures in *Pterodroma*), nares short relative to distance from hinge to nares (nares more elongate in *Pterodroma*), medial nasal bar arises abruptly from culmen (less abrupt in *Pterodroma*), coracoid short relative to tarsometatarsus length and with acrocoracoid much deeper than wide at end (coracoid longer, and acrocoracoid depth and width more even in *Pterodroma*), sternum with the dorsal articular facets forming lobes with a rounded notch between them anteriorly (no broad rounded notch in *Pterodroma*), *Pseudobulweria* wing bones with relatively slender ends for their length, humerus with impression for the *brachialis anticus* within the brachial fossa well-defined distally and nearly circular (not defined so well distally and more oval in *Pterodroma*), ulna with a notch ventrally on the carpal tuberculum (not in *Pterodroma*), carpometacarpus with robust pisiform process (small in *Pterodroma*), tarsometatarsus relatively elongate with strongly elevated lateral and medial ridges both dorsally and plantarly, and hypotarsal structure unique in that the middle and lateral ridges are coalesced such that only two ridges are apparent in plantar view (*Pterodroma* relatively shorter, ridges less developed, and hypotarsus with three discrete ridges).

The Mangareva bones differ from *P. rostrata*, apart from being much smaller, in the following features. The premaxilla has a deeper notch caudally above the junction with the quadrateojugal, distally on the ulna the carpal tuberculum is notched at its base rather than developed into a distinct distally directed hook, the tarsometatarsus hypotarsal structure differs in that in *P. rostrata* the middle ridge is coalesced at its base distally and both the middle and lateral ridge are capped plantarly by a bony bridge. In the Mangareva specimens, the middle ridge is lost entirely.

PUFFINUS PACIFICUS *WEDGE-TAILED SHEARWATER*

The remains of at least one individual are represented in the Mangareva archaeological sites. This species occurs throughout the tropical Indian and Pacific oceans but has breeding colonies at only scattered locations (Pratt et al. 1987). It is known to breed in the Gambier Islands on Manui and possibly Makaroa (Lacan and Mougin 1974). Steadman and Justice (1998) recorded its archaeological remains on Kamaka Islet.

PUFFINUS NATIVITATIS
CHRISTMAS ISLAND SHEARWATER

The remains of at least three individuals are represented in the Mangareva archaeological sites. This tropical species has a wide breeding distribution in the eastern Pacific, including Hawaii, Kiribati, Marquesas, Samoa, Tuamotu (including the Gambier Islands), Tubuai, Pitcairn, Easter and Sala y Gomez Island groups (Pratt et al. 1987; Taylor and Tennyson 1994). In the Gambier Islands, it is recorded breeding on Motu Teiku and Manui, and possibly Makaroa (Lacan and Mougin 1974). Steadman and Justice (1998) recorded its archaeological remains on Aukena and Kamaka islets.

FAMILY PHAETHONIDAE

PHAETHON RUBRICAUDA *RED-TAILED TROPICBIRD*

The remains of at least one individual are represented in the Mangareva archaeological sites. This tropical species has a widespread breeding distribution, including the Gambier Islands (Pratt et al. 1987) and is easily distinguished from its much smaller congener, the White-tailed tropicbird *P. lepturus* (Daudin, 1802). Note that we have not been able to compare the bones with those of the equally large Red-billed tropicbird *Phaethon aethereus* (Linnaeus, 1758), which is much less common in this region but which may currently breed as close as the Marquesas group (Pratt et al. 1987). Steadman and Justice (1998) recorded the archaeological remains of Red-tailed tropicbirds on Aukena and Kamaka islets.

FAMILY LARIDAE

GYGIS ALBA *WHITE TERN*

This was the second most common species (remains of at least six individuals) represented in the Mangareva archaeological sites. Referred to as *G. candida* by Steadman and Justice (1998), the white tern has many described, but poorly defined, subspecies and is one of the most widespread species in the tropical Pacific (Higgins and Davies 1996). Steadman and Justice (1998) recorded its archaeological remains on Kamaka Islet. Its wing bones are of similar size to those of *Anous minutus* but features of the bill, humerus, and coracoid at least, are qualitatively different, and the leg bones are far smaller, allowing it to be easily distinguished.

ANOUS STOLIDUS *BROWN NODDY*

The Brown noddy is represented by one bone in the Mangareva archaeological sites. This species occurs throughout the world's tropical oceans (Pratt et al. 1987). It is known to breed in the Gambier Islands (Lacan and Mougin 1974). Steadman & Justice (1998) recorded its archaeological remains on Kamaka Islet.

FAMILY COLUMBIDAE

A proximal and shaft of a tarsometatarsus, a proximal femur, and a L manus phal 2.1 are from a *Ducula* species. The tarsometatarsal morphology of *Ducula* is very different from that of *Gallicolumba* (Worthy 2001; Worthy and Wragg 2003). These specimens are not referable to the similar sized *Gallicolumba nui* (to which a humeral end of a coracoid and a shaft of a tibiotarsus from Kamaka Islet were referred by Steadman and Justice (1998)). The tarsometatarsus is of similar length to that of *Ducula galeata* but is considerably more robust. It is shorter and relatively more robust than tarsi of the Henderson pigeon (Worthy and Wragg, in press) and *D. lakeba* from Fiji (Worthy 2001), and has similar proportions to *D. david*, so far described only from the holotype from Uvea (Balouet and Olson 1987). These bones represent a further species of large fruit pigeon for which the fossil record is revealing now extinct taxa in most island groups across Polynesia from New Caledonia to the Marquesas (Steadman 1997; Worthy 2001; Worthy and Wragg, in press).

DISCUSSION

We identified 166 bones, representing 9 species (mainly seabirds), in the archaeological bird fauna of Mangareva. Most of the species that we recorded in the archaeological sites on Mangareva are species that would be expected, based on their known distributions.

There are two outstanding species represented in the deposits. The most common is apparently a species of *Pseudobulweria* petrel. No species of *Pseudobulweria*, of the size of the bones in this deposit, are known from the eastern Pacific, and it is likely that the remains represent an unknown species. The other unusual species is a *Ducula* pigeon, represented by three bones of at least one individual. No *Ducula* pigeons were previously known from the Gambier group, and it appears that these bones represent an extinct species.

Steadman and Justice (1998) recorded 12 species that we did not: Short-tailed shearwater *Puffinus tenuirostris* (Temminck, 1835), Audubon's Shearwater *P. lherminieri* (Lesson, 1839), Polynesian storm petrel *Nesofregetta fuligonosa* (Gmelin, 1789), White-tailed tropicbird, Great frigatebird *Fregata minor* (Gmelin, 1789), Lesser frigatebird *Fregata ariel* (Gray, 1845), Reef heron *Egretta sacra* (Gmelin, 1879), Chicken, Bristle-thighed curlew *Numenius tahitiensis* (Gmelin, 1879), Blue-gray noddy *Procelsterna cerulea* (Bennet, 1840), Society Islands ground-dove *Gallicolumba erythroptera* (Gmelin, 1789), and Giant ground-dove *Gallicolumba nui* (Steadman, 1992).

It would be an unusual occurrence if migrating short-tailed shearwaters had been harvested while en route on a migrant passage, because they would have been present for only a very short time in the waters around the Gambier Group. It seems likely that this record should be reassessed. In light of our determination of some bones as coming from a hitherto unknown *Pseudobulweria* species, we suspect that the bones Steadman and Justice (1998) identified from Aukena Islet as cf. Jouanin's petrel *Bulweria* cf. *fallax* (Jouanin 1955) could be the same species as our *Pseudobulweria*. Similarly, the identity of all previously reported procellariid bones needs to be reassessed, but because of the likelihood of occurrence of several similar-sized *Pterodroma* species, these remains may never be able to be assigned to a single species. Large forms of both *Ducula* and *Gallicolumba* are known from both the Marquesas (Steadman 1997) and Henderson Island (Worthy and Wragg 2003), so the presence of both a large *Ducula*, such as we report, and a large *Gallicolumba* (Steadman and Justice 1998) would not be surprising in the Gambier group also.

Thus the total archaeological bird fauna from the Gambier Islands is now known to contain at least seven petrels, two tropicbirds, two frigatebirds, one heron, the chicken, one wading bird, three noddies, and three pigeons. Of these 20 species, one *Pterodroma* petrel, two frigatebirds, and a ground-dove may be locally extinct (Steadman and Justice 1998) and another ground-dove (Steadman and Justice 1998), the *Pseudobulweria* petrel, and the *Ducula* pigeon may be globally extinct.

CHAPTER 7

Material Culture and Geochemical Sourcing of Basalt Artifacts

M.I. Weisler, E. Conte, and P.V. Kirch

In the course of our two field seasons, a variety of portable artifacts were recovered from the test excavations at several sites, and a number of adzes and flaked stone debitage were surface collected. In addition, in 2001 we studied and photographed 31 stone adzes in the collection of the Gambier Commune (housed in the Mairie of Rikitea) or in other private collections. In this chapter we report on both sets of materials, along with the results of the geochemical analysis of several adzes and flaked stone.

Portable Artifacts from Test Excavations

Our test excavations at Rikitea (TP-3), Atiaoa (190-06-ATA-1), Akamaru (TP-1), Kamaka (190-04-KAM-2),Onemea (190-12-TAR-6), and Nenega-Iti (190-02-AGA-3) yielded a collection of 507 portable artifacts, as enumerated in Table 7.1. The vast majority of these consist of flakes of volcanic dikestone (N = 410, 84%).[1] The Nenega-Iti rockshelter yielded the greatest quantity of materials related to fishhook manufacture and use, including hooks, worked pearlshell, and *Acropora* coral files.

Fishhooks

Fourteen fishhooks, mostly consisting of incomplete or fragmentary examples (including preforms), were recovered from the excavations, nine of these at Nenega-Iti rockshelter. Table 7.2 provides a list of specimens with diagnostic measurements, and several hooks are illustrated in Figure 7.1. All hooks are of pearlshell (*Pinctada margaritifera*) and were presumably manufactured with files of *Acropora* coral branches, which were also recovered at the sites. The hooks vary considerably in size, the largest and smallest measurable hooks having shank lengths of 37.7 and 13.5 mm, respectively. These size differences presumably reflect differences in prey capture strategies; the large hooks may have been intended for benthic fishing in the deep lagoon or on the outer reef slope, whereas the small hooks may have been more effective for angling off of rocky shelves or on reef flats. Stylistically, most of the hooks are too fragmentary to determine a typology (and, of course, the sample is limited), but it appears that most if not all of the hooks had recurved points. The most common head type (line-lashing device) is a knob, although one large hook has a simple notch. To the extent

TABLE 7.1 Portable artifacts from test excavations.

Artifact Category	Rikitea TP-3	Atiaoa (190-06-ATA-1)	Akamaru TP-1	Kamaka (190-04-KAM-2)	Onemea (190-12-TAR-6)		Nenega-Iti (190-02-AGA-3)
					TP-1	TP-2	
Fishhooks (including fragments and preforms)	1	2	1			1	9
Worked pearlshell		5		2			47
Whole pearlshell						1	1
Pearlshell disc					1		
Bone needles/awls					1		1
Acropora coral files		2		2	4	1	11
Pounders		1					1
Lithic flakes/blades		NA		NA	211	37	162
Manuports							2
Totals	1	10	1	4	217	40	234

NA = material not analyzed.

that this small sample allows us to make comparisons, most of the hooks from the Nenega-Iti site appear to correspond with what Weisler and Green (2001, fig. 31.3) illustrate under the rubric of "early acute recurved point tip." It will be instructive to revisit the issue of Mangarevan fishhook typology, with appropriate comparisons to other early Eastern Polynesian assemblages, once a large collection becomes available through continued excavations at Nenega-Iti and other sites.

WORKED AND WHOLE PEARLSHELL

The Nenega-Iti site yielded 47 pieces of worked pearlshell, as well as one entire valve of *Pinctada margaritifera*; most of this is presumed to represent the detritus of fishhook manufacture. The Atiaoa rockshelter yielded five pieces of worked pearlshell, and the Kamaka rockshelter two small pieces. The Onemea site yielded only one entire *Pinctada* valve, and no worked fragments, which suggests that fishhook manufacture was not a common practice at this site, at least not in the area of the site tested by our two *sondages*.

PEARLSHELL DISC

From TP-1 at the Onemea site, we recovered a small, finely worked pearlshell disc or tab, nearly circular in outline, with a diameter ranging from 9.8-10.9 mm, and thickness of 1.1 mm, illustrated in Figure 7.2a. The function of this disc is uncertain, although it may have been some form of inlay, for a wooden bowl, image (an eye inlay?), or similar object.

BONE NEEDLES/AWLS

From Onemea TP-1 we recovered a large fish spine (73.5 mm long) which showed evidence of use wear or working on the distal end, probably from use as a needle or awl (Fig. 7.2, b). At the Nenega-Iti rockshelter, what appears to be a rib bone of a larger mammal (pig, or possibly human?) has been cut and shaped to a point at one end; it might have functioned as a thatching needle (Fig. 7.3). This object measures 94.9 mm long.

TABLE 7.2 Fishhooks from test excavations.

Object No. (Illustration)	Type	Shank Length	Shank Diam.	Hook Width	Point Height	Comments
Rikitea, TP-3-2 (Fig. 7.1, f)	Possible preform					Uncertain if a hook or other type of object; 42 mm long
190-06-ATA-1-13	Shank with head frag.		2			Knobbed head
190-06-ATA-1-27	Preform					Roughly circular, 30x29 mm, 3 mm thick
Akamaru, TP-1-15	Point and bend frag.				15	Point diam. 2 mm
190-02-3-TP-1-2 (Fig. 7.1, c)	Bend frag.		3	18.5		Shank has circular cross-section
190-02-3-TP-1-3 (Fig. 7.1, e)	Unfinished preform frag.					Shank frag. 18 mm long
190-02-3-TP-1-1b	Head frag.					Knobbed head, prob. Unfinished
190-02-3-TP-1-27 (Fig. 7.1, i)	Point frag.				26+	Point of large hook
190-02-3-TP-1-28 (Fig. 7.1, g)	Bend, preform					Bend of unfinished preform
190-02-3-TP-1-43 (Fig. 7.1, d)	Hook, missing point	37.7	3.8	23		Large hook with notched head, missing point
190-02-3-TP-1-71a (Fig. 7.1, a)	Complete hook	13.5	2	10	11.1	Knobbed head, recurved point
190-02-3-TP-1-71b (Fig. 7.1, b)	Hook, missing point	18	2.5	15.3		Knobbed head, missing point
190-02-3-TP-1-72 (Fig. 7.1, h)	3 fragments of large hook		5		28+	Knobbed head, bend frag., point frag.
190-12-6-TP-2-12	Shank/bend frag.		7.2			Frag. from a large curved shank hook

All measurements in mm.

ACROPORA CORAL FILES

A total of 20 files or abraders from the branches of *Acropora* sp. coral were excavated. Most of these came from the Nenega-Iti site, which also had the greatest evidence for fishhook manufacture in terms of hooks and worked pearlshell. The files from Nenega-Iti are illustrated in Figure 7.4. These vary in the degree of working and the wear patterns; a detailed analysis of these files may shed light on patterns of fishhook manufacture.

