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Cover photo by Shankar Aswani.
Women collecting Kalipete crabs near Sasavele Village, Roviana Lagoon in 1994.

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Inquiries should be made to:

Hon. Secretary
The Polynesian Society
c/- Māori Studies
The University of Auckland
Private Bag 92019, Auckland

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Contributors to This Issue

Shankar Aswani is a Professor in the Department of Anthropology and Department of Ichthyology and Fisheries Science (DIFS) at Rhodes University, Grahamstown, South Africa. His expertise is in the human dimensions of tropical coastal and marine resource use, conservation, development and policy, with particular attention to the intersection between human ecology, marine science and conservation biology. His fields of specialisation include human behavioural ecology, vulnerability and resilience analysis, indigenous knowledge, GIS and marine spatial planning, and ethnohistory. Aswani also is active in applied conservation and development projects, hybridising natural and social sciences with local knowledge and institutions for comprehensive resource management.

Phyllis Herda is a Senior Lecturer in Anthropology and Women's Studies at the University of Auckland, New Zealand. She gained an MA degree in Anthropology at the University of Auckland and completed a PhD in Pacific History at the Australian National University. She has always worked across traditional disciplines. She continues to research and write on Tongan ethnography and history; gender, disease and colonialism in Polynesia; and Polynesian textiles, ancient and modern.

Lissa Gendreau is a Collections Technician at the Bernice P. Bishop Museum in Honolulu, Hawai'i. She holds a Bachelor of Arts in Art History from Pepperdine University, California.

Billie Lythberg is a Research Fellow at the University of Auckland, New Zealand and former Research Associate for "Artefacts of Encounter" at the Cambridge University Museum of Archaeology and Anthropology. Her research interests include indigenous economies and aesthetics, with particular foci on Māori and Tongan arts and literatures, the contexts in which these emerge and in which they are valued and exchanged, and 18th century artefacts (both tangible and intangible) of encounters with Europeans where object exchanges were harnessed to political and economic objectives.

Alex E. Morrison is a Post-Doctoral Research Fellow in Anthropology, University of Auckland, New Zealand. His research interests include paleoecological modelling, remote sensing and geophysical techniques, agent-based simulation and human predator-prey dynamics in marine ecosystems. Alex has been involved in archaeological research projects in Rapa Nui, Hawai'i, Samoa, Fiji, the Cook Islands, the Mariana Islands and Ecuador.

Andrew McAlister is a researcher in Anthropology, University of Auckland, New Zealand. His research interests include the archaeology of the Marquesas Islands, the Cook Islands and New Zealand, with an emphasis on investigating the distribution of material culture as a means of identifying social interaction.

Mara A. Mulrooney is an Assistant Anthropologist at Bernice P. Bishop Museum, Honolulu, Hawai'i. She has completed archaeological research throughout Oceania, most recently focused on Rapa Nui, Papua New Guinea, New Zealand, and the

Hawaiian Islands. She is the director of the Hoʻomaka Hou Research Initiative at the Bishop Museum, which is a collaborative collections-based research programme. Her primary research interests include landscape analyses and the refinement of chronological models.

Christopher M. Stevenson is an Assistant Professor in the Anthropology Program in the School of World Studies at Virginia Commonwealth University, Richmond, Virginia, U.S.A. His research interests include prehistoric agricultural systems on Rapa Nui and the Canary Islands, as well as glass hydrothermal experimentation, the application of obsidian hydration dating, and ceramic rehydroxylation dating.

INVESTIGATING CORAL REEF ETHNOBIOLOGY IN THE WESTERN SOLOMON ISLANDS FOR ENHANCING LIVELIHOOD RESILIENCE

SHANKAR ASWANI
Rhodes University

Coral reefs are of great socio-economic and cultural importance for many coastal communities across the tropics, yet little is known about the way people classify reefs locally and their close ecological and social relationships with these habitats. In a world in which coral reefs are increasingly threatened (Hughes *et al.* 2003, McClanahan *et al.* 2008), understanding how people perceive and use coral reefs is essential for predicting future ecological and social impacts, as well as for understanding human adaptation mechanisms to ecological change in these tropical marine ecosystems. This is particularly true for Oceanic islands, which are vulnerable socially and ecologically to deteriorating coral reefs, rising sea levels, and increasingly unpredictable climatic and geological phenomena (Lazarus 2012, McClanahan and Cinner 2012). Increasing human vulnerability to changing coral reefs, consequently, has resulted in numerous calls for comprehensive management using tools that include fishing regulations and quotas, marine protected areas (MPAs), and ecosystem-based management (EBM) for protecting coral reefs and other marine ecosystems. Other interventions, such as social safety nets, evacuation from vulnerable sites and diversification within fisheries, have been proposed to enhance adaptive capacity, ameliorate social and economic sensitivity, and reduce exposure to changing coral reefs (Cinner *et al.* 2012).

In the last few decades, authors have recurrently advocated the use of local/traditional/indigenous knowledge in the management of coastal ecosystems to ameliorate their degradation (Berkes 1999, Drew 2005, Narchi *et al.* 2014, Ruddle and Johannes 1985) and build resilience to human generated environmental and climate change (Alexander, Bynum, Johnson *et al.* 2011; Mercer *et al.* 2010). Research has shown that documenting indigenous ecological knowledge is crucial to understand human decision-making processes in coral reef-human interactions. Human foraging practices are constrained by the flow of information between fishers and the environment, the variability of spatio-temporal events, and the uneven distribution of prey species across coral reef ecosystems (Aswani and Hamilton 2004). Ethnographic research also has shown that for coastal people the sea is not an inert world but a dynamic and ever-changing one—a realm that in addition to providing daily sustenance is historically and spiritually meaningful to

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those who interact with it (Hviding 1996, Ruddle and Satria 2010). For many coastal peoples, then, coral reefs are more than just resource exploitation areas. They also are geomorphologic features that allow or bar people from navigating, markers that define property rights of the seascape in relation to other coastal and terrestrial habitats, and cultural and historical features that embody tribal identity and ideology (Aswani and Lauer 2006a).

In this article, I describe people's ecological and social relationships with coral reefs in two extensive lagoon ecosystems in the Western Solomon Islands (Fig.1) that while relatively unspoiled are increasingly being degraded by human actions. Building upon more than two decades of unpublished and published research that describe particular aspects of a long-term research programme in human ecology (e.g., Aswani 1998, Aswani and Vaccaro 2008), I combine ecological and ethnographic data to analyse the people's environmental perceptions and the dominant characteristics of coral reef habitats in the region. These include the productive practices carried out in these habitats by local inhabitants, the prevalent climatic and environmental phenomena associated with reefs and their transformation, and the socio-cultural meaning of reefs for lagoon peoples from the standpoint of local ecological knowledge. Documenting people's ecological classification and socio-economic and cultural use of coral reefs is not just a descriptive effort, but rather is relevant for understanding human-environmental interactions and for creating comprehensive base resource maps of people's perceptions and behaviour.

From the perspective of building socio-ecological theory, understanding people's capacity to perceive and classify their coral reefs, as well as their ability to identify environmental changes, has implications for how knowledge systems mediate between marine ecosystems and human communities—a capacity that can affect people's resilience and vulnerability as coral reefs become increasingly threatened by environmental and climate change (Aswani and Lauer 2014). From the perspective of management, this information can be used for designing hybrid marine and terrestrial conservation plans that integrate local forms of knowledge and management with Western approaches to fisheries managements including marine protected areas and ecosystems based management plans (Aswani and Ruddle 2013). Ultimately, building upon local people's knowledge and institutions not only fosters inclusiveness and equity in resource management and conservation, but also can result in greater resource management success and concomitant livelihood resilience to climate and other environmental change.

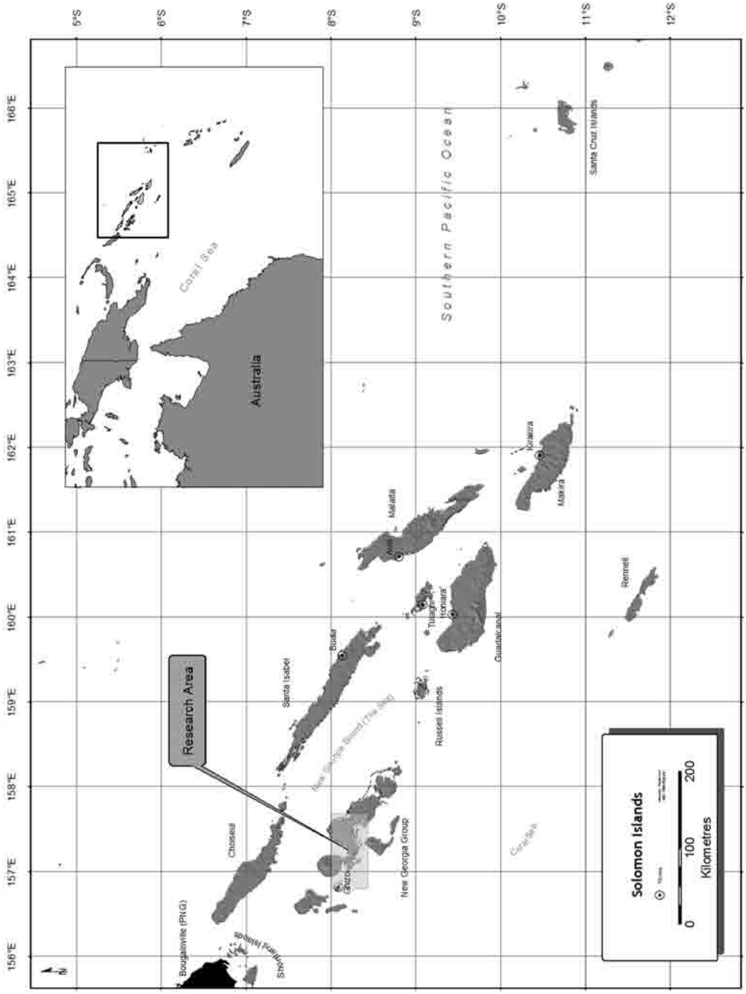

Figure 1. The Solomon Islands.

STUDY SITE

The Western Solomon Islands are mostly of volcanic origin and are covered with dense rainforest. Extensive lagoon systems, including the Marovo, Nono, Roviana and Vonavona lagoons (Fig. 1), shelter fish, shells, corals and other marine life, and make this region an important biodiversity hotspot within the Coral Triangle (Allen 2007). The lagoon ecosystems display a gradient of habitats, including mangrove forests, river mouths, mudflats, grassbeds, coral atolls, barrier reefs and marine lakes, and have characteristics of both coastal and coral atoll lagoons. The geomorphology of most Western Solomon lagoons resemble a combination of coastal “restricted” and “leaky” lagoons as they are shore parallel, have a distinctive tidal hydrology, and have more than two entrances connecting the lagoons with the open ocean (Kjerfve 1994). Their passages are wide and deep, permitting the movement of large volumes of water—a characteristic of estuarine and coral atoll ecosystems which permits unimpaired water exchange between the open ocean and the lagoons, thus allowing for the development of coral reef communities of diverse ecological characteristics in the entrances and central zones of the lagoons.

The Roviana Lagoon in New Georgia Island extends from Munda to Kalena Bay near Viru Harbour. The lagoon is protected by a series of offshore, raised coral islands that developed during the Pleistocene from sea-level changes and accretion of coral limestone, organic debris and volcanic detritus (Stanton and Bell 1969). The outer lagoon shoreline is characterised by rugged and notched limestone with numerous inlets, bays, carbonate-sand beaches and moats (Stoddart 1969), while in the inner lagoon there are small islets, coral reefs and intertidal reef flats. The Vonavona Lagoon, adjacent to Roviana, lies northwest of New Georgia between Kohinggo and Parara Islands and has a similar topography to Roviana (Fig. 2), although the movement of large masses of water has favoured the development of more coral reefs in southern Vonavona.

The Roviana and Vonavona region is home to about 15,000 people who share a common ancestry and history and are mostly Roviana speakers. The Roviana Lagoon is divided into the political districts of Saikile and Kalikoqu to the east, each a collection of villages that was ruled until recently by a paramount chief. To the west are the hamlets of Nusa Roviana, Dunde, Kekehe, Lodu Maho and Kindu in the Munda area which either have chiefs or council of elders who independently control each hamlet. Vonavona is similarly divided into small and large chieftainships. Community leaders exercise control over the use of and access to natural resources within their particular customary land and sea territories, although changing demographic and consumption patterns coupled with large-scale resource extraction ventures are increasingly eroding these indigenous management systems.

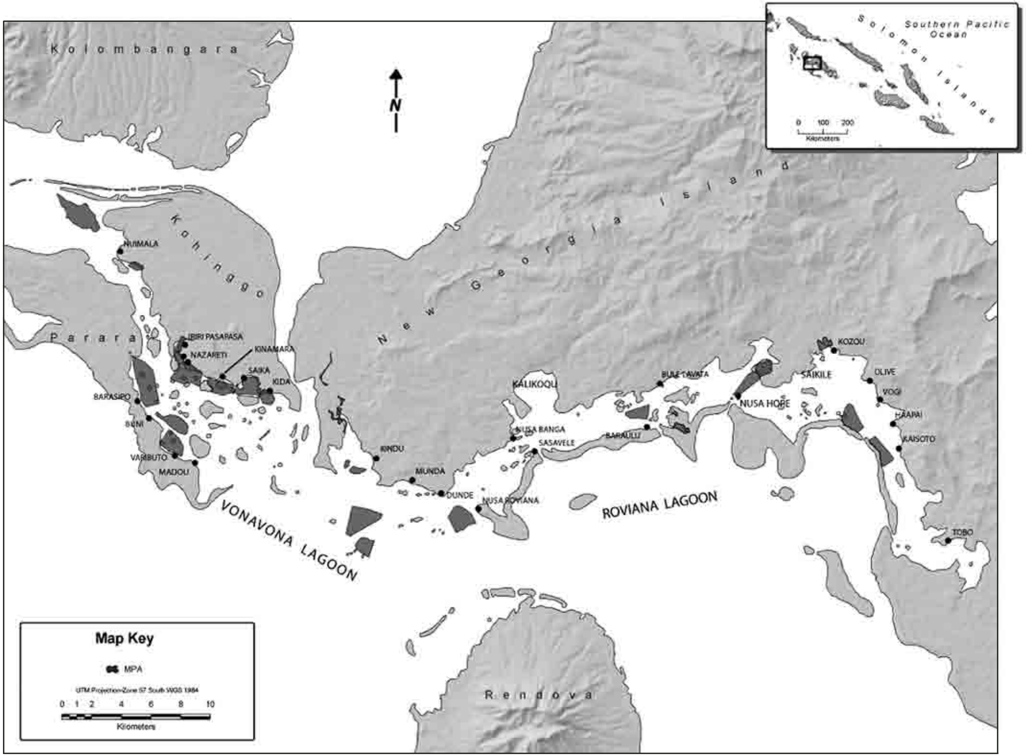

Figure 2. The Roviana and Vonavona Lagoons, New Georgia, Solomon Islands (MPA sites established under our research and conservation programme in collaboration with local communities shown in dark grey).

While people make money by shell diving, marketing of local produce, the selling of handicrafts, copra production and the operation of small stores, among other types of activities, the subsistence economy still plays a central role in the life of Roviana and Vonavona dwellers. Today, several livelihood activities threaten coral reefs. These include the small-scale, non-regulated exploitation of commercial species like holothurians, trochus and various shell species; increasing pressures on the subsistence fishery from small-scale commercial netting of fish, night diving for scarids and for rock lobsters for the growing tourist industry; collection of corals for building structures such as wharfs; the aquarium fish collection trade; and most importantly, sedimentation from poor land-based practices which impact on lagoon nursery areas (Halpern *et al*., 2013). These, coupled with environmental effects related to climate change, are increasingly degrading coral reefs and their future role in providing ecosystem services (e.g., local food sources).

Roviana and Vonavona fishers have a deep awareness of the biological rhythms of their lagoons and the creatures that inhabit the numerous habitats. They possess ecological knowledge rooted in the maritime experiences of the ancestral coastal peoples who inhabited these lagoons (Vuragare and Koloi tribes), knowledge that is not only an intergenerational transfer of information, but is also one that is transformed within the context of people's practical engagement with, experience of and performance of productive activities in a dynamic and changing marine environment (Ingold 1993). Even so, as suggested by Hviding (1996) for neighbouring Marovo Lagoon, the indigenous epistemology is being challenged as islanders increasingly entangle with the outside world. Indigenous ethnobiology is being transformed by the introduction of new fishing technologies and Western environmental categories. In fact, recent research suggests that Roviana people are increasingly losing the ability to make fine taxonomic distinctions of various marine species (Aswani n.d.). For all this change, local fishers still: (i) have cognitive maps of the seascape and marine organisms therein, which translate into actual resource classification, use and allocation geographically; (ii) recognise local ecological processes and changes, including habitat structure (habitat delineation), species composition and distribution, and spatio-temporal biological events (spawning aggregations) and (iii) possess proxy information to identify sites that incorporate the ecological processes which support biodiversity, including the presence of exploitable species, vulnerable life stages and inter-connectivity among habitats (Olds *et al*. 2014).

Since 1999 my research team and I have collaborated with local people to establish a series of conservation measures, including temporary and permanent closures to manage coral reefs across many sites in the Western Solomon Islands (32 MPAs) (Fig. 2). The management sites were selected through a combination of locally-driven assessments and the socio-ecological research of local habitats and associated management needs (as detailed in this paper). Temporal and permanent closures were selected following a perceived decrease in the size distribution and abundance of fish and invertebrates thought to be driven by fishing pressures, site preferences and village proximities. Some temporal closures, and their seasonal harvesting in particular, were established to conform to local social (e.g., death and feasting) and economic (e.g., need for cash for school fees) realities of Solomon Islands communities. As of 2014, various permanent and temporal closures were still operational (approximately seven or eight MPAs including Nusa Hope, Buni and Kozou among others), but a number of projects had been disbanded as a result of an ongoing religious conflict between various local communities.

METHODS

For over two decades, my team and I have collected multiple data sets using a combination of ecological, geospatial, and anthropological methods to analyse: (i) people's environmental perceptions and the dominant characteristics of coral reef habitats in the region, (ii) the prevalent climatic and environmental phenomena associated with reefs, (iii) the productive practices exerted in these habitats by the Roviana and Vonavona people, (iv) local perceptions and effects of environmental and climatic change on reefs and (v) the socio-cultural meaning of reefs for inhabitants from the standpoint of local ecological knowledge.

Documenting Coral Reef Ethnobiology

Indigenous ecological knowledge (IEK) of coral reefs was documented through extensive participation in fishing expeditions and interviews with fishers. Open-ended, semi-structured and structured interviews with several hundred young, middle-aged and elderly men and women from the region were conducted between 1992 and 2014 to elicit IEK. *Emic* (local perspective) categories for coral reefs and associated species (as well as those of other habitats [see Aswani and Vaccaro 2008]) were documented by inquiring about: (i) the name and ecological composition of recognised reef types, (ii) the associated species of fish, molluscs and crustaceans found in each reef category, (iii) seasonal variations in the availability of different taxa found within each reef type, (iv) the existence of particular seasonal events such as spawning aggregations, (v) varying weather, tidal and lunar conditions and their impacts on coral reef types and fauna and (vi) local uses for each coral reef type and its associated species. Emic environmental categories were matched with corresponding Western ones to designate habitat composition and biotic taxonomies. The Latin binomial nomenclatures for identifying corals follow Vernon (1993); for shells, Cernohorsky (1978) and Hinton (1972); for fish, Masuda *et al*. (1984), Munro (1967) and Randall, Allen, and Steene (1990); for echinoderms and algae, Morton and Challis (1969); and for sea grasses, Waycott *et al.* (2004). All organisms were identified through photographs and specimen collections (particularly shells).

Mapping Coral Reefs

To map the seascape, we first digitised 91 black-and-white aerial photos using a high-resolution scanner and then georectified the images so that they could be used as base maps. These digitised aerial photos were brought into the GIS and merged to create a mosaic of the lagoons. These large maps were used as visual tools to conduct participatory image interpretation exercises in each of the villages across the lagoons to identify coral reefs and other marine habitat types (Aswani and Lauer 2006a). During these focus-group exercises, fishers were instructed to identify and discriminate particular marine areas (e.g., coral reef types) to establish the spatial foundation for the ensuing analysis. Next, we worked with local fishers to delineate the seascape with GPS receivers and map indigenously defined biophysical areas, fishing grounds and spots, and associated coral reefs and other marine habitats. Local fishermen from each community guided a researcher in a small boat around the perimeter of each named area. During each trip, the locations of spawning, nursery, burrowing and aggregating sites for particular species within each recognised area were recorded and pinpointed with the GPS. The spatial extent of the area (represented as either lines or polygons) and the location of particular biological characteristics (represented usually as points) collected with the GPS receivers were consolidated into a large file and imported into our GIS database as a layer. Eventually, this information was ground-truthed (verified) via *in situ* habitat mapping and underwater visual census (UVC) surveys (see Aswani and Lauer 2006a for further details).

Recording Foraging and Productive Practices in Coral Reefs

Productive practices were recorded by extensive participation in fishing expeditions. Participant observation consisted of focal follows, which involved keeping *in situ* time-motion records of over a hundred fishers' behaviours and measuring their catches. In addition, various fishers kept self-reporting foraging (fishing and gleaning) diaries to supplement this data set. This information was used to understand seasonal movements of fishers, to forecast the decisions that fishers make in the types and abundance of fish that they prey on, the use frequency of different coral reefs, and to understand the fluctuating intensification of fishing efforts as fishers respond to environmental transformations related to climate change (see Aswani 1998).

Tracking Coral Reefs, Climate and Environmental Change
Indigenous ecological knowledge of environmental change was recorded through two methods: interviewing and participatory image interpretation. For the interviews we used semi-structured interviews and free-listing exercises. Respondents were asked to describe and list the changes they had observed in various coral reef habitats, as well as across other domains (open sea, inner lagoon, land ecology, agriculture and weather) (n = 266). The responses were "free-listed" allowing each respondent to list as many responses as they wanted. The assumption was made that the first response was the most important change recognised by the informant and so forth. For each change, respondents were asked to free-list the causes of change and concurrently they also were asked to explain how they "adapted" to the change. Finally, respondents were asked when they first noticed the change. Changes and causes were each coded into a common set of responses and were reduced to the codes that elicited 95 percent of the responses. The remainders were given the code of "other". Data were examined to determine the most common changes observed for each system. The scores for each change were summed across all data (first listed change = 4, second listed change = 3, third listed change = 2, fourth listed change = 1) (Aswani and Abernethy n.d).

Participatory image interpretation was conducted in two villages (Nusa Hope and Olive) to analyse local perceptions of change in coral reefs over the past 25 years (1986-2011). Knowledgeable informants were selected through a snowball sample to interpret remotely sensed data (identify reef types) and delineate changes in coral reefs (e.g., bleaching) on large-format image printouts. Groups convened upon arrival in each community and meetings were held in each village's town hall. The group was informed that the objective of the exercise was to map collectively observed changes in coral reefs (and other habitats too) across the lagoons. They did this by drawing points, lines and polygons on the satellite images, colour-coded according to the nature of the impact. Afterwards, I photographed the marked-up images with a digital camera for digitising. To enable further analysis, Esri's ArcGIS software was used to digitise the participants' drawings and associated written descriptions. The photographs of each marked-up satellite image were geo-referenced, and each drawing was digitised as a unique point, line or polygon feature representing the location of an impact on coral reefs. The digital features were assigned attributes corresponding to the ancillary written data collected during the mapping exercise. These attributes describe: (i) the village of the participants who created the drawing; (ii) the domain (e.g., coral reef types) associated with the drawing and (iii) a description of the noticed impact (e.g., bleaching, anchor damage, disease, etc.).

Identifying Cultural Meaning of Coral Reefs/Seascapes
To understand the cultural meaning of coral reefs for Roviana and Vonavona people, I studied customary management systems and their historical context using open and semi-structured interviews with household heads. These interviews explored kinship systems, tribal history, marine territoriality, and people's current perceptions of resource use and access rules. Key informants (mostly elders) were also interviewed about regional oral history and customary practices as they relate to fishing and coral reefs.

RESULTS

Coral Reef Ethnobiology
Western Solomon Islanders do not conceptually divide terrestrial and marine areas into separate domains. Rather they see their inclusive ancestral property estate, or *pepeso* for Roviana and Vonavona people, as including all terrestrial and marine habitats stretching from the interior of the New Georgia mainland all the way through to the open sea mid-way between the channel which separates New Georgia and other neighbouring islands (Fig. 3). Each *pepeso* is demarcated by a boundary (*voloso*) which divides the land and reefs of each respective estate. Boundaries generally follow major rivers flowing from the mountainous interior into the lagoon. At the barrier islands, territorial dissections are usually marked by the passages. In the Vonavona Lagoon area, where there are no major rivers, particularly on Parara Island, boundaries are marked by traditional shrines placed in inner lagoon islands and by certain topographic features. Within each major boundary, hundreds of smaller subdivisions separate individual land holdings, gardens, communal plantations, villages, and even households. A *pepeso* is divided into four major sections: The mainland (*tutupeka*), the lagoon (*poana* or *koqu*), the outer barrier islands (*toba*) and the adjacent sea-facing habitats (*vuragarena*), and the open sea (*lamana*). The *tutupeka* includes the interior forests, swamplands, rivers and bordering mangroves. The *poana* encompasses internal waters, inner lagoon islands, and from the mid-section to the interior shores of the barrier islands. The *vuragarena* comprises the mid-section of the barrier island (*toba*) to the outer shore, the adjacent reef drop, and the adjacent open ocean waters. Finally, the open-ocean where fishermen troll for bonito and tuna is considered the *lamana*. These domains, in turn, are highly diverse mosaic environments consisting of numerous habitat types.

Within each marine section, inhabitants divide each of the mentioned marine areas into named locations (the name usually preceded by the term *sagauru* 'reef') which are viewed as marine resource exploitation areas, geographical features that permit or restrict people from navigating, and cultural and historical markers that represent territorial boundaries and/or cultural sites

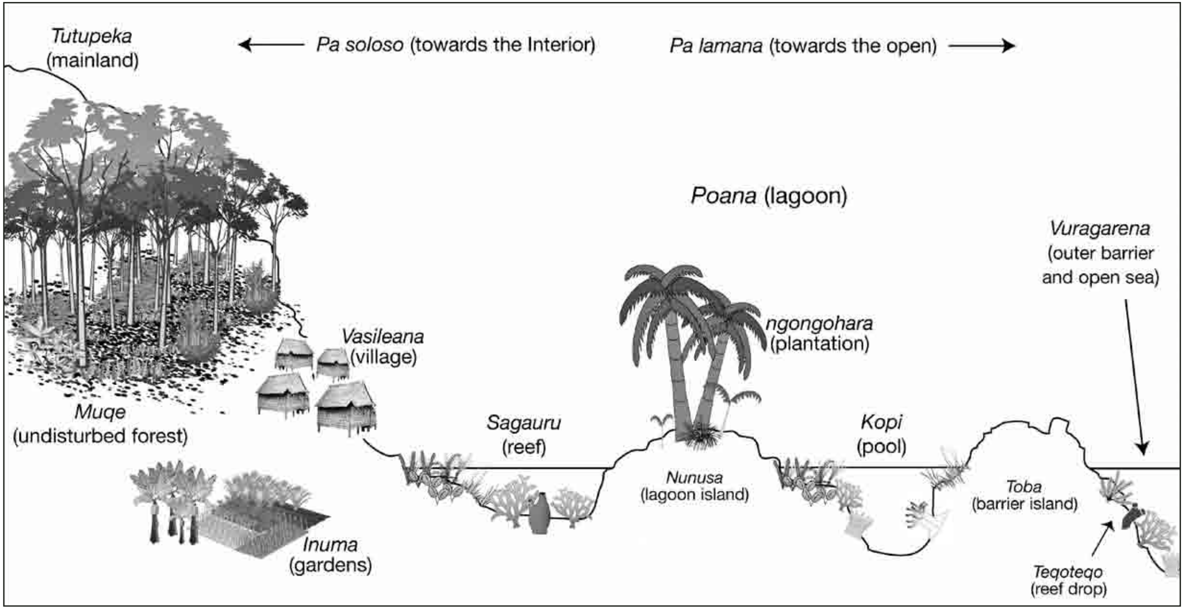

Figure 3. Roviana zoning of land and sea domains or *pepeso* (Aswani and Vaccaro 2008).

of importance. Next, fishers classify fishing grounds (*habuhabuana*) that are found within the locally named and delimited geographical areas (Aswani and Vaccaro 2008). Fishing grounds tend to be clearly definable habitats such as isolated reefs (or reefs surrounded by deep water), channels, bays, grassbeds, inland pools, coastal pools, mud flats, and sections of the outer reefs (reef slopes). Fishing grounds are recognised by native informants as productive depending on daily, lunar and seasonal variation. In areas where there are no human settlements, fishing grounds are identified as productive at all times, and other areas are only recognised as productive when certain migratory species pass through them. Fishing grounds themselves are composed of one or more areas or floating spots (*alealeana*), in which people drop their lines or nets to target particular species or assemblages of species. Underlying this cognitive construction of the seascape (Fig. 4), lagoon dwellers recognise a number of biological events of significance, such as spawning aggregations sites, as well as major and minor ecological assemblages of abiotic and biotic features (Figs 4 and 5). In what follows, I show the ethnobiological or emic conceptualisation of *major* and *minor* reef habitats and associated biotopes. Specifically, I review their correspondence with scientific habitat mapping, the activities that occur across these habitats, how people perceive changes in the marine environment and associated resources, and the place of spiritual beliefs in shaping cultural activities across the seascape.

Inner Lagoon Shallow Reefs (Major). The word *sagauru* is generic for 'reef', but it is usually employed locally in reference to inner lagoon shallow reefs ranging between one and four metres in depth. Shallow reefs or *sagaru masa*, are characterised by dead and live *Porites, Acropora, Millepora*, Faviidae,

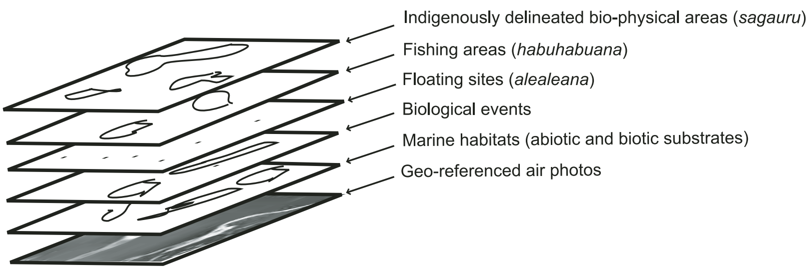

Figure 4. Roviana perception of the seascape as represented by layers (or themes) in the GIS (Aswani and Lauer 2006a).

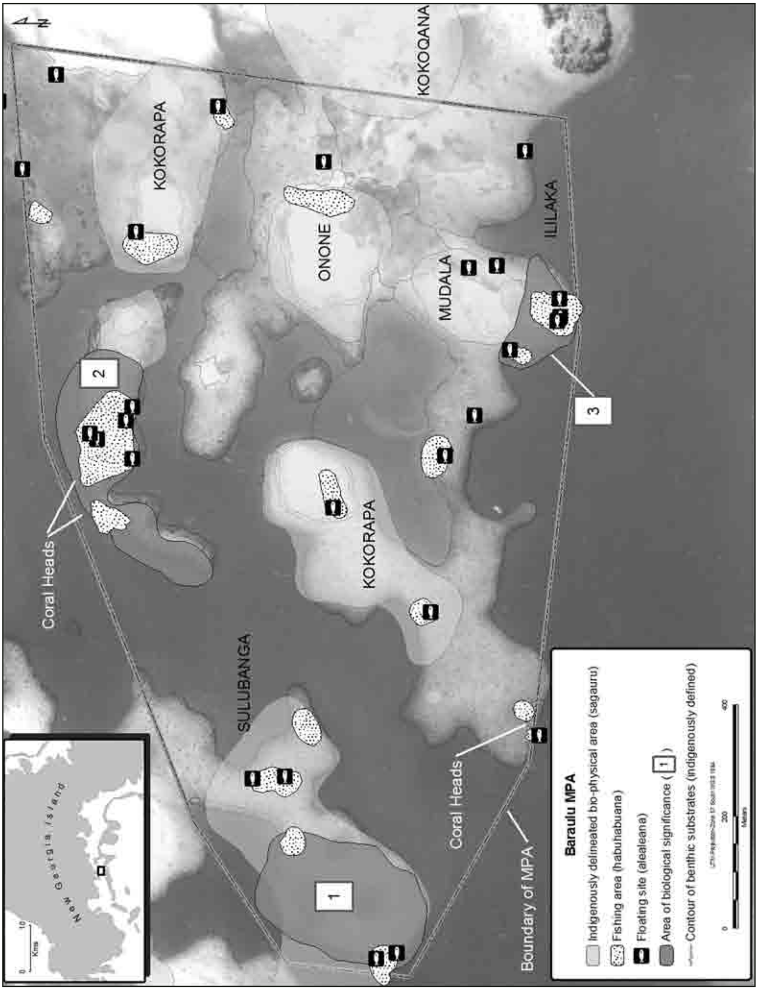

Figure 5. Local demarcation of predominant reefs and fishing sites of the Baraulu MPA (Aswani and Lauer 2006b).