POUNDERS

Two food pounders were found, one each from the Atiaoa and Nenega-Iti rockshelters (Fig. 7.5). That from Atiaoa, from the upper 10 cm of Layer II, is a cobble of a generally conical form resembling that of pounders. In addition, it shows traces of what appear to be pecking around the basal periphery and top which make one think it has been intentionally shaped. It is therefore reasonable to think that this cobble was used as a pounder. Its total height is 81 mm; its

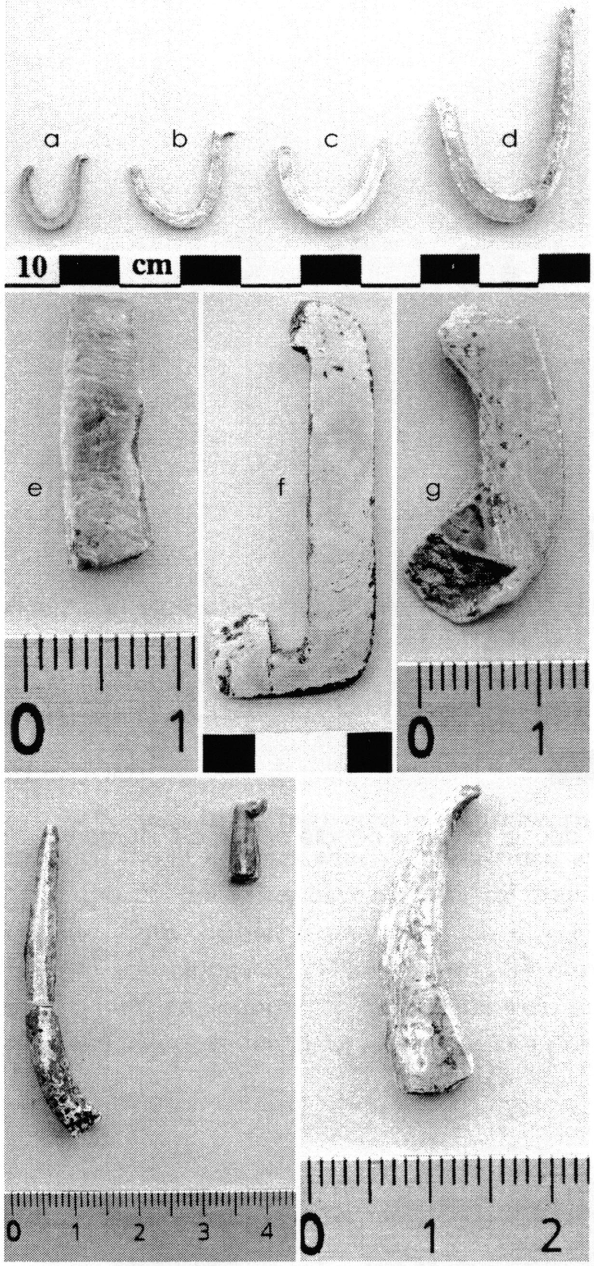


FIGURE 7.1. Fishhooks from the Nenega-Iti site and from TP-3 in Rikitea. See table 7.2 for details.

diameter (roughly oval in section) is 40 mm at the top and 65 mm at the base. It weighs 540 g.

The second specimen was found on the surface a few meters seaward of the Nenega-Iti rockshelter. This is of coral and lacks the head. In its present state it has a height of 140 mm. The base has a roughly oval form (75 mm x 65 mm) and is polished. It weighs 1,050 g. Some traces of abrasion are visible. Hiroa (1938a:218-22) describes ethnographically collected pounders from Mangareva, variously made of coral or coarse vesicular basalt, and notes that in general these "show lack of appreciation of careful shaping and finish." This specimen falls within the range of forms illustrated by Hiroa (1938a, figs. 13-15).

Lithic Flakes

Both the Onemea and Nenega-Iti sites yielded substantial quantities of flaked lithic material, primarily though not exclusively of dikestone. At Onemea, there is considerable difference in the density of lithics in TP-1 versus TP-2, which suggests the likelihood of different activity areas within the dune site.

The dikestone, which makes up more than 95% of the flakes, presumably derives from one or more of the numerous dikes which are exposed along the coasts of both Taravai and Agakauitai Island. The material at Onemea seems to come from a single source and has a dark grayish color with a slightly rough texture when flaked due to its microcrystalline structure; small whitish phenocrysts (0.5-2 mm in size) are present. The dikestone at Nenega-Iti is similar, but the phenocrysts are slightly smaller in size (<0.25 mm), and these probably derive from a different source.

The material tends to produce flakes that are either tabular or triangular shaped in cross section, and does not yield pronounced bulbs of percussion or other typical flake 'architecture'; this is characteristic of dike rock. Figure 7.6 shows a scatterplot of length and width for a sample of 70 flakes from Level 1 of TP-1 at the Onemea site. It can be seen that there is a strong tendency for flakes to be elongated (L ≥ 2xW), with quite a number of good blades with parallel sides (the line indicates the division between flakes and true blades, to the right). A few specimens show evident use-wear on one or more straight-sided edges. Our impression is that these blade-like flakes may have been used as expedient knives, scrapers, or other kinds of tools. The

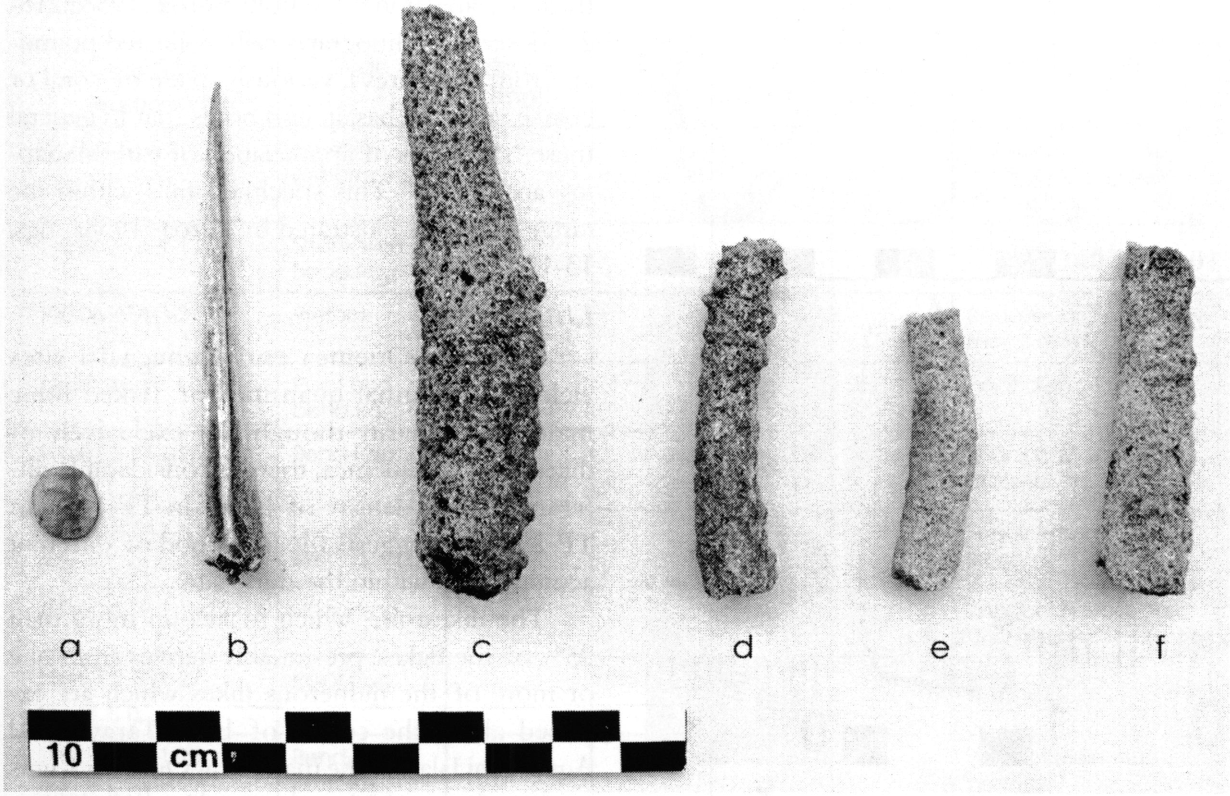


FIGURE 7.2 Artifacts from the Onemea site: a, pearlshell disc; b, fishbone needle or awl; c-f, *Acropora* coral files.

FIGURE 7.3 Worked bone object, possibly a thatching needle, from Nenega-Iti rockshelter.

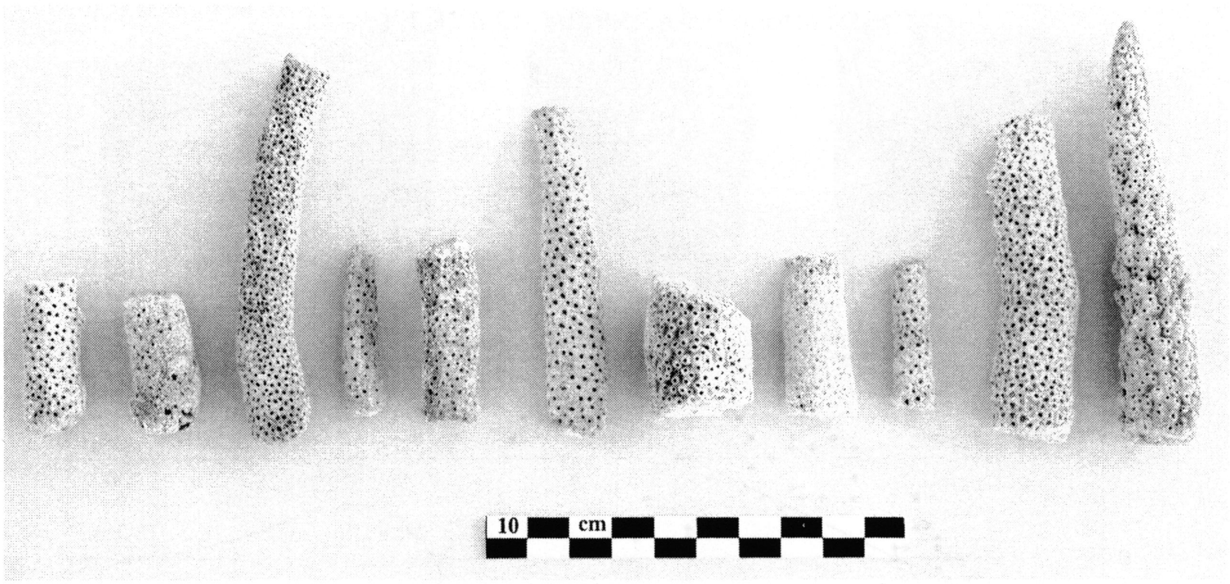


Figure 7.4 *Acropora* coral files from the Nenega-Iti site.

lithic assemblages at both sites do not appear to represent adze manufacture.

MANUPORTS

At Nenega-Iti we recovered two waterworn, rounded basalt cobbles which are classified as "manuports" since they have a geological origin off-site. One cobble, from Layer III, is very smooth and elongated (111 mm long, 44 mm max. width) and appears to have some wear or polish in places; it may have been used as a polishing or rubbing stone. The second manuport is a small volcanic pebble, 40 mm in diameter, found near the larger cobble.

MANGAREVAN AXES AND ADZES

The study of stone adzes has played a vital role in determining historical relationships between Eastern Polynesian island groups (e.g., Emory 1968), and adze types also provide a measure of temporal control for relative dating (e.g., Green and Davidson 1969:32). More re-

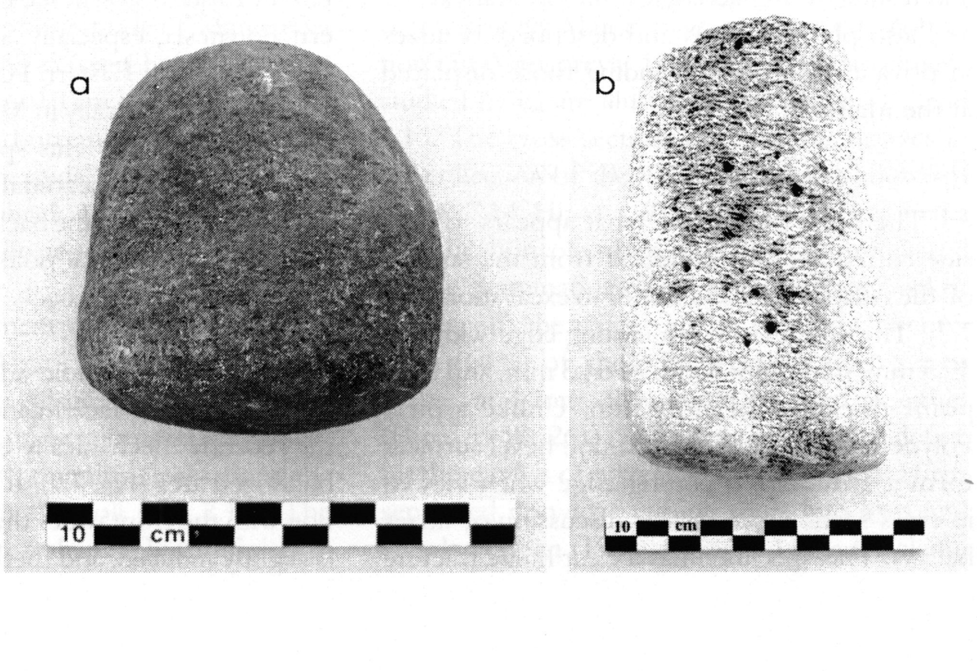


FIGURE 7.5 Pounders from the Atiaoa (a) and Nenega-Iti (b) rockshelters.

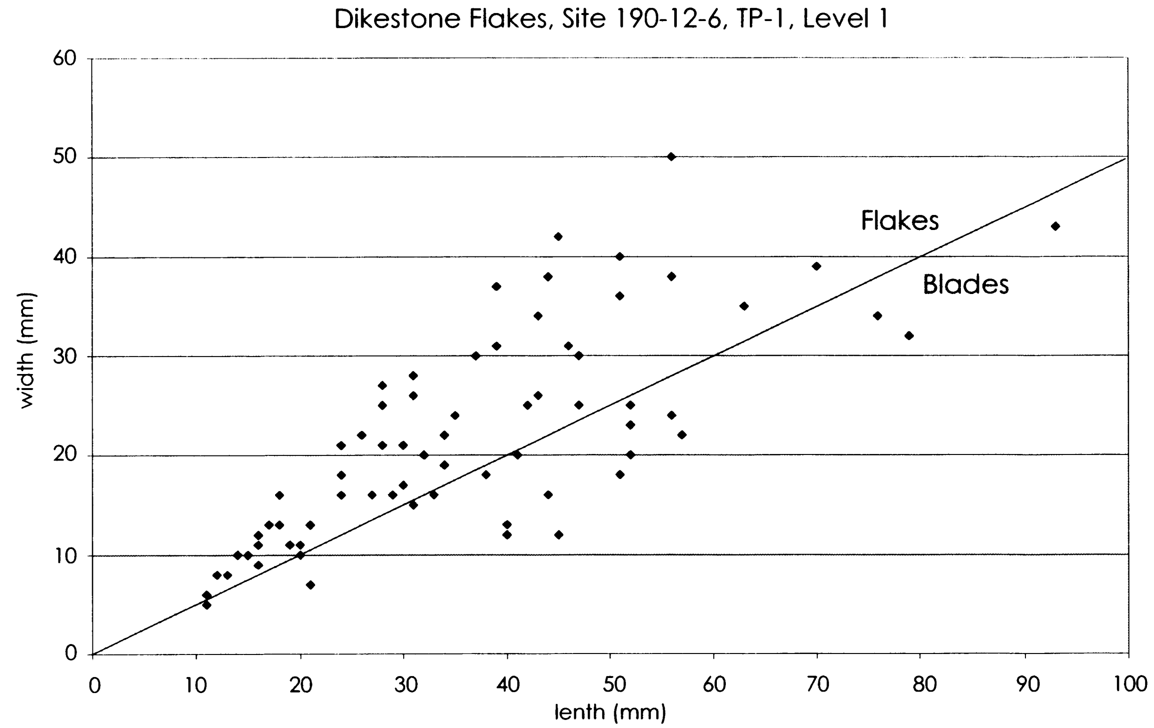


FIGURE 7.6 Scatterplot of length and width of flaked dikestone from TP-1 of the Onemea site (Level 1, N=70). Line shows distinction between flakes and blades.

cently, the geochemistry of basalt adzes found at dated habitation sites has made it possible to assign artifacts to geologic sources and therefore reconstruct ancient patterns of interaction over time (Best et al. 1992; Weisler, ed., 1997; Weisler 1998). We collected five adzes during our survey and testing of archaeological sites in Mangareva, and also photographed and described 31 adzes in private collections including those displayed at the Mairie in Rikitea.

SURFACE COLLECTED AXE AND ADZES

The bevel portion of what appears to be a side-hafted axe was collected from the surface of the Atiaoa rockshelter prior to excavation (Fig. 7.7). The specimen has a cutting edge width of 49.5 mm, mid-point width of 64.3 mm, and mid-point thickness of 46.1 mm. Unlike typical Polynesian adzes, the two ground bevel surfaces form a symmetrical cutting edge when viewed in cross-section (see further discussion of adzes below). This specimen has a clear hinge fracture and undoubtedly broke during use. Although geochemically similar to the other local adzes, its texture in hand is more grainy and has a somewhat sugary appearance.

Loaned by Tehotu Reasin of Rikitea, is a small adze of type 1 (Duff type 2C) which is rare in Eastern Polynesia, but common in Western Polynesia, especially Samoa. According to Duff (1959), in Eastern Polynesia it is the most important numerically in Mangareva, sporadic in Pitcairn and Rapa. This specimen is just under 100 mm long, trapezoidal in section with the front narrower than the back (Fig. 7.8). It is highly polished with ~75% polish on the front and ~60% polish on the back. The sides are almost completely ground.

The smallest whole adze is a type 5A collected on the surface inland of the Mairie near the recently mechanically excavated trench in a bulldozed area (Fig. 7.9). It is trapezoidal in section with the front wider than the back. The butt is slightly reduced, and there is an incipient tang.

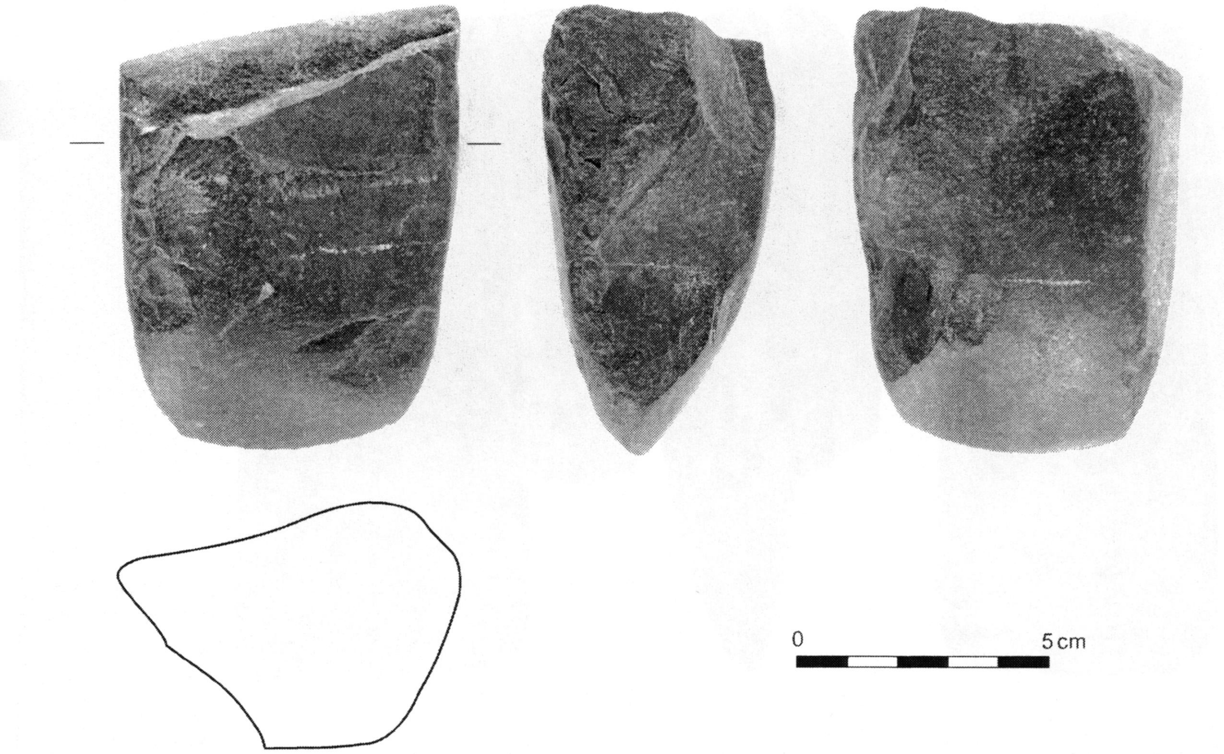


FIGURE 7.7 Bevel portion of a side-hafted axe collected from the surface of the Atiaoa rockshelter.

Aside from the butt area on the front side, the adze is well polished. This adze was sourced to the Eiao quarry in the northern Marquesas and joins a growing list of specimens that originated there (Weisler 1998).

An adze fragment was found in the erosional bank of an intermittent drainage that cuts through Gatavake on the east side of Mangareva Island, designated GAT-3 (see Chapter 3), coming from Layer I, about 10 cm above the contact with Layer II. It is a butt and midsection fragment (Fig. 7.10), trapezoidal in section with the front wider than the back. It is a Hiroa (1938a) type 1 or Duff 2A. The geochemistry suggests a local source.

A large axe fragment or wedge was loaned for study by Benoit Urarii who found it on the lagoon side of Rikitea village. The original specimen broke near the midsection and shows extensive reworking with thinning flakes along the butt, emanating from the poll (Fig. 7.11). The cutting edge has been reshaped, but unfinished. The surface of the Rikitea adze is black and shiny.

Classification of Mangarevan Axes and Adzes

We present here the classification and metrical attributes of the specimens described above, along with other adzes studied in the collection of the Rikitea Mairie, or in other private collections in Mangareva. Five additional specimens studied by us are illustrated in Figures 7.12 and 7.13. The cross-sections of 25 adzes or axes in the collection of the Rikitea Mairie are shown in Figure 7.14. Hiroa (1938a:258-270) developed a classification of adzes, axes, and chisels based on the examination of 50 specimens, only 44 of which could be assigned to his typology. Twenty-eight (64%) of these were adzes, twelve axes (27%), and four (9%) could be used as either (Hiroa 1938a:261). The attributes used to define his three types of adzes are adopted below. Hiroa separated non-adze cutting tools into axes and chisels. Green (1960) developed an adze classi-

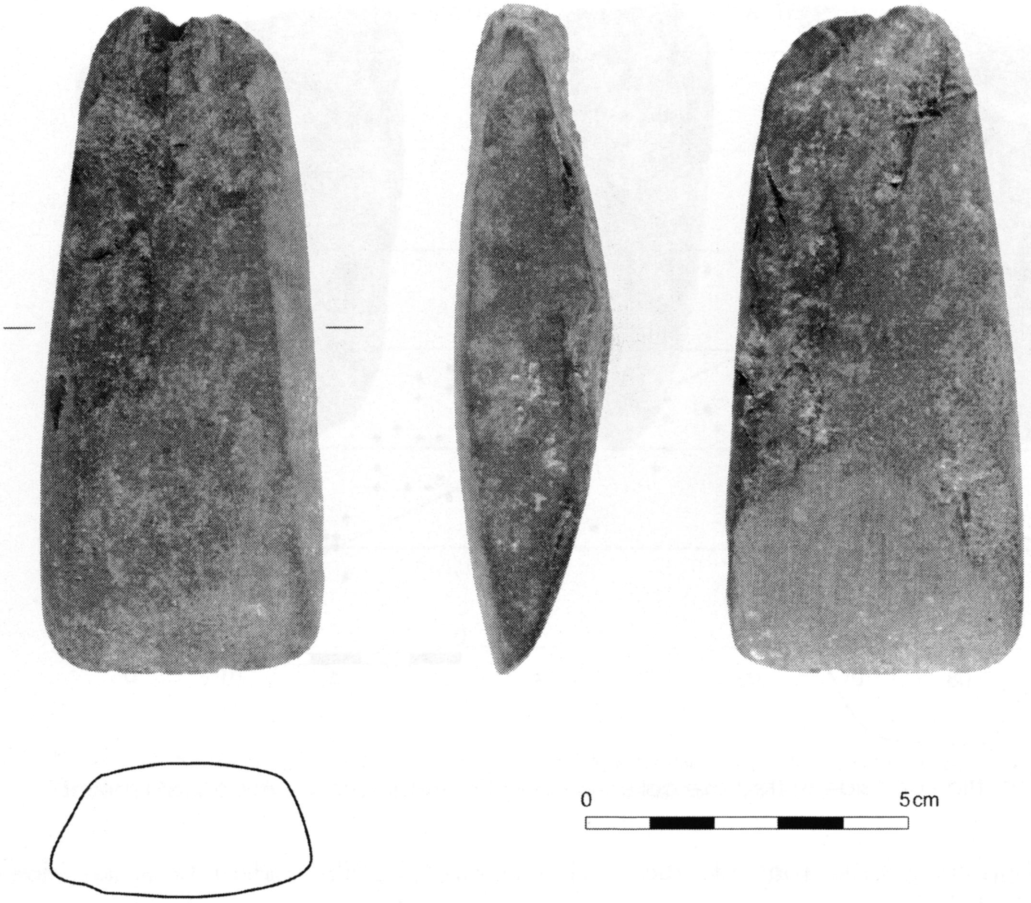


FIGURE 7.8
Type 1 adze from Rikitea loaned for study by Tehotu Reasin.

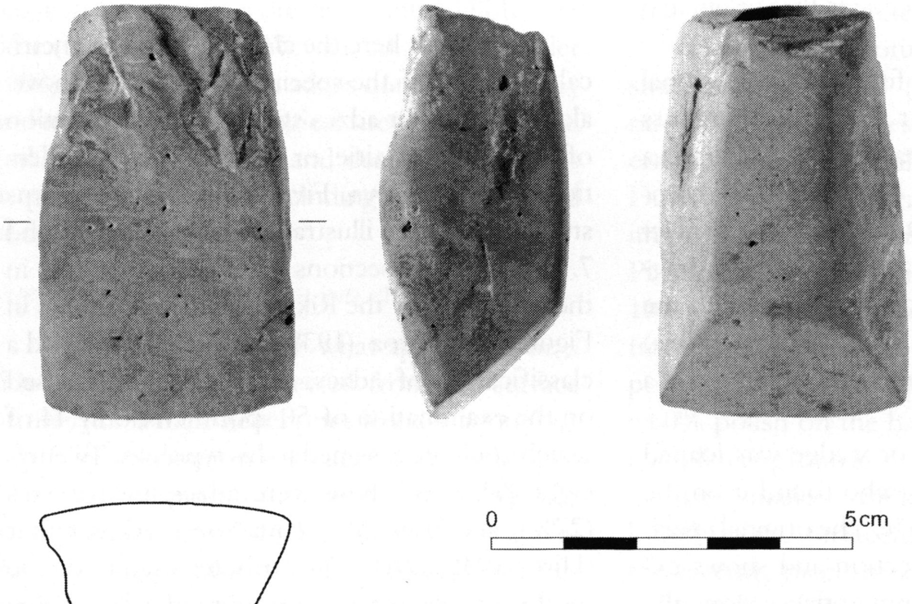


FIGURE 7.9
Small adze of type 5A collected from the surface near the stratigraphic trench in Rikitea Village. This adze has been sourced to Eiao Island (Marquesas).

FIGURE 7.10
Butt and mid-section fragment of an adze from Site GAT-3 at Gatavake.

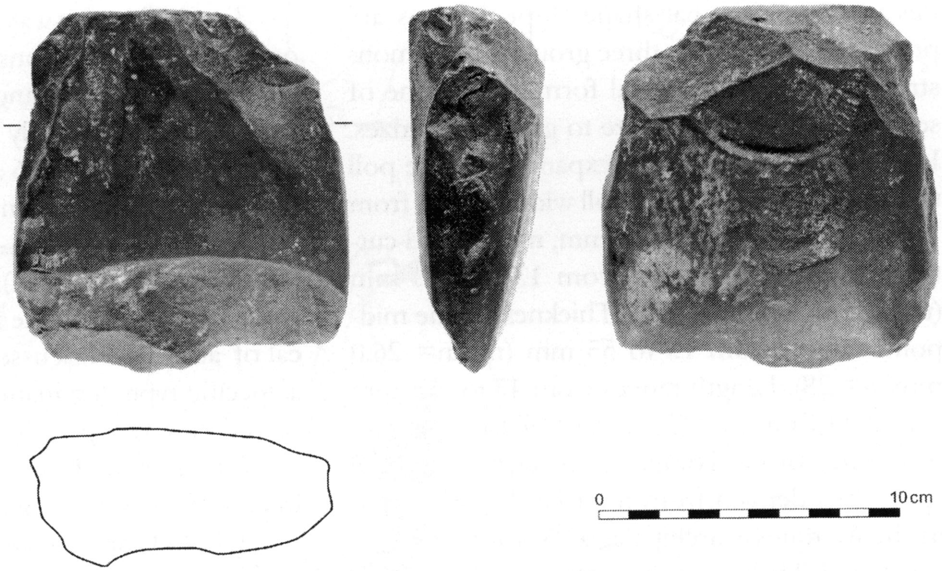


FIGURE 7.11
Fragment of large axe or wedge loaned for study by Benoit Urarii.

fication for Mangareva adzes, and we adopt that scheme here (see also Weisler and Green 2001:418-20). This scheme includes Hiroa's types 1-3 with the addition of two new types 4 and 5, described below (Weisler and Green 2001:419-20). Metric attributes for adzes and axes are presented in Table 7.3.

Type 1. This is by far the most numerous adze type in the collections studied and also among those reported by Weisler and Green (2001:418-20, table 31.2, figs. 31.5-31.10). As defined by Green (1960), adzes in this type are small to large, quadrangular in section and without a tang. The base is usually slightly narrower than the face. Our specimens exhibit a greater range of cross-sectional form, possibly due to the unfinished state of some of them (see Hiroa 1938a:261-64, figs 28-32). Figure 7.14 illustrates the range of

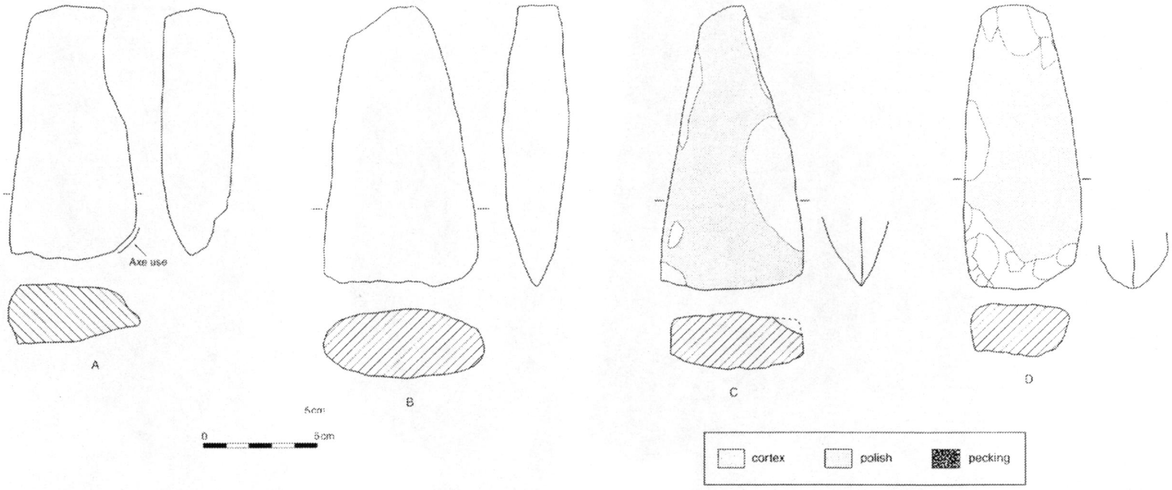


FIGURE 7.12 Adzes from Mangareva. (a) Axe from Kamaka Island, T. Reasin collection; (b) Type 1 adze from Rikitea, Mangareva, T. Reasin collection; (c) and (d) Type 1 adzes from Taravai Island, both made from dike rock, from the late J. Richeton collection.

cross-sectional variability of 25 adzes that were placed in one of three groups based on similarities in cross-sectional shape. Type 1 adzes are present in each of the three groups and demonstrates that cross-sectional form is only one of several attributes used here to group our adzes. In plan view, type 1 adzes expand from the poll towards the cutting edge. Poll width ranges from 16 to 50 mm (mean= 27.4 mm, n= 26) and cutting edge width ranges from 13 to 108 mm (mean= 51.2 mm, n= 26). Thickness at the midpoint ranges from 15 to 55 mm (mean= 26.0 mm, n= 28). Length ranges from 47 to 270 mm (mean 110 mm, n=27). Adzes of this type are most often of local origin; however, at least three specimens derived from the Eiao Island source in the Marquesas archipelago (Weisler 1998).