Agariciidae and *Pocillopora* coral colonies, as well as scattered *Fungia* corals. Other organisms such as branchial crowns (e.g., *Spirobranchus giganteus*) and sabellids (e.g., *Sabellastarte sanctijosephi*) inhabit the crevices of *Porites* coral heads (Womersley and Bailey 1969). Various species of Hydrocharitaceae sea grass (e.g., *Thalassia hemprichii* and *Halophila ovalis*) and *Halimeda* spp. macroalgae are spread over the dominant sand and coral rubble substrate (*zalekoro*). Shallow reefs are heavily exploited by everyone for fishing and collecting crustaceans and shells, particularly during the day low-tide/night high-tide season from May to September (*masa rane/odu bongi*). This habitat is good for fishing during early mornings and evenings but can also be good at noon on particular reefs. Fishers say that the best time for fishing in this habitat is during low and ebbing tides when reef and pelagic species concentrate in these areas. The best lunar phases are the new moon, first quarter and full moon. Fishing methods employed in shallow reefs include angling, trolling, netting, diving, spearing, and the use of piscicide leaves. The practice of each fishing method varies according to the tidal seasons or time of day. Some of the most important income-generating shells are gathered from these areas, such as cardita clams (*Beguina semiorbiculata*) and nassarius shells (*Nassarius camelus*), which are collected by men and women during the day low-tide season. Shells taken for subsistence purposes in shallow reefs include venus (*Gafrarium tumidum*) and ark shells (*Anadara* spp.). With the shift in tidal seasons in September, nocturnal low-tide permits divers to access multiple reefs where various species of sea cucumbers (*bêche-de-mer*) are found. Although sea cucumbers are harvested throughout the year, during this period the *bêche-de-mer* fishery intensifies. Once processed, *bêche-de-mer* is sold to Asian traders in Roviana and Honiara for export.

Inner Lagoon Mid-Depth Reefs (Major). Mid-depth reefs or *sagauru lamana* are inner lagoon reefs found at depths between five and 15 m. Like shallow reefs, mid-depth reefs include *Porites, Acropora, Millepora*, Faviidae, Agariciidae and *Pocillopora* coral colonies. Sea grasses and macroalgae are not as abundant as in shallow reefs because of water depth. The substrate is a mix of coral rubble and fine silt combined with sand. Mid-depth reefs occur throughout the lagoons and are prevalent in lagoon pools and channels. Local people recognise these areas as commonly colonised by large coral formations locally called *huquru* (*Porites cylindrica*), which in recent years have been severely affected by disease and bleaching. These coral colonies are good fishing spots because various species of fish, such as paddle-tail (*Lutjanus gibbus*), hussar (*Lutjanus adetii*) and yellow-margined (*Lutjanus fulvus*) snappers, aggregate in them during the full moon. While mid-depth reefs are considered good fishing grounds, they are not visited as commonly as shallow reefs. Men do most of the fishing here, as women and children prefer shallower waters. Line fishing is favoured during low-tide as larger fish concentrate in this habitat away from very shallow reefs, grassbeds and sand banks. Mid-depth reefs are visited throughout the year according to the lunar cycle and species targeted, and the preferred fishing times are as with shallow reefs. The most common fishing methods used in this habitat are drop-line, angling, trolling and diving. Diving in mid-depth reefs is more common in the Munda and Vonavona areas, since the waters are clearer than the more turbid Roviana ones.

Cape Reefs (Major). Cape reefs (*miho sagauru*) are reefs that are differentiated locally from other reef types because they form around capes or peninsulas that extend out from inner lagoon islands or mainland promontories, and present diverse prospects for fishing. These reefs are usually shallow and have similar characteristics to shallow inner lagoon reefs. However, colonies of soft corals such as *Sarcophytum* and *Sinularia* and some gorgonians are common in the sloping edges of these reefs. Common fishing techniques used by locals include trolling, angling, day and night spear throwing and spearfishing, netting and diving and gleaning for invertebrates. Various pelagic species, such as great barracudas (*Sphyraena barracuda*) and bluefin trevally (*Caranx melampygus*), aggregate in cape reefs, and experienced fishers know that fish forage up and down the fringing drops and wait for them to aggregate at the reef's edge. In the mornings and evenings between September and December, and during the last quarter of the lunar cycle, fishers angle and drop-line in cape reefs for yellowmargin (*Pseudobalistes flavimarginatus*) and titan (*Balistoides viridescens*) triggerfishes, scribbled snapper (*Lutjanus rivulatus*), and speckled-fin rock cod (*Epinephelus ongus*), as these species concentrate in the deeper edges of these areas.

Reef Drops (Major). The word *teqoteqo* refers to reef drops either in the inner or outer lagoon (smaller drops are known as *barapatu*). Those found in the inner lagoon extend from three to 40 m in depth and are located at the edge of lagoon channels, pools and passages. They are generally comprised of coral rubble and rocky substrates spotted with *Porites, Acropora, Pachyseris* and *Merulina* colonies, among other hermatypic coral families. In larger passages, colonies of soft corals such as S*arcophytum, Sinularia* and gorgonians are common. Fishing here is good and fishers prefer early morning and late evening, low-tide, and the new and full moons. Drops bordering passages are good for fishing scribbled snapper, triggerfishes, speckled-fin rock cod, and flowery cod (*Epinephelus fuscoguttatus*) during the last quarter and 'no moon' (*koroqana*) lunar phases.

Outer lagoon reef drops, on the other hand, range between three and 200 m in depth and are more diverse than inner lagoon reefs because waters are clearer, thus affecting the distribution and density of coral reef species. Outer lagoon corals can cover up to 100 percent of the limestone substrate and include *Pocillopora, Montipora, Acropora, Favia, Porites, Goniopora, Pavona, Echinophyllia, Lobophyllia, Seriatopora* and *Stylophora*, among many others. Fishing in this habitat is good and less influenced by tidal variation of than along the inner lagoon reef drops, though weather conditions govern their ease of access. Currents are also an important consideration when fishing in the outer drops; Roviana fishers say that the best fishing occurs when bait "scent" follows the direction of the current towards the known fish location. For instance, if a fisher is fishing at the edge of a drop and the current is flowing outward to sea, the fisher should position away from the drop in the shallow shelf and cast the line towards the reef drop. Fishing methods in the inner and outer reef drops are similar, the most common being angling, trolling, bottom-lining, spearing and diving. Inner reef drops are used throughout the year, while outer drops are mostly used from August through December when large schools of barracuda (e.g., *Sphyraena jello*, *S. putnamiae* and *S. barracuda*) congregate in specific areas.

Outer Lagoon Deep Water Reefs (Major). Sagauru ruata are deep water reefs found in the outer lagoon that are usually not visible from the surface. The depth of these reefs ranges from 15 to over 100 m and dense coral formations including various *Acropora, Montipora, Echinophyllia, Leptoseris, Pavona, Sinularia* and gorgonians species dominate the rocky substrate (Morton and Challis 1969). Some *ruata* reefs are near the outer lagoon intertidal zone, while others are hundreds of metres away from the shoreline. *Ruata* reefs are used by men and are only accessible at specific times because southeast trade and westerly winds prevent access to these sites. *Ruata* are considered good fishing spots and, unlike inner reefs, they are productive throughout the lunar cycle. Midday and nights are the favoured times to fish here and fishing is optimal on full moon nights as currents are not too strong and certain species like paddletail snappers, big-eye bream (*Monotaxis grandoculis*) and red bass (*Lutjanus bohar*) aggregate in these reefs. Traditionally, a local fishing method named *kura habili*, involving the use of traps to capture humphead Maori wrasse (*Cheilinus undulatus*), was practiced during the last quarter of the lunar phase from September to December of every year in the shallower areas of this habitat. Today, the most common fishing methods used in *ruata* reefs are drop-lining, vertical-trolling, and regular trolling if schools of fish are spotted on the surface.

Pede Coral Colony (Minor). Pede is used as a generic term to refer to coral colonies of the *Turbinaria, Pavona* and *Acropora* families, which are found in mid-depth and shallow areas of the inner lagoon. These infrequent colonies tend to stand apart in sandy bottoms away from coral reefs and, while visited throughout the year, these are more intensively exploited during the day low-tide season. The most commonreef fishing methods used here are angling and diving. All sorts of coral fish species are caught here, the most prevalent being paddletail snappers, various groupers (e.g., *Cephalopholis microprion*, *C. boenak*, and *C. cyanostigma*) and brown-headed emperor (*Lethrinus hypselopterus*). In recent years anthropogenic processes have led to the demise of many of these coral formations.

Huquru Coral Colony (Minor). Huquru or *Porites cylindrica* coral colonies, can be found in shallow reefs around islands inside the lagoons and are considered good fishing spots. Local divers note that they are good places to catch smaller green and hawksbill turtles, which often are found resting under these coral formations. Frequent reef fish include hussar snappers, various species of groupers, black-banded seaperch (*Lutjanus semicinctus*), yellow-margined seaperch, and sweetlips (*Plectorhinchus chaetodonoides*, *P. goldmanni*, and *P. obscurum*). Also, *hikama koqu* 'painted rock lobsters' (*Panulirus versicolor*) are found here. The prominent fishing methods practiced in *huquru* are angling and diving with locally-made spear throwers known as *bugiri*. Like *pede*, these formations have been decimated in recent years.

Patu Voa Coral Head (Minor). Patu voa "stones" are *Porites* corals formations (e.g., *P. lobata, P. australiensis* and *P. lutea*) that are the most widespread hermatypic corals in the Roviana and Vonavona lagoons. They are found everywhere, including in mangroves and near river mouths. These corals can be massive and thrive in the sediment-rich water of the lagoons (Vernon 1993). Colonies found in mangroves and grassbeds are small and many are dead, which are then classified locally as *patupatu.* Most reef fish species targeted by humans can be caught near these coral heads, the most prominent being several species of groupers (*Epinephelus ongus*, *Plectropomus areolatus* and *P. laevis*), titan triggerfish and sabre squirrelfish (*Sargocentron spiniferum*). Groups of surgeonfish and sweetlips aggregate in these coral heads at specific times. The most common fishing activities carried out in these formations include angling, diving and the use of traditional piscicides. Diving for cardita clams (*Beguina semiorbiculata*), which are found embedded in these corals, is also an important activity.

Patu Kakarapihi Coral Head (Minor). Favites and *Goniastrea* corals are locally referred to as *patu kakarapihi* and are recognised as being structurally similar to *patu voa* but much softer and less widespread. *Patu kakarapihi* are found in well-developed coral reefs near reef slopes and outer lagoon reefs; few are found in the inner shallow reefs of the lagoon. Common reef fish found here include paddletail snappers, yellow-margined seaperch, groupers and angelfish (*Pomacanthus* spp.). During the day low-tidal season these coral heads are visited by divers looking for fish and for cardita shells.

Coral Reef Maps

The local categories were compared with scientific habitat mapping and there was a close correspondence between these forms of habitat categorisation. The geospatial analysis of coral reef ethnobiology revealed that out of the 615 indigenously defined foraging areas, more than 400 areas were locally classified as "coral reefs" of some sort, particularly inner and outer lagoon coral reefs (Fig. 6). Notably, this emic map of the coral reef seascape corresponds with scientific habitat mapping conducted by our team (Albert, Grinham, Bythell *et al.* 2011), and an in-depth analysis of particular sites revealed high correspondence rates between indigenous classifications of coral reefs and scientific surveys. For instance, a point-to-point comparison between quadrat dive field survey results and indigenous aerial photo interpretation of dominant benthic substrates in the Baraulu MPA (Roviana Lagoon) (Fig.7) showed that equivalence rates for a moderately detailed classification scheme of the benthos were on average between 75 percent and 85 percent. For hard corals agreement ranged between 55 percent and 89 percent, depending of the mix of hard corals with other abiotic substrates (e.g., sand, rubble or rock) (Aswani and Lauer 2006a). The habitat mapping exercise, in tandem with the foraging analysis (next section), showed that inner shallow lagoon and outer drop reefs are among the most important habitat types in the lagoons and a large percentage of the total marine resources acquired come from these habitats.

Productive Practices in Coral Reefs

Roviana and Vonavona people have a close relationship with the illustrated coral reefs and a large proportion of marine protein for sustaining lagoon dwellers comes from these habitats. Lagoon peoples distinguish over 50 major fishing methods with numerous local variants that are adapted to particular environmental conditions and designed to target specific or general species clusters. There are four major interdependent physical forces that structure the times and places where fishers use these methods: (i) daily and seasonal tidal fluctuations, (ii) lunar phase periodicity, (iii) wind patterns and (iv) lagoon

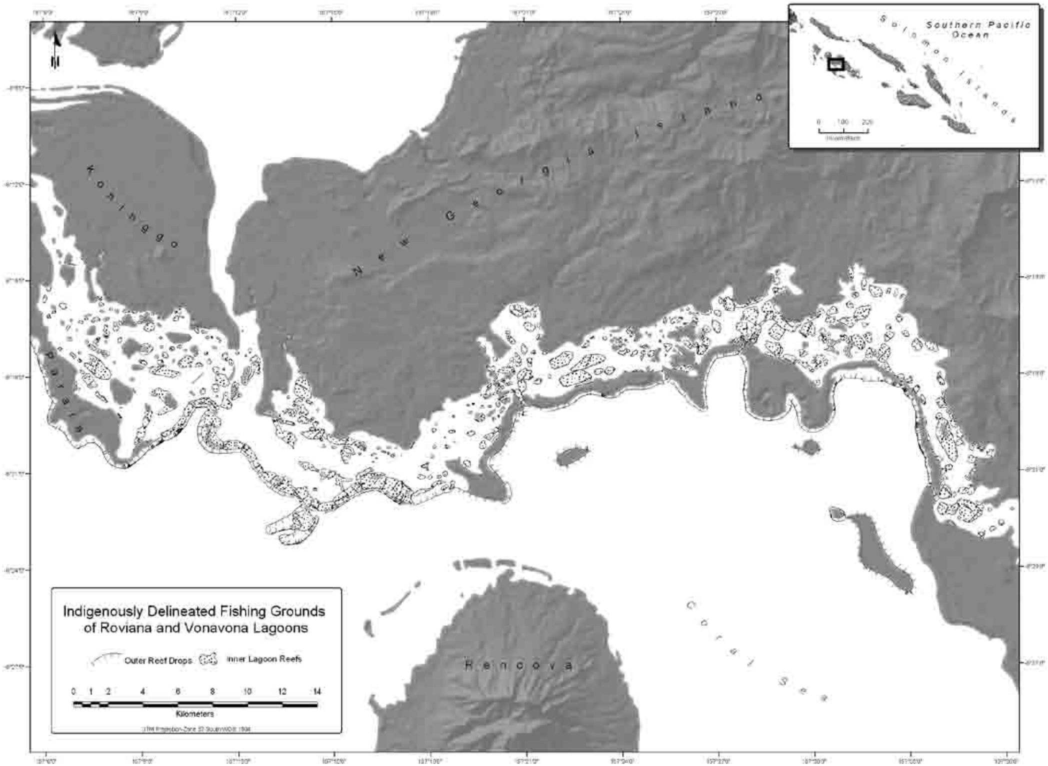

Figure 6. Locally delineated marine habitats with predominance of inner-lagoon and outer-lagoon reefs (Aswani and Lauer 2006b).

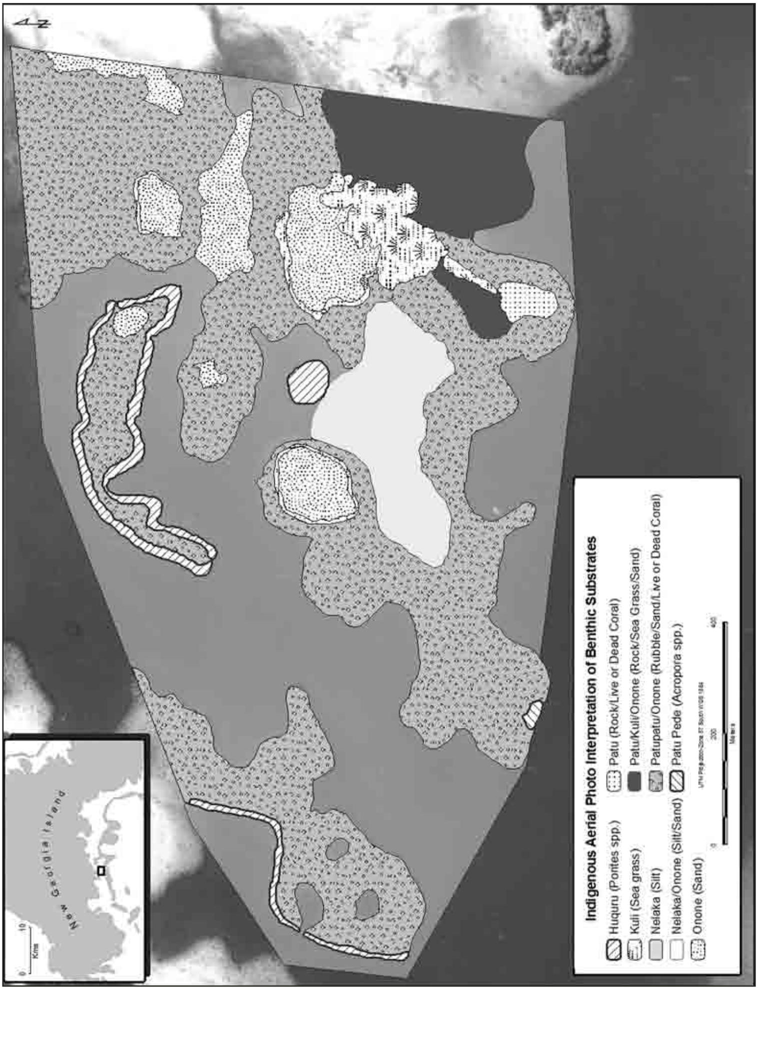

Figure 7. Local demarcation of predominant abiotic and biotic substrates of the Baraulu MPA, Roviana.

hydrology (see Aswani and Vaccaro 2008 for an in-depth discussion). Today, customary fishing methods have either been transformed by the introduction of new technologies or have been abandoned all together. Following the Second World War, less conventional methods such as damming rivers (*tukutuku leana*), or fishing with bow and arrow (*bokala*), were abandoned in favour of nylon fishing lines and iron hooks. Currently, the predominant methods are hook and line fishing, netting, diving, spearing and gleaning. Less frequent techniques include fish drives, piscicides, fish trapping, hand-fishing and dynamite fishing, but since the late 1990s these methods have been gradually abandoned. The use of each method is conditioned by seasonal tidal fluctuations, making some methods appropriate only under specific circumstances. For example, the *kuarao* fish drive method is only conducted from mid-May to the beginning of July when morning ebbing tides are at their optimum level for the successful performance of this method in the expansive Munda area reefs.

Fish in these lagoons, as in most Pacific Island coastal societies, constitutes the most basic form of protein intake, or what is referred to as *baso* by Islanders. Rarely will a meal take place without some kind of *baso*, whether seafood, canned food, or an occasional ration of fresh animal meat. Food consumption patterns vary regionally according to each hamlet's participation in the cash economy. However, the burgeoning influence of the market is eroding the traditional subsistence base of rural Roviana and Vonavona communities. In regional centres like Munda, for example, *baso* is increasingly coming from canned foods. Notwithstanding these changes, local seafood still constitutes a major source of food in the region, and catches are particularly high in the various types of coral reefs discussed in the previous sections (Table 1).

Roviana people can name hundreds of marine species and have an intimate knowledge of the behavioural ecology of the organisms with which they interact regularly. A series of related "species clusters" harvested across many habitats, including coral reefs, have emerged from two decades of measuring fishing excursions (Table 2). The annual variability of species' spatio-temporal distributions offers fishers opportunities to harvest numerous organisms at different times, and seasonal variation in species availability through lunar and tidal cycles. Monthly lunar spawning aggregations, such as those of orange-striped emperor on new moons, and yellow-margined seaperch and paddletail snapper during full moons are spatio-temporally predictable phenomena that potentially increase a fisher's harvestable stock throughout the year. Numerous other species, while not forming aggregations, respond to lunar changes by increasing feeding activities, hence becoming more vulnerable to human predation. Species characterised by spawning periodicity only increase in frequency during certain periods. According to local knowledge, the most

Table 1. Annual average catch rates expressed as a net mean return rate for lagoon habitats (major areas of coral reefs in bold).

Habitat	Annual net mean return rate (kcal per hour)
Outer lagoon islands	3776
Open ocean	3624
Grassbeds	3091
Sand banks	2622
Outer reef drops	2232
Passages	2070
Shallow inner reefs	1896
Outer shallow reefs	1689
Deep lagoon	1650
River mouths	1650
Mangroves	1272
Intertidal zones	732

significant aggregations occur between September and December, decreasing in intensity thereafter. Spawning peaks occur during the last quarter and new moon lunar phases (but see Hamilton *et al.* 2012). Species forming spawning aggregations that are targeted by fishers include barracuda, triggerfish, grouper and rock cod, and several snapper species. Figure 8 summarises the major prey species, particularly those occurring in or near coral reefs, and their lunar and seasonal occurrences (using indigenous names).

Seasonal and daily tidal variations have a great impact on how intensively some habitats and species are exploited. During the day high/night low-tidal season from September through late December and early January (*odu rane*/*masa bongi*) fishers prefer to fish in the passages and nearby reef drops because many fish aggregations occur in these habitats. This is a period when fishers turn into specialists by targeting a limited number of species. In contrast, during the day low/night high-tidal season (*masa rane*/*odu bongi*) fishers become *generalists* by reverting to inner lagoon habitats and exploiting all species in shallow reefs, grassbeds and mangrove areas. In-between tidal seasons, such as *vekoa kolo* ‘staying water’ (which runs from February to mid-April), fishers again switch between different habitats and species clusters, and move between inner reefs and the lagoon passages. This switching behaviour has a probable impact on the lagoon fishery by periodically alleviating pressure on some species and habitats. Aswani and

Table 2. Roviana and Vonavona prey species clusters.

Species cluster	English names	Latin binomial names	Roviana names	Major habitats
Estuarine/ mangrove cluster	Trevallies	Varied Carangidae	*mara*	Everywhere
	Mullet	*Valamugil seheli*	*lipa*	Estuarine
	Great barracuda	*Sphyraena barracuda*	*gohi*	Everywhere
	Mangrove jack	*Lutjanus argentimaculatus*	*kakaha*	Everywhere
	Biddies	*Nematalosa* spp.	*suliri*	Estuarine
	Rabbitfish	*Siganus* spp.	*tetego*	Estuarine
	Mud crab	*Scylla serrata*	*kapehe*	Mangroves
	Ark shells	*Anadara granosa*	*riki kosiri*	Mangroves
	Mud shells	*Geloina* spp.	*deo*	Mangroves
	Mangrove oysters	Ostreidae spp.	*roza*	Mangroves
Inner lagoon reef cluster	Paddlletail snappers	*Lutjanus gibbus/L. adetii*	*heheoku*	Inner-outer reefs
	Thumbprint emperor	*Lethrinus harak*	*osaŋa*	Shallow reefs, grassbeds
	Orange-striped emperor	*Lethrinus obsoletus*	*ramusi*	Shallow reefs, grassbeds
	Yellow-mar. seaperch	*Lutjanus fulvus*	*odoŋo*	Shallow reefs
	Speckled-fin grouper	*Epinephelus ongus*	*pazara kalula*	Shallow reefs
	Emperor	*Lethrinus hypselopterus*	*karapata*	Shallow reefs, reef drops
	Yellowmargin triggerfish	*Pseudobalistes flavimarginatus*	*makoto lio*	Shallow reefs, sandbanks
	Titan triggerfish	*Balistoides viridescens*	*makoto noa*	Shallow reefs
	Anchor tuskfish	*Choerodon anchorago*	*pakopako*	Shallow reefs, estuarine
	Monocle bream	*Scolopsis monogramma*	*pepata*	Shallow reefs
	Butterfish	*Pentapodus* spp.	*doŋopusi*	Shallow reefs
	Sabre squirrelfish	*Sargocentron spiniferum*	*hori*	Shallow reefs, reef drops

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Species cluster	English names	Latin binomial names	Roviana names	Major habitats
Inner lagoon reef cluster – *continued*	Grouper	Varied Epinephelinae	*pazara*	Shallow reefs, reef drops
	Ark shell	*Anadara antiquata.*	*riki repi ŋohara*	Sandbanks, grassbeds
	Cardita clam	*Beguina semiorbiculata*	*belaŋavi*	Shallow reef
Outer reef flat cluster	Striped surgeonfish	*Acanthurus lineatus*	*berabera*	Barrier reef, reef drops
	Blackstreak surgeonfish	*Acanthurus nigricauda*	*valiri*	Barrier reef, reef drops
	Convict surgeonfish	*Acanthurus* spp.	*tarasi* (generic)	Barrier reef, reef drops
	Unicornfish	*Naso* spp.	*isu/ino*	Barrier reef, reef drops
	Parrotfishes	*Scarus* spp.	*sinoku* (generic)	Barrier reef, reef drops
	Steephead parrotfish	*Scarus microrhinos*	*vele*	Barrier reef, reef drops
	Bumphead parrotfish	*Bolbometopon muricatum*	*topa*	Barrier reef, reef drops
	Humphead Maori wrasse	*Cheilinus undulatus*	*habili*	Barrier reef, reef drops
	Long-faced emperor	*Lethrinus elongatus*	*mihu*	Barrier reef, sandbanks
	Yellowlip emperor	*Lethrinus xanthochilus*	*suru*	Barrier reef, sandbanks
	Trochus shells	*Trochus niloticus*	*bikoho*	Barrier reef, reef drops
	Borrowing giant clam	*Tridacna crocea*	*gulumu*	Barrier, shallow reefs
	Horsehoof giant clam	*Hippopus hippopus*	*hohobulu*	Barrier, shallow reefs
	Spider shells	*Lambis* spp.	*riqasa*	Coral rubble
	Stromb shells	*Strombus* spp.	*ununusu*	Coral rubble, sandbanks
Outer reef drop-passage cluster	Barracudas	Varied *Sphyraena* spp.	*pipo*	Reef drops, passages
	Spanish mackerel	*Scomberomorus commerson*	*taŋiri*	Reef drops, passages
	Bigeye trevally	*Caranx sexfasciatus*	*moturu*	Reef drops, passages
	Giant trevally	*Caranx ignobilis*	*batubatu*	Everywhere

Species cluster	English names	Latin binomial names	Roviana names	Major habitats
Outer reef drop-passage cluster – *continued*	Bluefin trevally	*Caranx melampygus*	*mara balibaligutu*	Everywhere
	Maori seaperch	*Lutjanus rivulatus*	*sina*	Reef drops, passages
	Red bass	*Lutjanus bohar*	*riŋo*	Reef drops, passages
	Yellow-spotted emperor	*Lethrinus erythracanthus*	*kaburubaŋa*	Reef drops, passages
	Flowery cod	*Epinephelus fuscoguttatus*	*pazara veata*	Reef drops, passages
	Big-eye bream	*Monotaxis grandoculis*	*matalava*	Everywhere
	Chitons	*Acanthozostera gemmata*	*tatadu*	Barrier intertidal zone
	Turban shells	*Turbinidae* spp.	*popu*	Barrier intertidal zone
	Nerites shells	*Nerites* spp.	*sise*	Barrier intertidal zone
Open sea cluster	Skipjack tuna	*Katsuwonus pelamis*	*makasi*	Open Sea
	Island bonito	*Rastrelliger kanagurta*	*reka*	Open Sea
	Yellowfin tuna	*Thunnus albacares*	*tataliŋi*	Open Sea
	Big eye tuna	*Thunnus obesus*	*gomo*	Open Sea

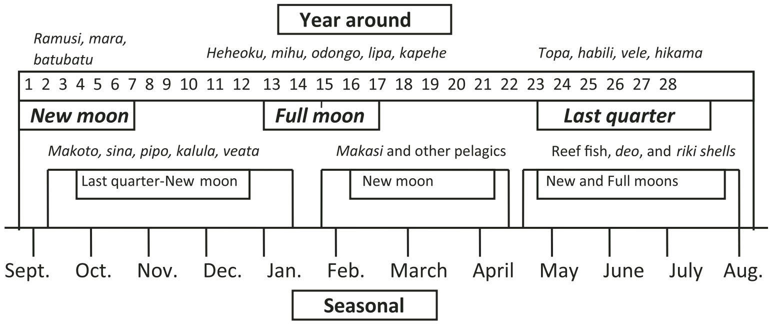

Figure 8. Lunar and seasonal periodicity of important prey species (emperor fish: *ramusi* and *mihu*) (snappers: *sina*, *heheoku* and *odongo*), (trevallies: *mara* and *batubatu*), (parrotfish: *topa* and *vele*), (wrasses: *habili*), (groupers: *kalula* and *veata*), (mullet: *lipa*), (triggerfish: *makoto*), (barracuda: *pipo*), (tuna: *makasi*), (crustaceans: *hikama* and *kapehe*), (molluscs: *riki* and *deo*). Also see Table 2.

Vaccaro (2008) provide an in-depth review of these environmental processes, major fishing methods practiced, fishing seasonality and species targeted.

In terms of division of labour and fishing it is commonly held by government fishery officers that artisanal fisheries are distinctly divided into two labour groups "man the fisher" and "woman the gleaner". Undoubtedly there is some truth to this generalisation in the Solomons as men are responsible for big game fishing, while women conduct most collecting activities. Upon a closer look, however, a distinct picture emerges from the activities of each gender (Table 3). In the lagoons of New Georgia, women are among the most avid anglers and are reputed for their fishing skills, so much so that many men blame women for the ongoing decline of inner lagoon reef fish, maintaining that women's use of small hooks affects the subsistence fishery by targeting immature fish. Jokingly, experienced fishermen refer to women's fishing as *habu malivi* 'fishing of the giant', because according to folk stories, when a race of giant men living in the interior of New Georgia descended into the lagoons they trampled over all coral reefs and living things. While the maritime activities of both sexes merge at the inner lagoon, angling fishery, they diverge when conducted in either the barrier islands/ outer lagoon (*vuragarena*) reefs and in the mainland mangrove forests (*petupetuana*). The former is the domain of men, where big game fishing is carried out, while the latter is where the most significant women's gleaning activities take place. Note that these are only generalisations as women

Table 3. Division of labour in fishing and gleaning.

	Men	Women	Both	Children
Fishing activities	Spearing Spear diving Bottom-lining Open sea trolling Vertical-trolling Turtle hunting Dugong hunting *Kura* trapping Netting	Seaweed diving Collecting *deo* clams Collecting *riki* shells Barrier reef gleaning	Angling Sink-line Trolling Collecting crabs Crab diving Shell diving Net drives Fish drives Piscicides	Angling Trolling Gleaning shells Collecting crabs Fish drives Netting

Table 4. Number of weekly hours allocated to fishing and gleaning according to age and sex across different areas (1994-1995).

Area/Village	7-16 years		17-26 years		27-45 years		46-75 years	
	Males	Females	Males	Females	Males	Females	Males	Females
Baraulu	5.2	4.8	6.9	6.6	12.8	6.6	13.5	7.5
Nusa Hope	4.5	5.6	7.1	6.1	8.7	8.9	11.7	9.8
Olive	6.0	4.3	3.8	8.2	11.6	9.5	14.5	8.1
Ha‘apai	5.2	3.9	3.1	–	10.9	8.9	–	–
Sasavele	4.7	4.7	3.5	4.9	9.9	7.5	8.6	6.2
Nusa Roviana	5.4	4.3	3.8	4.5	8.4	5.2	7.9	6.9
Munda area	4.5	4.2	3.6	2.9	7.6	5.8	6.4	5.8
Vonavona area	3.7	5.3	5.8	2.8	10.8	5.2	7.1	7.0
Mean hours	4.9	4.6	4.7	5.1	10.1	7.2	9.9	7.3

frequent barrier intertidal zones for gleaning and angling and men visit mainland mangrove habitats for spearing, netting and line fishing.

In terms of livelihood significance, Western Solomon Islands rural communities depend on marine resources for the bulk of their animal protein intake. National per capita consumption of seafood is among the highest in the world with an average of 33 kg/person/year (Bell *et al.* 2009). In New Georgia, rural communities are highly dependent on marine resources for subsistence and commercial purposes. Fishing and gleaning for shells and crabs are ordinarily carried out by everyone. Weekly mean time allocation to fishing and gleaning grouped by age and sex suggest that people are more active fishers after the age of around 30 (mostly married) and that men, notably mature men, allocate more per-capita time to marine foraging activities than women do (Table 4). The reasons for this are multiple, ranging from the absence of young women, who prefer working in town or at the Noro cannery, to seasonal preferences in foraging. Women tend to concentrate their gleaning and fishing efforts during the *masa rane* tidal season from May to September, while men tend to fish year-round. Weekly fishing and gleaning activities are partially structured around the church's recommended activity schedule, particularly in Christian Fellowship Church villages. Mondays and Fridays are assigned to working on gardens, while Saturdays are designated for fishing for meals after Sunday Mass. The remaining days are reserved for community work and for personal affairs. During the week, fishers tend to go out in the early mornings and/or evenings after working in their gardens, while on Saturdays they go on day-long gleaning and fishing excursions. Sunday is considered the Sabbath and no fishing, gardening or community work is conducted, albeit these patterns may vary from village to village.

Coral Reefs, Climate and Environmental Change

The analysis of local perceptions of environmental and climate-related change revealed that people are relatively aware of ongoing changes in coral reefs. Respondents were able to identify changes in the lagoon reefs as well as those in the outer lagoon. For the inner lagoon reefs, informants identified and ranked a number of changes (Fig. 9), the three most important being in order of importance as: (i) no change, (ii) turbid/dirty water and (iii) less fish. For the outer lagoon reefs, respondents also recognised and ranked a number of changes (Fig. 10), including the top three as: (i) no change, (ii) less fish and (iii) coral reef damage (Fig. 10). The identified causes for change in coral reefs were various, but the three most important (in order of importance) were: (i) logging operations and siltation, (ii) the effects of the 2007 earthquake/tsunami and (iii) sea changes/don't know were equal in ranking importance (Fig. 11). The vast majority of informants saw these changes as affecting their livelihoods negatively, particularly the notions of "less fish" and "coral

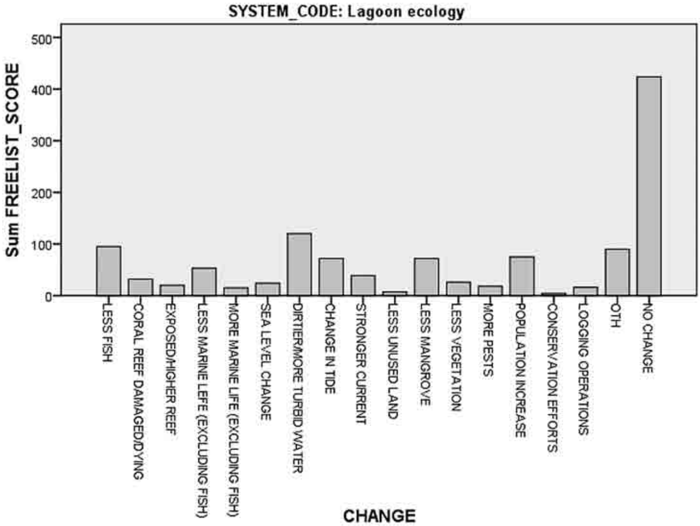

Figure 9. Changes identified for inner lagoon marine environments (predominantly shallow coral reefs).

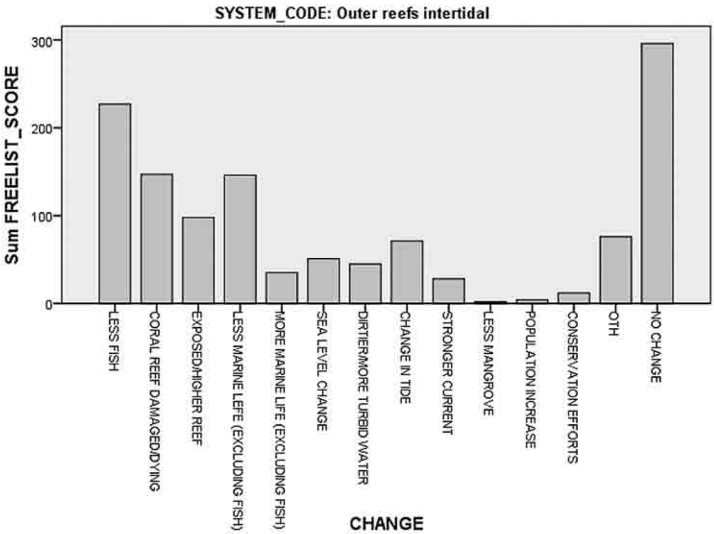

Figure 10. Changes identified for outer lagoon coral reefs.

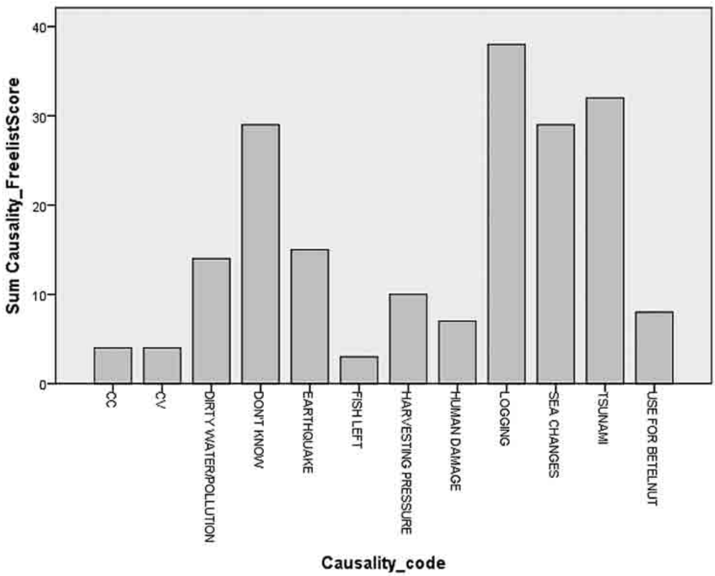

Figure 11. Causes of coral reef damage.

damage". In terms of when these changes began, most respondents agreed that while many changes started in the 1980s, the worst symptoms were noticed in the late 1990s and even more acutely after the 2007 earthquake/ tsunami. In fact, results for the mapping exercise revealed that informants recognised changes in areas of coral damage via bleaching and disease (which cannot be differentiated locally) over the last two decades. They also acknowledged that since 1986 there has been an increase in dead coral in the outer lagoon reefs (Fig. 12) rather than in the inner lagoon ones. These results correspond with a recent scientific survey which found that bleaching and diseases (white syndrome [WS]) induced coral mortality, mainly affecting *Acropora* and *Pocillopora* species, was higher in offshore drop-off areas than the inner lagoon (Albert *et al.* 2011) in the Olive and Nusa Hope areas and the lagoons more generally.

Cultural Meanings of Coral Reef/Seascapes
Fishing decisions are not only influenced by the flow of information between fishers and the physical environment, but also by that between fishers and a cultural land- and seascape. The seascape conveys multiple cultural meanings, such as the presence of benevolent or evil ancestral spirits, which can influence who may access an area, the fishing methods conducted there

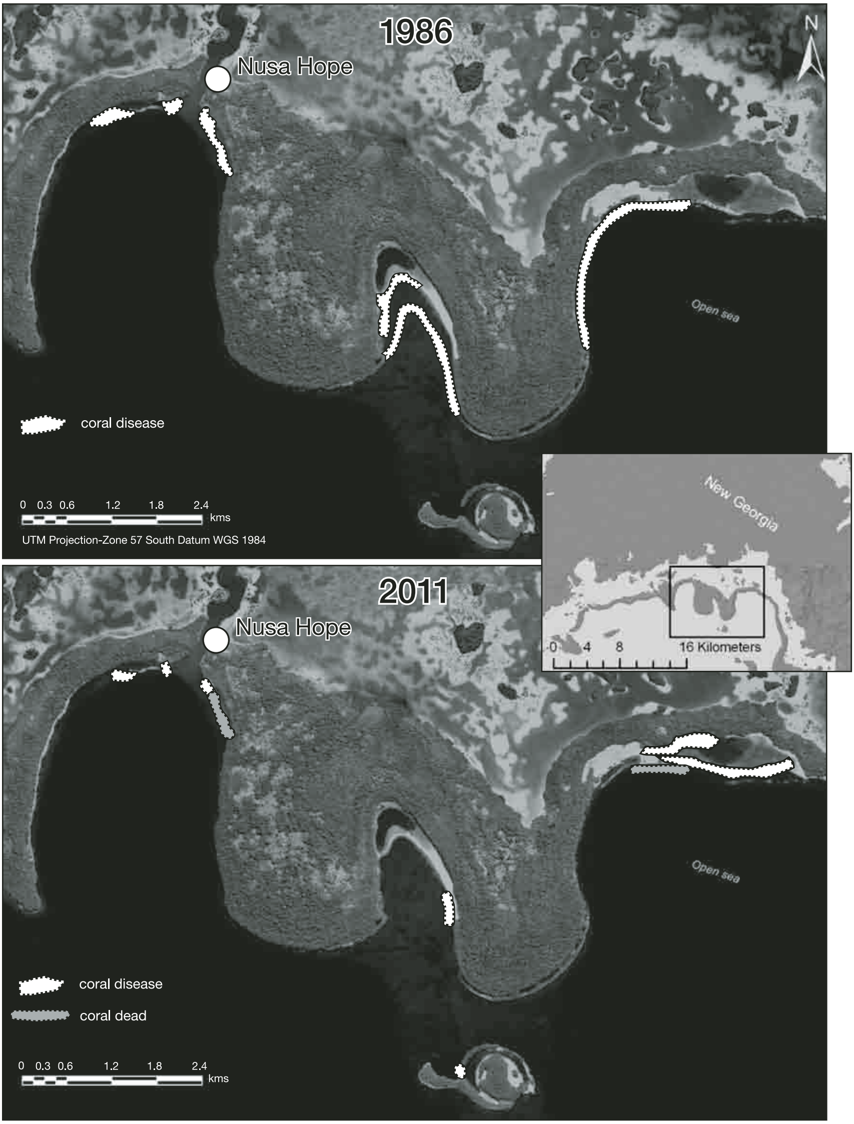

Figure 12. Locally recognised distribution of coral reef damage (disease and bleaching) prevalence in the Olive and Nusa Hope areas, comparing 1986 and 2011.

and the species collected. Even today, when the discourse of Christianity, modernisation and economic development pervades throughout the Solomon Islands, ancestral customary beliefs firmly persist, particularly those regarding physical space. New Georgia Islanders believe that magical powers to control natural phenomena emanate either from an individual's innate disposition or through acquired means. Those individuals conferred with powers flowing from their ancestral links can unilaterally employ magic to improve their fishing efforts or those of others. Conversely, they also can bestow 'unluckiness in fishing' (*dula-ia sa tie*) through the use of particular charms. Fishers are not defenseless against attempts to blemish their reputation or fishing capacity, and can use the essence of certain customary leaves, such as *zipolo* (species of *Cordyine* and *Dracaena*), to shield themselves against assailing spells. Prowess or failure in fishing also can originate from one's social behaviour and that of one's relatives, particularly female kin. Fortune in fishing is not so much attributed to one's good behaviour, as to misfortune from wrongdoing. The following account summarises the ripple effect of a woman's "mischievous" action on the daily activities of fishers:

> When a Baraulu man was bitten by a crocodile in March of 1995, fishing activities at Baraulu were significantly reduced. During a canoe trip to bring rice and other goods to Beulah Secondary School, the man and his wife were attacked by a crocodile. The man's leg was severely bitten, but fortunately, he was able to save it. Apparently the man, whose family totem is the crocodile, told the animal that it had no reason to bite him and so the animal released him. In Roviana nothing happens by accident. If a man is attacked by a shark or a crocodile, it is because he or someone in his lineage, usually a female, has committed some kind of misdeed. That same day it was known that the man's second cousin had been impregnated out of wedlock by the married nephew of an important religious personality. In New Georgia, as in the rest of the Solomon Islands, this is a serious customary breach that can only be solved by appeasement of ancestral spirits, or as it is done today, through the culprit's confession in church and compensation payment. After the man was bitten, the large crocodile was seen frequenting the village and trying to kill pigs. These events made people at Baraulu, especially women, very apprehensive and in consequence, very few women dared to go fishing for a whole month (Pastor Buka pers. comm. December 1994).

The cultural meaning of reefs and the seascape more generally also emanates from the spiritual significance of place. As mentioned, coral reefs are not only resource extraction areas but are also physical features that permit or hinder people from navigating, signs that define property rights of the seascape in relation to other coastal and terrestrial habitats, and cultural and historical features that embody tribal identity and ideology. For instance, the Rereghana Passage in Baraulu Village, Roviana Lagoon, a passage with shallow and sloping reefs, is of extreme economic and spiritual significance to the people of Baraulu. At the subsistence level, the passage is referred to as *mami epata* ‘our food basket’, as this area is a major fishing area for Baraulu people. Custodian rights to the passage have been passed to these people by their Koloi coastal ancestor who dwelt on the barrier islands of Roviana. On a spiritual plane, the passage is affectionately referred to as *Kaleqe Rereghana* ‘old women from Rereghana’, because many large manta rays, or incarnated ancestors, seasonally pass through it.

The passage is also guarded by the Tetepare Island customary sharks *Bugotu* and *Bilosi* which, in the past, were seasonally fed by *hiama* ‘priests’, with the first fruits of *Canarium* trees. Because of its spiritual significance, many customary restrictions exist in the area. For instance, women were barred from fishing here in pre-Christian times and even today, when no such customary restrictions are institutionalised, only women with direct kin relations to the original owners of the passage come here to fish. A contemporary interdiction forbids selling fish from Rereghana Passage, as this area was given in trust to Baraulu people for their subsistence needs. Villagers believe that ancestral spirits punish those who sell fish from the passage by lessening their catches. If fishers break this taboo, which they often do, they pay compensation (*here*) to their ancestral spirits by tossing a coin into the passage in the hope of regaining their fishing fortune. The flow of cultural and ecological information conditions and constrains the daily decisions made by fishers in their interaction with the marine ecosystem and, therefore, play an integral role in the use of coral reefs.

Do New Georgia fishers have an environmental ethic for managing and conserving their marine resources and coral reefs? The “original” indigenous views of nature and resource conservation have, after more than 100 years of colonial and postcolonial history, been entirely transformed. Keeping this in mind, a description of local environmental beliefs has to encompass the differentiated ancestral views of coastal and bush peoples, Christian doctrine, capitalist principles and, in recent years, Western environmental discourse. This ideological puzzle makes elusive any attempt to discern an autochthonous conservation ethic, and ecological research in the region suggests that such a view as understood by Westerners is not present (Aswani 1998). Roviana and Vonavona peoples’ understanding of ecological processes and the environmental impact of human action vary, from those who believe that God will regenerate all human ravages inflected on nature to those who foresee the cataclysmic ruin of the local ecological systems. For some individuals, particularly those with higher education, the need to establish guidelines for sustainable resource use and conservation are paramount. Many educated Islanders have been exposed to Western anti-logging environmental campaigns, notably from New Zealand and Australia, which encourage

Islanders to resist the assault of Asian logging companies. People are not oblivious to the steady decline of many marine species. For instance, recent surveys suggest that 68 percent of Roviana respondents feel that marine resources are susceptible to over-exploitation, while 24 percent think that marine resources cannot be depleted. In relation to exogenous development pressures, 74 percent of all respondents acknowledge that present logging activities are endangering the Roviana Lagoon (Aswani, n.d.).

New Georgians, as with Melanesian societies, do not customarily dichotomise nature from nurture as some Westerners do; humans are an integral part of a holistic environment. Roviana and Vonavona people have a deep sense of their interconnectedness with all things and are physically and spiritually bonded to their land and reefs. Hviding (1996: 28) suggests that Marovo people's interaction with the environment transcends a mere linear relation between consumers and natural resource exploitation, and includes material and spiritual "affordances" provided by nature. He defines the concept of *kino* in Marovo, with its equivalent *kinopu* in Roviana, as 'guardianship' and maintains that it is the basic tenet for an indigenous "holistic view of sustainability", or equivalent to a conservation ethic (1996: 366). In Roviana and Vonavona, the *kinopu* concept denotes "control of" and "stewardship of" traditional estates, but it does not explicitly suggest sustainable use of resources. In fact, chiefs and prominent men responsible for the "stewardship" of land and sea estates have monopolised or, rather, capitalised on their role as "guardians" by allowing Asian logging companies and Japanese bait-fishers to exploit their natural resources. Perhaps the concept of *kinopu* has been affected by the influences of economic development or maybe, instead of an autochthonous view of sustainability, *kinopu* embodies political contest and subsequent control of land and sea estates. In sum, there are numerous indigenous concepts, such as *kinopu*, that can be identified as approximating a conservation ethic, while there are others, such as the notion of *habu malivi* 'fishing of the giants', which denote the contrary. In a general sense, however, lagoon dwellers' relation to their environment is based on an intimate sense of place which potentially precludes Islanders from desecrating their land, albeit this sentiment is rapidly eroding as a result of modernisation forces.

* * *

This article has described people's ecological and social relationships with coral reefs in two extensive lagoon ecosystems in the Western Solomon Islands using a combination of ecological, geospatial and ethnographic data. Ethnobiological knowledge informs Roviana and Vonavona inhabitants on how to exploit their environment most efficiently. Annual fluctuations in species' spatial and temporal distributions allow fishers to harvest numerous organisms at different times and places—this variability being determined by lunar and tidal phases. Recurrent lunar aggregations are spatio-temporally predictable occurrences that can increase a fisher's catches across various periods of the year. Sometimes fishers become specialists by targeting a limited number of species, while at others times they act as generalists and exploit a wide range of species in various marine habitats. Roviana and Vonavona fishers, therefore, do not fall into the simple specialist versus generalist dichotomy, but rather move between these two types of strategies in response to environmental variability and thus ostensibly increase their resilience to stochastic resource variability. Understanding these knowledge systems and behavioral processes is crucial. As discussed below, this involves: (i) considering how ethnobiological understandings can affect a people's livelihood resilience or vulnerability, (ii) understanding the cultural and socio-economic importance of reefs to people and (iii) using this information to design comprehensive and participatory fishery management plans.

First, ethnobiological knowledge (biological, ichthyologic, climatic, etc.) of reefs not only aids people in understanding and taking advantage of a complex and variable marine environment, but also in understanding its transformation and adapting to such changes over time. Ethnobiological knowledge is not only the generational transfer of knowledge but also observations and ideas that are generated within the context of people's practical engagement with a dynamic and changing local marine environment (Ingold 1993). It also can be useful for mapping changes in the environment. This is particularly relevant because the ongoing transformation of marine and terrestrial habitats and associated biological communities as a result of anthropogenically-driven forces, such as climate change, is making coastal people more vulnerable nutritionally and economically. People's observation and perception of environmental changes, or lack thereof, plays a fundamental role in how they perceive the risks associated with change. In fact, anticipatory and autonomous adaptation to environmental change at the community level is shaped by the perceived changes and causes of change by people locally (Aswani *et al*. under review.) Thus, building resilience in coastal socio-ecological systems (traditional or otherwise) requires enabling coastal communities to learn quickly and enhance their adaptive responses and capacity to increasingly swift ecological transformations. As individuals detect and respond to change (or not), the acquired information feeds back into the socio-ecological system, which in turn affects people's livelihoods and their managerial responses to new environmental circumstances. Alternatively, people's incapacity to detect, comprehend and/or respond to ecological changes undermines resilience and exacerbates vulnerability. Current trends in the Solomons indicate that there is gradual abandonment of diversity of traditional capture technologies, as well as people's recognition of taxonomic distinctions of marine organisms over time. Processes of this kind are likely to make people's livelihoods more vulnerable to environmental variability and generalised environmental degradation in the near future (Albert *et al*. n.d.).

Second, this paper also has shown that reefs are not just resource exploitation areas, but also are signifiers of sea tenure property rights, and sites of deep cultural and historical significance, embodying tribal distinctiveness and an indigenous world view. Property rights over reefs and associated ethnobiological knowledge and beliefs encompass a cultural bundle or "customary management" (CM) system (Cinner and Aswani 2007). Beyond the basic design principles of authority, rights, rules, monitoring and enforcement, CM systems function to manage coastal communities, not just natural ecosystems, and also to ensure community harmony and continuity, which commonly emphasises the importance of ancestors, identity and place. Because "place" is so fundamental to people's subsistence and identity, any form of local alteration of a community's territory (e.g., through the introduction of development enterprises) can result in widespread local conflict and confrontations (Aswani and Ruddle 2013). This presents a considerable challenge for development in the region. Customary tenure and management over land and sea is at the core of Roviana and Vonavona socio-economic, political, and cultural life yet today, it is also at the roots of local conflicts and disputes, particularly in the context of capital extraction enterprises such as the logging of lowland rainforests. Further, as tourism development increases in the region, local disputes over reefs and associated habitats by multiple customary groups and their associated leaders (big men) are likely to increase. Thus, understanding the cultural and social meanings of the seascape is paramount.

Finally, ethnobiological knowledge can be utilised for managing and conserving marine resources. Results show that there is considerable congruence in local understandings of ecology and habitat with those of science which, in turn, can aid conservation efforts. In the Roviana and Vonavona case, our study of coral reef ethnobiology has allowed us to analyse the relationship between ecological complexities, indigenous knowledge and the ways in which this knowledge is used for productive purposes, as well as to understand rapid and protracted ecological change. By more fully understanding the characteristics of human-marine interactions, our programme has been able to design and implement management regimes (MPAs and watershed management) that move towards ecosystem-based resource management. A systematic articulation of local cultural knowledge and ecological values through anthropology and marine science can better promote local participation in the design and developments of community-based marine protected areas and produce a more inclusive approach to conservation. The documentation of coral reef and marine ethnobiology, in fact, has set the stage for the development of hybrid marine and terrestrial conservation plans. Integrated hybrid management schemes that combine local perceptions and beliefs with modern management systems are likely to be more successful than government driven top-down management plans. This is because hybrid approaches consider the social, political, economic and cultural contexts of Oceanic communities and can, to some extent, address fundamental concerns of local peoples, including coastal degradation, climate change, sea level rise, weak governance, corruption, increasing poverty, and limited resources and staff to manage and monitor marine resources, among others. The rapid degradation of coral reefs calls for urgent solutions. The research approaches outlined in this paper, in tandem with the work of other researchers (e.g., Cinner *et al*. 2005, Johannes 2002, Kittinger 2013, Ruddle 1993), provide examples of how to study reef ethnobiology and move towards more inclusive management regimes. This is key given the lack of resources for monitoring and policing in most of the tropics. There really are no other viable alternatives for holistic and successful management of watershed and marine ecosystems, which are needed to sustain the resilience of local livelihoods into the future.

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ABSTRACT

Coral reefs are of great socio-economic and cultural importance for many coastal communities across the tropics, yet little is known about people's local classifications and their social and ecological relationships with these habitats. In the case of island peoples, coral reefs are more than just resource exploitation areas; they are also geomorphologic features that allow or bar people from navigating, markers that define property rights of the seascape in relation to other coastal and terrestrial habitats, and cultural and historical features that embody tribal identity and ideology. Building upon over two decades of research, this paper uses published and unpublished data to describe people's ecological and socio-economic relationships with coral reefs in two extensive lagoon ecosystems in the Western Solomon Islands. It combines ecological, geospatial and ethnographic data to analyse the dominant characteristics of coral reef habitats in the region, the prevalent environmental phenomena associated with reefs and their transformation, the productive practices exerted in these habitats by the local inhabitants, and the socio-cultural meaning of coral reefs for lagoon peoples from the standpoint of local ecological knowledge. Understanding people's classification and socio-economic and cultural use of coral reefs is not just a descriptive effort. Rather, it is an essential step toward understanding human-environmental relationships theoretically and creating comprehensive base resource maps for planning marine and terrestrial conservation, including marine protected areas (MPAs) and ecosystems-based management (EBM) plans that potentially can enhance people's livelihood resilience.

Keywords: Coral reefs, ethnobiology, conservation, livelihoods, marine fisheries, resilience, Solomon Islands

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[1] Corresponding author: Department of Anthropology, Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown 6140, South Africa. Email: s.aswani@ru.ac.za

FEATHERWORK AND DIVINE CHIEFTAINSHIP IN TONGA

PHYLLIS HERDA and BILLIE LYTHBERG
University of Auckland

In 2011 a fanned feathered headdress, whose materials and construction are commensurate with 18th century Tongan objects, was uncovered in storage at Madrid's Museo de América (Fig. 1).[1] Such headdresses, known as *palā tavake*, receive scant attention in the academic accounts of Tonga, despite being described by anthropologist Adrienne Kaeppler as "the most spectacular of all objects of indigenous Tongan manufacture" (Kaeppler 1978: 213).

There are only three mentions of *palā tavake* in the 18th century European explorer literature on Tonga. Members of the Cook (1777), Bruni d'Entrecasteaux (1793) and Malaspina (1793) Expeditions all saw and obtained *palā tavake* during their stays in the Tongan archipelago. The exact present day locations of these acquired headdresses are unknown. For many years researchers pondered whether a fanned, feather headdress in Vienna's Weltmuseum (formerly Museum für Völkerkunde) might be a *palā tavake*. However, recent research suggests that it is not Tongan, but instead comes from Eastern Polynesia (Lythberg 2014). Sacred regalia incorporating feathers were common throughout Polynesia (Coote and Uden 2013: 235; Hooper 2006; Kaeppler, Kaufmann and Newton 1993: 83-86). Nonetheless, it is probable that the headdress located in Spain, whose own provenance is not entirely certain, is the only surviving *palā tavake*. Its discovery initiated discussion and debate surrounding its origins, its journey to Madrid and its significance for an understanding of Tonga's past. In this article we describe the feather headdress found in Madrid and consider its probable historical context and connections—both Tongan and Spanish. In addition we discuss the association of *palā tavake* with the Tu'i Tonga, the sacred ruler of Tonga, and the changing nature of the title in the late 18th century.

Tongans stopped manufacturing *palā tavake* sometime during the late 18th or early 19th century. The headdresses were part of the regalia of the Tu'i Tonga—the traditional sacred ruler of Tonga—and became redundant by the early 19th century with the rise of the Tupou Dynasty and the decline and eventual elimination of the Tu'i Tonga title. Conversations with non-chiefly people in Tonga in the late 20th century revealed that many did not recognise images of the headdresses as Tongan. More recently, however, *palā tavake* have been embraced by Tongans as a symbol of their pre-monarchical past and have been incorporated into Tongan art (Fig. 2). The discovery of the headdress in Spain adds another element of interest and excitement to the

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Figure 1. Feather Headdress, front view, Museo de América, Madrid.

Figure 2. ‘Palā Tavake Flag’, by Benjamin Work, Auckland, 2013.

revitalisation of this element of Tonga’s past. This article considers the feather headdress located in Madrid and its likely provenance, as well as examining the place of *palā tavake* in Tongan history and the political transformation of Tonga in the late 18th and early 19th centuries.

THE FEATHERED HEADDRESS IN SPAIN

The headdress in Madrid is a fan of 33 feather-covered and barkcloth-wrapped bundles of reeds or sticks attached to a broad band with wide ties or drapes at either side. The ties are made of black barkcloth with a subtle stripe. The fan is dark at the bottom and pale at the top. Its top edge contains remnants of long white vestiges of a fan of tail feathers presumed to be from the white-tailed tropic bird (*Phaethon lepturus*) which was known in Tonga as the *tavake* and for whom the headdress is named. Fragments of short red feathers likely to be from the red-breasted musk parrot or *koki* (*Prosopeia tabuensis*) remain in the dark barkcloth bindings. The bindings of the headdress are intricate and the regularity of the bundles of sticks speaks of exacting rigour. The fan is further supported by a barkcloth-covered structure at the back of the headdress wrapped in strings of small shell discs (Fig. 3). Six small appendages adorn the rear of the headdress. They are regularly spaced on every fourth bundle of sticks; there would have originally been seven altogether, but one is missing.

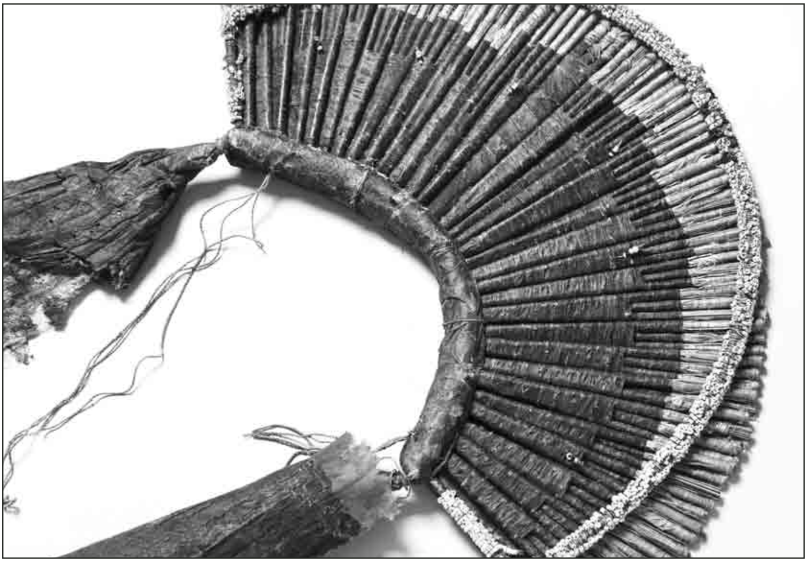

Figure 3. Feather Headdress, rear view, Museo de América, Madrid.

Each contains four beads, one white, one black, then two white. One includes a single European glass trade bead, anchored in place with indigenous resin suggesting, perhaps, that an association with a previous European visitor was desired by its maker or owner.

The remains of the headdress in Madrid match the one described by Cook and portrayed by Webber while at Tongatapu in 1777:

> These Caps or rather bonnets are made of the tail feathers of the Tropic Bird with the red feathers of the Paroquets worked upon them or in along with them, they are made so to tie upon the forehead without any Crown, and they have the form of a Simicircle [*sic*] whose radis is 18 or 20 inches; But a painting which Mr Webber has made of Fattafee Polaho [*sic*] [Fatafehi Paulaho or Pau] dressed in one of these bonnets will convey the best idea of them. (Beaglehole 1967 [III]: 117)

John Webber's portrait of the Tu'i Tonga Pau or Paulaho[2] wearing a headdress (Fig. 4) is still the best surviving image of a *palā tavake*. It fans out above the Tu'i Tonga's head, in clear bands of at least two different coloured feathers.