Type 2. There were no type 2 adzes collected during our fieldwork. For comparative purposes we illustrate a type 2 adze (Fig. 7.13B) that was collected from Tenoko *motu* and reported by Weisler and Green (2001:419; see Table 1). These adzes are poorly defined at present, with one or two mesial edges occurring along the sides, while in plan the shape expands from the pointed poll towards the cutting edge (Hiroa 1938a:264-66, figs. 33-5). Hiroa stated that "though a number of quadrangular adzes show a rounding off of the sides, especially on the butt, they fit better with type 1…" (1938a:264).

Type 3. This type was described by Hiroa from only four adzes and consists of thick, long adzes with a more or less triangular cross section (apex towards front), roughly finished and without a grip (1938a:266, figs. 36 and 37). One of his two illustrations of this form was described as having a cutting edge with an "axlike appearance" (1938a:fig. 36 caption), yet other specimens within this type have the asymmetrical bevel typical of adzes. As discussed below, we have given a specific type designation to axes and have reserved Hiroa's type 3 for true adzes.

Type 4. This is a newly defined type for Mangareva first reported by Weisler and Green (2001:419). Only one adze from our recent collections was tentatively assigned to this type. It is fragmentary consisting of the bevel end. Type 4 adzes are familiar Eastern Polynesian types that are tanged, quadrangular, and without lugs. One such adze reported by Weisler and Green (2001:438, table 31.5) was surface collected from Rikitea village by Green in 1959 and was sourced to the Society Islands based on its geochemistry.

Type 5. This is the second newly defined type first reported in Weisler and Green (2001:419-20).Type 5 adzes are triangular to subtriangular

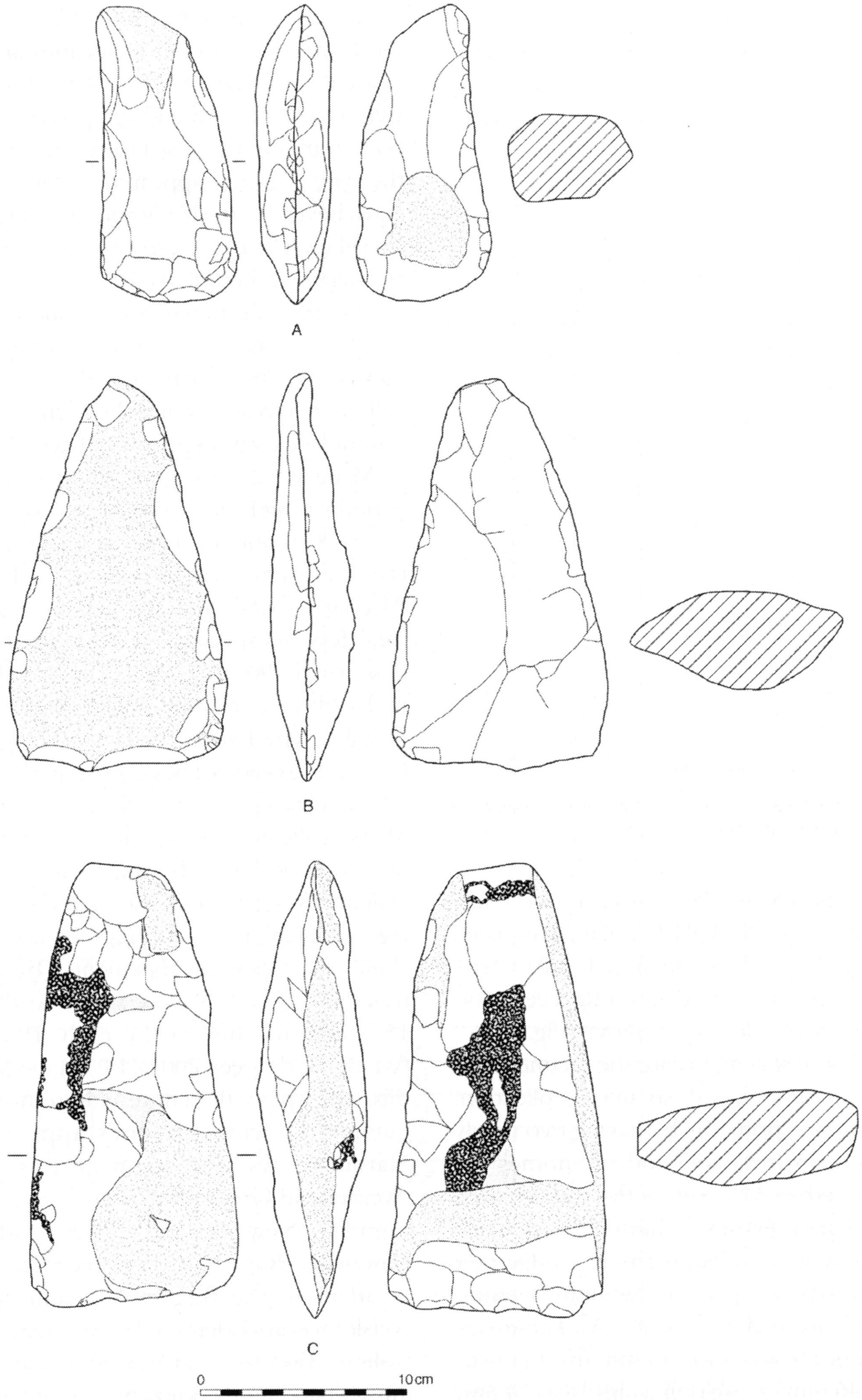


FIGURE 7.13 (a) Type 1 adze, from Taravai Island, made from dike rock, from the late J. Richeton collection; (b) Type 2 adze, from Tenoko (specimen exhibits water rounding); (c) Type 1 adze found by T. Reasin 15 m east of site KAM-2, Kamaka Island.

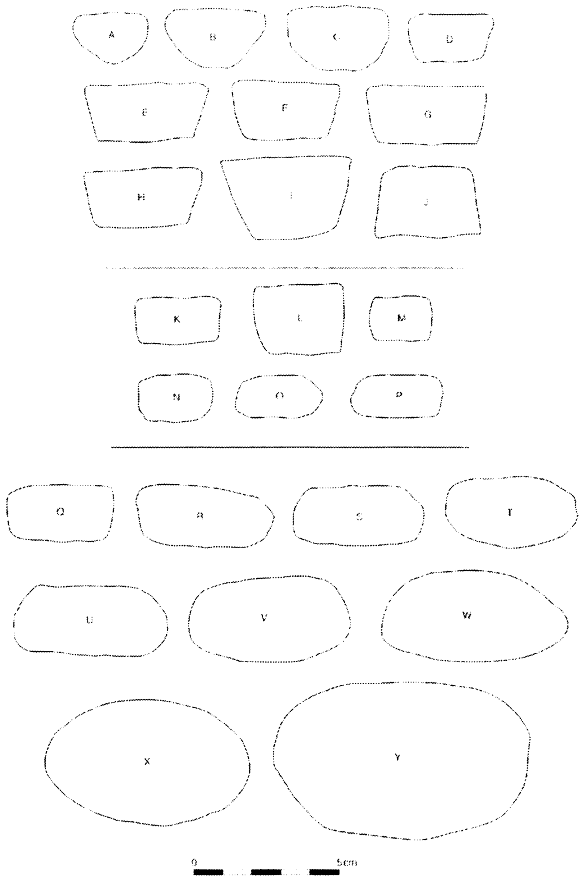


FIGURE 7.14 Cross sections of 25 adzes or axes in the collection of the Rikitea Mairie.

in cross section with apex towards the back. Weisler and Green (2001: 419-420) differentiated a tanged type 5A from an untanged variant, type 5B. We have one type 5 adze in our recent collections which was described above (Fig. 7.9).

Axes. These specimens are the second most common cutting tool, with six in our collection. They are defined primarily by having two nearly equal bevels on the blade and oftentimes are heavier than adzes. One side is flat and is hafted against the handle (as in side-hafted adzes), while the other side is rounded, forming a ridge that tapers towards the poll to facilitate lashing (Weisler and Green 2001:418; fig. 1A). These axes range in length from 64 to 114 mm (n=4); thickness 15 to 46 mm (n=6); poll width 18 to 74 mm (n=5); and, cutting edge width 33 to 101 mm (n=6).

Figure 7.15 summarizes the frequency of these adze types in our collections and in those collected by Green in 1959. Some 71.6% of adzes were type 1. Type 5 and the percentage of axes both numbered 11.3%. However, some adzes in the type 1 group appeared to have somewhat equal bevels on the blade and may in fact be axes. It is likely, then, that axes are the second highest frequency of cutting tools.

Despite the fact that only one of the adzes was from a dated subsurface context (site 190-06-GAT-3), the remaining surface collected adzes still can tell us something about chronology. The assemblage consists primary of type 1 adzes and, in Mangareva, these generally date to the later period of prehistory. Green and Weisler (2000: 28, 37-8) report on two such adzes: one from the late prehistoric settlement at Tokani Bay, Akamaru Island, and another from within cultural deposits at Aukena (Green's site GA-1, now designated 190-03-AUK-4) dating to before the mid-18th century. This small sample does suggest that type 1 adzes are late in Mangareva prehistory. It would not be surprising if adzes found on the surface, as most of the adzes in the Rikitea Mairie collection were, date from the late prehistoric period. An adze fragment was tentatively assigned to type 4 and although it could be foreign to Mangareva, its fragmentary state precludes any conclusive statements. Type 5A adzes have been dated in Mangareva to the 13th to 15th century and to the early 19th century (Weisler and Green 2001:419). In the Marquesas, this type spans the entire culture-historical sequence. However, it does appear that the Marquesas was the origin of this adze type (Weisler and Green 2001: 420). Type 1 adzes are found in New Zealand, Pitcairn, Marquesas, Hawaii and Rapa Nui. From recent examination of adzes in the Bishop Museum collection, Weisler has also identified type 1 adzes from the atolls of Takapoto and Makatea in the Tuamotus, thus expanding the known geographic range of this adze type. Our type 1 and 5A adzes, then, show links with the Pitcairn group, the Tuamotus,

TABLE 7.3 Mangarevan adzes.

Illustration	Length	Thickness	Width			Type
			Cutting Edge	Midpoint	Poll	
Fig. 7.14.A	100	25	41	37	22	1
B	96	21	41	35	22	1
C	270	55	105	89	38	1
D	67	17	33	30	20	1
E	70	15	37	32	24	1
F	69	17	18	26	19	1
G	83	23	32	35	22	1
H	69	18	27	26	20	1
I	80	25		31	23	1
J	47	16	13	22		1
K	76	15	35	30	16	1
L	64	15	33	32	18	axe
M	92	25	47	46	31	axe
N		29	44	45		4
O	110	21	50	45	23	1
P	119	30	59	56	21	1
Q	82	25	59	53	33	1
R	89	22	55	48	29	axe
S	107	21	47	43	25	1
T	144	32	67	65	20	1
U	165	44	83	71	41	1
V	78	21	43	41	29	1
W	75	20	41	37	27	1
X	87	21	40	37		1
Y	117	21	47	42	30	1
Fig. 7.12.A	114	31	57	51	33	axe
B	127	30	68	63	39	1
C	128	34	66	58	24	1
D	126	30	57	56	28	1
Fig. 7.13 A	155	40	72	68	50	1
Fig. 7.13B	192	40	98	89	53	2
Fig. 7.13C	222	52	108	96	46	1
Fig. 7.8	100	22	41	39	24	1
Fig. 7.9	57	24	34	34	27	5A
Fig. 7.10		18		38	27	1
Fig. 7.11		44	101	106	74	axe
Fig. 7.7		46	50	64		axe

All measurements to the nearest mm. Types after Weisler and Green (2001:418-420).

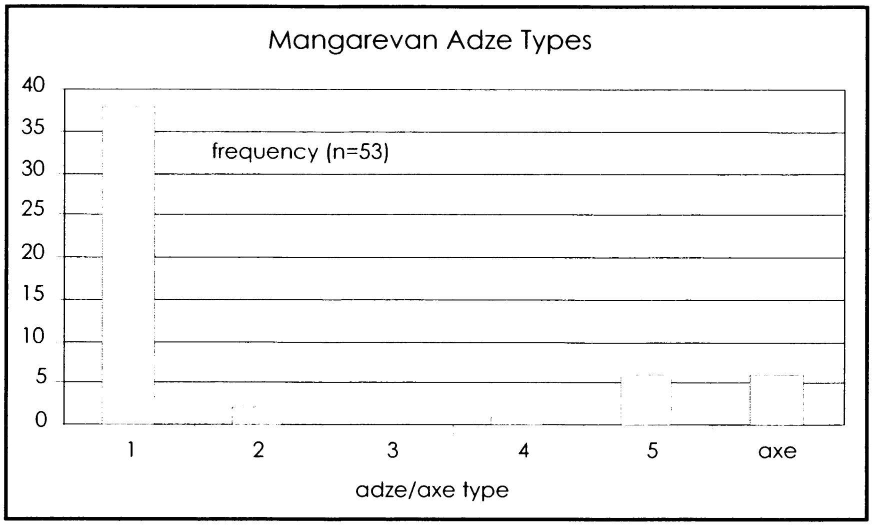


FIGURE 7.15
Frequency of adze and axe types in Mangareva.

and the Marquesas, the closest neighbors to Mangareva where—on the basis of geochemical sourcing—Mangareva was the nexus of a long-distance interaction sphere (Weisler 2002). This demonstrates the complimentary nature of typological and sourcing studies.

Mangarevan adze assemblages are dominated by type 1 (Fig. 7.15), yet it is of particular note that axes, characterized by their roughly ground and unfinished forms, are the second most common type. In pondering the high frequency of axes, Hiroa (1938a:277) suggested that this heavier wood-working tool in Mangareva might be correlated to the use of rafts. Beechey was greeted by Mangarevans on rafts when he sailed into the lagoon in 1824, and he saw no canoes. Buck suggests that axes performed better for cutting down trees for rafts, while adzes are better suited for hollowing out logs for canoes. Based on current archaeological data, however, adzes co-occur with axes during late prehistory, and it is unfortunate that no axes have been collected from dated contexts. Consequently, we do not know when axes first appear in Mangareva. Based on sourcing studies of Eastern Polynesian adze material, Mangareva was the center of a long-distance interaction network that linked the Pitcairn group, the Marquesas, the Society Islands, and undoubtedly the Tuamotus until sometime in the 15th century when the collapse of long-distance voyaging may have been triggered regionally by late prehistoric social unrest on several island groups (Weisler 2002:267-68). For Mangareva, Hiroa describes inter-tribal warfare and cannibalism as characterizing late prehistoric society. If Hiroa (1938a:277) was right that axes are correlated to raft construction and are therefore more numerous in late prehistory, then we may expect that axes would be more common after the collapse of long-distance voyaging, after the 15th century. With the decline or end of long-distance voyaging, large ocean-going canoes were no longer needed to support the chiefly prerogatives of obtaining (and then regulating at home) the distribution of exotic goods. Perhaps additional evidence for a deteriorating Mangarevan society can also be inferred from the typical unfinished state of axes. Unlike adzes, axes are typically made from coarse-grained rock (probably all local) and are ground mostly at the bevel leaving the rest of the tool unfinished, thus exhibiting the original weathered rock surface. Perhaps axes were considered an expedient tool only fashioned to produce inferior watercraft.

GEOCHEMICAL ANALYSIS OF BASALT ARTIFACTS

All five adzes collected in the field in 2001 (Fig. 7.7 to 7.11) along with 18 pieces of basalt debitage were selected for geochemical analysis.

The adzes were cored with a diamond-tipped drill through the poll or, in the case of broken adzes, through the exposed surface. The holes were refilled with modeling clay and the filled hole was painted with water-based paint to match the surrounding adze surface color.

The samples were processed for wavelength dispersive X-ray fluorescence (WDXRF) analysis following procedures outlined by Johnson *et al.* (1999) and summarized here. The cored samples and debitage were each reduced in a hardened steel jaw crusher to small chips that were hand picked and placed into a Tema swingmill with tungsten carbide surfaces and milled for two minutes. Up to 3.5 grams of this rock powder were then weighed into a plastic mixing jar with pure lithium tetraborate ($Li_2B_4O_7$) and, with an enclosed plastic ball, mixed for 10 minutes. The mixed powders were emptied into graphic crucibles and placed on a ceramic tray and loaded into a muffle furnace. Fusion took five minutes in a preheated furnace at 1000°C. The crucibles were removed and cooled for 10 minutes, then loaded into a Tema swingmill and ground for 35 seconds. The resulting glass powder was replaced in the graphic crucibles and refused for five minutes. Following the second fusion the cooled beads were labeled, the lower flat surface ground on 600 grit, finished briefly on a glass plate to remove any metal from the grinding wheel, washed in an ultrasonic cleaner, rinsed in alcohol, and dried. The beads were then loaded in to the XRF spectrometer.

The results of the WDXRF analyses of the five adzes and one flake are presented in Table 7.4, and a bivariate plot of the key geochemical signatures of these artifacts is provided in Figure 7.16. The flake is from site GAT-3 where a habitation pavement (*paepae*) was exposed in a stream cut (see Chapter 3); it is uncertain whether the flake collected from this stratigraphic context derived from a nearby source, possibly from the adjacent drainage. However, this flake, the adze fragment also collected from the exposed section at GAT-3, and an adze from Rikitea collected by Benoit Urarii all share similar geochemical properties, suggesting a common source. Two other adzes, one collected from the Rikitea shoreline by Tehotu Reasin and another from Atiaoa, are similar in major elements and most trace elements to the Gatavake flake suggesting a geologically related source. That source may be in Gatavake Valley, but samples should be obtained from this drainage to determine the range of geochemical variability of the water-rounded rock found there. The geochemistry of secondary deposits such as this is often difficult to pin down since source rock may come from the entire length of the drainage which taps into multiple geologic formations upstream, each with unique geochemistry. Another adze collected from Rikitea is clearly from the Eiao basalt source in the Marquesas Islands. The Eiao geochemistry is relatively homogeneous, and artifacts assigned to this source characteristically match closely.

Table 7.5 documents the geochemical composition of 18 basalt flakes and their source assignment, where possible. Most of the analyzed flakes were from the site ATA-4 flake scatter Location A (see Chapter 3), while a few were from Location B, an accumulation of ash and fire-altered rock with some debitage—probably a refuse dump. The flakes from Location A are characterized by one dominant geochemical signature. There are two flakes, however whose origin was clearly Tautama, Pitcairn Island, the largest basalt source in southeast Polynesia (Weisler 1997:156). Two other flakes from Location 4 had a unique geochemistry (ATA-4B-2 and ATA4-SA2), and may represent material collected inland on the taluvial slopes at Atiaoa. One of these flakes matches closely to a flake collected near the exposed trench in Rikitea, just inland from the Mairie (Table 7.4).

In his ethnography of Mangareva, Hiroa did not obtain any information about adze quarries (1938a:275) and, from what is known of the islands' geological formations, it is likely that no large fine-grained basalt sources exist. However, future surveys in Mangareva should target areas

TABLE 7.4 WDXRF analytical results for Mangarevan adzes.

Figure No.:	7.9		----	7.10	7.11	7.8	7.7
Locus	Rikitea Trench	Eiao, Marquesas	GAT-3	GAT-3	Rikitea	Rikitea shoreline	Atiaoa
Artifact type:	adze		flake	adze	axe	adze	axe
Source:	Eiao, Marquesas	Source-a	Local Mangareva	Local Mangareva	Local Mangareva	Local Mangareva	Local Mangareva
Un-normalized Major Elements (Weight %):							
SiO^2	47.50	46.95	48.51	48.11	48.42	49.34	49.27
$Al2O^3$	14.89	15.23	15.440	15.28	15.25	15.05	14.83
TiO^2	3.861	3.900	2.51	2.490	2.484	2.458	2.369
FeO	12.53	12.18	10.563	10.67	10.84	10.12	10.00
MnO	0.165	0.160	0.17	0.166	0.166	0.151	0.146
CaO	9.37	9.32	11.21	11.18	11.07	11.82	11.79
MgO	6.43	6.47	7.47	7.57	7.69	6.86	7.22
K^2O	1.00	1.00	0.69	0.65	0.67	0.65	0.65
Na^2O	3.08	3.18	2.290	2.19	2.22	2.31	2.20
P^2O^5	0.511	0.540	0.33	0.308	0.309	0.311	0.302
Total	99.33	98.93	99.175	98.61	99.12	99.07	98.78
Un-normalized Trace Elements (ppm):							
Ni	95	100	107	108	104	103	119
Cr	93	87	178	180	179	258	302
Sc	17	24	23	28	30	28	29
V	294	297	267	275	252	249	237
Ba	159	187	148	156	142	148	142
Rb	20	18	13	13	11	13	19
Sr	575	591	394	393	386	393	391
Zr	280	306	154	154	152	154	148
Y	36	37	67.0	21	21	37	73
Nb	28.0	28.0	30	28.1	29.0	27.1	26.8
Ga	24	nd	20	17	20	21	19
Cu	38	47	63	69	67	73	36
Zn	125	130	94	87	88	86	97
Pb	3	nd	3	4	5	2	1
La	31	nd	40	25	16	38	43
Ce	71	nd	75	36	61	51	40
Th	5	nd	3	4	3	1	1

Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO.
"R" denotes a duplicate bead made from the same rock powder.
"†" denotes values >120% of our highest standard.

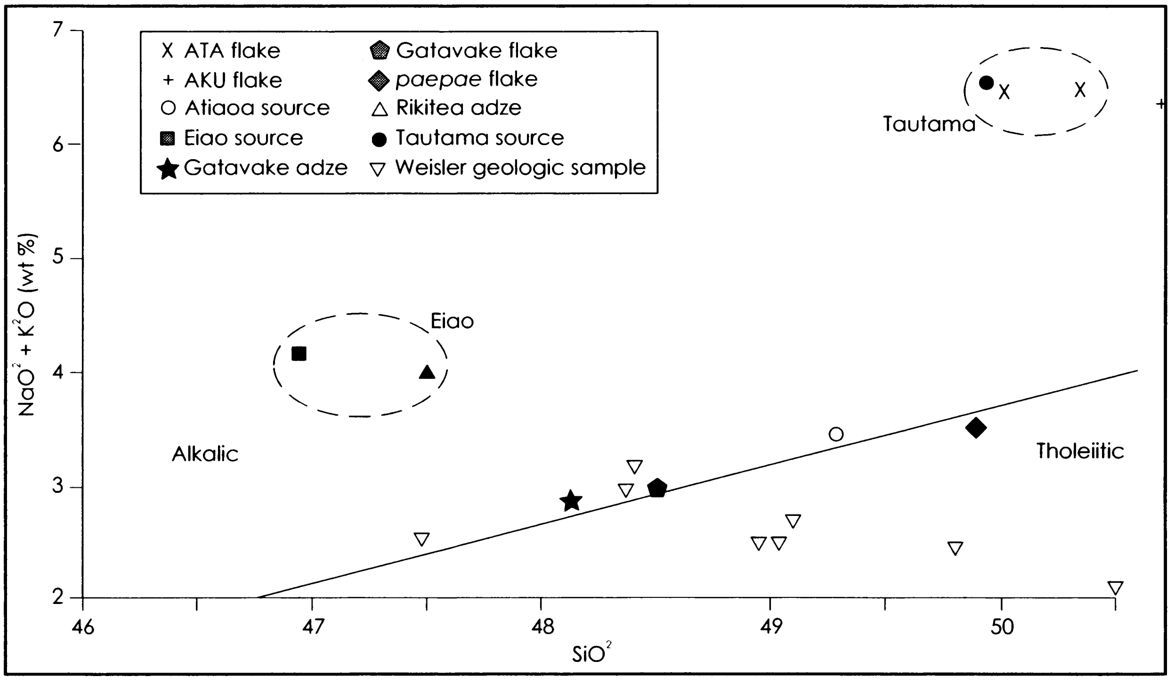


FIGURE 7.16 Bivariate plot of SiO_2 versus $K_2O + Na_2O$ for adzes and flakes analyzed from Mangareva, along with Eiao (Marquesas) and Tautama (Pitcairn) sources.

likely to have localized fine-grained basalt, such as the alkalic exposures identified by Brousse and Guille (1974:161, 218) on Mangareva, Akamaru and Makapu islands. If new *in situ* geologic sources are identified, it will be necessary to: (1) identify the geologic event that produced the fine-grained basalt (e.g., dike or flow); (2) collect artifacts (debitage, adze performs) and geological material to unequivocally link the artifact geochemistry to the geological source; and (3) demonstrate the geochemical variability of the source by multiple analyses (Weisler and Sinton 1997:187-88). This should be a top priority of future research.

The geochemical analysis of debitage and adzes collected during our fieldwork was aimed at our objective of better understanding social relationships within the archipelago and to add to our knowledge of the Eastern Polynesian interaction sphere (Weisler 1998: fig. 1; 2002: fig. 13.1). Because no *in situ* geologic sources of fine-grained basalt were located during our surveys, or during those of Weisler (1996), we decided to analyze debitage to determine the variability of stone used for adze production within Mangareva. Although we do not know the precise *geologic* sources of this adze material, it is possible to infer some form of interaction if two or more sites contain artifacts of the same geochemistry. Thus our data suggest that the same source that dominates the debitage at Atiaoa site ATA-4 was also transferred to the site ATU-1A *paepae* at Atituiti, and from Atiaoa to Rikitea. Correlations also exist with artifacts from Gatavake and Rikitea.

Rikitea, on the eastern side of Mangareva Island, is divided from Taku on the west and oceanside by a mountainous spine that follows the long axis of the island. According to Hiroa, these two villages grew into centers of influence which became the principal and competing polities into which the island was divided (1938a:5-6). Although our archaeological studies were conducted exclusively within the Rikitea district, our geochemical analysis suggests that the villages of Atiaoa, Gatavake, Atituiti, and Rikitea were linked in some manner of social interaction. Unfortunately, none of the geochemically analyzed artifacts are from dated contexts, so it

TABLE 7.5 Results of XRF analysis of basalt debitage from Mangareva, and of source material from Eiao (Marquesas) and Tautama (Pitcairn).

	ATA-4A-1	ATA-4A-7	ATA-4A-9	ATA-4-SA3	ATA-4-SA1	ATA-4B-1	ATA-4B-6	ATA-4A-3	Paepae Atituiti flake	ATA-4-SA2	RIK-2 flake
	Probable Atiaoa Source									Atiaoa Subsource	
Unnormalized Major Elements (Weight %)											
SiO^2	49.79	49.28	48.98	49.41	49.21	48.86	49.61	49.12	49.89	49.44	49.17
Al^2O^3	14.77	14.60	14.54	14.66	14.58	14.41	14.56	14.72	14.64	14.65	14.98
TiO^2	3.060	3.058	3.063	3.075	3.005	3.020	3.043	3.041	3.059	2.886	2.988
FeO	10.36	10.66	10.67	10.75	10.94	11.36	11.10	10.48	10.83	11.14	11.49
MnO	0.167	0.160	0.167	0.169	0.165	0.173	0.165	0.166	0.155	0.180	0.169
CaO	11.34	11.22	11.37	11.30	11.39	11.23	11.35	11.56	11.29	11.36	11.07
MgO	5.99	6.13	6.10	6.04	6.17	6.31	6.11	6.03	5.95	6.39	6.35
K^2O	0.89	0.85	0.80	0.86	0.79	0.82	0.80	0.76	0.89	0.52	0.57
Na^2O	2.71	2.65	2.66	2.73	2.66	2.60	2.59	2.63	2.64	2.30	2.44
P^2O5	0.412	0.411	0.419	0.414	0.409	0.408	0.412	0.408	0.414	0.351	0.390
Total	99.49	99.02	98.77	99.40	99.32	99.19	99.74	98.91	99.76	99.21	99.62
Unnormalized Trace Elements (ppm):											
Ni	79	72	79	79	76	72	74	76	75	60	68
Cr	64	65	65	70	68	61	68	69	67	98	90
Sc	30	26	28	29	30	27	31	24	24	32	31
V	291	289	293	294	289	282	295	293	298	290	299
Ba	198	201	201	181	165	188	188	204	184	145	158
Rb	19	16	13	17	14	10	15	9	16	10	8
Sr	424	420	430	416	421	423	425	444	412	379	393
Zr	193	192	194	195	190	195	192	190	195	171	181
Y	25	24	25	25	24	26	24	25	25	25	27
Nb	37.4	37.1	37.6	37.1	36.9	38.1	37.7	37.4	38.2	32.9	33.9
Ga	20	20	22	22	22	20	17	20	21	21	19
Cu	92	93	87	98	96	94	87	92	92	79	96
Zn	99	100	102	100	100	97	99	100	98	104	105
Pb	2	4	0	2	1	1	0	0	1	0	2
La	29	29	29	8	13	17	21	20	10	37	12
Ce	78	58	62	61	58	54	47	58	76	52	36
Th	4	6	3	4	4	2	4	5	4	2	1

Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO.
a= Data from Sinton and Sinoto (1997:table 11.7). $Fe^{2}0^{3}$ converted here to total Fe by dividing 1.1113 into 13.53.
b= US is the abbreviation for unknown source.
c= Precision determined by analyzing a duplicate bead made from the same rock powder.
R=repeat.

is not possible to place these interactions in a temporal framework. However, because much of our analyzed adze material derives from surface contexts, it is probable that the artifacts were deposited during later prehistory. If so, the spatial distribution of these artifacts relates to so-