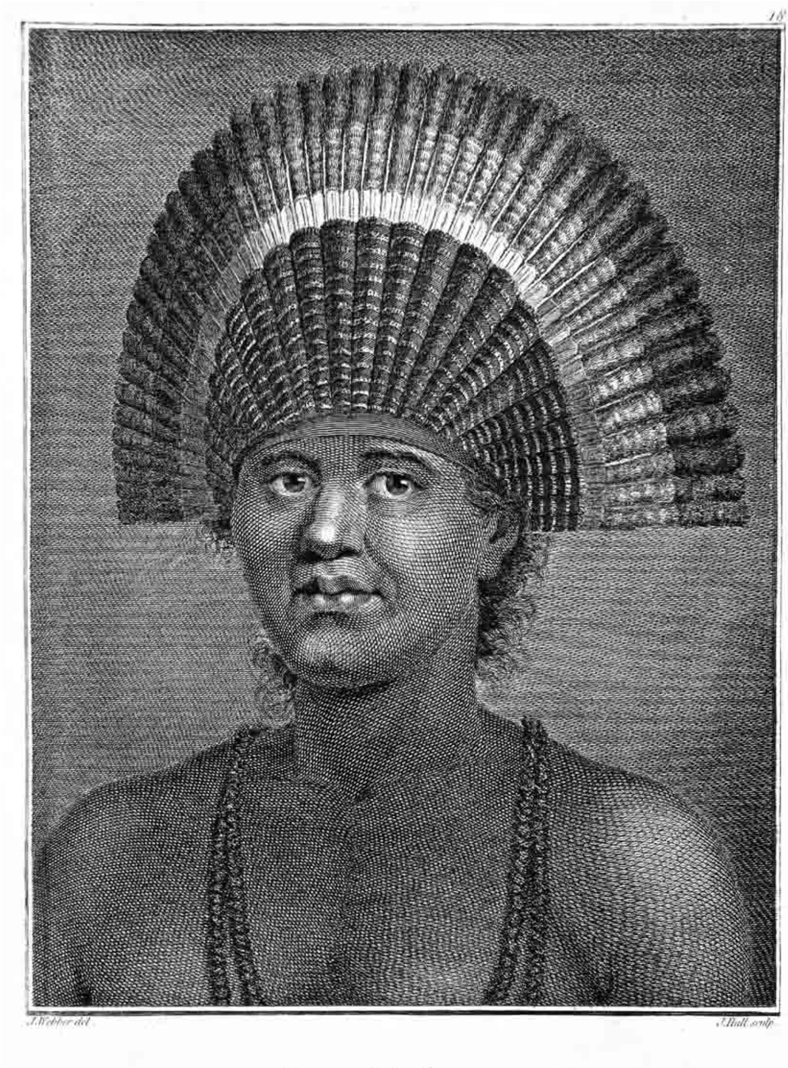

Figure 4. John Webber & John Hall, 1784, 'Poulaho, King of the Friendly Islands', engraving on paper, Auckland Art Gallery Toi o Tāmaki, Auckland.

The materials are commensurate with other 18th century Tongan chiefly objects and the headdress itself is comprised of high value and high status items. The hundreds of shell beads were time-consuming to prepare, especially in the quantities used in the headdress, required to completely wrap the supporting structure at the back of the fan. The black barkcloth is of a variety of barkcloth known as *ngatu'uli*. *Ngatu'uli* is decorated with fine candlenut soot which is difficult and time-consuming to make and is reserved for chiefly usage. Black barkcloth has particular efficacy in Tongan events that occur at the threshold between the world of the spirits and the living, such as funerals, where it is are placed closest to the body of the deceased. In addition, the headdress required many feathers from the red-breasted musk parrot and tail feathers of the white-tailed tropic bird. Each tropic bird has only two of the long feathers which were used en masse to crown the headdress. Many birds of both species would have been needed to decorate the *palā tavake*.

The *palā tavake* in Madrid is an exquisitely crafted item. It is clear that considerable time and skill were invested in creating it. There is a precision to the preparation of materials and their assembly that speaks not only of the extraordinary expertise of its maker but also of a desire or need to make the headdress a beautiful object to be worn by an individual of illustrious rank. This is understandable considering the intended wearer was the Tu'i Tonga, the sacred ruler of Tonga who was a direct descendant of a god. In Tonga the head is regarded as *tapu* to someone of lower rank. *Palā tavake*, placed on the head of the Tu'i Tonga, would, therefore, have been regarded as an immensely sacred item.

DIVINE CHIEFTAINSHIP IN TONGA

Palā tavake were closely associated with the highest ranking of Tonga's elite. By the late 18th century Tonga was one of the most highly stratified polities in Polynesia based around chiefly rank, titular authority and tribute. At that time there were three great titles in Tonga—the Tu'i Tonga, the Tu'i Ha'atakalaua and the Tu'i Kanokupolu. The Tu'i Tonga was the highest ranking of the three paramount titles, as the first Tu'i Tonga was thought to be the son of the god Tangaloa 'Eitumatupu'a. 'Eitumatupu'a was said to have descended from the heavens to Tongatapu and impregnated a local woman. Their son was 'Aho'eitu. When 'Aho'eitu came of age, he sought out his father and was given the title Tu'i Tonga and the authority to rule the islands. This descent from divine ancestors promulgated honour and authority to the titleholder and his close relatives. It is, by far, the oldest of the three titles. The Tu'i Ha'atakalaua and Tu'i Kanokuplou are collaterally descended from the elder title with the first holder of the Tu'i Ha'atakalaua title a younger brother of a Tu'i Tonga.[3] Although junior in chiefly rank to the Tuʻi Tonga, the Tuʻi Haʻatakalua and Tuʻi Kanokupolu were vested with executive authority and were, essentially, the political rulers of the Tongan archipelago in the late 18th and throughout the 19th centuries.

It was, however, the Tuʻi Tonga who was the embodiment of divinity and society due to his direct and senior lineal descent from the gods. This divinity was marked in several ways, including the wearing of the *palā tavake*. To emphasise the difference in their essence, status and power, the Haʻatakalaua and Kanokupolu titles and chiefs were known as *Kauhalalalo* ʻfrom the sea side of the road' while the Tuʻi Tonga was said to be *Kauhalauta* ʻfrom the bush side of the road'. This distinction was not just locational but also marked the inherent difference in the rank of the Tuʻi Tonga. The very body of the Tuʻi Tonga and his close relatives (*faleʻalo*) were regarded as corporally different from the *Kauhalalalo* due to their senior divine ancestry. This difference further emphasised by the exclusive designation of *sinoʻeiki* ʻbody of the chief' for the Tuʻi Tonga and the *faleʻalo*. In addition, the body of the Tuʻi Tonga was distinguished from his male subordinates by not being circumcised or tattooed, both customary practices for Tongan men at that time (Martin 1817 [II]: 78-79).

The Tuʻi Tonga commanded ritual seniority and was the "Significant One", to borrow Sahlins's phrase (1983: 523-24), in early Tongan society. He was the one that mattered, the central structuring figure of society and its wellbeing. Offerings, known as the *ʻinasi*, were made twice year to the god/goddess Hikuleʻo and his/her embodiment, the Tuʻi Tonga, in recognition that their participation was essential to the prosperity of the land. The seedlings of the *kahokaho* yam, a special variety of *Dioscorea alata* reserved for chiefs, were presented to the Tuʻi Tonga on behalf of the Hikuleʻo at the time of planting and at the time of harvest.[4] They were brought to him in a ceremony which was performed at the tomb of the father of the incumbent Tuʻi Tonga and thus emphasised the Tuʻi Tonga's lineal descent from divinity (Farmer 1855: 129-30; Gifford 1929: 76, 103, 217).

The tombs of the Tuʻi Tonga were known as *langi*, which also means ʻsky' in Tongan. *Langi* could also denote the person of the Tuʻi Tonga and he was often thus referred to in narratives, poems, songs and chants (Collocott 1928: 79, Malupo 1870, Thomas n.d.: 25). The multiple meanings of *langi* reference the divine origin of the Tuʻi Tonga and his title and also alludes to Tangaloa ʻEitumatapuʻa's descent from the sky. This divine lineal descent of the Tuʻi Tonga also was reflected in the special *tapu* state (ʻsacred', but also ʻprohibited') which surrounded the Tuʻi Tonga and his immediate family (*faleʻalo*) and their ability to make things *tapu*. This sanctity set them apart from the rest of Tongan society and, as elsewhere in Polynesia, sacred regalia, including the *palā tavake*, were part of that distinction. The *palā tavake*, with its multitude of red and white feathers, is yet another reference to the sky, with birds being creatures (like the Tuʻi Tonga) who move between earth and the heavens. It is not known if the females and other males of the *fale ʻalo* were traditionally vested in regalia, but the Tuʻi Tonga wore the *palā tavake*—the large headdress composed of red and white feathers which fanned out like a sunburst from ear to ear. In Tonga, they were associated with Tangaloa ʻEitumatupuʻa, the god who lived in the sky and from whom the Tuʻi Tonga descends. The spiralling barkcloth-covered sticks adorned with red and white feathers reach upwards to Tangaloa reinforcing this bond and the Tuʻi Tonga's own personal efficacy as earthly representative of divinity. The honour bestowed upon the title and its holder also is evident in the skill and beauty of the objects made for them, including the *palā tavake*.

Palā tavake were not the only feathered ornaments in Tonga worn by chiefly individuals. Gifford (1929: 127) recorded that "a headdress of feathers (*fae* or *faefae*) was worn by chiefs during times of festival or ceremony or at the outset of a war expedition". Kaeppler suggests that *palā tavake* were not worn exclusively by the Tuʻi Tonga although they were reserved for very high ranking chiefs (Kaeppler 1999: 47). However, *palā tavake* do seem to be associated with the title or, as will be argued below, those aspiring to it.

PALĀ TAVAKE AND EARLY EUROPEAN VISITORS TO TONGA

There are few European accounts of *palā tavake* that might inform an understanding of the splendid specimen in Madrid. Of the various European voyagers who stopped at the Tongan Islands in the 18th and early 19th centuries only three described having seen *palā tavake*. British expeditions under the command of Captain James Cook stopped at Tonga three times during their second and third Pacific voyages. They made two short calls of seven and four days in 1773-74 and a more significant ten week visit in 1777. Cook and his men obtained three *palā tavake* during their last visit to Tonga (Beaglehole 1967 [III]: 117). Of the three headdresses, two were traded to Tahitians or Marquesans and presumably dismantled by them (Gathercole 2004). The third is not among any identified in the known Cook collections. Sixteen years later in 1793 Tonga was visited by two European expeditions within a month of each other who both saw and received *palā tavake*. A French expedition, under the command of Joseph Antoine Bruni d'Entrecasteaux, visited Tongatapu in April and early May and received one (Labillardière 1800: 375). Research (Douglas, Lythberg and Veys n.d.) is underway to identify the Bruni d'Entrecasteaux collections dispersed in museums in France, Norway and the Netherlands, but to date no feather headdress has been identified. A Spanish expedition, under the command of Alejandro Malaspina, stopped at the northern archipelago of Vavaʻu in May 1793. Arcadio Pineada, a member of the Malaspina Expedition, saw two headresses and acquired one during the Spanish expedition's stay in Vavaʻu in May of 1793 (Pineada n.d.). Although there is no accompanying documentation which identifies the headdress in the Museo de América as having been collected by members of the Malaspina Expedition, the Museo does contain other Tongan artefacts attributed to the voyage and it seems highly likely that the recently discovered *palā tavake* returned to Spain with the Expedition.

To more fully assess the origins of the headdress in Madrid, we also consider specific individuals who were engaged with Tongans in the late 18th century. Identifying in existing genealogies and traditions the individual Tongans met by the various Europeans who came to Tonga is not easy even when names are provided. The visitors rendered the names as they heard them which was, understandably, more often than not, imperfectly. In addition, Tongans were often known by several different names during their lifetime and this compounds the challenge of accurate identification. However, to appreciate the political transformations surrounding divine chieftainship in Tonga, it is important to distinguish the central individuals associated with the feather headdresses who were met by the European chroniclers.

When Cook and his men visited Tonga in 1777, Pau was Tuʻi Tonga, Maealiuaki appeared to be Tuʻi Haʻatakalaua and Tupoulahi was Tuʻi Kanokupolu although, because he was elderly and almost blind, his son, Tuʻihalafatai, exercised the practicalities of actual rule (Afuhaʻamango n.d.: 5, Beaglehole 1967 [III]: 892-93, Erskine 1853: 128, Thomas 1879: 153). Cook seems to have known Tuʻihalafatai by the name "Finau" (Beaglehole 1967 [III]: 177, Bott 1982: 19-20).

In 1793 Bruni d'Entrecasteaux and his men met Tuʻi Kanokupolu Mumui whom they knew as Tubou [Tupou], as well as a clearly high ranking and influential woman whom they called "Queen Tiné" or "Tineh" on Tongatapu (Labillardière 1800: 351). The French understood that Queen Tiné was performing the duties of the male Tuʻi Tonga until Pau's son was of age (Labillardière 1800: 376). All genealogies point to Queen Tiné being Tuʻi Tonga Fefine Nanasipauʻu, the elder half-sister by a different mother to Tuʻi Tonga Pau. Bott believes that the Tongans called her "*taʻahine*", the term for a chiefly woman, but that the French thought that this was her name, which they rendered as "Tiné" or "Tineh" (Bott 1982: 61, see also Thomas n.d.: 29). Her explanation is probable. At the time of the French visit there was no reigning Tuʻi Tonga because Maʻulupekotofa had died some time previously. Nanasipauʻu was Maʻulupekotofa's elder full sister; she was also Tuʻi Tonga Fefine.

One month after the French visited Tongatapu, a Spanish expedition under the command of Alejandro Malaspina called at the northern Tongan archipelago of Vavaʻu. Of all the people they met, "Vuna" appears to be the central figure. He is described as a man of about 45 years of age and as "King of Vavao" [Vava'u]. The Spaniards recorded that he had more than four wives, at least two of whom were the daughters of the late Tu'i Tonga "Paulajo" [Paulaho/Pau] and his wife "Dubou" [Tupoumoheofo]. The second in command of the expedition recorded the women's names as "Fatafegi" [Fatafehi] and "Taufa" [Taufa]; Malaspina referred to them as the "two Fatafegis". The son of the one known as "Taufa" was a boy of about eight to ten years old named "Feileua" (also spelled as Feyloe-hua).

Bott believed that the man known to Malaspina as Vuna was, in fact, Tu'iha'ateiho Fā'otusia Fakahikuo'uiha whose personal or nickname may have been Vuna (Bott 1982: 34-36). Gifford's work also tends to support this claim (Gifford 1929: 81, 137). Fā'otusia is recorded as the son of Tu'iha'ateiho Haveatunga and the Tu'i Tonga Fefine Nanasipau'u, the woman known by Bruni d'Entrecasteaux as "Queen Tiné".

Bott bases her supposition of Vuna's identity as Fā'otusia on the Tongan genealogies (*hohoko*) which list the two daughters of Tu'i Tonga Paulaho and Tupoumoheofo (Sinaitakala and Fatafehi Lapaha) as being married to Tu'iha'ateiho Fā'otusia (see Fig. 5). One daughter, Fatafehi Ha'apai, is remembered as marrying only Fā'otusia and having one daughter by him named "Fana" (Bott 1982: 34). Collocott recorded a poem about a man who wished to marry the Fatafehi Ha'apai, but was bitterly disappointed to find that she had gone to Vava'u to marry a man named Vuna (Collocott 1928: 86-87). The other daughter of Tu'i Tonga Paulaho and Tupoumoheofo recorded as marrying Fā'otusia was Fatafehi Lapaha. Her son by Fā'otusia was Makamālohi who was the Tama Tauhala 'Extraordinary Child' (Spillius [Bott] 1958-1959). Gifford was told (1929: 81) that there was only one individual in history who held this title. In many ways he was treated as a Tu'i Tonga. He is buried near Lapaha in a tomb known as a *langi* and Queen Sālote stated that Makamālohi was sent a *moheofo*—a practice usually reserved for only the Tu'i Tonga (Bott 1982: 36). The *moheofo* was the highest ranking and principal wife of the Tu'i Tonga and also the mother of the subsequent titleholder. Undoubtedly Makamālohi was of extraordinarily high chiefly rank, greater than that of the Tu'i Tonga of the time. His association with a *palā tavake* is intriguing and may indicate a shift in Tongan politics in the late 18th century.

EXCHANGES WITH THE VISITORS

When Europeans visited Tonga, Tongans made available to them things of great value in both the archipelago and wider Polynesia. Chief among these were items decorated with feathers, especially red feathers. Red was a colour associated with rank and chiefliness throughout Polynesia and it proved to be persuasive inducement in trade all over the region. In fact,

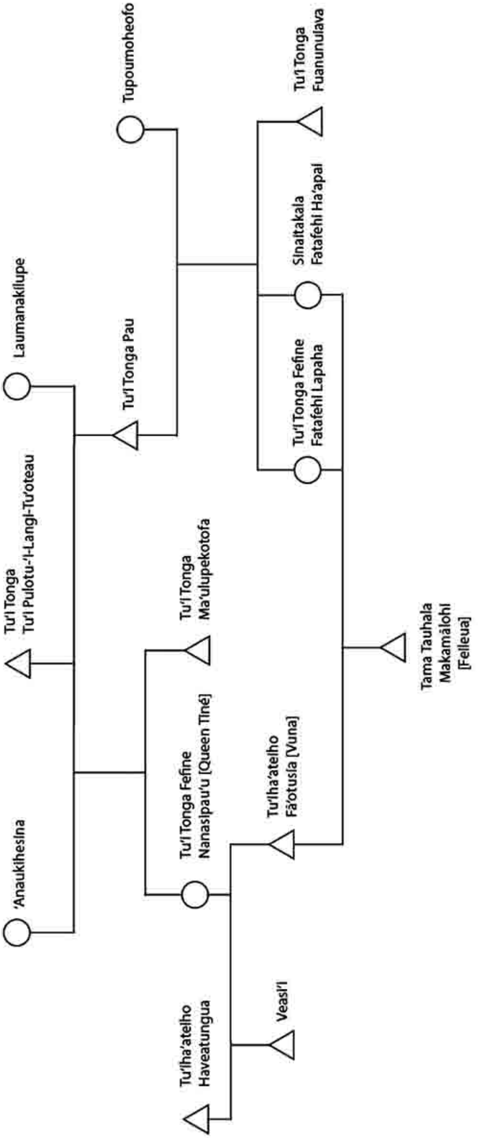

Figure 5. Genealogy of Tuʻihaʻateiho Fāʻotusia Fakahikuoʻuiha and Tuʻi Tonga Pau.

it has been suggested that the richness of the collections associated with Cook's second voyage, in particular, was made possible through obtaining and redistributing these red featherwork items from Tonga (Gathercole 2004). Cook had on board with him Mahine, a man from Borabora in the Society Islands, who correctly advised of their high value to Tahitians. They would prove as desirable to Marquesans. To Forster it was indicated "a bit of two inches square, covered with feathers, would at any time, be eagerly purchased with a hog" (Forster 1778: 367). This was a considerable incentive for Cook and his men given their need in the course of their expeditions for fresh food to keep both health and morale high. Significantly, red feathers sourced in Tonga were also traded for other high status objects from other Polynesian islands including at least ten of the now famous "Chief Mourners' Costumes" acquired from Tahiti (Coote and Uden 2013: 235, Gathercole 2004). In Tonga in 1793 the Bruni d'Entrecaseaux Expedition presented Tu'i Kanokupolu Mumui with red cloth, having realised that red was a very desirable colour for Tongans:

> The king expressed much thankfulness for them; but, of all that was offered him, nothing so much excited the admiration of this numerous assembly, as a piece of crimson damask, the lively colour of which produced from all sides an exclamation, of eho! eho! which they continued repeating a long time, with an appearance of the greatest surprise. They uttered the same exclamation, when we unrolled a few pieces of ribbon, in which red was the prominent colour. (Labillardière 1800: 357)

They also presented Fuanunuiava, who would later be Tu'i Tonga, with a "scarlet suit of clothes", reserving a blue suit for a lower ranking chief (Labillardière 1800: 340).

Cook's men traded eagerly for collections of red feathers attached to portions of banana leaf and sections of woven coconut fibre or *kafa*. The highest-ranking feathered items were, undoubtedly, the fanned feather headdresses associated with the rule of the Tu'i Tonga and the feathered waist garments worn by chiefs for "ceremonial dress or dancing" (Kaeppler 1971: 211-13). Their acquisition was not easy, yet during their visits to Tonga Cook and his men gathered at least 20 feathered waist garments known as *sisi fale*. These were made from finely plaited coconut fibre and adorned with red feathers and fine shell beads (Kaeppler 1971: 211-13). Although greatly desired, the red and white *palā tavake* proved more difficult to obtain and were not acquired until Cook's third voyage. Cook wrote that:

> though very large prices were offered not one was ever brought for sale, which shewed [*sic*] they were no less valuable to the people here, nor was there a person

> in either Ship that got one but my self [*sic*] Capt Clerke and Omai', and only from the incumbent Tu'i Tonga Paulaho himself. (Beaglehole 1967 [III]: 117)

Part of the issue may have been the notion of bartering or selling. Tu'i Tonga Fefine Nanasipau'u made this distinction very clear to members of the Bruni d'Entrecasteaux expedition in 1793:

> She was very careful to let us know that she did not give them by way of barter; affecting to repeat with an air of dignity ikai fokatau, and to inform us by the word doupe, that she made us a present of them. Indeed the chiefs never offered to barter their articles for ours; they made us presents, and received whatever we thought proper to give. (Labillardière 1800: 354)

Labillardière also reported (1800: 375) that Bruni d'Entrecasteaux was given "as a present a diadem, made with the beautiful red feathers of the tropic-bird, with some other very small feathers of a brilliant red colour". One month later Arcadio Pineada, a member of the Malaspina Epedition, recorded that the "Monarch", whose name was "Vuna" (Tu'iha'ateiho Fā'otusia), "was distinguished [from the populace] by a hat or diadem of red feathers, like that which Cook described when he spoke of Paulajo" (Pineada n.d.). Pineada also noted that Vuna's younger brother (Veasi'i) also wore a diadem that was "a different make" than his brother's and contained both red and white feathers. He also recorded that they were given one of the diadems. It seems likely that the specimen in Madrid came from the Malaspina Expedition. It is odd that the commander of the expedition did not record the acquisition of such a magnificent headdress. However, while compiling the official record of the voyage after their return to Spain, Malaspina was arrested. Upon his release he returned to his native Italy in poor health and soon passed away. Meanwhile, the expedition's manuscript material was seized and placed in the Museo Naval under a one hundred year publication ban. As the preparation for publication was not finished, it is not possible to know whether the final official publication would have mentioned the *palā tavake* received in Vava'u.

POLITICS AND THE REIGN OF THE TU'I TONGA IN THE LATE 18TH CENTURY

The sole surviving *palā tavake* described here takes on added historical significance given that it is emblematic of crucial social and political changes of late 18th century Tonga. It was a *palā tavake* that distinguished Tu'i Tonga Pau as Tonga's senior ranked elite upon Cook's arrival and it was a gift he specifically made to members of the expedition. Cook's arrival and this transaction coincided with a watershed in Tongan history in several ways. Among the significant events while he was Tu'i Tonga was the said visit of

James Cook and his expedition to the islands. The mark Cook left on Tonga was not one of introduced transformation, for his direct influence on Tongan politics and social life was negligible, although he did introduce a few agricultural crops, some livestock and probably dogs, not to mention venereal disease, to the islands. Cook's greatest impact on Tonga was an historical one. Overall Cook found provisions easy to obtain in Tonga owing to the economic control exercised by the chiefly hierarchy with whom he associated. He visited the islands three times during his Pacific voyages (1773, 1774, 1777) with his final stay in Tonga lasting eleven weeks. With such prolonged contact, Cook and some of his men came to know the Tongans as individuals and, while they did not understand the intricacies of Tongan custom and ideology, they described the situations they saw with the Tongan actors named and, for the most part, identifiable in the Tongan genealogies. In addition to providing a cameo, albeit foreign, of 18th-century life in Tonga, the large amount of accessible manuscript and published material of Cook and his crew provided a framework within which later European visitors observed and wrote about Tonga. Literature from the Cook voyages became essential for libraries of individuals heading to the Pacific, just as they are now indispensable for those interested in Tonga's past. In effect, the Cook Expedition observations, whether right or wrong, became the stereotype for traditional Tongan culture.

In the late 1770s Pau was Tu‘i Tonga, Maealiuaki appeared to be Tu‘i Ha‘atakalaua and Tupoulahi was Tu‘i Kanokupolu although, because he was elderly and almost blind, his son, Tu‘ihalafatai, exercised the practicalities of actual rule (Afuha‘amango n.d.: 5, Beaglehole 1967 [III]: 892-93, Erskine 1853: 128, Thomas 1879: 153). Conflict between the two titular lineages of the Tu‘i Tonga and Tu‘i Kanokupolu was perhaps inevitable, especially as the authority of the Tu‘i Ha‘atkalaua title waned with the establishment of the Tu‘i Kanokupolu title. This eclipse can be seen in the shift of the natal lineage of the principal wife (*moheofo*) of the Tu‘i Tonga from the Ha‘atakalaua to the Kanokupolu line at the time of the 4th Tu‘i Kanokupolu Mataeleha‘amea. The relationships of the individuals re-inscribed the relative rank, power and authority of the titles in each generation through this marriage and succession of rule (see Bott 1982: 59-60). These tensions were further aggravated by the ambitions of Tu‘i Tonga Pau who desired more secular authority (Erskine 1853: 129, Gunson 1979: 40, Thomas 1879: 172).

This desire may have been prompted by the questionable foundation upon which his own succession was based. Pau was neither his father's eldest son nor his son by the acknowledged *moheofo*. Pau's father had many wives among whom were some very high ranking women, however, Pau was the son of a lower ranking, although still chiefly, wife (see Fig. 5). The first of Pau's father's illustrious marriages produced only one child, a son, who was said to have died young (Bott 1982: 100). His second wife also was called *moheofo* (Hala'api'api n.d.: 201). She had five children with the Tu'i Tonga: three daughters (Nanasipau'u, Fatafehi and Fakaolakifanga) and two sons (Manumata'ongo and Ma'ulupekotofa). Pau's mother was not considered a *moheofo*; however, when the Tu'i Tonga died it was Pau who succeeded him as Tu'i Tonga. Some believe that it was the rank of Pau's grandmother and great grandmother which saw him succeed or that it was the choice of his father's sister the Tu'i Tonga Fefine. Others argue that it was because Pau was an able leader and had distinguished himself as a warrior and may even have been called *hau,* a term which signified a challengeable position of secular authority and considerable power (Erskine 1853: 129; Gunson 1979: 29, 39, 2005: 324; Tu'i'āfitu 1970; Ma'afu Tupou pers. comm.,). For whatever reason, Pau became Tu'i Tonga instead of arguably more senior candidates.

An indication of the strain surrounding Pau's succession to the title appeared during the *'inasi* ceremony which occurred while the Cook Expedition was in Tonga in 1777. There is little doubt that ceremony was the *'inasi 'ufimui* when the seedlings of the chiefly yam *kahokaho* were presented to the Tu'i Tonga to ensure the success of the growth of the yams in the coming season. The Europeans were told that the yams presented "were a portion consecrated to the O'tooa [*o'tua*] or divinity" and that the ceremony was called "natche" or "anache" (Beaglehole 1967 [III]: 916-17, 1308, 1363). However, there also was a suggestion that this was not a conventional *'inasi*. Cook and his men were told that the second day of the ceremony was designed to allow Fuanunuiava, the son of Pau, to eat with his father but "as it was only ceremonial... he would just eat a single mouthful [*sic*] of yam and his father the same" (Beaglehole 1967 [III]: 916; see also 913). The prestations of the *'inasi* normally occupied only one day and the *tapu* of not eating in the presence of one's superior was strongly held in Tonga. To break it in relation to the sacred ruler was no small deed. Even the Europeans, with their limited understanding of Tongan custom, sensed the gravity of this action: "His father... either from an ancient custom or perhaps to insure the succession wishes to see it done whilst alive" (Beaglehole 1967 [III]: 916). John Thomas, a Wesleyan missionary who lived in Tonga for many years during the 19th century, described it thus:

> Bau [Pau] the King and his son were present on the occasion and it seems it was during the ceremony of the Inaji [*'inasi*] that the Prince was named to honor equal to his father and from that time was to sit at meals with his father. It was quite a new thing, a violation of Tongan custom and usage. (Thomas n.d.: 11-12)

Although the ritual breaking of the eating *tapu* between father and son was most unusual, the presentation of textile and agricultural items to the Tu'i Tonga was a common ceremony known as *fakataumafa* 'to provide for', in which the people demonstrated their obeisance and fidelity to him with a pledge of continuing sustenance (Spillius [Bott] 1958-1959 [II]: 241-42, Ve‘ehala pers. comm.). In a sense, the *fakataumafa* marked the succession to the honour and title, as there was no specific installation ceremony for the Tu‘i Tonga. This was yet another instance of recognising and distinguishing the Tu‘i Tonga from other chiefly individuals. On the one hand, all the rest of male titles in Tonga were bestowed at a kava ceremony attended by the new titleholder and other chiefs who had significant relationships to the title. On the other hand, the Tu‘i Tonga, by right of his ancestry, automatically succeeded his father. The succession came at the time of the Tu‘i Tonga’s death. While there is nothing unusual in a *fakataumafa* for a new Tu‘i Tonga, it was a radical break with Tongan tradition for the ceremony to occur while the incumbent Tu‘i Tonga was not only alive, but presiding over the ritual. Many sources assume that Tupoumoheofo, the principal wife (*moheofo*) of Tu‘i Tonga Pau, was the instigator of this unusual event to secure her son’s succession (*fua ‘ai hau*) (Bott 1982: 39-40, Cummins 1977: 66-67, Gunson 1979: 39-40, Lātūkefu 1974: 13). However, as has been argued elsewhere (Herda 1987), it appears more likely that it was Pau, not Tupoumoheofo, who was interested in securing his son’s succession lest it be challenged in his absence.

His fears appear well-grounded as fighting broke out between the *Kauhala‘uta* (Tu‘i Tonga) and the *Kauhalalo* (Tu‘i Kanokupolu), reportedly over the ambitions of Tu‘i Tonga Pau who attempted to increase his secular authority (Erskine 1853: 129, Gunson 1979: 83, Thomas 1879: 172). The conflict escalated over time and ended with violent unrest and the death of Pau around 1784 (Novo y Colson 1885: 382, Thomas 1879: 172, Thomson 1894: 321). Members of the Malaspina Expedition were told:

> Paulajo... was dethroned and murdered by a conspiracy hatched between Vuna, Monmuy [Mumui], and Tubou [Tupoumoheofo], wife of the same Paulajo. The conspirators set out from Tonga with some 20 large canoes; putting into the ports of the Islands of Annamoka [Nomuka] and Happai [Ha‘apai]. They passed to Vavao [Vava‘u] where Paulajo, as the head of his people, received them. There was a clash which ended with the death of the latter at the hands of Vuna, after these two leaders had fought hand to hand. (Novo y Colson 1885: 382)

The consequences of the death of Tu‘i Tonga Pau were far-reaching. Initially there was no successor to Pau appointed, ostensibly because the Kanokupolu people, most likely Mumui and his son Tuku‘aho, would not allow Fuanunuiava to assume the sacred duties of the office despite Pau’s attempt to elevate his son to the Tu‘i Tonga title during his lifetime. It was said that the more recent holders, presumably a derogatory reference to

Pau, were not descended from a *moheofo* as dignity and custom required (West 1865: 55). As a further insult and indictment of his low birth, Pau was buried in Vava‘u “not as a Tu‘i Tonga, but as an ordinary chief” (Novo y Colson 1885: 382). A successor was eventually named to the title. He was Mau‘ulupekotofa, Pau’s older and senior half-brother. His appointment would have appealed to the Kanokupolu people as he was said to be an amiable fellow with little or no political interests or ambition (Thomas 1879: 174). Mau‘ulupekotofa was Tu‘i Tonga for only a few years before he died. During this time, however, he seemed content to perform his sacred duties and not interfere with the secular rule of Tonga by the Kanokupolu chiefs. After his death no Tu‘i Tonga was appointed. The sacred duties of the office were thought to have been performed by Nanasipau‘u (Labillardière 1800: 376). Nanasipau‘u was Ma‘ulupekotofa’s elder full sister; she was also Tu‘i Tonga Fefine. She reported that Pau’s son, the eligible successor to the title, was too young to succeed (Labillardière 1800: 376).