	ATA-4B-2		ATA-4-BH1 flake	ATA-4A flake	AKA-11 flake	MAN-5 US-b flake	IGERU-1 flake	IGERU-2 flake	AKU -32	AKU -35	ATA-4A-3	ATA-4A-3R
	Unknown Source	Tautama Source n=21-a					Unknown Source		Akamaru Source		Precision-c	
Unnormalized Major Elements (Weight %):												
SiO^2	49.41	49.93	50.03	50.36	50.68	48.51	49.74	49.60	50.75	51.22	49.12	49.04
Al^2O^3	15.14	15.57	15.30	15.32	15.45	15.44	15.02	15.15	15.27	15.65	14.72	14.62
TiO^2	2.398	2.680	2.699	2.675	2.770	2.510	3.071	3.041	1.696	1.736	3.041	3.018
FeO	9.87	12.10	11.95	12.25	11.84	10.56	11.45	11.26	10.27	9.53	10.48	11.13
MnO	0.149	0.220	0.218	0.214	0.202	0.166	0.171	0.168	0.138	0.135	0.166	0.165
CaO	12.07	7.09	7.13	7.03	7.26	11.21	10.29	10.43	11.42	11.70	11.56	11.47
MgO	7.21	3.49	3.54	3.46	3.36	7.47	5.71	5.71	6.42	6.56	6.03	5.98
K^2O	0.65	1.99	1.99	2.04	1.96	0.69	0.93	0.88	0.53	0.45	0.76	0.76
Na^2O	2.30	4.55	4.48	4.45	4.42	2.29	2.73	2.69	2.11	2.14	2.63	2.64
P^2O5	0.315	1.250	1.251	1.237	1.282	0.326	0.451	0.424	0.188	0.204	0.408	0.404
Total	99.52	98.87	98.59	99.04	99.22	99.18	99.56	99.35	98.79	99.33	98.91	99.23
Unnormalized Trace Elements (ppm):												
Ni	113	1	1	3	1	107	60	55	84	92	76	74
Cr	310	8	1	0	3	178	64	64	286	293	69	67
Sc	30	14	16	15	14	23	30	33	24	23	24	29
V	245	109	131	132	121	267	287	297	208	206	293	291
Ba	141	458	453	449	435	148	206	199	87	77	204	193
Rb	16	39	35	39	38	13	16	17	20	14	9	10
Sr	405	589	587	588	594	394	402	403	284	293	444	451
Zr	150	417	386	392	381	154	213	199	99	100	190	193
Y	21	48	47	46	47	67	26	27	17	16	25	25
Nb	28.0	89.0	67.5	69.5	67.9	29.7	39.3	36.6	17.4	17.8	37.4	37.5
Ga	17	nd	25	27	29	20	22	19	17	20	20	22
Cu	79	15	15	18	8	63	61	63	74	80	92	94
Zn	80	171	161	159	160	94	107	106	85	85	100	102
Pb	1	nd	5	4	4	3	2	1	2	1	0	2
La	22	nd	49	63	57	40	21	12	10	12	20	17
Ce	46	nd	115	125	122	75	66	56	29	32	58	62
Th	3	nd	5	7	7	3	3	3	2	4	5	4

cial conditions during late prehistory. To be sure, our interpretations are preliminary at this stage, yet determining the spatial scale and temporal span of fine-grained adze material on Mangareva Island may tell us something about the development of political boundaries and social groups on the island over time.

External relations with islands outside the Mangareva archipelago are indicated by an adze from Eiao, Marquesas found at Rikitea, and by three flakes originating from Pitcairn Island (one flake from Akamaru and two from Atiaoa, Mangareva). The straight-line distance from Mangareva to the Marquesas is ~1,750 km and would entail at least two weeks of navigation far from the sight of any island landmarks. Indeed, it is likely that the transport of adzes from the Marquesas to Mangareva was not direct, but via "down-the-line" exchange via the Tuamotu archipelago. Even the Pitcairn source, at ~400 km, is at least four days sail distant. These are purposeful, long-distance movements that required planning and navigational skill, not to mention the expense of building and maintaining ocean-going watercraft. The reasons for long-distance voyaging and exchange have been canvassed before (Earle 1997) with Anderson most recently suggesting that such voyages were limited in extent (2003:173). However, with geochemical sourcing studies in Eastern Polynesia still being in their early stage (Weisler ed. 1997), it is premature to attempt to assess the frequency of inter-archipelago interaction on a regional scale. Nonetheless, we do know that inter-archipelago interaction ended sometime during the 15th century (Weisler 2002) when the presence of imports is no longer detected in the archaeological records of many Eastern Polynesian island groups.

Mangareva was part of one of the best-documented prehistoric interaction spheres in Polynesia. From ~A.D. 900 to 1450 there is abundant and varied evidence of the transfer of cultigens, domesticated animals, oven stones, medium-grained basalt, and vesicular oven stones to resource-poor Henderson Island some 400 km to the east (Weisler 1997:fig 9.9). From our recent sourcing studies, we know that fine-grained basalt from Pitcairn Island was transferred back to Mangareva where it appears on that island as well as on Akamaru. One flake of this Pitcairn basalt had been identified previously on Aukena (Weisler and Woodhead 1995). This is a rare example in the prehistoric record of Polynesia of the *two-way* transfer of commodities.

While we have tentatively documented the content and diversity of this interaction sphere, and have suggested reasons for its inception as well as its demise (Weisler 1997, 2002), we now need to understand the operation of this interaction sphere within Mangareva. When was Mangareva colonized and how soon after did daughter populations bud off to found new settlements to the east? Was the development of this interaction sphere a strategy for island colonization (Kirch 1988), or did it serve to enhance the prestige of Mangarevan chiefs who acquired and regulated the distribution of valuable commodities such as turtles, red feathers, and fine-grained basalt? Can we tie political events on Mangareva, such as the development of monumental architecture, to the changing diversity and magnitude of transferred commodities? Were more prestige items brought to Mangareva during later prehistory, at the very time of increased status rivalry? Or, did the deterioration of Mangarevan society coincide with the end to inter-island voyaging, as Weisler (2002) has suggested? Further characterization and sourcing studies, chronologically tied to the sociopolitical and economic events of Mangareva, will provide a fuller understanding of the processes of development and change within Mangarevan society.

CHAPTER 7 ENDNOTE

[1] This total does not include flaked stone from the Atiaoa or Kamaka sites which was collected in 2000, but which we have not been able to analyze in detail.

CHAPTER 8

Emerging Patterns of Mangarevan Prehistory

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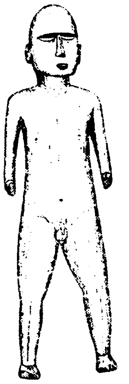

The Mangareva Islands have for too long remained a significant lacuna in the emerging picture of Polynesian culture history. In spite of Roger Green's pioneering excavations in 1959, little work had been done in subsequent decades. At the international conference on Eastern Polynesian archaeology held at Mo'orea in 2000 (see Preface), participants signaled their view that Mangareva was a key area for renewed archaeological investigations. Thanks to significant support from the French Polynesian Ministry of Culture, our team has been able to take up the problems of Mangarevan archaeology and prehistory with field seasons in 2001 and 2003. As reported in the preceding chapters of this monograph, a number of key localities and sites have been discovered and investigated, and the excavated materials have been studied in the laboratory. In this concluding chapter, we assess these results in terms of the four specific objectives laid out at the commencement of our project (see Chapter 1). We then briefly consider several research directions that we feel may reward further investigation in these fascinating islands.

Results Achieved to Date

The Mangarevan Archaeological Record

The first of four objectives that we laid out at the commencement of field research in 2001—"to contribute to the inventory of archaeological sites"—reflects the relatively undeveloped state of Mangarevan archaeology. Initial assessments of Mangarevan archaeology were not promising (see Chapter 1). Emory (1939) thought that virtually all of the important sites (especially *marae*) had been destroyed and that Mangareva did not present a productive area for research. Although he found and dug in rockshelter sites, Emory lacked an appreciation of stratigraphy and failed to recognize that these sites contained a diachronic record of cultural change. Applying the more advanced methods of stratigraphic excavation which E. W. Gifford had introduced to Pacific archaeology just after World War II (Kirch 2000a:27-29), Roger Green in 1959 demonstrated that these rockshelter sites, relatively common in Mangareva, contained well-stratified cultural deposits. With his emerging interest in Polynesian settlement patterns, Green also mapped a settlement complex at Tokani Bay on Akamaru Island (Green and Weisler 2000, fig. 2) and drew upon Mangarevan ethnohistoric sources to interpret contact-period settlement patterns (Green 1967). Unfortunately, full publication of Green's promising results was delayed nearly forty years, and in the interim the archipelago returned to its status as an archaeological backwater, even as research was advancing in other Eastern Polynesian venues such as the Marquesas, Society Islands, Cook Islands, Rapa Nui, Hawaii, and Aotearoa.

Our two field seasons to date have convinced us that the Mangarevan archaeological record is indeed rich, both in stratified sites with good potential to yield a chronologically controlled record of cultural change, and in stone structural remains which are amenable to settlement-pattern and landscape analytical approaches. Although it is true that the impressive architectural works initiated by Père Laval and his missionary colleagues resulted in much destruction to the most important indigenous monuments, Emory (1939:5) was misguided in his claim for "the complete disappearance of all important structures in the Mangarevan group." Indeed, even parts of the foundation of the great Marae Te Kehika are extant to this day (see Fig. 3.5). We suspect that the ruins of other *marae*, such as Marae Mata-o-Tu at Atituiti Raro, may have considerable excavation potential, even if portions of their superstructures were robbed of stone during the missionary zeal to build cathedrals and parish houses. More importantly, our work at Atituiti Ruga and in the Atiaoa Valley have demonstrated that intact archaeological landscapes have escaped destruction even on the most heavily populated island of Mangareva itself. Indeed, at Atituiti Ruga the large ATU-1A *paepae* site adds a new dimension to Mangarevan settlement archaeology, with the possibility that this unique structure represents a class of sites used by the Mangarevan priests for solstitial observation, as described in ethnohistoric sources (Laval 1938). In addition to these two localities, reconnaissance survey has shown that there are extensive stone structural complexes on the colluvial slopes inland of Rikitea Village, and at Rauriki surrounding the Paepae o Uma site. In short, there is much potential for applying a settlement-pattern approach in Mangarevan archaeology, as has been so fruitful in other parts of Eastern Polynesia.

In Appendix B, we provide a checklist of 79 archaeological sites recorded to date in the Mangareva Islands. Several of these sites incorporate large numbers of individual stone structural features, such as platforms and terraces. However, it is clear that this list represents only a fraction of the archaeological record still extant in the archipelago. A high priority for continued work in Mangareva should be to add to this inventory, through reconnaissance survey as well as detailed mapping in all of the principal valleys and coastal plains of the high islands. We would urge the Service de la Culture et du Patrimoine of the government of French Polynesia to allocate resources towards such continued survey and inventory work, so that the rich cultural patrimony of Mangareva can be recorded, studied, and protected.

CULTURAL CHRONOLOGY

Our second objective also reflects the lack of definitive knowledge on Mangarevan prehistory, specifically the timing of initial Polynesian discovery and settlement of the archipelago. Green and Weisler (2000) had argued that the earliest sites in Mangareva were yet to be discovered; determining the age of earliest Polynesian settlement in these islands was regarded as critical to resolving the on-going debate about "long" and "short" chronologies in Eastern Polynesian generally (see Chapter 1). Moreover, if—as some have claimed—Mangareva was the "gateway" to the discovery and settlement of that perennially enigmatic island, Rapa Nui, then determining when people first established a foothold in Mangareva will also be critical to resolving the question of when Rapa Nui was settled.

Our excavations at the Onemea site on Taravai Island have now provided important new evidence for the timing of early Polynesian presence in Mangareva. Based on what we know of the pristine avifaunas of other oceanic islands prior to or at the time of early human arrival, these should be characterized by a high diversity of seabirds (Steadman 1989, 1995). Such naïve seabird populations were evidently highly susceptible to predation by humans, and may also have suffered considerably from attacks on their eggs or nesting young by human-introduced rats (*Rattus exulans*). Thus it is the seabirds which are typically the first to decline or disappear from the zooarchaeological record on Polynesian islands. This is exactly the situation we have in evidence at the Onemea site, with a rich diversity of seabird taxa (as well as at least one now extinct *Ducula* sp. pigeon) present in the Layer III deposit and in the lowest levels of the cultural Layer II. The transition from Onemea Layer III to II occurs at about cal A.D. 1000, according to the ^{14}C dates thus far obtained. Taravai, being the second largest island in the group, with considerable arable land and freshwater sources, is in our view likely to have been settled relatively soon after the main island of Mangareva. It seems improbable that large populations of breeding and nesting seabirds would have been able to sustain themselves in Onemea Valley long after Taravai was permanently settled.[1] We are therefore inclined to believe that the base of TP-2 at Onemea dates to within a century of the initial human occupation of the Mangareva Islands. By A.D. 1200-1300, represented by the basal deposits in the Kamaka Island and Nenega-Iti rockshelters, bird bones are scarce in the middens, suggesting that bird populations had already been decimated by the time these sites were occupied. If we are right in our interpretations—and we stress that further excavation and dating is necessary to confirm this—then the arrival of Polynesians in the Mangareva Islands cannot have been much before A.D. 900.

Our program of radiocarbon dating has also allowed us to begin to refine a cultural chronology for the Mangareva Islands as a whole. Figure 8.1 shows the time spans assignable to the various sites we have investigated, and may be compared with the chronology for Green's 1959 excavations (see Fig. 1.3). Clearly, we need more sites and expanded samples from the earliest phase, thus far represented only by TP-2 at Onemea. We continue to believe that the Rikitea area on Mangareva Island is important in this respect, and additional work there has potential to yield materials of equal age to Onemea. At the same time, other localities on Taravai (such as the large valleys of Aganui and Gahutu) likewise have potential to yield evidence for early settlement. The middle phase of the Mangarevan sequence is now represented by several stratified rockshelters, such as the KAM-1 and -2 sites on Kamaka, by the lower deposits at Te Ana Pu on Aukena, by Nenega-Iti on Agakauitai, and by the Atiaoa rockshelter and the as yet unexcavated coastal midden at Atiaoa (ATA-4). The last few centuries of the sequence are represented by the uppermost deposits in the Kamaka and Aukena island rockshelters, and presumably by the extensive settlement landscapes at Atituiti Ruga (Mangareva) and Tokani Bay (Akamaru). While there are still many gaps in this sequence, a chronological framework is beginning to take shape, and we believe that with targeted excavation and dating it will be possible to produce a well-controlled cultural sequence for the islands within the next few years.

LONG-DISTANCE EXCHANGE

Our third objective was to contribute to the evolving archaeological understanding of interactions or exchanges between Mangareva and other Eastern Polynesian islands and archipelagoes, specifically through the application of geochemical (XRF) characterization and sourc-

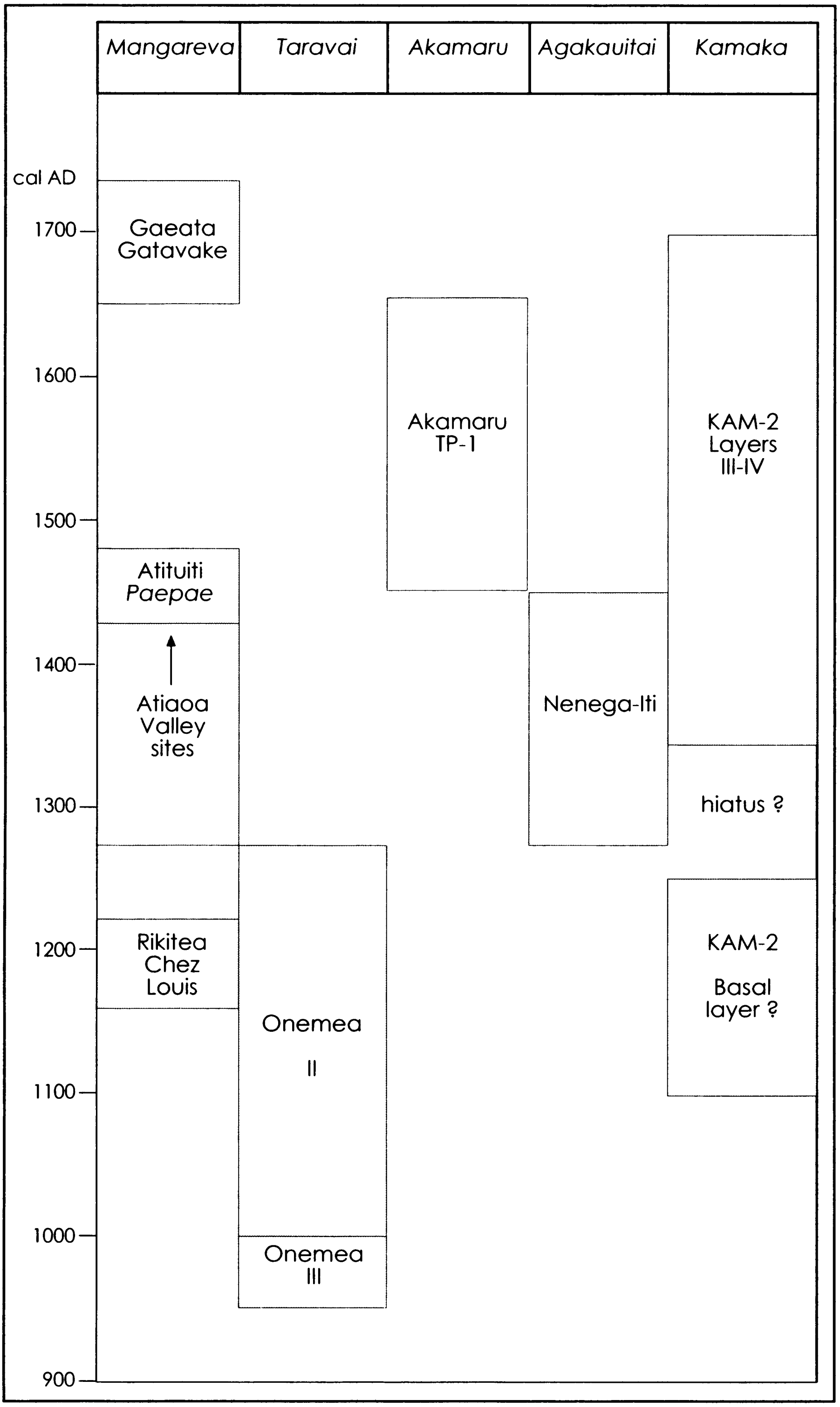

FIGURE 8.1 Chronology of excavated and dated sites in the Mangareva Islands.

ing of basalt adzes or other artifacts which had been transported between islands. Our success in this area has been somewhat limited, as the available samples of stone artifacts that can be analyzed by the XRF method are not very extensive. Nonetheless, as reported in Chapter 7, we have obtained significant results with respect to the importing of lithic materials to Mangareva from other islands in Eastern Polynesia. A small adze collected from the surface of Rikitea near the long stratigraphic trench described in Chapter 3 has an origin on the Marquesan island of Eiao, known to be a major adze quarry (Rolett et al. 1997). This adze joins a growing list of specimens from Mangareva known to have derived from the Marquesas and the Society Islands (Weisler 1998; Weisler and Green 2001), reinforcing the interpretation that Mangareva maintained connections with these archipelagoes at some period in its history. Given the difficulties in sailing directly from the Marquesas to Mangareva, it is likely that these connections involved the Tuamotu archipelago. As Weisler and Green suggested on the basis of their holistic analysis of interaction spheres in southeastern Polynesia, "the Tuamotus undoubtedly filled an integral role in the transfer of commodities from the Society Islands to Mangareva" (2001:439). Most likely, the importation of adzes from the Marquesas and Society groups to Mangareva represents a case of "down-the-line" exchange, with one or more communities in the Tuamotu chain acting as intermediaries.

Equally important to advancing our knowledge of Mangareva's external contacts was the identification of flaked stone debitage, from the ATA-4 site at Atiaoa on Mangareva Island and from Akamaru Island, which derives from the Tautama source on Pitcairn Island. Weisler (1997:164-65, fig. 9.7) has previously demonstrated that oven stones of tholeiitic basalt had been imported from Mangareva into the Pitcairn-Henderson group, based on the analysis of archaeological specimens from Henderson Island. The identification of three flakes at two sites in Mangareva, deriving from Tautama, now confirms that high-quality basalt was being imported from Pitcairn to Mangareva, as previously inferred by Weisler (see Fig. 1.2). The Tautama quarry was a major locus of extraction and working of basalt for adzes (Gathercole 1964:38-46; Carter 1967:19-21; Weisler 1997; Weisler and Sinton 1997), and the alkalic, fine-grained properties of its stone may have been superior to sources locally available in Mangareva. Until we have expanded lithic assemblages from Mangarevan sites, it is not possible to say whether Tautama was being imported to Mangareva as finished adzes, preforms, or blocks of raw material (or all of these). However, the discovery of Tautama material at two sites on both Mangareva and Akamaru islands strengthens the argument that there were regular connections between Mangareva and Pitcairn, separated by an open sea distance of 400 km. Unlike the down-the-line exchange which we infer connected Mangareva to the Society Islands and Marquesas, the connection with Pitcairn must have been one of either direct access or of home-base reciprocity.

Environmental Change

Our fourth and final objective was to add to our understanding of the dynamic relationships between people and their island ecosystems. We observed that Mangareva had been described by biologists as an example of an island group heavily impacted by human activities, already extensively deforested by the time the first European explorers arrived. Analysis of the limited sample of bird bones recovered from Green's 1959 excavations (Steadman and Justice 1998) hinted that Mangareva originally had a far more diverse bird fauna than has been the case in historic times. We hoped that with additional excavation and the use of fine-meshed sieves we could obtain new zooarchaeological evidence for the nature of the Mangarevan biota prior to human impact.

The discovery of the rich bird bone assemblage at the base of the Onemea site (TP-2) provides the first clear sample of the Mangarevan avifauna at the period of initial human settlement. As Worthy and Tennyson report in Chapter 6, the list of bird taxa now known to have inhabited the Mangareva Islands includes at least seven petrels, two tropicbirds, two frigate birds, one heron, one wading bird, three noddies, and three pigeons; Polynesians introduced the chicken. Of these species, one *Pterodroma* petrel, two frigate birds, and a ground-dove seem to be locally extinct, while another ground-dove, the *Pseudobulweria* petrel, and the *Ducula* pigeon are most likely globally extinct. Moreover, the effect of human arrival in the islands was not simply one of reduction in species richness. In historic times, seabirds have been almost exclusively confined to the small high islands and rocky islets in the southern part of the Mangareva lagoon, where steep cliffs and rugged topography make the birds hard to reach or prey upon (Lacan and Mougin 1974). The Onemea assemblage now demonstrates that substantial populations of nesting and breeding birds were present on the larger high islands at the time of human arrival.

The substantial bird populations which we hypothesize to have been present on all of the Mangareva Islands would have provided a major food resource to the arriving Polynesian colonizers. As a naïve fauna without ground predators prior to human arrival, these birds would have been extremely easy to take, which may account in large part for their rapid demise. At the same time, it is possible that these seabirds played a key role in the terrestrial ecodynamics of Mangareva, specifically through the continued transferal of nutrients from sea to land, by means of their consumption of fish and deposition of guano. Recent research on nutrient cycling and limitation in oceanic islands (Vitousek 2004; Wardle et al. 2004) has shown that on volcanic substrates older than a few hundred thousand years, natural inputs of key nutrients such as phosphorus (P) have declined to such low limits that vegetation is limited by nutrient availability. In Mangareva, where the substrates are ~5-6 million years old, it is likely that P limitation is a major constraint in local soils. This is compounded by the fact that the Eastern Polynesian flora is poor in N-fixing plants. A third relevant factor is that Mangareva lies in a region of the eastern Pacific where airborne inputs of Asian dust (another significant source of nutrients such as P, Ca, and Mg) are at their lowest levels.[2] Given these biogeochemical limitations, substantial inputs of both P and N from seabird guano may have been essential to the maintenance of the terrestrial ecosystem that flourished in Mangareva prior to human arrival. With the decimation of these seabird populations, and their restriction to the smaller islets of the southern lagoon, this major source of nutrient input would have been eliminated. We hypothesize that the impact of humans (directly through predation, and probably indirectly through the effects of human-introduced *Rattus exulans*) on seabirds created a situation in which the nutrient cycling so critical to forest maintenance on the high islands was disrupted. The pervasive deforestation of the high islands may owe as much to the elimination of seabirds and their nutrient inputs, as to the direct effects of human clearing and burning of the native forest. Certainly, the apparent inability of the natural Mangarevan vegetation to recover would seem to be influenced by persistent nutrient limitation. These are hypotheses we hope to test through further research.

Additional evidence for ecosystem change within the period of Polynesian occupation of Mangareva comes from land snails in archaeological and sedimentary contexts. As with other oceanic islands, the land snail fauna of Mangareva exhibited considerable taxonomic richness and high levels of endemicity, but this fauna has only been known to malacologists from the subfossil record. From our excavations, we have recovered samples of several endemic taxa, such as *Gambiodonta* cf. *grandis* and *Omphalotropis margarita*, which are today extinct in the islands. While these taxa are present in sediments dating to the middle period of the Mangarevan cultural sequence, they seem to have been on the decline by the late prehistoric period. Meanwhile, Polynesian introduced garden snails such as *Lamellidea oblonga* are the most common in the late prehistoric sediments at Gaeata. Land snails of the species *Allopeas gracile*, another Polynesian introduction, are present in the deepest layers at Onemea (TP-2). This species is associated with gardening and economic plants, and its presence may provide indirect evidence of crop plant introductions at the time of initial human settlement on Taravai Island.

At the same time that the emerging evidence suggests significant human-induced impacts to the terrestrial ecosystem of Mangareva, we have been unable to find evidence for similar effects on the marine ecosystem. Based on the limited samples of marine invertebrates and fish that we have been able to study thus far, there is no sign of size reductions, or of reduction in representation of large and more highly prized prey, either of which would potentially signal resource depression as a consequence of predation pressure (see, for example, Butler [2001] on the Mangaia case). Indeed, we would hypothesize that given the vast extent of the Mangarevan reef-lagoon ecosystem in contrast to the available area of arable land, it has always been terrestrial resources which are human population-limiting in Mangareva, not marine resources. This hypothesis fits well with the available ethnohistoric evidence (see Chapter 2), which indicates that the sea provided the bulk of protein in the traditional Mangarevan diet, while carbohydrate food sources were limited, with control over agricultural lands and crops being the cause of intense competition and warfare.

PROBLEMS FOR CONTINUED INVESTIGATION

Having summarized some of the key results emerging from our first two field seasons in Mangareva, as well as formulating several hypotheses arising from these findings, we turn now to a brief consideration of research questions that we believe are deserving of further investigation. We hope to be able to address these research problems through continued work in the archipelago over the next few years.

THE NATURE OF LONG-DISTANCE INTERACTION

As reviewed in Chapter 1, an important advance in Eastern Polynesian prehistory over the past two decades has been the demonstration that the early communities who emplaced themselves on the scattered islands and archipelagoes were not immediately isolated following initial settlement. Rather, an emerging body of evidence increasingly demonstrates that inter-island and interarchipelago contacts continued after colonization, in some cases for several centuries or even up until the time of European contact (as certainly was the case between the Society Islands and Tuamotu group). On the other hand, some islands (such as Rapa Nui and the Hawaiian chain) clearly did become cut off from contact with other populations after a period of time. Essential to this emerging picture of long-distance interaction has been the development of geochemical methods (particularly XRF) of characterization and sourcing of basalt artifacts, especially adzes. As discussed above, the limited results obtained by our project have added to the evidence for down-the-line transfer of basalt adzes from the Marquesas and Society Islands into Mangareva, and for direct contact between Mangareva and the Pitcairn-Henderson group.

As work continues in Mangareva, it will be essential to continue to apply the best analytical tools to the problem of tracing the movement of materials into and out of Mangareva. In addition to work on basalt artifacts, characterization and sourcing analytical techniques need to be developed for other classes of material, such as artifacts of pearlshell. Research on long-distance interaction networks in the western Pacific, particularly during the Lapita period, has shown that such networks exhibit considerable complexity, as well as changing configurations over time (Green and Kirch 1997). Admittedly, tracking such changes through the archaeological record is facilitated in the case of Lapita by a more diverse set of material types, including pottery. In Eastern Polynesia, the range of materials potentially amenable to sourcing analysis is more restricted, and this poses challenges to our ability to reconstruct interaction networks. Nonetheless, this line of research is critical, because understanding to what degree and in what ways the early populations of southeastern Polynesia were in contact with each other, to what extent they were able to share cultural innovations, and why and when they became isolated and cut-off from external contacts, are fundamental to explaining the course of Eastern Polynesian culture history.

DYNAMICS OF CULTURAL CHANGE

To date, most of our effort (as with that of Green before us) has gone into the tedious but essential tasks of defining the Mangarevan archaeological record in time and space. This is as it must be in any area or region where there has been little prior research, and where the basic parameters of local culture history must be established. Defining basic variability in the archaeological record (site types, settlement distribution, artifact sequences), establishing when Mangareva was first inhabited by humans, and constructing a well-dated cultural chronology are fundamental tasks that must be accomplished before other kinds of research questions can ever be posed. Fortunately, this kind of basic archaeological work is now approaching the point in Mangareva where, we believe, it is possible to address questions of broader and more theoretical interest. Foremost among such questions will be those of the dynamics of cultural change.

As discussed in Chapter 2, Mangarevan ethnography presents a fascinating variant on the range of sociopolitical structures evidenced within Eastern Polynesian societies. Evincing some aspects of hierarchy and stratification as found in the classic model of Polynesian chiefdoms (Kirch 1984), Mangareva simultaneously exhibits trends that run counter to this model, suggesting considerable fluidity, competition, and heterarchy (Ehrenreich, et al. 1995). Social and political competition between several major status categories (hereditary elites, warriors, and priests, in particular) seems to have marked the protohistoric society in ways that are comparable to the Marquesas Islands (Thomas 1990; Kirch 1991), and possibly also to Rapa Nui. In Chapter 1, we quote Goldman (1970) on the significance of the Mangarevan case for understanding the role of economic scarcity in the evolution of a chiefdom society. The problem, of course, is one that must be tackled by archaeology, for as we have pointed out, ethnographic analysis is limited to the comparison of historical endpoints. To fully understand the nature of Mangarevan society on the eve of European contact, we must reconstruct the historical record of social and economic changes over the preceding eight or nine centuries.

Attempting to reconstruct the *longue durée* of Mangarevan society will be a complex task, and several kinds of data will be required. An underlying variable of great importance is that of human population levels and densities. Regardless of one's theoretical position on the role of demography in sociopolitical change, basic data on the size of the Mangarevan population over time will be critical to testing various models of cultural dynamics. For example, did the Mangarevan population reach a high density relative to available arable land rapidly after initial settlement (as is theoretically possible given human reproductive rates, the absence of most Old World diseases prior to European contact, and the small area of land), or was population growth a more gradual process with high density levels achieved only late in prehistory? This is a fundamental question, but one that we are as yet unable to answer. The methods to resolve it are in principle available, but it will require targeted fieldwork and much dating of residential sites to develop the required database.