It is not clear why Nanasipau‘u claimed that Pau’s son, presumably Fuanunuiava, was not of age. Cook and his men witnessed the unusual *fakataumafa* conducted by Pau to insure his son’s succession when he was estimated to be between 12 and 15 years old some 15 years earlier, so the boy would have been an adult in 1793. Members of the Bruni d’Entrecasteaux expedition met Fuanunuiava in 1793 and described him as an adult (Labillardière 1800: 336). Mariner (Martin 1817 [I]: 133) estimated him to be about 40 years old around 1806. It may be that he was unable to succeed while his father’s sister, the Tu‘i Tonga Fefine Nanasipau‘u, was alive. Queen Sālote indicated that strict protocol would not usually allow this to happen (Spillius [Bott] 1958-1959). However, as previously mentioned, much that occurred at this time was not according to Tongan custom and it seems more likely the political ambitions of the Kanokupolu and the Tu‘iha‘ateiho people that prevented Fuanunuiava from being called Tu‘i Tonga at this time. The French and Spanish expeditions that visited Tonga in April and May of 1793 indicated that Fuanunuiava was not an eligible successor. The Bruni d’Entrecasteaux Expedition recorded a slighting remark that a chief of the Kanokupolu people made about Fuanunuiava that “everybody passed themselves off for chiefs (egui [*‘eiki*])” (Labillardière 1800: 340). Malaspina’s men were told in Vava‘u that Fuanunuiava had “either been assassinated or was living confused with the lowest common people in Tongatabu” (Novo y Colson 1885: 382). Despite these incongruities, Fuanunuiava was eventually named Tu‘i Tonga in 1795. Tu‘i Kanokupolu Mumui directed his succession in an attempt to restore political order in Tonga (Spillius [Bott] 1958-1959).

POLITICS AND FEATHERWORK IN TONGA

The details of the three references to *palā tavake* in the European explorer literature help to explain the connection between the feathered diadems and the sacred Tuʻi Tonga title, as well as the social and political transformations surrounding the title in the late 18th century. *Palā tavake*, as previously mentioned, were acquired by the Cook Expedition in Tongatapu in 1777, the Bruni d'Entrecasteaux Expedition in Tongatapu in 1793 and the Malaspina Expedition in Vavaʻu in 1793. Items of wealth index the realm of status, authority and power in Tonga and the individuals associated with *palā tavake* suggest a time of dynastic rivalries and political transformation in the archipelago in the late 18th century. The gifting of *palā tavake* to visiting Europeans can be seen both as a means of cementing a relationship between elites as well as a way of positioning the political ascendancy of the giver to the wider world.

Tuʻi Tonga Pau gifted three *palā tavake* to Cook and his men on his third visit to Tonga; two of these three were later traded within Polynesia. Pau's title and status fit with what is known about *palā tavake* and their standing as sacred feathered regalia in Tonga. It was said that Pau's *palā tavake* was made at a time when the knowledge of how to create them was in danger of being forgotten. Pau, reportedly, offered a *matapule* 'chiefly attendant' title to anyone able to make one (Kaeppler 1971: 214, Ko e Makasina ko e Loʻau 1970). The title he established was "Helu" which means 'comb' in Tongan. A man from Foa created an authentic *palā tavake* and received the title which was passed to his descendants. The gravestone of a later Helu who died in 1884 commemorates this honour: "Helu who made the comb (helu) called PALATAVAKE" (Helu 2014).

The suggestion that the creation of *palā tavake* in the 1770s may have been a revival of an earlier practice is intriguing. It may be that Tuʻi Tonga Pau in an effort to secure his own line's succession, and to increase his power and the secular authority of the title, sought the re-creation of sacred feathered regalia to evoke the sole rule of the Tuʻi Tonga in times long past. Pau's association with the *palā tavake* is also commemorated in the carving on a war club given to Cook and his men which depicts the Tuʻi Tonga wearing a feathered headdress (Kaeppler 2010: 169, 252; Mills 2009). This harkening back to a time of exclusive and pre-eminent rule, as well as the commemoration of Pau's prowess as a warrior, makes sense considering his tenuous genealogical right to the title.

Members of the Bruni d'Entrecasteaux Expedition were given a *palā tavake* during their visit to Tongatapu in April and May of 1793. The headdress was presented by "Feenou" [Fīnau] whom the French identified as "chief of the warriors" and "whose body was covered with scars in various places... received by spears in different battles against the people of Feejee" (Labillardière 1800: 334). The French spent a large amount of time with "Feenou". He was most probably Fīnau ʻUlukālala-ʻi-Maʻofanga. Fīnau was a renowned warrior who travelled to Fiji and fought alongside the Tui Nayau earning himself an envious reputation both in Fiji and Tonga. (Hocart n.d: 242, Spillius [Bott] 1958-1959, Deryck Scarr pers. comm., Fergus Clunie pers. comm.).

Why Fīnau ʻUlukālala-ʻi-Maʻofanga had the *palā tavake* is a mystery. He was not Kauhalaʻuta (the Tuʻi Tonga's people) nor did the French record that he wore the headdress. There is no record of him taking part in the battles between the Tuʻi Kanokupolu's people and Tuʻi Tonga Pau, but it is entirely possible that he was involved. He was politically ambitious and, as mentioned, had a reputation as a fierce warrior. If he was in Tonga at the time of the battles, it is not hard to imagine that he would have participated. If he was directly involved with Pau's death this may explain why he was in possession of the *palā tavake* and why he chose to gift it to the French. He certainly called himself *hau*, indicating that he ruled because of his success in battle, and he may have acquired the feather diadem as a battle trophy. Gifting such an item would have enhanced his status.

The third European description and acquisition was from Vuna to members of the Malaspina Expedition in 1793. If Malaspina's "Vuna" was, in fact, Tuʻihaʻateiho Fāʻotusia Fakahikuoʻuiha, it is not out of the question that he wore a *palā tavake*. As mentioned, Fāʻotusia was of exceedingly high rank. In addition the Tuʻihaʻateiho title originated with a Tuʻi Tonga Fefine and, therefore, was regarded as being Kauhalaʻuta or on the same ʻside of the road' as (i.e., intimately related to) the Tuʻi Tonga. It may be that Fāʻotusia was attempting to raise himself or his son, Makamālohi, to the Tuʻi Tonga title. Pau's less than illustrious genealogy would have emphasised the stellar rank of Makamālohi, as previously mentioned, the very highest ranking individual in all of Tongan history. It may be that some felt him a more worthy holder of the title or it may be that Fāʻotusia sought to supplant the title with the Tuʻihaʻateiho title. Vuna [Fāʻotusia] was said to have been part of the conspiracy against Tuʻi Tonga Pau:

> The chiefs Eyguis Buna [ʻEiki Vuna] and Mumui, gathered their forces in Vabau [Vavaʻu], home of the queen [Tupoumoheofo] who was a Tubou [Tupou]. Paulajo [Paulaho] with all his authority, accompanied by his son Fatafegui [Fatafehi Fuanunuiava] (the same one that Captain Cook saw crowned) marched against Hapay (Haʻapai), attacked and held it. He defeated Anamuka [Nomuka]; but was unhappy in Vabau [Vavaʻu]. The conspirators repelled the landing and, in particular, the combat between Paulajo [Paulaho] and Buna [Vuna] left Paulajo [Paulaho] defeated. (Pineada n.d.)

If Pau had been acknowledged as *hau* then his defeat in combat by Tuʻihaʻateiho Fāʻotusia would entitle the latter to be Pau's successor. Indications based on records from the 1793 European visits to the archipelago suggest that the aim may have been to supplant the Tuʻi Tonga. Fāʻotusia's mother, Nanasipauʻu, was performing the duties of the Tuʻi Tonga on Tongatapu at the same time the Spaniards heard about the "revolution" in the islands. They were told that Vuna's [Fāʻotusia's] son, Feileua [Makamālohi], was "heir Prince to Vavao [Vavaʻu], Happai [Haʻapai], and Annamoka [Nomuka]...[eventually at age] the rights of Feileua would be extended to Tongatabu [Tongatapu]" (Novo y Colson 1885: 383). The denigration of Pau's son, Fuanunuiava, in Tongatapu intimate that those in league against Pau and his son were, at least in part, successful. This suggestion is further supported by the evidence that Makamālohi [Feileua] was treated like a Tuʻi Tonga with the presentation of a *moheofo*. The absence of a *palā tavake* being worn by Fuanunuiava, a clear successor to the Tuʻi Tonga title, in Tongatapu, at the same time that Vuna [Tuʻihaʻateiho Fāʻotusia] and his younger brother [Veasiʻi] are wearing them in Vavaʻu, suggest the usurpation of ritual authority if not political power of the Tuʻi Tonga. The rank of Fāʻotusia was exceedingly high; that of his son was unmatched in Tongan history. That they would position themselves and their title as more suitable and viable sacred rulers of Tonga is not out of the question. It also seems probable that the splendid headdress in the Museo de América was most likely the one worn by Vuna [Fāʻotusia] or his younger brother [Veasiʻi] in Vavaʻu in 1793 and brought back to Madrid by members of the Malaspina Expedition. *Palā tavake* were magnificent adornments, beautifully created and regally worn. Undoubtedly, they were designed to impress.

* * *

While the accepted accounts of Tonga's past have, by and large, been portrayed as absolute and unchanging, it is increasingly clear that power relations within Tonga were more fluid and competitive than received traditions suggest and the late 18th century proved to be a time of intense dynastic rivalries in the archipelago. The possible revival of the feather headdress known as *palā tavake* by Tuʻi Tonga Pau signalled a shift in the history of Tongan politics, as the sacred ruler may have attempted to extend the authority of his title to political as well as sacred power. His goal was only temporarily realised, ending with his death and the denigration of the title by dynastic rivals which included Tuʻihaʻateiho Fāʻotusia. It appears that Fāʻotusia attempted to name himself or his son as the new sacred ruler of Tonga adopting the *palā tavake* as a symbol of this conquest.

They may have been the last to wear the feather headdress in Tonga. By the turn of the 19th century, the dynastic rivalries would explode into 20 years of civil war in Tonga. The archipelago would not be fully united again until after 1845 which saw the installation of Tāufaʻāhau as Tuʻi Kanokupolu. Significantly at this time Tāufaʻāhau was also crowned King Tupou I: the first monarch and the beginning of the modern Tongan royal line. The new rule favoured the new Christian religion so the old ways of the gods in Tonga and their association with divine chieftainship, including its sacred regalia, were replaced. The rule of the Tupou Dnasty was further strengthened when Tuʻi Tonga Laufilitonga died in 1865 and Tāufaʻāhau ordered the sacred title to be abolished. The establishment of the modern Kingdom of Tonga heralded an era of political centralisation and unification that still exists today.

Today the *palā tavake* is regarded as a symbol of ancient chieftainship in Tonga. The discovery of a surviving example in Madrid will be welcomed by Tongans as a link with that distant past. It is recalled in contemporary Tongan poetry, textile design and visual art (see Fig. 2) where it is inextricably linked with the sacred ruler of Tonga who held the title Tuʻi Tonga. These works proclaim and reclaim the sacred chiefly regalia as part of an ancient, enduring and unified political past. However, rather than embodying a peaceful time of political unification the appearance, possible revival and subsequent disappearance of the *palā tavake* reveal a history of intense dynastic rivalries with the transformation and eventual end of the scared Tuʻi Tonga title in Tonga.

NOTES

1. The headdress in Madrid was uncovered by Maia Nuku, University of Cambridge, with Beatriz Robledo, Museo de América, Madrid in November 2011. It was conserved by Mercedes Ramos Amezaga, also of the Museo de América (Amézaga Ramos and Cerezo Ponte 2013).
2. Paulaho roughly translates as ‘large scrotum or testicles’ and is somewhat offensive to modern Tongans who prefer the nomenclature Pau.
3. See Campbell (1982) and Herda (1995: 43-45) for a discussion of establishment of the Tuʻi Haʻatakalaua title.
4. The ceremony at the time of planting was known as the *ʻinasi ʻufimui*. It acknowledged the part of the goddess Hikuleʻo and the Tuʻi Tonga in the fertility of the land and invoked the continuation of that fertility. At the time of the harvest the first portion was likewise consecrated to Hikuleʻo through the Tuʻi Tonga. This first fruits ceremony was known as *ʻinasi ʻufimotuʻa*. Clunie (2013: 187) contends that the *ʻinasi* offerings were presented to Kaloafutonga rather than Hikuleʻo.

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ABSTRACT

Palā tavake were sacred regalia, feather headdresses, reserved for the traditional sacred ruler of Tonga, the Tuʻi Tonga. Recently a fanned feathered headdress whose materials and construction are commensurate with 18th-century Tongan objects was uncovered at Madrid's Museo de América. This paper considers the feather headdress located in Madrid, its probable historical context and connections—both Tongan and Spanish. In addition we discuss the association of *palā tavake* with the Tuʻi Tonga, the sacred ruler of Tonga, and the changing nature of the title in the late 18th century.

Keywords: palā tavake, feather headdress, sacred regalia, Tongan political history, Tuʻi Tonga, Western contact

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[1] Corresponding author: Anthropology, University of Auckland, Private Bag 92019, Auckland, New Zealand. E-mail: p.herda@auckland.ac.nz

[2] Mira Szászy Research Centre, University of Auckland, Private Bag 92019, Auckland, New Zealand. E-mail: blyt002@aucklanduni.ac.nz

SOURCING RAPA NUI *MATA'A* FROM THE COLLECTIONS OF BISHOP MUSEUM USING NON-DESTRUCTIVE pXRF

MARA A. MULROONEY
Bernice P. Bishop Museum

ANDREW McALISTER
University of Auckland

CHRISTOPHER M. STEVENSON
Virginia Commonwealth University

ALEX E. MORRISON
University of Auckland

LISSA GENDREAU
Bernice P. Bishop Museum

Obsidian and volcanic glass provided useful material for the manufacture of cutting implements throughout the Pacific during the period before European contact. Obsidian artefacts including flakes, cores and a variety of cutting tools are commonly encountered in archaeological deposits situated in both Near and Remote Oceania (e.g., Ambrose 1996; Kirch and Yen 1982; Sheppard *et al.* 2011; Torrence, Kelloway and White 2013; Vargas, Cristino and Izaurieta 2006). Advances in provenance methods since the early 1970s have resulted in a proliferation of studies that utilise techniques such as X-ray fluorescence (XRF) and instrumental neutron activation analysis (INAA) to accurately characterise the chemical properties of obsidian and other lithic materials (see Shackley 2005). Studies of obsidian characterisation in Oceania (e.g., Bird *et al.* 1978; Reepmeyer and Clark 2010; Sand and Sheppard 2000; Smith, Ward and Ambrose 1977; Specht 2002; Spriggs, Bird and Ambrose 2010; Torrence *et al.* 2013; Weisler 2012; Weisler and Clague 1998; White and Harris 1997) and more specifically in New Zealand (e.g., Green 1962, 1964; Green *et al.* 1967; Leach and Anderson 1978; McCoy *et al.* 2010; Mosley and McCoy 2010; Sheppard *et al.* 2011) and on Rapa Nui (e.g., Beardsley, Ayres and Goles 1991; Beardsley and Goles 1998, 2001; Bird 1988; Stevenson *et al.* 2013) have been widespread. These studies have been fundamental in providing insights into the dynamics of local and regional interaction spheres in a variety of contexts throughout the region.

Rapa Nui contains four sources of obsidian in the southwestern portion of the island (Fig. 1) that have been identified through intensive archaeological survey (McCoy 1976; Stevenson, Shaw and Cristino 1984; Vargas *et al.* 2006).

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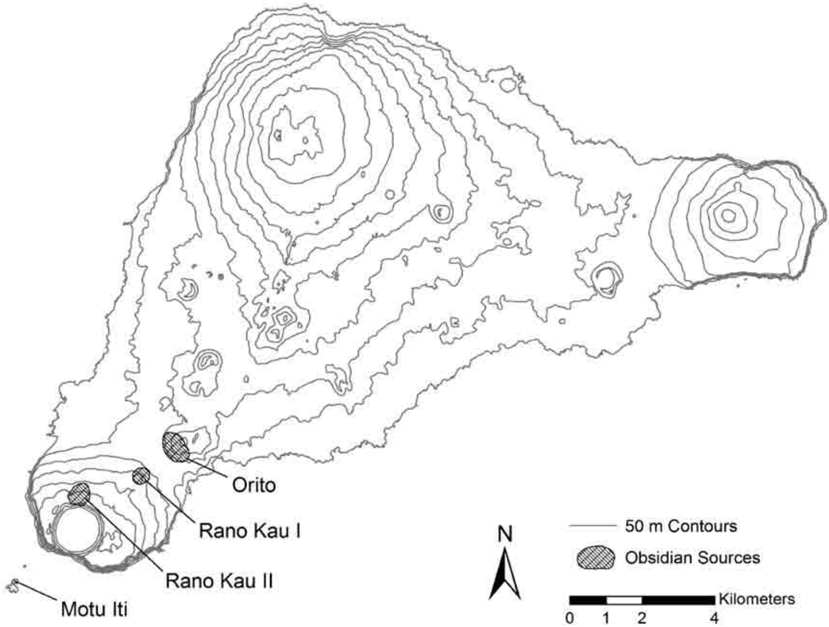

Figure 1. Obsidian source locations on Rapa Nui.

As the only large source of true obsidian outside of New Zealand in East Polynesia, this material would have been both a novel and valuable resource for the production of portable artefacts. Artefacts that were manufactured using obsidian are common across the island, and the assignment of geographical provenances using geochemical sourcing methods has provided insights into the exploitation of these source locations and social dynamics relating to access and exchange (e.g., Beardsley, Goles and Ayres 1996; Cristino *et al.* 1999; Stevenson *et al.* 2013).

The obsidian artefacts encountered on Rapa Nui are the product of a core-flake reduction technology (Stevenson *et al.* 1984) and include unretouched flakes, scrapers, small adzes and *mata‘a* (tanged obsidian tools). *Mata‘a* are reported to have “proliferated widely on Rapa Nui in late archaeological and surface contexts” (Van Tilburg 1994: 109) although chronometric data to substantiate this are lacking. Although typically described as spear points (e.g., Flenley and Bahn 2002: 152-53, Métraux 1940: 166-67), use-wear analyses carried out during the 1990s identified wear patterns and edge damage associated with the cutting of fibrous plants and wood, suggesting that *mata'a* were more likely used for crop harvesting and/or light woodworking (Church 1994, 1998; Church and Ellis 1996; Church and Rigney 1994). More recent analyses have identified the remains of sweet potato (*Ipomoea batatas*) on the cutting edges of these artefacts (Stevenson pers. comm. 2013), further suggesting that they were involved in food preparation. This empirical archaeological evidence is supported by the early observation of Bouman, a mariner onboard the first recorded European ship to visit the island in 1722 under the command of Jacob Roggeveen. Bouman observed that the Rapanui "cut their bananas with a sharp little black stone" (von Saher 1990: 52), but this observation may pertain to flakes rather than *mata'a.*

If *mata'a* did have an agricultural function, they would have been an important production tool for the chiefly economy, which was reliant on dryland agricultural practices which developed throughout the Rapa Nui cultural sequence (see Ladefoged *et al.* 2010, Stevenson 2002, Stevenson and Haoa 2008). However, the fact that hundreds of *mata'a* were surface-collected from ceremonial contexts, including 355 from the Vinapu area on the southwest coast and 287 from the Ahu Akivi-Ahu Vai Teka inland ceremonial complex (Mulloy 1961, Mulloy and Figueroa 1978) may suggest that they were not solely agricultural tools.

In the present study, we analyse a total of 332 artefacts, including 302 complete *mata'a* and 30 broken *mata'a*, from the Ethnology Collections of the Bishop Museum using pXRF (portable X-ray fluorescence) to assign geological provenances. This builds on the recent research of Stevenson *et al.* (2013), who used Discriminant Function Analysis (DFA) of laboratory-based EDXRF (energy dispersive X-ray fluorescence) data to source 331 obsidian flakes from various archaeological contexts across the island in an effort to explore regional exchange and use patterns. Stevenson *et al.* (2013) assigned the artefacts to the four geological sources that were exploited during Rapa Nui prehistory, and their findings suggested that quarries were differentially represented in ceremonial versus domestic contexts. Here, we apply a similar approach and utilise pXRF to non-destructively source the complete and incomplete *mata'a* from the collections at the Bishop Museum. Discriminant Function Analysis (DFA) and Support Vector Machines (SVM) source attribution studies were carried out to explore obsidian procurement activities and the results of these analyses are used to address the reasons for differential obsidian source exploitation and how elite personnel may have played a role in this process.

BACKGROUND

Mata'a *in the Collections of Bishop Museum*

In general, the *mata'a* curated by the Bishop Museum are ethnographic collections that lack specific provenance information. Along with a number of other cultural objects from Rapa Nui, a total of 232 complete and incomplete *mata'a* were purchased in 1920 from the private collector, J.L. Young. Young was a merchant who lived in French Polynesia and often travelled to Rapa Nui during the 1880s. Many of the *mata'a* from Young's collection have twine around the neck of the artefact, which suggests that they were likely purchased from the CEDIP (Compania Explotadora de Isla de Pascua) store on the island (historic photos of the company store show artefacts displayed on the wall using twine). Bishop Museum anthropologist Kenneth P. Emory collected 81 *mata'a* during a research expedition in 1929-1931, and these were accessioned in 1931. The remaining 20 artefacts were gifts to the museum: six *mata'a* from the Hawaiian National Museum in 1891, seven from J.L. Young in 1902, two from the Societe d'Etudes Oceaniennes in 1928, another two from ethnographer Alfred Métraux in 1936 and three from ethnobotanist Douglas Yen in 1964. Those donated by Yen are the only artefacts for which any provenance details are given. Yen indicated that these artefacts were collected near an *ahu* (ceremonial platform) in the northeastern area of the island. Aside from this very general description, there is no specific provenance information for any of the *mata'a* in the Bishop Museum collections. The argument made here is that despite limited provenance information, these artefacts can be used to explore general features of obsidian procurement.

Mata'a *Classifications*

Mata'a exhibit a wide range of morphological variation. Numerous classifications have been put forth, but they have generally been based on an intuitive or *ad hoc* selection of attributes. Ethnographic accounts from the late 19th and early 20th century (Routledge 1919, Thomson 1891) described these tools as weapons, and Thomson and Routledge both attempted to classify them based on overall shape. Thomson divided a collection of *mata'a*, which he purchased in 1886 from A.A. Salmon, an entrepreneur resident on Rapa Nui, into nine types and assigned each one a Rapanui name. Similarly, Routledge (1919: 223) was given 14 different descriptive names for *mata'a* by Rapanui informants, such as "tail of a fish", "backbone of a rat" and "leaf of a banana". It is, however, not certain if these names were used traditionally or relate to different functional types.

Since the early 20th century, a number of more formal classification schemes have been presented for *mata'a.* During the early 1920s, H.D. Skinner classified 194 artefacts from the collections of the Bishop Museum (as cited in Métraux

1940: 166-67). His classification was based on overall shape and consisted of six types (Fig. 2). In 1951, Bórmida studied 500 specimens from a museum collection in Chile and presented a classification consisting of four types, three of which had two subdivisions. He concluded that particular edge morphologies might have been employed for different woodworking functions. Bórmida's (1951) classification and Skinner's earlier one were built upon by Mulloy (1961), who analysed 355 surface-collected *mata'a* from the Vinapu area during the Norwegian Expedition to Rapa Nui in 1955-1956. A total of 219 of these were placed into Skinner's categories and "Type 2" specimens (distinguished by having a straight cutting edge) were more prevalent than the other types, with the most variation occurring in the blades of the artefacts, which were "almost infinitely varied" (Mulloy 1961: 152). Heyerdahl (1961: 399) added that "about two hundred additional surface specimens collected from most other sections on the island evince the same general characteristics…" and he thus concluded that Mulloy's study reflected island-wide variation in the morphology of these tools. In 1978, Mulloy and Figueroa expanded upon

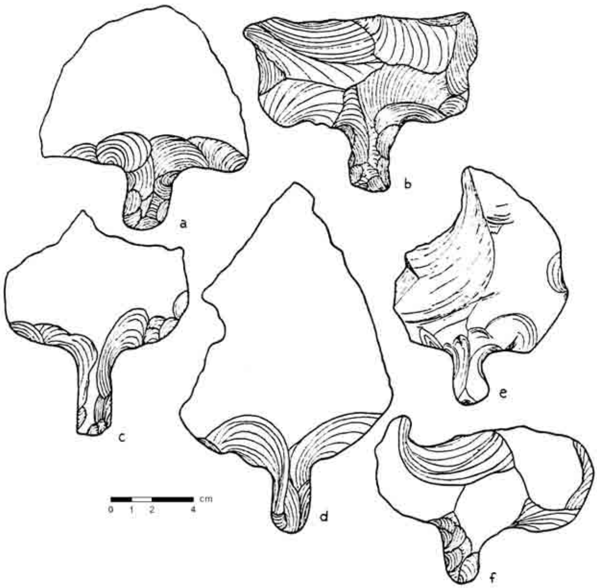

Figure 2. Examples of *mata'a* from the Bishop Museum collections showing Skinner's classification (drawings by H. D. Skinner; reproduced from Métraux 1940: 166, Fig. 3).

Mulloy's previous analysis and compared the *mata'a* assemblages from Vinapu and Ahu Akivi. Most recently, Lipo, Hunt and Hundtoft's (2010) stylistic seriation of 447 artefacts from various areas of the island suggested localised patterns in *mata'a* stylistic attributes. Overall, previous studies suggest that there is a wide range of variation, and that there is potential for the identification of some regional stylistic attributes in at least some areas of the island. In the present study, however, a stylistic seriation analysis was not undertaken due to a lack of geographic and temporal provenance for the artefacts under study.

Rapa Nui Geology and Obsidian Sourcing Studies

Rapa Nui's four major obsidian sources are all associated with the final eruptive phase of the Rano Kau volcanic series (Vezzoli and Acocella 2009). These include: (i) the Motu Iti source, consisting of a massive dyke of obsidian located on the small (1.6 ha) offshore islet of Motu Iti, which is associated with a dense accumulation of flaking debris; (ii) the Orito source, situated on the vitrophyric dome of Maunga Orito, which contains expansive north and south flanking exposures of blocky material ~10-30 cm in length, which was extracted through open pit mining; (iii) the Rano Kau I source, located at the perlitic dome of Te Manavai, consisting of a light surface distribution of fragmentary obsidian on the northeast slopes of Rano Kau and (iv) the Rano Kau II source, which consists of small obsidian shards contained within a 20 m thick breccia along the northern edge of the Rano Kau caldera (see Fig. 1; see also McCoy 1976, Vezzoli and Acocella 2009: 874).

The material attributes of the Rapa Nui obsidian sources may have imposed some constraints on the production of *mata'a*. The small and irregular shards of the Rano Kau II source preclude the production of large flakes and we would not expect any *mata'a* to be made from this glass. Larger cobbles or fragments of obsidian are present at the Rano Kau I source, but they frequently contain perlite inclusions which likely made the material difficult to work (McCoy 1976: 329) and may have been visually undesirable. The Motu Iti source has a very suitable material for the production of large flakes, but with the practical drawback that it is located offshore. The Orito source contains large, easily acquired blocks of obsidian that are tabular in shape and are well-suited for the creation of large flakes from which *mata'a* could be fashioned. We therefore predict that most of the *mata'a* in the collections of Bishop Museum will be from the Orito source with significantly fewer *mata'a* from Motu Iti and Rano Kau II.

Previous sourcing studies have had variable success in distinguishing between the four sources of obsidian on Rapa Nui. In 1974, Baker, Buckley and Holland utilised major, minor and trace element analysis on single samples to geochemically characterise the Orito, Motu Iti and Rano Kau I sources. Their analysis showed that the sources were broadly similar, and they were unable to distinguish among any of the sources completely. Bird (1988) performed a composition analysis using the PIXE/PIGME technique and, based on an analysis of 13 elements, found that the Te Manavai (Rano Kau I) source's geochemistry overlapped with the Orito and Rano Kau II sources.

In 1996, Beardsley *et al.* analysed 39 flakes from archaeological contexts and carried out a trace element analysis; they concluded that 82 percent of the samples (n = 32) came from the Orito source and 18 percent of the samples (n = 7) likely came from the Motu Iti source. They also assessed five obsidian samples from a site on the crater rim of Rano Kau (Site 1-193) and all five were assigned to the Orito source. As with Bird's previous study, their analysis could not distinguish between the Orito, Rano Kau I and Rano Kau II sources. Shortly thereafter, Cristino *et al.* (1999) utilised INAA and EDXRF to analyse 567 samples of source material in carrying out an extensive elemental characterisation of the four obsidian sources. Using DFA, which included 23 elements determined by INAA and seven major and minor oxides determined using EDXRF, they assessed 120 samples from Rano Kau II (identified simply as Rano Kau by Cristino *et al.*), 118 samples from Rano Kau I (identified as Te Manavai), 118 samples from Motu Iti and 211 samples from Orito. Their analysis was unable to fully partition the sources, with the Orito and Rano Kau I sources showing considerable overlap.

In 2007, Thomas, Neff and Lipo carried out an analysis of *mata'a* from nine parcels in the interior Te Miro O'one and Te Kahurea areas of the island and also analysed source material using TOF-LA-ICP-MS (Time of Flight-Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry). They used DFA to separate out the Rano Kau I (Te Manavai) and Orito sources and concluded that the vast majority of the *mata'a* under study came from the Orito source and a small number came from Motu Iti.

Most recently, Stevenson *et al.* (2013) processed 331 obsidian flakes from nine archaeological deposits and utilised a reference collection of 126 source material samples to assign provenance to the artefacts. They carried out a DFA of EDXRF data on seven elements and were able to accurately classify 89.6 percent of the 126 samples of source material analysed. They then compared archaeological samples to the geological sample distribution and showed that the sources were differentially represented in domestic versus ritual contexts (domestic: 47 percent Orito, 45 percent Rano Kau I, 2 percent Motu Iti, 5 percent Rano Kau II; ritual: 70 percent Orito, 16 percent Rano Kau I, 14 percent Motu Iti, 0 percent Rano Kau II). They also showed that the Rano Kau II source was rarely used. Here, we build on these previous sourcing analyses and use two methods (DFA and SVM) to assign geographic provenance to *mata'a* from the collections of Bishop Museum.

METHODS

The 332 *mata'a*, as well as a reference collection of 115 geological samples (Table 1), were analysed using a Bruker Tracer III SD pXRF instrument; the same reference collection was utilised by Stevenson *et al.* (2013). In the present study, these reference samples were re-analysed using the same pXRF instrument that was used to analyse the *mata'a*. Of the 115 geological samples, 31 came from the Maunga Orito source. Samples from the Orito pit mines on the northwest flanks were collected by Stevenson (Stevenson *et al.* 1984) and samples from across the site were collected by Beardsley during the course of a systematic survey of the entire dome (Beardsley and Goles 2001). Twenty-nine geologic samples came from the Rano Kau I and Rano Kau II sources. The former were collected by Stevenson from the Te Manavai exposure and the latter came from a road-cut adjacent to the road leading to the summit of Rano Kau. From Motu Iti, Stevenson collected 20 geologic surface samples and also obtained samples from an underwater area of cultural debris. Six additional geologic samples from Motu Iti were provided by Sonia Haoa.

All samples were processed in the Bishop Museum's Conservation Laboratory. Samples were placed on the instrument with a base covering mylar film and were exposed to 200 seconds of live counting time. Values for iron (Fe), gallium (Ga), manganese (Mn), niobium (Nb), rubidium (Rb), strontium (Sr), thorium (Th), yttrium (Y), zinc (Zn) and zirconium (Zr) were calculated as parts-per-million (ppm) concentrations using the S1CalProcess software provided with the Bruker instrument. The instrument was calibrated for analysing obsidian by the manufacturer before it was loaned to Bishop Museum and a supplied reference sample was run daily to check for analytical stability.

The resulting dataset was analysed using two techniques: Discriminant Function Analysis (DFA) and Support Vector Machines (SVM) classification. Discriminant Function Analysis is commonly used in archaeological studies (e.g., Sheppard *et al.* 2011) but SVM classification is a recently-developed technique (see Cortes and Vapnik 1995). The method is conceptually similar to DFA, in that it assigns unknown specimens to groups based on a reference set. However, it operates on non-parametric principles; instead of maximising the distance between group *means*, as is the case with DFA, this method maximises the distance between group *boundaries*, potentially making it less sensitive to departures from the assumptions of parametric techniques, such as normal group distributions and equality of group variance. Employing two methodologically different techniques provides a useful means of ensuring robust results.

Table 1. Means and standard deviations for the four Rapa Nui obsidian sources; all values are in parts-per-million (ppm).

Element	Rano Kau II (n=29)		Motu Iti (n=26)		Orito (n=31)		Rano Kau I (n=29)	
	μ	S.D.	μ	S.D.	μ	S.D.	μ	S.D.
Mn	440	55.3	644	88.3	555	54.2	622	66.7
Fe	20,732	1468.9	23,950	1508.5	22,367	1094.6	24,156	931.6
Zn	236	17.8	220	17.3	214	16.8	240	15.4
Rb	96	6.1	81	5.6	84	5.1	91	4.6
Sr	9	1.8	46	2.5	26	2.2	28	2
Y	160	8.3	139	7.5	143	7.6	154	5.7
Zr	837	45.3	751	110.7	837	114	880	65.7
Nb	132	5.3	122	5.3	124	5.4	130	4.5
Ga	31	3.2	29	4.2	28	2.6	31	2.9
Th	13	2.5	11	2	12	1.9	12	2.5

RESULTS

Discriminant Function Analysis

A DFA was carried out using the IBM SPSS statistics program (Version 20). Various combinations of elements were examined using standardised and log-transformed data, most of which gave similar results. It was found that using the same seven (untransformed) elements as in Stevenson *et al.*'s (2013) previous study (i.e., Mn, Fe, Zn, Rb, Sr, Y and Zr) produced results with the fewest misclassifications among the geological sample material. This DFA analysis placed the four sources into separate clusters, two of which overlapped slightly

Table 2. Predicted group assignments for obsidian source samples and artefacts as determined by Discriminant Function Analysis (DFA). The upper table shows the original results and the lower shows the results of Leave Out One Cross Validation (LOOCV).

Original	*Predicted Group*				
Actual Group	Rano Kau II	Motu Iti	Orito	Rano Kau I	*Correctly Classified*
Rano Kau II	29				1.000
Motu Iti		26			1.000
Orito			27	4	0.871
Rano Kau I			2	27	0.931
Artefacts		7	316	9	
Overall Correct Classification Rate					0.948

Original	*Predicted Group*				
Actual Group	Rano Kau II	Motu Iti	Orito	Rano Kau I	*Correctly Classified*
Rano Kau II	29				1.000
Motu Iti		26			1.000
Orito			26	5	0.839
Rano Kau I			4	25	0.862
Overall Correct Classification Rate					0.922

(Fig. 3). Overall, 94.8 percent of the source material samples were accurately classified, a figure which dropped slightly to 92.2 percent under Leave Out One Cross Validation (LOOCV) (Table 2). All misclassifications involved specimens from the Orito and Rano Kau I sources. The resulting discriminant functions were used to provide a geological provenance to the *mata'a* (n = 332). The vast majority of the artefacts (95.2 percent) were assigned to the Orito source (n = 317). Nine artefacts (2.7 percent) were assigned to the Rano Kau I (Te Manavai) source and seven (2.1 percent) to the Motu Iti source (see Appendix). No *mata'a* were assigned to the Rano Kau II source.

Table 3. Predicted group assignments for obsidian source samples and artefacts as determined by Support Vector Machines (SVM) classification. The upper table shows the original results and the lower shows the results of Leave Out One Cross Validation (LOOCV).

	Predicted Group				
Actual Group	Rano Kau II	Motu Iti	Orito	Rano Kau I	*Correctly Classified*
Rano Kau II	29				1.000
Motu Iti		26			1.000
Orito			26	5	0.839
Rano Kau I			2	27	0.931
Artefacts		8	319	5	n/a
Overall Correct Classification Rate					0.948

LOOCV	*Predicted Group*				
Actual Group	Rano Kau II	Motu Iti	Orito	Rano Kau I	*Correctly Classified*
Rano Kau II	29				1.000
Motu Iti		26			1.000
Orito			25	6	0.806
Rano Kau I			2	27	0.931
Overall Correct Classification Rate					0.930

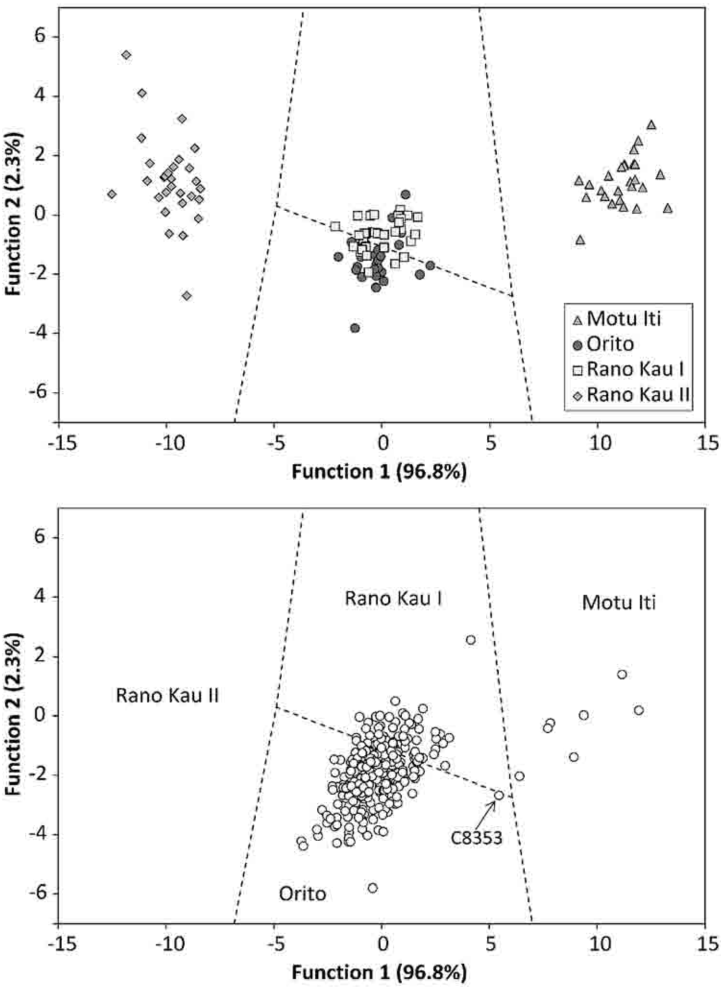

Figure 3. Plot of the first two Discriminant Functions of *mata‘a* (n = 332) from the Bishop Museum collections and reference samples (n = 115). The upper plot shows the separation of the reference samples. The lower plot shows the assignment of *mata‘a*. Dashed lines indicate the Discriminant Function group boundaries. Sample C8353 (labelled) was assigned to the Orito source by the DFA and to the Motu Iti source by the SVM classification.

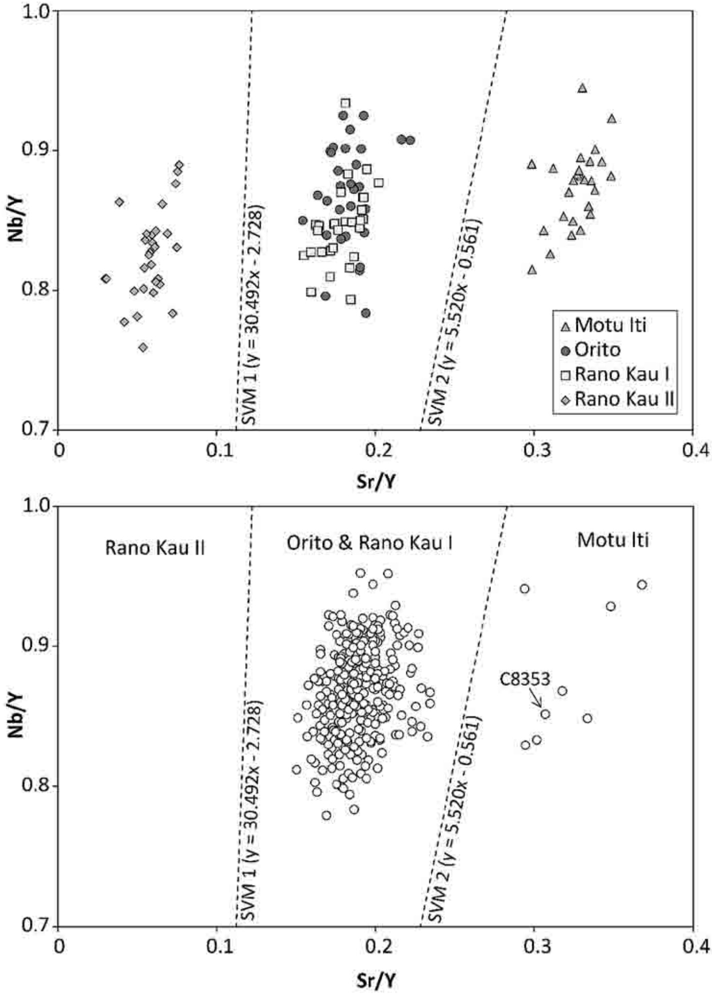

Figure 4. Stage 1 of the Support Vector Machines classification. The upper plot shows the separation of the Motu Iti and Rano Kau II reference samples from the other two sources. The lower plot shows the assignment of *mata'a*. Data are the same as in Figure 3. Sample C8353 (labelled) was assigned to Orito by the DFA and to Motu Iti sources by the SVM classification.

Support Vector Machine (SVM) Classification

The SVM analysis was carried out using the *ksvm* implementation in the Kernlab package for R (Karatzoglou, Smola and Hornik 2013: 54-61). The *vanilladot* kernel was selected to produce a linear classification function and all other settings were left at their default values. An initial assessment of the reference data suggested that different combinations of elements would be required to separate the four sources. Accordingly, a nested approach was used for the analysis; first, a pair of mid-Z element ratios (Sr/Y against Nb/Y) was used to discriminate the two most distinct sources, Motu Iti and Rano Kau II (Fig. 4). This combination produced a clear separation for these sources but resulted in considerable overlap among the Orito and Rano Kau I samples.

For the second stage of the analysis, all paired combinations of elements and element ratios were examined and the pair that best visually separated Orito from Rano Kau I (Y against Zn) was used to generate an SVM classification function (Fig. 5). This resulted in seven misclassifications for the reference samples; five samples from the Orito source were assigned to Rano Kau I, while two Rano Kau I samples were assigned to Orito. Overall, 93.9 percent of the geological reference samples were classified correctly using SVM and 93.0 percent under LOOCV (Table 3), a result almost identical to the DFA. The SVM classification functions were then applied to the artefacts. Eight were assigned to the Motu Iti source and the remainder (n = 324) were assigned to either the Orito or Rano Kau I sources (Fig. 4). No artefacts were assigned to the Rano Kau II source. For the second stage of the SVM classification, five artefacts were assigned to Rano Kau I, and the remaining 319 to Orito (Fig. 5).

Comparison of Results

Overall, both methods gave very similar results; the Motu Iti and Rano Kau II sources each possess distinct chemical compositions and were completely separated using either method. The same seven *mata'a* (2.4 percent) were assigned to the Motu Iti source by both methods, but the SVM assigned one additional artefact (Accession Number C8353) to Motu Iti, which was assigned to Orito in the DFA. The scatterplot of the DFA classification shows that this specimen plots close to the junctions of three DFA grouping boundaries (Orito, Rano Kau II and Motu Iti) and appears to be more closely associated with the cluster of artefacts assigned to the Motu Iti source than to the Orito artefact cluster (Fig. 3). This artefact (Accession Number C8353) also plotted close to group boundaries when log-transformed data were used in a DFA. In contrast, the SVM analysis shows the specimen to be clearly associated with the Motu Iti reference samples and artefacts assigned to that

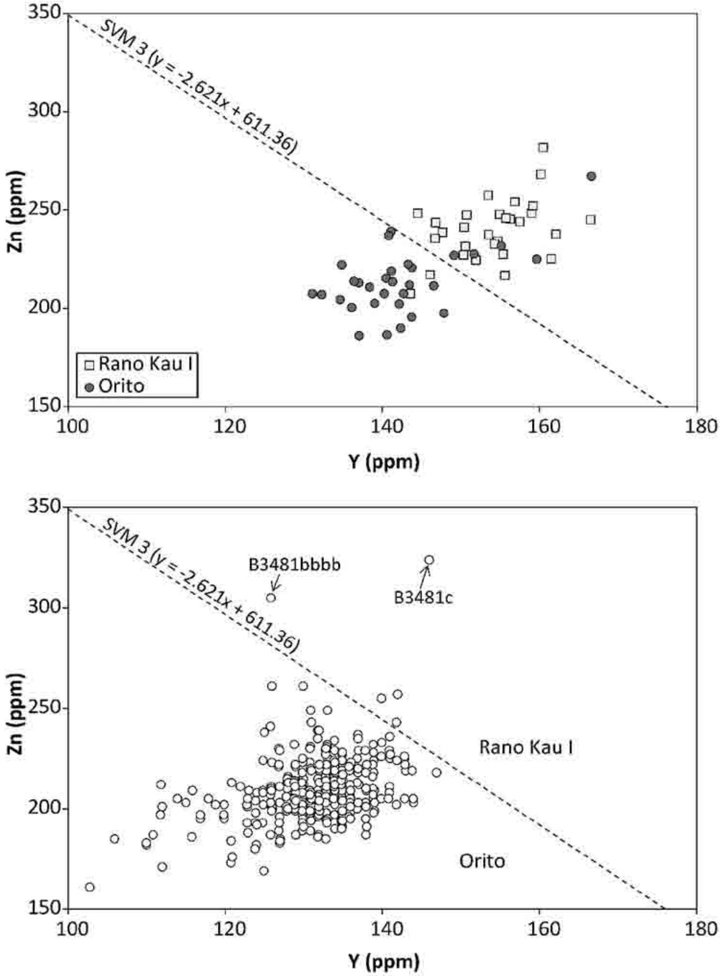

Figure 5. Stage 2 of the Support Vector Machines classification. The upper plot shows the separation of the Orito and Rano Kau I reference samples. The lower plot shows the assignment of *mata'a* assigned to those two sources in Figure 4.

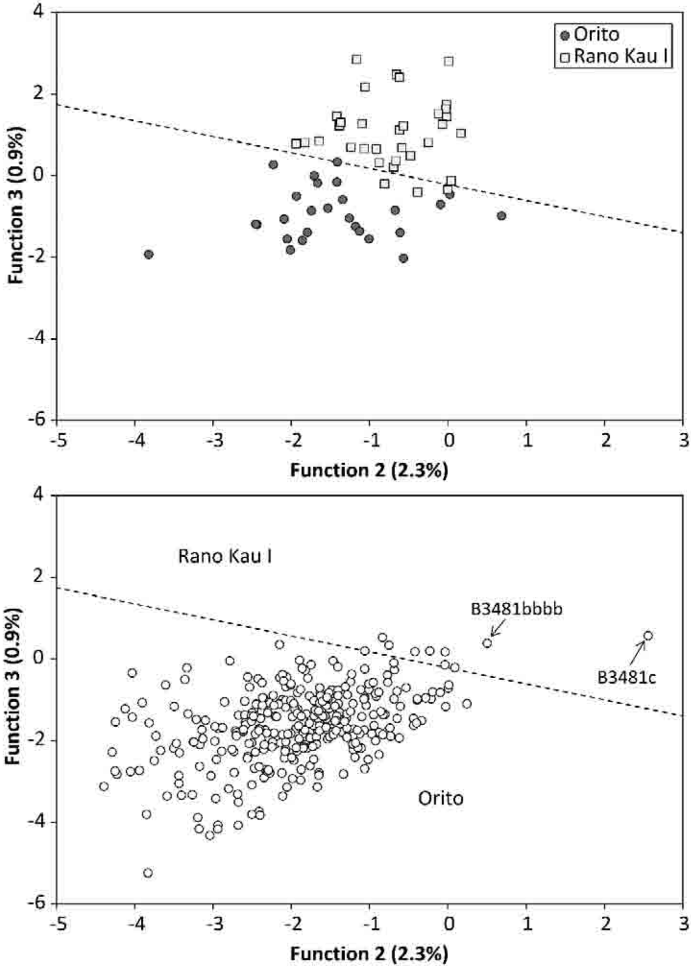

Figure 6. Plot of the second and third functions from the DFA, showing the separation of the Orito and Rano Kau I sources. The Motu Iti and Rano Kau II source materials and associated artefacts are omitted for clarity. The upper plot shows the separation of the reference samples. The lower plot shows the assignment of *mata‘a*. The dashed line indicates the Discriminant Function group boundary.

source (Fig. 6). On balance, these results suggest that the artefact is more likely derived from the Motu Iti source. It is noteworthy that Sample C8353 has the lowest values for Zr (523 ppm) and Nb (86 ppm) of all of the artefacts, so it may represent the extreme range of the Motu Iti source.

The other two sources, Rano Kau I and Orito, could not be completely separated using either method. Six reference samples were misclassified by DFA and seven by the SVM analysis. Our results concur with previous analyses (e.g., Stevenson *et al.* 2013) and indicate that the Rano Kau I and Orito sources are too similar to be completely separated by geochemical means alone. However, with the exception of two specimens (B3481c and B3481bbbb), which appear to be clearly associated with the Rano Kau I source, the remainder of these artefacts form a single homogenous cluster that is more closely associated with the Orito reference samples than those from Rano Kau I. The virtually identical results obtained using two methodologically different (i.e., parametric and non-parametric) techniques (see Figs 5 and 6) suggests that Orito is the most likely source for this cluster.

Comparison of Mata'a *Metric Data by Obsidian Source*

Upon completion of the source discrimination, we measured *mata'a* length, width and calculated length/width ratio metrics. The primary aim was to determine if material source might have limited or constrained *mata'a* shape or dimensions. Consequently, if significant metric differences exist between *mata'a* items sourced to various quarry locales, future hypotheses linking tool function, raw material quality and ultimately resource extraction and procurement may be addressed. However, these results should be viewed with some caution due to the small sample size for *mata'a* from sources outside Orito.

In carrying out this analysis, the maximum length and width of each *mata'a* was measured and each artefact was weighed. Length was measured from the base of the stem to the top of the tool, and maximum width measurements were taken perpendicular to the stem. Incomplete *mata'a* were not included in the analysis. A total of 302 *mata'a* were measured. This included 288 that were assigned to the Orito source by both DFA and SVM, seven assigned to the Motu Iti source by DFA and SVM and seven that were assigned to the Rano Kau source by DFA.

Comparison of the width for *mata'a* from the three obsidian sources suggests that the mean width of *mata'a* from each source group is similar (Table 4, Fig. 7). Although samples sizes for the Rano Kau source (n = 7) and the Motu Iti source (n = 7) are relatively small when compared to Orito (n = 288), a Kruskal-Wallis non-parametric comparison of mean width returned a value of $X^2 = 2.168$ (sig. = 0.338) which indicates that the mean

Table 4. Descriptive statistics for width for *mata‘a* from Orito, Motu Iti and Rano Kau I.

Source	N	Min	Max	Mean	S.D
Orito	288	29.5	169.2	85.84	24.39
Motu Iti	7	63.2	122.8	92.71	23.86
Rano Kau I	7	54.0	126.5	98.17	28.36

Table 5. Descriptive statistics for length for *mata‘a* from Orito, Motu Iti and Rano Kau I.

Source	N	Min	Max	Mean	S.D
Orito	288	43.8	202.4	94.52	22.66
Motu Iti	7	90.1	151.8	113.27	21.68
Rano Kau I	7	14.5	308.8	118.29	97.33

Table 6. Descriptive statistics for length/ratio for *mata‘a* from Orito, Motu Iti and Rano Kau I.

Source	N	Min	Max	Mean	S.D
Orito	288	0.47	2.72	1.15	0.3012
Motu Iti	7	0.96	1.58	1.26	0.2386
Rano Kau I	7	0.27	2.5	1.11	0.7486

width differences between sources is not statistically significant at a 90 percent confidence level.

Mata‘a length was also compared between the obsidian source groups (Table 5, Fig. 8). The Kruskal-Wallis non-parametric comparison of group means indicates that *mata‘a* made from different source material are significantly different in mean length at a 90 percent confidence level ($X^2 = 5.1773$, sig. = 0.075). To determine if there were significant differences between the three quarry groups, we ran a set of Mann-Whitney U t-tests comparing the groups pairwise. The results indicate that the only difference

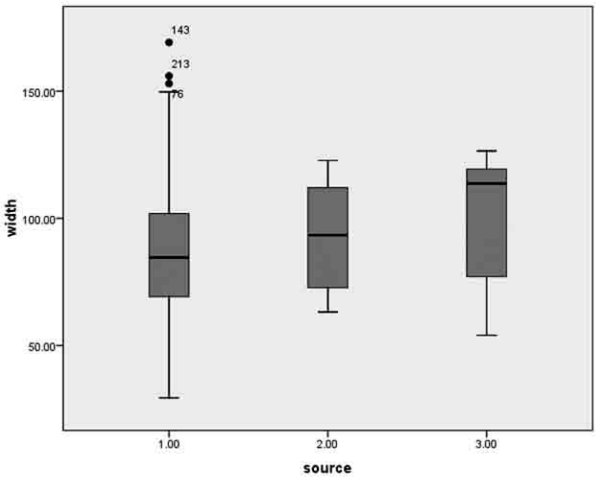

Figure 7. Box-plots of *mata'a* width values by obsidian source: 1.00 = Orito, 2.00 = Motu Iti and 3.00 = Rano Kau I.

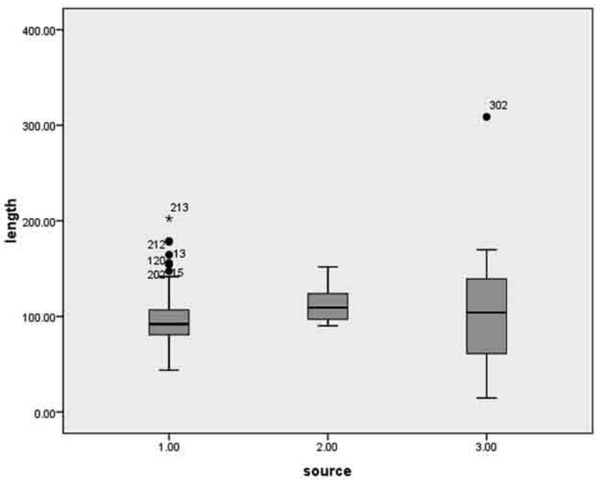

Figure 8. Box-plots of *mata'a* length values by obsidian source: 1.00 = Orito, 2.00 = Motu Iti and 3.00 = Rano Kau I.

between *mata'a* mean length is found when comparing Orito *mata'a* to the Motu Iti samples (z = -2.26, sig. = 0.02). Inspection of the group mean values and the sign of the z score indicate that the Orito source was associated with smaller mean length *mata'a* in comparison to *mata'a* from the Motu Iti source. Additional Mann-Whitney U t-tests did not identify any differences between Orito and Rano Kau assemblages (z = -0.130, sig. = 0.0897) or Motu Iti and Rano Kau assemblages (z = -0.575, sig. = 0.620).

The length/width ratio of *mata'a* from the three different sources was also compared using the Kruskal-Wallis non-parametric test (Fig. 9). The results demonstrate that *mata'a* from different sources are not significantly different in mean length/width ratios (X^2 = 2.120, sig. = 0.346). Descriptive statistics for the length/width ratios for three quarry sources are presented in Table 6.

Overall, the mean dimensions of artefacts from all three identified sources were similar. The only significant difference identified was that of *mata'a* from Orito, which were on average 21 mm shorter than those from the other sources. This may be due to differences in raw material form or, given the non-significant differences in width, more intense resharpening of *mata'a* from Orito. However, the dimensional ranges of *mata'a* from all three sources overlap, suggesting functional similarities across all sources. Additionally, we note more variability in the lengths of the artefacts sourced to Rano Kau I (see Table 5), which might reflect difficulties in flaking due to perlite inclusions.

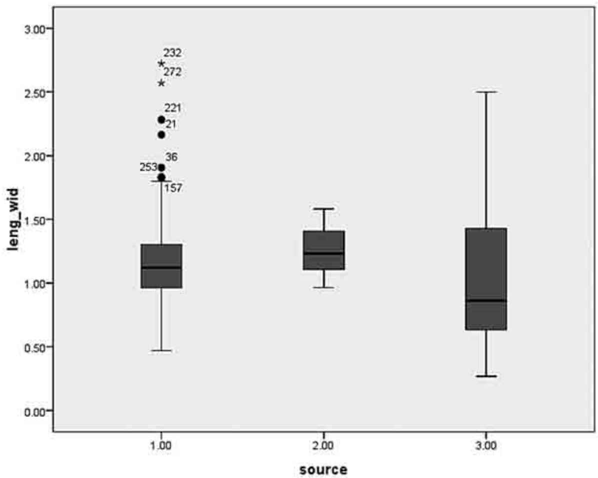

Figure 9. Box-plots of *mata'a* length/width values by obsidian source: 1.00 = Orito, 2.00 = Motu Iti and 3.00 = Rano Kau I.

DISCUSSION

With the exception of very recent analyses (e.g., Stevenson *et al.* 2013), most previous provenance studies on Rapa Nui have relied on destructive methods of analysis. As shown by this study, which employed two separate analytical methods, the use of non-destructive pXRF analysis results in source discrimination with levels of accuracy similar to those obtained using destructive techniques. Museum collections, like the one examined herein, sometimes lack well controlled artefact provenances when compared with assemblages from excavated contexts. However, because museum collections are often from a variety of contexts, they might provide a useful space and time-averaged overview of "typical" resource exploitation for a region. This can provide a baseline for comparing to individual site assemblages, associations which may have had different functions (i.e., domestic vs. ritual) or status.

Another advantage of the present study was analysis of complete tools as opposed to flakes. This may provide better quantitative insights into obsidian tool production, because several dozen flakes could potentially represent the manufacturing process involved in making a single tool. Therefore, even though this collection is not from secure archaeological contexts, it does provide general insights into resource exploitation on Rapa Nui.

Both of the sourcing methods used here indicate that a very low proportion of artefacts were manufactured using obsidian from the Motu Iti (n = 7) and Rano Kau I (n = 7) sources, and no artefacts in our sample were fashioned using obsidian from the Rano Kau II source. The absence of obsidian from Rano Kau II in this study (which contains artefacts that may represent variable time periods and/or geographical areas) suggests that this source was never intensively exploited. We suggest that this past use pattern may stem from the fact that the Orito and Motu Iti obsidians are of a better quality than the Rano Kau II material, which has unfavourable fracture properties (Baker *et al.* 1974, McCoy 1976, Thomas *et al.* 2007).

The results of the present analysis also are in general agreement with the findings of Stevenson *et al.* (2013) in relation to the extraction of obsidian from the Motu Iti source, especially in the case of the assemblages they analysed from inland habitation contexts. In those contexts, Stevenson *et al.*'s study suggested that only two percent of flakes were sourced to Motu Iti (versus coastal ritual contexts, where 14 percent of flakes are from the Motu Iti source). Both of the analytical methods employed in the present study suggest that approximately two percent of the Museum's collections were made using obsidian from the Motu Iti source.

With respect to the Rano Kau I source, the number of *mata'a* made from this material constitute two to three percent of the Museum assemblage (in six out of ten cases, the DFA and SVM were not in agreement in assigning tools to either the Rano Kau I or Orito sources). This is considerably lower than the 45 percent reported by Stevenson *et al.* (2013) for the occurrence of Rano Kau I obsidian in their flake assemblage. This may suggest that the material size, or quality, of this obsidian was not desirable for the production of *mata'a*, or that some of the tools in the present study that were assigned to the Orito source could have come from a portion of the Rano Kau I source that overlaps considerably with Orito. However, the high proportion of Rano Kau I obsidian identified by Stevenson *et al.* might also indicate that this material was commonly used for informal flake tools.

The vast majority of the *mata'a* analysed in this study were quarried from Orito, the largest source on Rapa Nui, suggesting that the ancient Rapanui may have chosen geographical ease of access and abundance of raw materials, as well as performance characteristics of the raw material, when manufacturing these tools. The very low proportion of artefacts manufactured using the less accessible offshore Motu Iti source, coupled with the possibility that more controlled distribution may have been enforced by elites, as has been suggested by Stevenson *et al.* (2013:119), may indicate that Orito became the preferred option. However, an elite presence in the immediate vicinity of Orito in the form of a chiefly dwelling (*hare paenga*), as noted by Stevenson *et al.* (2013), raises the possibility that access to the quarry may also have been controlled. Instead of restriction, as appears to have been the case for Motu Iti, chiefly control at Orito may instead have involved encouraging access to this source of high-quality obsidian as a means of building and maintaining prestige. Indeed, the ubiquity of *mata'a* on Rapa Nui raises the question as to whether or not they were used exclusively in subsistence activities. The possibility of elite intervention in their production hints at an ideological component for this object which is reinforced by the prolific occurrence of these items at ceremonial centres.

* * *

In the current study, a Discriminant Function Analysis and Support Vector Machines classification produced almost identical results. However, neither method could completely separate the Orito and Rano Kau I sources. In this respect, our analyses agree with previous research, suggesting that the compositions of the sources are too similar to allow complete separation using the suite of major and trace elements commonly quantified with XRF instruments. While it is likely that more precise analytical techniques, such as radiogenic isotope analysis (Woodhead and Weisler 1997), could provide better source discrimination, these methods tend to be at least partially destructive, which might preclude their use on artefacts, especially those from museum collections.

Overall, each of the methods outlined here appears to be effective in assigning geographical provenances to source materials and artefacts, as indicated by the fact that each method correctly assigned geologic sample materials to source over 90 percent of the time. Even when we take into account the small amount of overlap between the Orito and Rano Kau I sources, the results of both analyses suggest the ancient Rapanui preferentially accessed the Orito source in manufacturing these tools. These findings are in line with previous studies of both *mata'a* tools (Thomas *et al.* 2007) and simple obsidian flakes (Stevenson *et al.* 2013). The discovery that the overwhelming majority of these island *mata'a* were manufactured at the Orito quarry adds another indication of possible chiefly involvement in the activities at the quarry, as initially identified on the basis of residential architecture. Future sourcing studies on securely-provenanced *mata'a* may lend further insights into lithic extraction and exchange patterns across the island and the elite management entailed therein.

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APPENDIX

The following table shows pXRF data and source determinations for *mata'a* in the Bishop Museum collections by Support Vector Machines (SVM) classification and Discriminant Function Analysis (DFA).