Tracking the course of economic change is likewise another component to understanding long-term cultural dynamics. Zooarchaeological analysis of faunal assemblages has begun to contribute useful data. We now know, for example, that marine resources played a vital role in the subsistence economy, yet seem to have been fairly resilient to human predation pressures. On the other hand, we have also learned that terrestrial protein sources rapidly became limited after the early decimation of indigenous and endemic bird populations. Pigs, dogs, and chickens were introduced to the islands by the Polynesians, but none of these seems ever to have become a major source of food, and both the pig and dog were eliminated from the subsistence base prior to European contact. We know far less, however, about how the horticultural basis of production developed over time. Were there attempts early on in Mangarevan history to develop extensive gardening on the hillslopes, in an intensified swidden mode? Could such efforts have failed due to the environmental conditions of nutrient limitation mentioned earlier? When did Mangareva develop its particular emphasis on breadfruit and wet taro cultivation as described in the ethnohistoric sources? All of these are questions potentially amenable to archaeological investigation.

While population and subsistence production anchor the base of the social structure—the infrastructure of classic Marxian terminology—we also want to know how the superstructure evolved over time. This requires a different set of archaeological data, focused particularly on settlement pattern analysis and monumental architecture, such as the remains of ritual sites (*marae*) and elite residences. Unfortunately, it is true that a significant portion of the key monumental sites, especially at Rikitea on Mangareva Island, were so damaged or destroyed that investigating them may be next to impossible. Nonetheless, we are encouraged to find that other monumental sites are still extant, such as the *paepae* at Atituiti Ruga and the well-known Paepae o Uma at Te Rauriki. Our limited work at the ATU-1A *paepae* has already allowed us to tentatively position this site within the emerging cultural chronology for Mangareva, around the mid 15th-century A.D. If, as we have hypothesized, this platform is linked to the uniquely Mangarevan practice of solstitial observation and to the annual cult of the breadfruit (Kirch, in press), then we have an initial clue as to the emergence of one of the key tensions between the priests and hereditary chiefs. Further work at this site, at Paepae o Uma, and at other sites where architectural evidence of hierarchy or social differentiation appears, may well hold vital clues for the interpretation of Mangarevan social history.

HUMAN ECODYNAMICS

Finally, we continue to be convinced that Mangareva offers an ideal location for the study of what has recently been termed "human ecodynamics," the complex interactions linking human populations with their environment (McGlade 1995; van der Leeuw and Redman 2002). Oceanic islands, of which Mangareva is just one example, have the advantage of standing as "model systems" for human-environment interaction, in the same way that islands have recently been treated as model systems for investigating natural ecosystem dynamics (Vitousek 1995, 2002, 2004). As Vitousek elegantly puts it, a model system is one that "displays a general process or property of interest, and does so in a way that makes it understandable" (2004:6). Typically, model systems are useful because they are simpler than other systems of the same type, so the phenomenon of interest is not obscured. Some of the properties that make Polynesian islands model systems for human ecodynamics are their restricted geological substrates and highly orthogonal interactions between substrate age, climate, and nutrient gradients, combined with relatively late settlement by an initially culturally homogeneous human population practicing sophisticated horticulture, yet lacking draft animals or metallurgy.

Over the past two or three decades, studies in such Polynesian islands as Mangaia, Rapa Nui, Tahuata, and the Hawaiian chain, as well as in the more complex (because of its continental scale and geology) Aotearoa, have already made important contributions to human ecodynamics and historical ecology (Kirch and Hunt, eds., 1997). Mangareva represents a case with certain kinds of environmental factors not previously represented. Like Mangaia, Mangareva is a relatively old island and hence displays the kinds of terrestrial nutrient limitations already discussed. Unlike Mangaia or Rapa Nui, however, Mangareva does not exhibit severe restriction of marine habitats and consequent limitation of marine resources seen in the first two cases; rather, its reefs and lagoons are extensive and provide a rich resource base. In Mangareva, we appear to have a situation in which the terrestrial resource base, including the amount of arable land, was the key limiting factor, and in which marine resources were sufficiently extensive and resilient as to be relatively unaffected by human activity. In contrast to any of the cases mentioned above, moreover, the land area of Mangareva is tiny, roughly one-half that of Mangaia, and several orders of magnitude smaller than the Hawaiian Islands.

We have already made some progress towards unraveling the story of long-term human ecodynamics in Mangareva, as reported in this volume. However, much more work is needed, and will require interdisciplinary collaboration as has been the case in similar studies elsewhere. In coming field seasons, we hope to engage the efforts of appropriate specialists to define quantitatively the nutrient gradients and limitations within Mangareva that may have constrained both natural ecosystem development and human efforts to sustain production systems. In addition to expanding our zooarchaeological samples of marine and terrestrial fauna, we need to acquire paleobotanical data sets (such as charcoal and opal phytoliths) that will allow us to reconstruct sequences of vegetation change over precisely dated time frames.

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By way of closing, we venture a personal perspective on Mangareva and our experience of doing archaeology in these engaging and beautiful islands. Archaeology by its very nature is a physical as much as a human science—it depends upon scraps of physical evidence gleaned from the soil—and its practice forces one into an intimate association with the land and its sedimented traces of human endeavor. Of course, full exploitation of the hard-won field data requires investment of time in the laboratory, but for us the sheer joy of archaeology lies in its nature as a field science. To do archaeology in Mangareva is not just to excavate the burnt-umber colored sands of Onemea, or to feel the excitement of first spotting exquisitely preserved bones of ancient frigate birds and tropic birds as these appeared in the sifting screen, knowing that one had just opened a tiny window onto the world of the first Mangarevans. It is not only to discover that Kenneth Emory, the oft-revered pioneer of Eastern Polynesian archaeology, had made perhaps the most serious error in his career when in 1934 he dismissed Mangareva as a wasteland for research. Nor is it merely to spend long hours at the plane table, squinting through an alidade lens while trying to simultaneously swat a cloud of persistent mosquitoes in the midst of thick, humid secondary growth. To practice archaeology in Mangareva is also to live—for a time—in what continues to be a uniquely fascinating ecosystem, and one wildly beautiful. A place of wintry storms and tropical downpours, as we discovered through days of rain and mud, never-drying clothes, and slippery dirt roads. A place of stunning coral heads and reefs among deep-blue lagoons, where large parrotfish and wrasses abound in the shallow waters, visible in the crystal clear waters gliding just below the surface as we returned by boat from Onemea to Rikitea. Dramatic topography prevails, ranging from the rocky pinnacles of Makaroa and Motu Teiku, to the burial cliff of Ana Tetea on Agakauitai, to the long *Miscanthus*-grass covered ridges of Taravai and Akamaru.

But more than any of these things, to do archaeology in Mangareva, as indeed throughout most of Polynesia, is to experience the privilege of being accepted into the community of Mangarevans, themselves the continuing legacy of Mangarevan history. The people of Mangareva welcomed us, in their individual ways, as we met them and as we attempted to explain what purpose had brought us to their islands. They asked questions, and they much more frequently answered questions posed by us. Some of them shared indigenous knowledge, as that which concerns the importance of solar observation, and the locations of former *marae*, or more mundane matters such as fishing in stone weirs, or knowing which fish are likely to be ciguatoxic. We are grateful for that generous sharing. At the same time, we hope to have reciprocated at least a bit through our efforts to bring the methods and perspectives of archaeology to bear on the task of uncovering—and writing—a history of their *longue durée*. We say, advisedly, *a* history for we know full well that history is constructed, even as any given construction must be referenced to a body of empirical evidence. The Mangarevan people themselves have a rich oral-aural historical tradition, keyed to lengthy genealogies and a rich toponymic landscape. We seek, not to replace or rewrite that locally embedded history, but to attempt as the French historian Paul Veyne (1971) once wrote, "to lengthen the questionnaire." Archaeology can ask different historical questions, and with much work, sometimes answer them.[3] We hope that this modest volume will be seen as a contribution toward that end.

CHAPTER 8 ENDNOTES

[1] The situation at Onemea finds a close parallel in the Hanamiai site excavated by Rolett on Tahuata Island, Marquesas (Rolett 1998:94-95, table 5.1). In the Hanamiai site, 91% of all bird bones were recovered from the basal two layers (G and H), and 84% of the assemblage represents seabirds.

[2] Vitousek (2004:106-107, fig. 6.4) provides data indicating that whereas the Hawaiian Islands receive between 100-1000 mg/m^{2}/yr^{1} inputs of Asian dust, Mangareva lies in a zone receiving <10 mg/m^{2}/yr^{1}. In Hawaii, these Asian dust inputs are critical to forest ecosystem maintenance on the older island substrates. Given that Mangareva receives at least an order of magnitude lower inputs of Asian dust, and that the islands are equivalent in age to Kaua'i Island, one can infer that Mangareva is likely to be even more nutrient limited than the oldest Hawaiian islands.

[3] We also had to cross our own intellectual cultures to explore the other's academic traditions, for there are significant differences between anglophone and francophone archaeology, sometimes made more puzzling by linguistic barriers. These included embedded practices of excavation and mapping, a true *habitus* of archaeology!

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APPENDIX A: SITE NUMBERING CODES FOR THE GAMBIER ARCHIPELAGO

190- general code for the Gambier Islands
Island Codes:
- -01 Akamaru (AKU)
- -02 Agakauitai (AGA)
- -03 Aukena (AUK)
- -04 Kamaka (KAM)
- -06 Mangareva (see letter codes for districts)
- -07 Makaroa (MAK)
- -12 Taravai (TAR)
- -13 Temoe (TEM)
- -14 Tenoko (TEN)

Districts within Mangareva Island:
- RIK- Rikitea
- ATU- Atituiti
- GAA- Ganoha
- KOK- Kokoue
- GAU- Gahutupuhipuhi
- ATA- Atiaoa, Atiaoha
- GAT- Gatavake
- KIR- Kirimiro
- TAK- Taku

- GAN- Gahututenohu
- GTU- Gahutu
- AKA- Akaputu
- GAE- Gaeata
- ATR- Atirikigaro
- VAI- Vaituatai
- REV- Revaru

APPENDIX B: INDEX TO RECORDED ARCHAEOLOGICAL SITES IN THE MANGAREVA ISLANDS

SITE NO.	LOCALITY/NAME	SITE TYPE	EMORY (1939)	WEISLER (1996)	THIS VOLUME (PAGE #)
MANGAREVA 190-06-					
RIK-1	Te Kehika	*marae*	p. 19		88
RIK-2	Te Hau-o-te-vehi	*marae*	p. 19		
RIK-3	Hiriga-tapu	*marae*	p. 22		
RIK-4	Taputapuatea	*marae*	p. 22		
RIK-5	Hetu-kura	'royal nursery', pavement	p. 22		
RIK-6	Maoa	'royal nursery', pavement	p. 23		71
RIK-7		stone-faced terrace			40
RIK-8		stone pavement			40
RIK-9		stone-faced terrace			40
RIK-10		stone-faced terrace			40

SITE NO.	LOCALITY/NAME	SITE TYPE	EMORY (1939)	WEISLER (1996)	THIS VOLUME (PAGE #)
RIK-11		stone-faced terrace			40
RIK-12		stone-faced terrace			40
ATU-1	Atituiti-Ruga	large *paepae* and associated features			48-58
ATU-2	Atituiti-Raro	buried cultural deposit			58
ATU-3	Te Mata-o-Tu	*marae*	p. 24		58
ATU-4	Atituiti-Raro	irrigation system (stone-faced terraces)			
ATU-5	Atituiti-Ruga	19th century lime kiln		MAN-2	
ATU-6	Atituiti-Raro	stone fish trap complex			58, 59
GAA-1	Ganoha	village complex and irrigation terraces		MAN-3	
ATA-1	Atiaoa	rockshelter		MAN-4	60-63
ATA-2	Atiaoa	stone structural complex in valley			66-67
ATA-3	Atiaoa	*paepae* near coast			60
ATA-4	Atiaoa	buried coastal midden deposit			63-66
GAT-1	Gatavake, Ruanuku	*marae*	p. 24		
GAT-2	Gatavake, village complex	stone pavements	p. 25		
GAT-3	Gatavake	buried cultural deposit		MAN-5	68-70
GAT-4	Te Rauriki, Paepae o Uma	large stone terrace	p. 25	MAN-1	70-71
TAK-1	Apeakava, Kuoiti	*marae*	p. 26		
TAK-2	Ruanuku	*marae*	p. 26		
TAK-3	Tagaroa	*marae*	p. 26		
TAK-4	Aganuku	rockshelter, test excavated by Green in 1959 (site GM-1)	p. 26		
GTU-1	Gahututenoho, Ana-o-mea-hiti	rockshelter	p. 26		
AKA-1	Akaputu, Tautini	*marae*	p. 26		
GAE-1	Gaheata	sedimentary deposit with charcoal and snails		MAN-7	70
GAE-2	Gaheata	stone alignment in inter-tidal zone			
AUKENA IS. 190-03-					
AUK-1	Mana	*marae*	p. 26		
AUK-2	Tautoro	*marae*	p. 27		
AUK-3	Te Ana o Tiki	large rockshelter	p. 27		

SITE NO.	LOCALITY/NAME	SITE TYPE	EMORY (1939)	WEISLER (1996)	THIS VOLUME (PAGE #)
AUK-4	Te Ana Pu	Rockshelter, excavated by Green in 1959 (GA-1)			
AUK-5		stone enclosure in inter-tidal zone			92
AUK-6		rockshelter		AUK-1	
AUK-7		rockshelter		AUK-2	
AUK-8		coastal midden deposit		AUK-3	
AKAMARU IS. 190-01-					
AKU-1	Marae Rua	*marae*	p. 31		
AKU-2	Te Ana-o-Porotutu	burial cave of the Akamaru chiefs	p. 31		
AKU-3	Tokani	extensive stone structural complex, mapped by R. C. Green	p. 32		
AKU-4	Te Umu-o-Tu, Manahune	midden in coastal beach ridges		AKA-1	
AKU-5		rockshelter		AKA-2	
AKU-6		coastal midden deposit			75
AKU-7		coastal midden deposit			75
KAMAKA IS. 190-04					
KAM-1	Sancho's Cove, Kitchen Cave	rockshelter, excavated by Green in 1959 (GK-1)			
KAM-2	Sancho's Cove	rockshelter, excavated by Green in 1959 (GK-2)			76-78
KAM-3	Sancho's Cove	*marae* excavated by Green in 1959 (GK-3)			
MAKAROA IS. 190-07-					
MAK-1		midden in coastal beach ridge			
AGAKAUITAI IS. 190-02-					
AGA-1	Teana-o-raveika	rockshelter	p. 29		88
AGA-2	Nenega-iti	small rockshelter			88
AGA-3	Nenega-iti	rockshelter, test excavated in 2003			88, 87-91
AGA-4	Nenega-iti	*paepae*			88
AGA-5	Nenega-iti	boulder overhang shelters			88
AGA-6	Te Rua o Pou	cave	p. 30		88
AGA-7	Te Aga o Tane	*marae*	p. 28		88
AGA-8		terrace			88
AGA-9	Nenega-Nui	rockshelters		AUG-1 ?	88

Site No.	Locality/Name	Site Type	Emory (1939)	Weisler (1996)	This Volume (page #)
AGA-10	Kauai Point	rockshelter			88
AGA-11	Te Ana Tetea	rockshelter and burial ground	p. 30		88
AGA-12	Te Ana Vehivehi	excavated by Emory in 1934	p. 30		88
Taravai Is. 190-12-					
TAR-1	Agakono	cave site			81
TAR-2		rockshelter			81
TAR-3	Agakauiuta	coastal midden and associated features		TAR-5	81
TAR-4		rockshelter			81
TAR-5	Onemea Point	rockshelter			81
TAR-6	Onemea Bay	midden site in beach ridge, tested in 2003		TAR-3	81, 82-85
TAR-7	Aganui	rockshelter			81
TAR-8	Aganui	coastal midden site and associated features		TAR-2	81
TAR-9		rockshelter			81
TAR-10	Toku Tokuku	rockshelter		TAR-1	81
TAR-11		rockshelter			81
TAR-12	Te Kumete o Matane	natural feature with associated oral tradition			81
Tenoko 190-14-					
TEN-1		midden deposit in *motu*		TEN-1	