Sample No.	MnKa1	FeKa1	ZnKa1	RbKa1	SrKa1	Y Ka1	ZrKa1	NbKa1	GaKa1	ThLa1	Source (SVM)	Source (DFA)	Description
2013.057.001	569	22256	236	84	27	141	988	116	28	11	Orito	Orito	*mata‘a* (incomplete)
2013.057.002	558	22023	215	83	26	130	759	114	26	8	Orito	Orito	*mata‘a* (incomplete)
2013.057.003	591	20964	217	79	25	135	790	116	27	8	Orito	Orito	*mata‘a* (incomplete)
5962	483	21634	255	79	25	140	865	119	28	12	Rano Kau 1	Orito	*mata‘a* (complete)
5963	495	21221	208	80	24	135	700	122	25	12	Orito	Orito	*mata‘a* (complete)
5964	587	21540	232	79	24	129	796	110	26	13	Orito	Orito	*mata‘a* (complete)
5965	479	19668	208	71	21	124	703	109	27	11	Orito	Orito	*mata‘a* (complete)
5966	543	20080	203	79	21	127	866	114	22	9	Orito	Orito	*mata‘a* (complete)
5967	694	22322	195	77	44	132	662	112	24	12	Motu Iti	Motu Iti	*mata‘a* (complete)
6714	632	21938	215	90	23	132	770	118	23	12	Orito	Orito	*mata‘a* (complete)
6715	438	18605	182	62	22	110	603	92	20	9	Orito	Orito	*mata‘a* (complete)
6716	543	20978	213	80	21	133	726	116	29	13	Orito	Orito	*mata‘a* (complete)
6717	570	21357	199	82	24	139	800	117	26	12	Orito	Orito	*mata‘a* (complete)
6718	470	21144	206	78	25	133	901	120	28	12	Orito	Orito	*mata‘a* (broken stem)
6719	513	18178	187	69	23	111	737	97	25	7	Orito	Orito	*mata‘a* (complete)
B3481a	557	21557	211	80	30	141	1078	118	21	12	Orito	Orito	*mata‘a* (complete)
B3481a_6	671	20989	214	77	27	128	703	112	27	10	Orito	Orito	*mata‘a* (complete)
B3481a_7	457	21123	218	77	25	133	739	114	28	8	Orito	Orito	*mata‘a* (complete)
B3481a_8	447	19681	200	70	23	136	779	106	23	15	Orito	Orito	*mata‘a* (complete)
B3481a_9	628	21740	209	79	24	139	804	115	26	10	Orito	Orito	*mata‘a* (complete)
B3481aa	582	20290	209	72	25	131	844	112	23	12	Orito	Orito	*mata‘a* (complete)
B3481aaa	664	20835	225	83	25	137	883	120	24	12	Orito	Orito	*mata‘a* (complete)
B3481aaaa	579	21082	207	70	39	112	605	104	22	13	Motu Iti	Motu Iti	*mata‘a* (complete)
B3481aaaaa	512	20369	261	80	24	130	731	111	26	14	Orito	Orito	*mata‘a* (complete)
B3481b	489	21340	207	83	25	136	763	114	24	13	Orito	Orito	*mata‘a* (complete)
B3481b_6	503	21265	213	80	26	128	715	116	25	10	Orito	Orito	*mata‘a* (complete)
B3481b_7	485	21352	214	81	25	135	791	115	24	13	Orito	Orito	*mata‘a* (complete)
B3481b_8	531	19432	196	75	24	120	658	102	26	11	Orito	Orito	*mata‘a* (complete)
B3481b_9	537	19110	195	73	22	117	650	104	30	9	Orito	Orito	*mata‘a* (complete)

B3481bb	597	22112	205	83	26	133	758	121	24	11	Orito	Orito	*mata'a* (complete)
B3481bbb	510	21151	209	81	27	132	713	116	27	15	Orito	Orito	*mata'a* (complete)
B3481bbbb	556	20957	305	80	26	126	712	107	29	13	Rano Kau 1	Rano Kau 1	*mata'a* (complete)
B3481bbbbb	505	19202	186	71	22	116	682	106	25	9	Orito	Orito	*mata'a* (complete)
B3481c	569	21781	324	82	34	146	968	122	24	13	Rano Kau 1	Rano Kau 1	*mata'a* (complete)
B3481c_6	572	21556	225	80	30	133	761	114	24	10	Orito	Orito	*mata'a* (complete)
B3481c_7	542	21085	223	79	23	131	822	119	28	11	Orito	Orito	*mata'a* (complete)
B3481c_8	470	19129	195	68	20	120	667	105	23	11	Orito	Orito	*mata'a* (complete)
B3481c_9	513	21041	205	82	24	134	807	117	27	14	Orito	Orito	*mata'a* (complete)
B3481cc	548	21077	205	83	25	136	746	117	27	8	Orito	Orito	*mata'a* (complete)
B3481ccc	568	20834	197	76	29	130	729	110	25	10	Orito	Orito	*mata'a* (complete)
B3481cccc	448	22115	205	79	28	139	881	113	26	10	Orito	Orito	*mata'a* (complete)
B3481ccccc	433	21086	216	78	23	128	753	110	22	14	Orito	Orito	*mata'a* (complete)
B3481d	580	21272	187	83	28	138	966	115	25	14	Orito	Orito	*mata'a* (complete)
B3481d_6	538	21844	210	82	26	135	780	122	27	15	Orito	Orito	*mata'a* (complete)
B3481d_7	512	17397	185	64	21	106	603	94	23	9	Orito	Orito	*mata'a* (complete)
B3481d_8	515	21047	204	78	26	124	689	111	27	10	Orito	Orito	*mata'a* (complete)
B3481d_9	652	20497	200	78	23	126	788	110	24	12	Orito	Orito	*mata'a* (complete)
B3481dd	532	22092	205	83	24	134	773	123	24	13	Orito	Orito	*mata'a* (complete)
B3481ddd	617	21163	207	83	26	132	826	120	20	14	Orito	Orito	*mata'a* (complete)
B3481dddd	463	19105	209	70	22	116	683	100	24	7	Orito	Orito	*mata'a* (broken stem)
B3481ddddd	589	21543	208	75	24	126	772	112	29	12	Orito	Orito	*mata'a* (complete)
B3481e	535	21382	226	83	25	140	940	112	23	10	Orito	Orito	*mata'a* (complete)
B3481e_6	633	21065	229	84	22	133	778	119	24	7	Orito	Orito	*mata'a* (complete)
B3481e_7	571	20884	230	81	23	127	744	109	29	15	Orito	Orito	*mata'a* (complete)
B3481e_8	518	21059	205	74	27	133	710	111	23	11	Orito	Orito	*mata'a* (complete)
B3481e_9	518	20747	210	74	25	139	944	112	19	11	Orito	Orito	*mata'a* (complete)
B3481ee	394	21520	219	79	26	135	813	115	25	10	Orito	Orito	*mata'a* (complete)
B3481eee	552	20081	209	77	24	133	705	113	28	11	Orito	Orito	*mata'a* (broken stem)
B3481eeee	618	21446	227	82	25	135	848	121	24	9	Orito	Orito	*mata'a* (complete)
B3481eeeee	530	21629	228	89	27	135	992	120	24	14	Orito	Orito	*mata'a* (complete)
B3481f	638	21720	209	77	27	134	771	121	28	15	Orito	Orito	*mata'a* (complete)

Sample No.	MnKa1	FeKa1	ZnKa1	RbKa1	SrKa1	Y Ka1	ZrKa1	NbKa1	GaKa1	ThLa1	Source (SVM)	Source (DFA)	Description
B3481f_6	652	22183	206	82	26	135	806	118	25	12	Orito	Orito	*mata‘a* (complete)
B3481f_7	542	21438	227	83	24	133	765	115	27	12	Orito	Orito	*mata‘a* (complete)
B3481f_8	469	18991	197	73	24	117	739	100	26	12	Orito	Orito	*mata‘a* (complete)
B3481f_9	559	18926	197	66	20	112	634	99	28	5	Orito	Orito	*mata‘a* (complete)
B3481ff	599	22704	257	83	28	142	836	118	26	9	Rano Kau 1	Rano Kau 1	*mata‘a* (complete)
B3481fff	574	20854	203	77	27	137	792	114	20	11	Orito	Orito	*mata‘a* (complete)
B3481ffff	429	18064	171	68	20	112	620	100	22	13	Orito	Orito	*mata‘a* (complete)
B3481fffff	597	21209	214	81	24	129	718	113	30	12	Orito	Orito	*mata‘a* (complete)
B3481g	592	20672	209	80	27	138	984	113	22	14	Orito	Orito	*mata‘a* (complete)
B3481g_6	613	21519	207	76	24	126	720	120	26	14	Orito	Orito	*mata‘a* (complete)
B3481g_7	545	21864	197	77	24	133	770	119	30	10	Orito	Orito	*mata‘a* (complete)
B3481g_8	623	21508	243	77	29	131	725	118	25	11	Orito	Orito	*mata‘a* (complete)
B3481g_9	565	21825	218	83	25	137	809	119	23	12	Orito	Orito	*mata‘a* (complete)
B3481gg	499	21193	225	77	24	141	767	116	25	11	Orito	Orito	*mata‘a* (complete)
B3481ggg	591	20294	217	79	23	134	693	114	28	10	Orito	Orito	*mata‘a* (complete)
B3481gggg	566	20958	198	76	24	133	726	113	23	9	Orito	Orito	*mata‘a* (complete)
B3481ggggg	608	21909	215	80	27	135	797	122	27	13	Orito	Orito	*mata‘a* (complete)
B3481h	644	21066	212	80	24	130	747	119	24	14	Orito	Orito	*mata‘a* (complete)
B3481h_6	521	20655	224	72	24	125	711	114	25	11	Orito	Orito	*mata‘a* (complete)
B3481h_7	495	20745	198	83	23	136	734	116	24	12	Orito	Orito	*mata‘a* (complete)
B3481h_8	645	21525	196	81	27	135	778	118	26	13	Orito	Orito	*mata‘a* (complete)
B3481h_9	600	21152	229	83	26	134	726	118	27	15	Orito	Orito	*mata‘a* (complete)
B3481hh	544	21054	211	79	24	126	801	115	27	10	Orito	Orito	*mata‘a* (complete)
B3481hhh	571	20974	212	77	27	137	731	117	27	11	Orito	Orito	*mata‘a* (complete)
B3481hhhh	625	20974	261	79	23	126	735	114	25	14	Orito	Orito	*mata‘a* (complete)
B3481hhhhh	633	22339	204	75	41	129	681	112	26	8	Motu Iti	Motu Iti	*mata‘a* (complete)
B3481i	674	21634	225	83	26	143	729	119	27	10	Orito	Rano Kau 1	*mata‘a* (complete)
B3481i_6	454	18425	212	63	25	112	626	94	26	8	Orito	Orito	*mata‘a* (complete)
B3481i_7	546	19853	202	74	24	131	712	106	24	14	Orito	Orito	*mata‘a* (complete)

B3481i_8	420	21601	205	78	27	143	1139	118	27	17	Orito	Orito	*mata'a* (complete)
B3481i_9	604	23562	214	84	25	133	758	118	28	10	Orito	Orito	*mata'a* (complete)
B3481ii	444	21182	219	79	23	143	1234	120	22	15	Orito	Orito	*mata'a* (complete)
B3481iii	650	21097	209	78	26	125	715	119	25	12	Orito	Orito	*mata'a* (incomplete)
B3481iiii	480	19867	197	73	24	120	645	102	26	11	Orito	Orito	*mata'a* (complete)
B3481iiiii	507	18892	193	71	23	124	658	100	28	10	Orito	Orito	*mata'a* (complete)
B3481j	625	21780	215	74	26	130	858	113	26	11	Orito	Orito	*mata'a* (complete)
B3481j_6	549	20146	206	76	22	132	750	110	22	9	Orito	Orito	*mata'a* (complete)
B3481j_7	609	20700	210	77	23	128	729	106	25	10	Orito	Orito	*mata'a* (complete)
B3481j_8	606	20579	196	72	27	132	726	112	20	10	Orito	Orito	*mata'a* (complete)
B3481j_9	559	20819	216	82	25	133	952	118	24	13	Orito	Orito	*mata'a* (complete)
B3481jj	514	20690	195	78	23	130	727	110	26	11	Orito	Orito	*mata'a* (complete)
B3481jjj	563	21355	224	79	23	139	771	116	28	11	Orito	Orito	*mata'a* (broken stem)
B3481jjjj	550	20737	214	75	26	134	865	115	27	13	Orito	Orito	*mata'a* (broken stem)
B3481jjjjj	530	19631	201	73	23	123	697	110	25	13	Orito	Orito	*mata'a* (broken stem)
B3481k	702	21510	235	76	28	132	768	117	27	9	Orito	Orito	*mata'a* (complete)
B3481k_6	548	20833	187	81	28	126	743	111	25	11	Orito	Orito	*mata'a* (complete)
B3481k_7	383	21507	218	79	24	147	1309	117	20	13	Orito	Orito	*mata'a* (complete)
B3481k_8	660	21003	212	81	26	130	752	116	23	12	Orito	Orito	*mata'a* (complete)
B3481k_9	517	20302	198	75	22	131	710	111	25	8	Orito	Orito	*mata'a* (complete)
B3481kk	629	21247	225	77	26	137	741	114	23	12	Orito	Orito	*mata'a* (complete)
B3481kkk	369	18710	205	70	21	118	696	101	28	11	Orito	Orito	*mata'a* (complete)
B3481kkkk	532	20634	215	77	23	128	754	110	21	9	Orito	Orito	*mata'a* (complete)
B3481kkkkk	618	21511	219	77	28	132	735	115	23	10	Orito	Orito	*mata'a* (complete)
B3481l	508	20544	223	76	25	126	724	116	24	13	Orito	Orito	*mata'a* (complete)
B3481l_6	638	20073	187	71	23	132	1014	110	22	12	Orito	Orito	*mata'a* (complete)
B3481l_7	615	20580	199	76	27	129	914	114	22	12	Orito	Orito	*mata'a* (complete)
B3481l_8	504	20740	219	75	23	136	889	118	25	10	Orito	Orito	*mata'a* (complete)
B3481l_9	498	20796	202	79	24	126	684	109	23	10	Orito	Orito	*mata'a* (complete)
B3481ll	441	20411	191	76	25	135	733	115	26	13	Orito	Orito	*mata'a* (complete)
B3481lll	652	21559	233	78	32	140	985	118	27	11	Orito	Orito	*mata'a* (complete)
B3481llll	584	20361	189	73	23	130	755	116	22	13	Orito	Orito	*mata'a* (complete)

Sample No.	MnKa1	FeKa1	ZnKa1	RbKa1	SrKa1	Y Ka1	ZrKa1	NbKa1	GaKa1	ThLa1	Source (SVM)	Source (DFA)	Description
B3481lllll	514	21520	212	82	26	130	721	119	25	10	Orito	Orito	*mata‘a* (complete)
B3481m	582	21106	211	79	24	130	774	115	25	12	Orito	Orito	*mata‘a* (complete)
B3481m_6	542	20283	237	74	24	137	738	115	26	12	Orito	Orito	*mata‘a* (complete)
B3481m_7	602	21734	213	80	24	137	783	117	28	12	Orito	Orito	*mata‘a* (complete)
B3481m_8	514	21530	229	84	25	137	736	119	27	13	Orito	Orito	*mata‘a* (complete)
B3481m_9	558	21065	191	81	26	138	791	119	27	11	Orito	Orito	*mata‘a* (complete)
B3481mm	563	20285	209	76	24	123	702	105	29	10	Orito	Orito	*mata‘a* (complete)
B3481mmm	584	21238	210	82	25	134	730	119	28	11	Orito	Orito	*mata‘a* (complete)
B3481mmmm	542	21416	206	82	27	133	858	121	24	12	Orito	Orito	*mata‘a* (complete)
B3481mmmmm	559	21758	204	75	38	126	660	105	25	8	Motu Iti	Motu Iti	*mata‘a* (complete)
B3481n	573	20754	215	76	30	128	727	110	24	14	Orito	Orito	*mata‘a* (complete)
B3481n_6	602	21021	211	75	23	122	727	106	26	12	Orito	Orito	*mata‘a* (broken stem)
B3481n_7	703	21410	222	79	27	139	745	116	26	11	Orito	Rano Kau 1	*mata‘a* (complete)
B3481n_8	576	21476	223	76	26	130	771	113	28	14	Orito	Orito	*mata‘a* (complete)
B3481n_9	632	21241	216	74	21	134	841	115	27	9	Orito	Orito	*mata‘a* (complete)
B3481nn	562	22425	203	81	28	144	869	122	25	15	Orito	Orito	*mata‘a* (complete)
B3481nnn	596	20797	185	74	26	127	764	109	24	10	Orito	Orito	*mata‘a* (complete)
B3481nnnn	501	21639	210	79	25	126	733	119	27	12	Orito	Orito	*mata‘a* (complete)
B3481nnnnn	558	22366	202	76	38	129	655	107	27	8	Motu Iti	Motu Iti	*mata‘a* (complete)
B3481o	644	21590	220	79	26	137	749	121	27	11	Orito	Orito	*mata‘a* (complete)
B3481o_6	640	22234	229	87	26	141	727	116	29	9	Orito	Rano Kau 1	*mata‘a* (broken stem)
B3481o_7	550	21487	189	80	22	131	803	115	24	12	Orito	Orito	*mata‘a* (complete)
B3481o_8	607	21386	225	74	26	130	708	113	28	12	Orito	Orito	*mata‘a* (complete)
B3481o_9	548	21469	239	81	26	132	744	112	28	9	Orito	Orito	*mata‘a* (complete)
B3481oo	531	21794	231	82	26	131	729	112	29	12	Orito	Orito	*mata‘a* (complete)
B3481ooo	507	21192	208	81	24	125	729	115	28	12	Orito	Orito	*mata‘a* (complete)
B3481oooo	597	21214	200	77	25	137	784	114	25	11	Orito	Orito	*mata‘a* (complete)
B3481ooooo	392	21059	200	78	24	132	730	119	29	14	Orito	Orito	*mata‘a* (complete)
B3481p	489	21292	209	80	26	135	781	116	24	14	Orito	Orito	*mata‘a* (complete)
B3481p_6	512	21431	223	81	25	136	846	108	20	11	Orito	Orito	*mata‘a* (complete)

B3481p_7	583	20865	193	75	25	123	714	113	24	12	Orito	Orito	*mata'a* (complete)
B3481p_8	562	21715	239	75	25	132	733	120	29	13	Orito	Orito	*mata'a* (complete)
B3481p_9	613	21170	207	81	23	134	843	116	25	13	Orito	Orito	*mata'a* (complete)
B3481pp	590	19284	203	74	19	115	742	97	23	11	Orito	Orito	*mata'a* (complete)
B3481ppp	642	22285	235	81	27	137	733	120	27	12	Orito	Rano Kau 1	*mata'a* (broken stem)
B3481pppp	607	20542	201	79	25	131	817	110	27	11	Orito	Orito	*mata'a* (incomplete)
B3481ppppp	501	21879	218	81	25	139	879	111	21	14	Orito	Orito	*mata'a* (complete)
B3481q	514	21007	196	82	23	136	766	119	24	13	Orito	Orito	*mata'a* (complete)
B3481q_6	595	20335	232	74	25	133	1005	116	25	13	Orito	Orito	*mata'a* (complete)
B3481q_7	568	20288	197	77	24	132	732	112	19	11	Orito	Orito	*mata'a* (complete)
B3481q_8	504	18855	183	73	25	110	684	100	19	6	Orito	Orito	*mata'a* (complete)
B3481q_9	543	19517	202	77	23	120	685	107	26	11	Orito	Orito	*mata'a* (complete)
B3481qq	454	21351	215	81	28	130	742	113	24	10	Orito	Orito	*mata'a* (complete)
B3481qqq	539	21077	203	76	27	133	794	114	27	14	Orito	Orito	*mata'a* (broken stem)
B3481qqqq	502	20628	221	77	26	129	739	114	22	12	Orito	Orito	*mata'a* (complete)
B3481qqqqq	508	21593	222	76	26	129	818	118	26	13	Orito	Orito	*mata'a* (complete)
B3481r	566	21453	206	79	24	131	753	119	29	12	Orito	Orito	*mata'a* (complete)
B3481r_6	696	20164	213	74	27	121	704	107	27	14	Orito	Orito	*mata'a* (complete)
B3481r_7	581	20864	221	75	27	127	726	118	26	12	Orito	Orito	*mata'a* (complete)
B3481r_8	478	18612	197	78	25	134	1397	105	24	11	Orito	Orito	*mata'a* (complete)
B3481r_9	541	20189	201	73	21	128	716	112	23	17	Orito	Orito	*mata'a* (complete)
B3481rr	612	21125	207	76	26	130	739	114	30	9	Orito	Orito	*mata'a* (complete)
B3481rrr	456	20547	183	85	23	127	821	112	26	12	Orito	Orito	*mata'a* (broken stem)
B3481rrrr	569	21701	227	78	25	141	806	116	26	13	Orito	Orito	*mata'a* (complete)
B3481rrrrr	625	19125	173	74	22	121	699	103	23	9	Orito	Orito	*mata'a* (complete)
B3481s	691	21555	224	79	24	134	751	115	25	9	Orito	Orito	*mata'a* (complete)
B3481s_6	394	18945	205	70	23	114	652	104	21	9	Orito	Orito	*mata'a* (complete)
B3481s_7	579	21155	186	84	23	132	697	116	29	9	Orito	Orito	*mata'a* (complete)
B3481s_8	567	20153	200	79	23	129	779	119	24	10	Orito	Orito	*mata'a* (complete)
B3481ss	371	20206	182	77	23	124	773	109	23	9	Orito	Orito	*mata'a* (complete)
B3481sss	540	21892	249	79	23	131	702	110	25	12	Orito	Orito	*mata'a* (complete)
B3481ssss	639	19786	193	71	23	125	808	107	21	11	Orito	Orito	*mata'a* (complete)

Sample No.	MnKa1	FeKa1	ZnKa1	RbKa1	SrKa1	Y Ka1	ZrKa1	NbKa1	GaKa1	ThLa1	Source (SVM)	Source (DFA)	Description
B3481sssss	463	18795	201	68	20	112	625	100	24	8	Orito	Orito	*mata'a* (complete)
B3481t	504	21681	218	80	28	130	728	118	21	13	Orito	Orito	*mata'a* (complete)
B3481t_6	572	21118	217	82	26	135	802	120	26	11	Orito	Orito	*mata'a* (complete)
B3481t_7	621	21356	206	80	23	134	765	114	30	15	Orito	Orito	*mata'a* (complete)
B3481t_8	633	21059	209	77	25	126	788	114	24	15	Orito	Orito	*mata'a* (complete)
B3481tt	602	20785	213	76	23	129	712	111	24	11	Orito	Orito	*mata'a* (complete)
B3481ttt	490	21309	212	78	25	135	1027	117	22	10	Orito	Orito	*mata'a* (complete)
B3481tttt	520	19393	184	75	22	121	703	110	25	12	Orito	Orito	*mata'a* (complete)
B3481ttttt	612	21497	195	80	23	138	809	112	27	10	Orito	Orito	*mata'a* (complete)
B3481u	571	20996	214	80	22	129	807	119	23	13	Orito	Orito	*mata'a* (complete)
B3481u_6	515	20030	201	79	25	126	817	111	26	12	Orito	Orito	*mata'a* (complete)
B3481u_7	472	20966	205	75	22	131	730	111	26	9	Orito	Orito	*mata'a* (complete)
B3481u_8	663	23310	221	85	27	136	855	116	23	13	Orito	Orito	*mata'a* (complete)
B3481uu	621	21024	205	80	23	136	820	118	25	14	Orito	Orito	*mata'a* (complete)
B3481uuu	642	21780	220	84	25	131	742	111	23	9	Orito	Orito	*mata'a* (complete)
B3481uuuu	490	21421	224	81	23	135	762	116	25	9	Orito	Orito	*mata'a* (complete)
B3481uuuuu	523	19790	196	76	24	127	810	113	21	8	Orito	Orito	*mata'a* (complete)
B3481v	613	21187	199	84	28	132	709	121	25	10	Orito	Orito	*mata'a* (complete)
B3481v_6	571	19927	198	71	22	124	684	107	24	10	Orito	Orito	*mata'a* (complete)
B3481v_7	391	19793	188	69	24	123	692	104	24	11	Orito	Orito	*mata'a* (complete)
B3481v_8	495	21246	204	79	26	131	795	114	23	14	Orito	Orito	*mata'a* (complete)
B3481vv	526	20702	203	77	27	138	790	118	23	10	Orito	Orito	*mata'a* (complete)
B3481vvv	585	20723	193	76	29	135	922	113	26	14	Orito	Orito	*mata'a* (complete)
B3481vvvv	568	22992	205	85	22	140	804	117	22	11	Orito	Orito	*mata'a* (complete)
B3481w	666	21083	216	78	22	134	725	115	26	7	Orito	Orito	*mata'a* (complete)
B3481w_6	497	20592	195	77	22	133	784	115	26	14	Orito	Orito	*mata'a* (complete)
B3481w_7	536	21481	201	85	26	132	758	120	23	11	Orito	Orito	*mata'a* (complete)
B3481w_8	581	21076	205	87	24	131	897	116	22	12	Orito	Orito	*mata'a* (complete)
B3481ww	635	21667	243	79	23	142	776	116	27	11	Rano Kau 1	Rano Kau 1	*mata'a* (complete)

B3481www	553	21369	211	80	23	130	733	114	25	13	Orito	Orito	*mata‘a* (broken stem)
B3481wwww	487	20707	230	78	25	131	765	106	26	11	Orito	Orito	*mata‘a* (complete)
B3481wwwww	610	21237	210	78	26	138	779	113	28	11	Orito	Orito	*mata‘a* (complete)
B3481x	530	21533	207	86	27	139	805	112	23	13	Orito	Orito	*mata‘a* (complete)
B3481x_6	486	21357	222	78	25	138	832	114	25	7	Orito	Orito	*mata‘a* (complete)
B3481x_7	585	20311	193	77	21	130	742	114	24	14	Orito	Orito	*mata‘a* (complete)
B3481x_8	610	21625	212	86	28	136	971	120	23	14	Orito	Orito	*mata‘a* (complete)
B3481xx	615	19748	180	75	25	124	718	108	26	7	Orito	Orito	*mata‘a* (complete)
B3481xxx	607	21438	232	78	25	139	753	119	24	12	Orito	Orito	*mata‘a* (complete)
B3481xxxxx	559	20631	208	78	24	129	773	113	26	11	Orito	Orito	*mata‘a* (complete)
B3481y	583	20039	192	72	24	124	698	101	23	11	Orito	Orito	*mata‘a* (complete)
B3481y_6	724	20816	213	81	25	130	743	115	25	14	Orito	Orito	*mata‘a* (complete)
B3481y_7	507	21573	213	88	26	132	729	116	26	11	Orito	Orito	*mata‘a* (complete)
B3481y_8	574	20915	202	74	25	130	759	116	25	13	Orito	Orito	*mata‘a* (complete)
B3481yy	457	20268	205	77	23	131	701	105	20	9	Orito	Orito	*mata‘a* (complete)
B3481yyy	665	21194	213	78	27	128	777	114	26	12	Orito	Orito	*mata‘a* (complete)
B3481yyyy	604	21367	223	77	29	134	727	114	25	13	Orito	Orito	*mata‘a* (complete)
B3481yyyyy	491	21938	190	80	26	134	752	119	27	10	Orito	Orito	*mata‘a* (complete)
B3481z	674	21504	203	85	26	136	851	116	27	12	Orito	Orito	*mata‘a* (complete)
B3481z_6	547	21105	208	78	23	130	786	113	25	12	Orito	Orito	*mata‘a* (complete)
B3481z_7	528	20527	194	79	24	133	705	115	27	7	Orito	Orito	*mata‘a* (complete)
B3481z_8	490	19909	187	79	23	129	790	111	24	11	Orito	Orito	*mata‘a* (complete)
B3481zz	587	21251	198	83	24	139	950	113	25	11	Orito	Orito	*mata‘a* (complete)
B3481zzz	535	21256	203	79	24	126	792	113	27	12	Orito	Orito	*mata‘a* (complete)
B3481zzzz	540	19489	200	78	23	129	766	115	24	10	Orito	Orito	*mata‘a* (complete)
B3481zzzzz	527	19820	185	75	20	133	686	108	20	10	Orito	Orito	*mata‘a* (complete)
B3482a	541	21174	206	75	30	128	744	111	24	11	Orito	Orito	*mata‘a* (incomplete)
B3482b	540	21398	204	79	24	132	726	110	28	10	Orito	Orito	*mata‘a* stem
B3482c	582	21553	249	78	29	133	879	121	25	13	Orito	Orito	*mata‘a* stem
B3482d	687	21644	205	72	35	119	640	112	26	6	Motu Iti	Motu Iti	*mata‘a* (incomplete)
B611	571	21060	222	77	23	134	828	118	26	12	Orito	Orito	*mata‘a* (complete)
C4120	558	18505	161	61	22	103	659	94	19	10	Orito	Orito	*mata‘a* (complete)

Sample No.	MnKa1	FeKa1	ZnKa1	RbKa1	SrKa1	Y Ka1	ZrKa1	NbKa1	GaKa1	ThLa1	Source (SVM)	Source (DFA)	Description
C4121a	531	21479	221	83	25	134	764	116	27	9	Orito	Orito	*mata‘a* (complete)
C4121aa	597	21595	209	81	25	136	770	117	30	10	Orito	Orito	*mata‘a* (complete)
C4121aaa	570	19573	176	70	25	121	703	105	20	10	Orito	Orito	*mata‘a* (complete)
C4121aaaa	460	19886	238	75	23	125	706	112	21	10	Orito	Orito	*mata‘a* (complete)
C4121b	616	20794	214	81	28	134	721	116	22	11	Orito	Orito	*mata‘a* (complete)
C4121bb	548	21722	218	85	26	134	833	117	28	13	Orito	Orito	*mata‘a* (complete)
C4121bbb	664	22067	219	76	25	133	740	121	28	10	Orito	Orito	*mata‘a* (complete)
C4121bbbb	606	21849	208	79	24	141	743	117	26	12	Orito	Orito	*mata‘a* (complete)
C4121c	580	21207	201	80	23	138	776	118	23	10	Orito	Orito	*mata‘a* (complete)
C4121cc	649	21059	222	80	25	133	736	116	26	10	Orito	Orito	*mata‘a* (incomplete)
C4121ccc	449	21072	199	81	24	135	1004	110	28	9	Orito	Orito	*mata‘a* (complete)
C4121d	542	20835	208	78	26	131	736	118	23	12	Orito	Orito	*mata‘a* (complete)
C4121dd	552	20565	241	76	27	126	706	109	26	11	Orito	Orito	*mata‘a* (broken stem)
C4121ddd	428	20736	191	77	24	130	750	113	26	12	Orito	Orito	*mata‘a* (complete)
C4121e	604	21385	216	82	27	139	745	122	26	13	Orito	Orito	*mata‘a* (complete)
C4121ee	586	20966	201	76	24	136	711	113	21	9	Orito	Orito	*mata‘a* (complete)
C4121eee	691	21687	228	86	24	139	747	120	22	13	Orito	Rano Kau 1	*mata‘a* (complete)
C4121f	463	21110	231	77	25	133	791	114	25	13	Orito	Orito	*mata‘a* (complete)
C4121ff	682	22172	194	88	25	135	836	120	26	11	Orito	Orito	*mata‘a* (complete)
C4121fff	530	19762	202	74	25	125	974	111	28	8	Orito	Orito	*mata‘a* (complete)
C4121g	553	20001	208	73	23	129	678	111	21	8	Orito	Orito	*mata‘a* (complete)
C4121gg	548	20908	199	82	25	126	710	115	28	11	Orito	Orito	*mata‘a* (broken stem)
C4121ggg	542	22115	201	79	23	129	776	113	26	10	Orito	Orito	*mata‘a* (complete)
C4121h	444	20157	187	78	25	129	770	115	27	8	Orito	Orito	*mata‘a* (complete)
C4121hh	586	22335	220	80	25	137	998	118	25	12	Orito	Orito	*mata‘a* (complete)
C4121hhh	618	22884	218	86	26	138	741	120	29	13	Orito	Orito	*mata‘a* (incomplete)
C4121i	494	20385	169	77	26	125	789	107	24	13	Orito	Orito	*mata‘a* (complete)
C4121ii	470	19524	202	72	22	123	702	104	24	9	Orito	Orito	*mata‘a* (complete)
C4121iii	528	21294	203	81	25	137	935	120	30	11	Orito	Orito	*mata‘a* (complete)

C4121j	628	21589	202	77	23	142	859	114	30	12	Orito	Orito	*mata'a* (complete)
C4121jj	554	20729	197	79	24	134	783	115	26	9	Orito	Orito	*mata'a* (complete)
C4121jjj	640	20747	222	78	22	127	724	117	24	13	Orito	Orito	*mata'a* (complete)
C4121k	512	20677	234	75	25	134	703	118	24	10	Orito	Orito	*mata'a* (complete)
C4121kk	629	21072	207	81	25	131	757	118	23	7	Orito	Orito	*mata'a* (complete)
C4121kkk	553	21576	199	76	28	131	794	118	24	10	Orito	Orito	*mata'a* (complete)
C4121l	529	21181	213	81	22	129	851	118	26	14	Orito	Orito	*mata'a* (complete)
C4121ll	654	20904	209	79	24	134	699	119	27	11	Orito	Orito	*mata'a* stem
C4121lll	633	23674	225	81	46	125	651	118	27	11	Motu Iti	Motu Iti	*mata'a* (complete)
C4121m	585	20401	214	78	23	133	786	112	27	8	Orito	Orito	*mata'a* (complete)
C4121mm	439	20945	194	79	24	131	781	112	25	12	Orito	Orito	*mata'a* (complete)
C4121mmm	593	21382	190	82	24	135	699	115	25	11	Orito	Orito	*mata'a* (complete)
C4121n	534	20897	211	82	25	133	954	121	26	10	Orito	Orito	*mata'a* (complete)
C4121nn	557	20797	199	77	24	128	856	114	25	11	Orito	Orito	*mata'a* (complete)
C4121nnn	578	22747	219	76	25	144	771	121	25	13	Orito	Orito	*mata'a* (complete)
C4121o	579	21594	205	80	25	141	738	118	25	11	Orito	Orito	*mata'a* (complete)
C4121oo	553	20962	229	76	28	127	737	116	22	8	Orito	Orito	*mata'a* (complete)
C4121ooo	524	21035	204	78	25	135	838	118	23	9	Orito	Orito	*mata'a* (complete)
C4121p	517	21738	214	82	27	135	789	114	28	12	Orito	Orito	*mata'a* (complete)
C4121pp	401	21986	203	80	24	129	845	121	24	12	Orito	Orito	*mata'a* (complete)
C4121ppp	617	20616	200	87	27	129	845	119	24	14	Orito	Orito	*mata'a* (broken stem)
C4121q	445	20122	189	76	25	127	674	112	21	12	Orito	Orito	*mata'a* (complete)
C4121qq	520	20217	202	79	23	129	692	108	23	13	Orito	Orito	*mata'a* (complete)
C4121qqq	564	21239	229	78	23	134	740	114	28	12	Orito	Orito	*mata'a* (complete)
C4121r	538	22986	229	87	25	138	781	119	26	10	Orito	Orito	*mata'a* (complete)
C4121rr	539	21392	222	82	25	143	979	120	25	12	Orito	Orito	*mata'a* (incomplete)
C4121rrr	604	21100	203	75	21	139	789	118	26	9	Orito	Orito	*mata'a* (complete)
C4121s	449	20018	193	76	24	127	710	111	24	11	Orito	Orito	*mata'a* (complete)
C4121ss	491	21258	220	78	25	132	768	111	25	11	Orito	Orito	*mata'a* (complete)
C4121sss	566	21316	223	81	25	134	740	117	26	11	Orito	Orito	*mata'a* (complete)
C4121t	509	20297	219	79	25	134	806	115	25	8	Orito	Orito	*mata'a* (complete)
C4121tt	530	22155	224	84	29	142	802	117	27	10	Orito	Orito	*mata'a* (complete)

Sample No.	MnKa1	FeKa1	ZnKa1	RbKa1	SrKa1	Y Ka1	ZrKa1	NbKa1	GaKa1	ThLa1	Source (SVM)	Source (DFA)	Description
C4121ttt	542	21284	217	81	22	135	839	115	23	10	Orito	Orito	*mata‘a* (complete)
C4121u	638	21192	212	81	26	135	756	117	25	11	Orito	Orito	*mata‘a* (complete)
C4121uu	501	21347	222	77	25	132	714	114	25	10	Orito	Orito	*mata‘a* (complete)
C4121uuu	617	19971	193	76	24	133	804	117	22	10	Orito	Orito	*mata‘a* (complete)
C4121v	509	20596	230	76	23	133	748	109	24	12	Orito	Orito	*mata‘a* (complete)
C4121vv	550	21447	214	78	24	135	705	115	22	9	Orito	Orito	*mata‘a* (complete)
C4121vvv	580	21135	211	80	27	134	756	118	22	10	Orito	Orito	*mata‘a* (complete)
C4121w	523	20526	195	78	24	136	840	120	25	11	Orito	Orito	*mata‘a* (complete)
C4121ww	483	20178	202	77	27	119	701	107	25	10	Orito	Orito	*mata‘a* (complete)
C4121www	593	21596	212	77	28	134	744	117	24	11	Orito	Orito	*mata‘a* (complete)
C4121x	551	20203	184	72	21	127	770	112	25	10	Orito	Orito	*mata‘a* (complete)
C4121xx	556	21069	202	81	25	134	787	111	28	9	Orito	Orito	*mata‘a* (complete)
C4121xxx	529	19228	205	73	22	123	694	104	25	13	Orito	Orito	*mata‘a* (complete)
C4121y	638	21082	205	81	23	144	740	118	23	12	Orito	Orito	*mata‘a* (complete)
C4121yy	638	21737	226	80	24	143	912	120	21	14	Orito	Orito	*mata‘a* (complete)
C4121yyy	516	20919	205	83	24	129	740	118	26	11	Orito	Orito	*mata‘a* (complete)
C4121z	464	20722	199	77	26	130	824	114	27	12	Orito	Orito	*mata‘a* (complete)
C4121zz	582	21111	200	81	27	128	759	118	24	12	Orito	Orito	*mata‘a* (complete)
C4121zzz	663	21704	205	78	24	134	751	116	25	13	Orito	Orito	*mata‘a* (broken stem)
C602	550	20725	211	83	26	129	742	111	21	11	Orito	Orito	*mata‘a* (complete)
C603	580	21082	211	78	22	127	751	109	26	9	Orito	Orito	*mata‘a* (complete)
C8353	541	18501	174	61	31	101	523	86	21	9	Motu Iti	Orito	*mata‘a* (complete)
C8354	643	21101	194	80	24	135	738	120	24	13	Orito	Orito	*mata‘a* (complete)
D2969	575	21737	217	84	27	135	729	121	24	12	Orito	Orito	*mata‘a* (complete)
D2970	533	21286	219	79	30	131	821	114	24	14	Orito	Orito	*mata‘a* (complete)
D2971	492	21038	204	82	24	129	750	116	23	7	Orito	Orito	*mata‘a* (broken stem)

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ABSTRACT

On Rapa Nui (Easter Island), four geological sources of rhyolitic obsidian were utilised to manufacture obsidian artefacts, including tanged implements known as *mata‘a*. In the present study, a total of 332 *mata‘a* from the collections of Bishop Museum were analysed using portable X-ray fluorescence (pXRF). Two analytical methods, Discriminant Function Analysis and Support Vector Machines Classification, were used to assign geographical provenance to these artefacts. These appear to be manufactured using obsidians predominantly from Orito, one of four geological sources on the island. This study demonstrates how non-destructive analyses of museum collections can contribute to our understanding of obsidian procurement and production on Rapa Nui.

Keywords: obsidian, museum collections, geochemical sourcing, portable X-ray flourescence, Rapa Nui, Easter Island

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Mulrooney,[1] Mara A., Andrew McAlister,[2] Christopher M. Stevenson,[3] Alex E. Morrison[2] and Lissa Gendreau,[4] 2014. Sourcing Rapa Nui *mata‘a* from the collections of Bishop Museum using none-destructive pXRF. *Journal of the Polynesian Society* 123(3): 301-338; DOI: http://dx.doi.org/10.15286/jps.123.3.301-338

[1] Corresponding author: Anthropology Department, Bernice P. Bishop Museum, Honolulu, Hawai‘i, U.S.A. email address: mara@bishopmuseum.org

[2] Department of Anthropology, University of Auckland, New Zealand

[3] Anthropology Program, School of World Studies, Virginia Commonwealth University, Richmond, Virginia, U.S.A.

[4] Cultural Collections Department, Bernice P. Bishop Museum, Honolulu, Hawai‘i, U.S.A.

Kirch, Patrick Vinton: *Kuaʻāina Kahiko: Life and Land in Ancient Kahikinui, Maui*. Honolulu: University of Hawaiʻi Press, 2014. 336 pp, illustrations, maps, US$49.00 (hardcover).

ALEX E. MORRISON
University of Auckland

Patrick V. Kirch's latest book, *Kuaʻāina Kahiko: Life and Land in Ancient Kahikinui, Maui*, is an extensive summary of the author's nearly 20 years of archaeological research in the *moku* ʻland division' of Kahikinui, southeastern Maui. Written for the general public, this remarkable book synthesises dozens of scholarly articles, monographs and personal reflections into a thought-provoking, well researched and entertaining treatise. The book includes a variety of engaging visual aids, such as aerial photographs, plan view maps and personal photos spanning a period of over half a century.

Kuaʻāina Kahiko and Kirch's research in Kahikinui in general is significant for a number of reasons. First, the *moku* of Kahikinui, Kaupō, and Kīpahulu have seen less development and urban sprawl than most areas in the Hawaiian Islands and consequently provide an unprecedented archaeological landscape from which to examine a number of questions about the past. Second, due to a lack of historic documents and ethnohistorical information, the life-ways of the inhabitants of ancient Kahikinui are less well known than in other locales in Hawaiʻi. Archaeological studies must therefore play a central role in understanding how people managed to survive for over four centuries in the harsh and limited landscape of southeastern Maui. Finally, *Kuaʻāina Kahiko* provides an important link between Native Hawaiians now reclaiming their ancestral lands in Kahikinui with the people of the past. This final point highlights the significant contribution that archaeology can make to indigenous rights issues and exemplifies how to report archaeological findings to the general public in a meaningful and accessible way.

Kirch has a personal relationship with Kahikinui that goes back to 1966 when, as a teenaged Punahou High School student, he first visited the *ahupuaʻa* (further division of land within *moku*) of Kīpapa with Peter Chapman, William Kikuchi and Elspeth Sterling. Those interested in the history of archaeology in Hawaiʻi will find Chapter 1 informative, as it is filled with personal reflections and historical background to archaeological research in the *moku*. In Chapter 2, Kirch describes his return to Kahikinui in 1995, where he finds a political struggle between the Native Hawaiian group Ka ʻOhana O Kahikinui and the Department of Hawaiian Homelands (DHHL). Ka ʻOhana wishes to re-inhabit the Kahikinui landscape of their ancestors but are being dissuaded by DHHL because of the harshness and remoteness of the area. Recognising the role that archaeology can play in substantiating that Hawaiians once lived successfully in Kahikinui, Kirch situates his presentation of the results of nearly two decades of research within this greater political climate.

The majority of the 17 chapters that make up this book revolve around three primary themes. One theme is defined by the remarkable innovations that ancient Hawaiians living in Kahikinui developed to make a living in the drought-prone lands and impoverished marine environs of southeastern Maui. Chapters 3, 4, and 10 primarily provide background on the difficult and impoverished Kahikinui marine and agricultural environments, while Chapters 8 and 12 describe in detail archaeological evidence for the unique solutions that inhabitants of Kahikinui developed to harness scarce rain water and extensively utilise limited productive soils for the growth of sweet potato.

A second theme discussed in the book is domestic and religious life in ancient Kahikinui. Chapter 5 describes the range of stone structures identified in the Kahikinui survey area and gives a brief introduction to the methods of settlement pattern analysis that orient much of Kirch's research protocol and those of Peter Chapman's original 1966 survey. Chapter 9 moves from regional scale settlement pattern analysis to focus on social organisation and the fundamental archaeological unit of the *kauhale* 'homestead'. Some of the noteworthy results that are presented in this chapter are archaeological indications of the practice of *'ai kapu* or gender-based eating restrictions and the presence of a ritual garden, interpreted as evidence for social distinction in Kahikinui. Two chapters, 13 and 14, are devoted to describing and explaining formal variation in *heiau* 'temple' or 'shrine' structures. In these two chapters Kirch argues, based on the results of a series of Uranium-Thorium (U/Th) dates from coral offerings placed on and within a range of *heiau* forms, that these structures were used contemporaneously. Considering both the pantheon of Hawaiian gods and the orientation of *heiau*, Kirch suggests that formal variation in *heiau* may reflect differential devotion to various deities.

Finally, Chapters 6 and 11 deal with the important questions of Hawaiian demography. In Chapter 6, Kirch provides an answer to when the first people settled Kahinkinui. Based on an extensive database of radiocarbon and U/Th dates, Kahikinui was initially settled around the 15th century. Chapter 6 also provides a nice marriage of oral history based genealogical data and radiometric-based time estimates, a practice which Kirch has developed in greater depth in two other recent books, *How Chiefs Become Kings* (2010) and *A Shark Going Inland is My Chief* (2012) (both University of California Press, Berkeley).

What makes this book particularly noteworthy is the sheer amount of data spanning archaeological surface structures and excavations, oral traditions, historic documents, and a variety of laboratory analyses, which are seamlessly assembled in a coherent and clear narrative about the prehistory and early history of Kahikinui. Achieving this goal is only possible owing to Kirch's skilful writing style and personal reflections which are interspersed throughout the book. Although nearly 300 pages in length, the writing is eloquent, the personal reflections are interesting and relevant, and the flow of the chapters will ensure that the non-archaeologist and archaeologists alike will find the exposition an enjoyable read.

Archaeological practice in Hawai'i has gone through a number of significant changes over the past decade. Perhaps most importantly the discipline has seen a growing number of Native Hawaiian students and graduates entering both academic and cultural resource management positions. One can only assume that this growth is a symbol of the increasing interest that Native Hawaiians have in the information that can be acquired through archaeology as well as movement forward as stewards of the material remains of their ancestors. *Kua'āina Kahiko: Life and Land in Ancient Kahikinui, Maui,* is an example of how archaeological research plays a significant role in this process and can be of service to the greater public good.

Morrison, Hugh, Lachy Paterson, Brett Knowles and Murray Rae: *Mana Māori and Christianity*. Wellington: Huia Publishing, 2012. 327 pp., biblio., glossary, illustrations, index, photos, (softcover).

MICHAEL P. J. REILLY
University of Otago

The work of the spirit is a prominent and valued element in the indigenous cultures of all Pacific peoples. In *Mana Māori and Christianity* the authors describe how the spirit has worked through both churches and individuals in the New Zealand Māori world since the colonial period. Although *mana* Māori is not specifically defined in this book it might be described as the working of a distinctively Māori spiritual life in the beliefs and practices of believers and faith communities. Like other Huia publications the book is a credit to its publishers (and editors) who collectively present a well written text, supplemented by interesting historical photographs, and very helpful aids such as a bibliography and index.

The editors divide the book into two parts. The first comprises six chapters that discuss the degree to which *mana* Māori has been embraced by different churches. What may surprise some is the struggle many Christian denominations have had in embracing *mana* Māori. Wayne Te Kawa shows how the Presbyterians, with honourable exceptions, remained a white, immigrant church until the 20th century when it began to develop a strong engagement with the Māori world. Harold Hill reveals how the Salvation Army, hampered by culturally ignorant leaders, failed to support its limited 19th century Māori mission, and continues to be an institution where Māori more often appear as users of its various social services rather than in the ranks of the Army itself. Similarly, Simon Moetara explains how many of the Pentecostal churches, with the partial exception of the Apostolic churches (ACTS), view any expression of *mana* Māori as an impediment, with the unsurprising result that few Māori participate in these churches and even fewer as leaders. Philip Carew and Geoff Troughton's examination of the Assemblies of God reveals a similar neglect of any specific mission to Māori in favour of a stress on multiculturalism. By contrast, Robert Joseph highlights how from the earliest beginnings in 1881 Mormon missionaries learned Māori language (*te reo*) and lived in their communities, establishing deep roots that were further assisted by cultural affinities shared by Mormons and Māori, such as the value both placed on the significance of prophecy. Peter Lineham examines the new Destiny Church, including its affiliations to Black

Pentecostalism, its expression of a fundamentalist and exclusive world view, and most interestingly, its location within the Māori prophetic tradition, especially its similarities with the Rātana Church.

Perhaps not surprisingly in a book with strong Dunedin connections, the Presbyterian Church looms large in the second half of this book. Hugh Morrison interprets representations of Māori in the juvenile Presbyterian magazine, *Break of Day*, suggesting that beneath the dominant messages of Eurocentrism and racial superiority there was, to some degree, a more morally ambivalent reading of colonialism's consequences. Lachy Paterson charts the development of Pākehā female missionaries as inter-war leaders in the Presbyterian Māori mission, a role that disappeared with the evolution of a Māori arm of the church, Te Hinota Māori, in the 1950s. Complementing this general study is Hone Te Rire's intimate oral history of one Pākehā mission worker, Sister Annie Henry/Te Hihita, drawing from the memories of the Tūhoe children who knew her. The pleasurable intimacy of this essay is enhanced by Te Rire's descent from one of the boys Te Hihita adopted as a *whāngai*. Murray Rae explores Rua Kēnana's theology, revealing its affiliations to the religion developed by Black slaves in the United States and, more recently, to liberation theology; all articulate a belief that God serves not the masters but those they oppress. Keith Newman discusses the prophetic life of Rātana and the incomplete legacy of his relationship with the Labour Party. Bookending these essays are two that look at less known elements of two major churches that otherwise do not appear in this collection. Nathan Matthews surveys those *kaikatikīhame*, 'catechists', who sustained a distinctive Māori Catholic spiritual life, even as they were abandoned by an increasingly Irish church, marked by paternalistic attitudes, and unwilling to understand the world view of their Māori co-religionists. Bernard Kernot interprets the carved art work by the Anglican priest, Hapai Winiata, and discusses his theological prioritising of Christianity over culture, in marked contrast to the views of colleagues such as Māori Marsden.

Christianity began in New Zealand exactly 200 years ago when Samual Marsden preached on Christmas Day 1814. This collection reveals how far the different Christian churches have come in their acceptance and creative engagement with *mana* Māori, and how much further they need to go. Perhaps more attention could have been devoted to certain major Christian churches, but even so, this collection makes an important contribution to historical and contemporary studies of Māori Christianity. The diverse approaches and interests of the authors is a strength. I enjoyed the objective academic studies of some, as well as the more subjective and intimate writings by others. *Mana* Māori afterall affects the whole person. The book has much to say both to those who believe and are open to the working of *mana* Māori in their practice of Christianity, as well as to those who wish to understand the long history of Christianity within the Māori world.

PUBLICATIONS RECEIVED*

March 2014 to September 2014

Besnier, Niko and Kalissa Alexeyeff (eds): *Gender on the Edge: Transgender, Gay, and Other Pacific Islanders*. Honolulu: University of Hawaiʻi Press, 2014. 378 pp., biblio., illustrations, index. US$35.00 (softcover).

Goodyear-Kaʻōpua, Noelani, Ikaika Hussey and Erin Kahunawaikaala Wright (eds): *A Nation Rising: Hawaiian Movements for Life, Land, and Sovereignty*. Durham, North Carolina: Duke University Press, 2014. 416 pp., biblio., indices, photographs. US$27.95 (softcover).

Hviding, Edvard and Cato Berg (eds): *The Ethnographic Experiment: A.M. Hocart and W.H.R. Rivers in Island Melanesia, 1908*. New York: Berghahn Books, 2014. 320 pp., appendices, biblio., illustrations, index. US$95.00 (hardcover).

O'Malley, Vincent: *Beyond the Imperial Frontier: The Conquest for Colonial New Zealand*. Wellington: Bridget Williams Books, 2014. 280 pp., biblio., illustrations, index, notes. NZ$49.99 (softcover).

Schütz, Albert J.: *Fijian Reference Grammar*. Honolulu: Pacific Voices Press, 2014. 453 pp., biblio., illustrations, index. N.p. (softcover).

Shore, Cris and Susanna Trnka (eds): *Up Close and Personal: On Peripheral Perspectives and the Production of Anthropological Knowledge*. New York: Berghahn Books, 2013. 284 pp., biblio., illustrations, index. US$95.00 (hardcover).

Sorrenson, M. P. K.: *Ko Te Whenua Te Utu Land is the Price: Essays on Maori History, Land and Politics*. Auckland: Auckland University Press, 2014. 338 pp., index, notes. NZ$49.99 (softcover).

* The inclusion of a publication in this list neither assumes nor precludes its subsequent review.

MINUTES OF THE 123nd ANNUAL GENERAL MEETING OF THE POLYNESIAN SOCIETY (INC.), 23 JULY 2014, DEPARTMENT OF MĀORI STUDIES, UNIVERSITY OF AUCKLAND.

Present: Dr Richard Benton in the chair and 14 members.

Apologies: Ethan Cochrane, Hamish Macdonald.
Benton/Carter: "That the apologies be sustained." Agreed.

Minutes of 2013 AGM: Carter/Allen: "That the Minutes be received as a true account of the meeting." Carried.

Presentation and Adoption of the Council's Report

The Hon. President presented and spoke to the Council's Annual Report.

- The membership has increased slightly which could be attributed to the online availability of the *Journal* and the online payments system. The Society relies heavily on the Institutional Subscriptions, and the slight increase there, especially given online provision, is particularly welcome. Substantial payments from some online providers keeps income maintained. Annual dues and subscriptions cover production and postage of the *JPS* and the Society's running expenses. Although members' dues and subscription payments do not cover other expenses, income from other sources (e.g., royalties on publications) cover these.
- The Society's website and Facebook page are maintained by designated Council members who post *Journal* contents and information regarding membership, submission of manuscripts, etc. Contents and information regarding membership are also sent to several appropriate newsletters and websites. Having the *Journal* online also provides publicity.
- In September the Society co-sponsored an event at Te Papa at which three distinguished New Zealand archaeologists—Janet Davidson, Atholl Anderson and Geoffrey Irwin, all recipients of the Best Medal—spoke. President Richard Benton represented the Society at that function which was initiated and organised by Sean Mallon.
- Council members attending relevant conferences in New Zealand and overseas, set up displays of the Society's publications and flyers about the Society.
- The Society and its members benefit from the support of the University of Auckland which allows the Society to keep costs down. Specifically, the Department of Māori Studies provides the Society with its office and storage space, as well as access to office equipment; likewise, the Anthropology Department provides for the Hon. Editors and the *JPS*. These arrangements are not only economical but also very convenient and congenial.

Annual Accounts have been completed for 2013 and were presented for information by the Treasurer Rangimarie Rawiri.

The Reviewers' report was attached to the Annual Accounts and the Treasurer noted:

- This year we had Subscriptions Recovered of $846 and therefore no write-off required, as noted for 2012.
- Copyright and royalties have decreased markedly for the 2014 year and the Council is pursuing unpaid amounts which may have not been accounted for.
- The Accounts are prepared on cash and accrual bases, i.e., people who have not paid need to be accounted for in the financial accounts.
- The Income derived from royalties and copyright fees has enabled us to maintain the membership fees at the current level.
- The Council will continue to monitor the effect of online access to the *JPS* on subscription income and the extent to which payments from online providers compensates for any income decline.

Rawiri/Carter: "That the 2013 Accounts be accepted." Carried.

Honoraria

Benton/Reilly: "That the honoraria for the year 2014 be at the same rate as 2013, and that they be paid." Carried.

Presentation and Adoption of the Editors' Report

The Hon. Editors' report was presented and the following matters were highlighted.

- Over the past year there has been one change in the editorial team: Ethan Cochrane has joined Lyn Carter as Book Review Editor. Melinda Allen and Judith Huntsman continue as co-editors, each taking responsibility for two issues a year, and Dorothy Brown is carrying on as assistant editor. Production arrangements with Hamish Macdonald continue to be extremely satisfactorily. Hamish has not only continued to prepare each issue for the printer and advise on printing arrangements but also to advise and initiate in matters digital. The generous and generally anonymous referees who pass judgments and provide comments are crucial partners in maintaining the quality of our venerable publication. On behalf of the Officers and Council, we thank them.
- Journal Production Schedules: Actual publication dates continue to fall behind stated publication dates, and there is little the editors can do about it. The *JPS*, like many scholarly journals, is experiencing a paucity of publishable submissions and the reasons for this are beyond our control. Members can however expect that journal issues will appear eventually, if not exactly in their designated quarterly month.
- Other Publications: One manuscript submitted as a possible Memoir was not accepted for publication. Some of its contents may be submitted for publication

in the *Journal*. The Editors are not soliciting or encouraging new Memoir submissions, simply because we do not have the capacity to edit them ourselves.

Huntsman/Benton: "That the Hon. Editors' Report be accepted." Carried.

Election of Officers

Having been duly nominated and seconded, the following were elected to hold office until the year 2015 AGM:

President: Richard Benton
Hon. Secretary: Rangimarie Rawiri
Hon. Treasurer: Rangimarie Rawiri
Hon. Co-Editors: Judith Huntsman and Melinda Allen

Election of Council Members

The following, whose nominations were duly nominated and seconded, were elected as Members of the Council for two years: Michael Goldsmith, Sean Mallon, Peter Sheppard and Ben Davies. Marama Muru-Lanning having been duly nominated and seconded was elected as a Member of the Council for one year following the resignation of Council Member Matthew Campbell.
The President thanked Dr Campbell for his service to the Society.

Election of Reviewers:

Rawiri/Allen: "That Tane & Assocs., Chartered Accountants be the elected Reviewers." Carried.

General Business

No items of General Business.

The President Dr Richard Benton thanked the Council and members for their support during the year.

There being no more business, the President thanked members for their attendance and declared the 2014 AGM Meeting closed at 6:00pm

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PUBLICATIONS OF THE POLYNESIAN SOCIETY

The publications listed below are available to members of the Polynesian Society (at a 20 percent discount, plus postage and packing), and to non-members (at the prices listed, plus postage and packing) from the Society's office: Department of Māori Studies, University of Auckland, Private Bag 92012, Auckland. All prices are in NZ$.

Some Memoirs are also available from: The University Press of Hawai'i, 2840 Kolowalu Street, Honolulu, Hawai'i 96822, U.S.A., who handle North American and other overseas sales to non-members. The prices given here do not apply to such sales.

MĀORI TEXTS

1. NGATA, A.T. and Pei TE HURINUI, *Ngā Mōteatea* (Part 1). New Edition of 1958 edition, 2004. xxxviii + 464 pp., two audio CDs, genealogies. 2004. Price $69.99 (hardback).
2. NGATA, A.T. and Pei TE HURINUI, *Ngā Mōteatea* (Part 2). New Edition of 1961 edition. xxxviii + 425 pp., two audio CDs, genealogies. 2005. Price $69.99 (hardback).
3. NGATA, A.T. and Pei TE HURINUI, *Ngā Mōteatea* (Part 3). New Edition of 1970 edition. xlii + 660 pp., audio CD, genealogies. 2006. Price $69.99 (hardback).
4. NGATA, A.T. and Hirini Moko MEAD, *Ngā Mōteatea* (Part 4). New Edition of 1991 edition with English translation. xviii + 380 pp., two audio CDs, genealogies. 2007. Price $69.99 (hardback).

MEMOIR SERIES

14. OLDMAN, W.O., *The Oldman Collection of Maori Artifacts*. New Edition with introductory essay by Roger Neich and Janet Davidson, and finder list. 192pp., including 104 plates. 2004. Price $30.
15. OLDMAN, W.O., *The Oldman Collection of Polynesian Artifacts*. New Edition with introductory essay by Roger Neich and Janet Davidson, and finder list. 268pp., including 138 plates. 2004. Price $35.
37. DE BRES, Pieter H., *Religion in Atene: Religious Associations and the Urban Maori*. 95pp. 1971. Price $4.10.
38. MEAD, S.M., Lawrence BIRKS, Helen BIRKS, and Elizabeth SHAW, *The Lapita Pottery Style of Fiji and Its Associations*. 98pp. 1975. Price $7.00.
39. FINNEY, Ben R. (comp.), *Pacific Navigation and Voyaging*. 148pp. 1975. Price $8.00.

41. McLEAN, Mervyn,. *An Annotated Bibliography of Oceanic Music and Dance*. 252pp. 1977, with 74pp. 1981 Supplement. Price $12.30.

43. BLUST, Robert, *The Proto-Oceanic Palatals*. 183+x pp. 1978. Price $12.00.

45. HOOPER, Antony and Judith HUNTSMAN (eds), *Transformations of Polynesian Culture*. 226+viii pp. 1985. Price $35.00.

47. SIIKALA, Jukka. *'Akatokamanāva. Myth, History and Society in the South Cook Islands*. 153+xi pp. 1991. Price $29.95.

49. SORRENSON, M. P. K., *Manifest Duty: The Polynesian Society Over 100 Years*. 160pp. 1992. Price $32.50.

50. BROWN, DOROTHY (comp.), *Centennial Index 1892-1991*. 279pp. 1993. Price $30.00.

51. TE ARIKI TARA 'ARE, *History and Traditions of Rarotonga.* Translated by S.Percy Smith. Edited by Richard Walter and Rangi Moeka'a. 216pp., genealogies and song texts. 2000. Price $70.00.

52. REILLY, Michael P.J., *War and Succession in Mangaia—from Mamae's Texts.* 112pp., geneaologies and maps. 2003. Price $16.00.

53. BIGGS, Bruce Grandison, *Kimihia te Mea Ngaro: Seek That Which is Lost.* 80pp. figs. 2006. Price $30.00.

54. REILLY, Michael P.J., *Ancestral Voices from Mangaia: A History of the Ancient Gods and Chiefs*. xiv + 330 pp., maps, drawings, genealogies, index. 2009. Price $40.00.

55. TE HURINUI, Pei, *King Pōtatau: An Account of the Life of Pōtatau Te Wherowhero the First Māori King*. 303 + xiv pp., figs, genealogies, indexes, maps. 2010. (Available to members of the Society only at $40.00.)

56. McRAE, Jane, *Ngā Mōteatea: An Introduction / He Kupu Arataki*. Māori translation by Hēni Jacobs. 158 pp., biblio., figs, notes, song texts. 2011. (Available to members of the Society only at $28.00.)

MISCELLANEOUS PUBLICATIONS

TOKELAU DICTIONARY. lii + 503 pp. Price: $35.00.

INCEST PROHIBITIONS IN MICRONESIA AND POLYNESIA: Special Issue, June 1976. 155pp. Price $12.00.

FUTURE DIRECTIONS IN THE STUDY OF THE ARTS OF OCEANIA: from *Special Issue*, June 1981. 70pp. Price $4.00.

BIOLOGICAL ANTHROPOLOGY IN THE PACIFIC: Special Issue, March 1994. 108pp. Price $12.50.

KIE HINGOA *'NAMED MATS'*, 'IE TŌGA *'FINE MATS' AND OTHER TREASURED TEXTILES OF SAMOA & TONGA: Special Issue*, June 1999. 120pp. Price $15.00.

ESSAYS ON HEAD-HUNTING IN THE WESTERN SOLOMON ISLANDS: Special Issue, March 2000. 144pp. Price $15.00.

POSTCOLONIAL DILEMMAS: REAPPRAISING JUSTICE AND IDENTITY IN NEW ZEALAND AND AUSTRALIA: Special Issue, September 2003. 124 pp. Price $15.00.

POLYNESIAN ART: HISTORIES AND MEANINGS IN CULTURAL CONTEXT: Special Issue, June 2007. 192 pp. Price $30.00.

COLONIAL GRIEVANCES, JUSTICE AND RECONCILIATION: Special Issue, June 2012. 116 pp. Price $15.00.

TABUA *AND* TAPUA: *WHALE TEETH IN FIJI AND TONGA. Special Issue*, June 2013. 127 pp. Price $15.00.

EXTRAORDINARY POLYNESIAN WOMEN: WRITING THEIR STORIES. Special Issue, June 2014. 230 pp. Price $15.00.

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BACK ISSUES OF THE JOURNAL AVAILABLE

THE SOCIETY holds copies of most issues from Volume 76 (1967) onwards. Some copies of issues from earlier volumes are available, or become available from time to time. Orders and inquiries should be directed to the Assistant Secretary, Polynesian Society, Department of Māori Studies, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

Prices per issue are as follows (exclusive of the *Special Issues* above):
Vol. 119 (2010) and earlier: $2.00 plus postage and packing
Vol. 120 (2011) onwards: $15.00 plus postage and packing

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