

**Contemporary Uses of *Limu* (marine algae) in the Vava'u Island Group,
Kingdom of Tonga: an Ethnobotanical Study**

by

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ABSTRACT

Seaweeds (*limu*) have a long tradition of human use in Tonga. Poorer families who reside near tidal areas rely almost exclusively on ocean resources for their family's nutritional needs and eat *limu* as part of their regular diet. However, most Tongans consume *limu* as a specialty item in their diet, with the exception of times of stress that follow major hurricanes and droughts. One specific type of *limu*, *tanga'u* (*Cladosiphon sp.*), is now being commercially harvested in Tonga and sent to Japan. There are no rules or laws establishing a gathering season nor restricting the amount of *limu* that can be harvested. Conservation is practiced primarily on an incidental level in Tonga, meaning that conservation takes place mostly because of other issues. Up until now, *limu* has been a sustainable resource. However, with the lack of formal conservation methods, limited research, and recently introduced industrial farming techniques the future of *limu* as a sustainable resource is questionable.

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To Joe,
my husband and partner

Without whom, I would not be who I am today –
nor would any of this have been possible.

Chapter 1 Introduction

This research focuses on the use and cultural roles of marine algae, called *limu*, by the indigenous people of Tonga. Previous work in Tonga (Ostraff et al., 2000; Ostraff and Ostraff, 1997; 1999) indicated that *limu* harvesting was an important women's activity, and *limu* was an important component of the traditional food system of Tongans.

However, very little research or documentation has been accomplished regarding this important aspect of this traditional Tongan food system, nor the knowledge women hold regarding collection and use of *limu* species and the tidal flat environments in which they are found. In this introductory chapter, I first provide a discussion of the historical uses of macroscopic marine algae, or seaweed, by humans. Then I present my research objectives. Finally, I outline the framework of the dissertation.

1.1 Historical Uses of Seaweed

Seaweeds have been used throughout coastal regions of the world for food, fodder, medicine and other uses for thousands of years, especially in Asia (Abbott, 1988; Chapman and Chapman, 1980; Turner, 2003). Indigenous coastal societies from Siberia to Tasmania have gathered and eaten seaweed (Guiry, 2003). Not only in Hawaii, but also in Japan, algae have been considered a delicacy fine enough to serve as an offering to the Gods (Madlener, 1977). In fact seaweed was so popular in early Hawaii that a

specific type of cultivation was practiced. The Hawaiian *ali'i*, or chiefs, created special marine gardens in which they transplanted their favorite types of algae (Shoenfeld-Leber, 1979).

The earliest recorded reference to seaweed occurs in a Chinese encyclopedia dated 3000 BC. The ancient Greeks (according to Pythagoras), the Aztecs and the Vikings all recorded eating seaweed (Surey-Gent, 1987). Vikings used seaweed not only for food for beasts and humans, but as fuel, mulch and cushion stuffing in chairs. Some other early uses of seaweed were for the soap and iodine industries, and in glass making for which the seaweed was burned. Burned seaweed was also used to procure salt (Kurlansky, 2002; Surey-Gent, 1987).

Seaweeds are among the most nutritious plants on earth (Guiry, 2003). Nutrients in seawater are constantly being restored, and the plants have the ability to absorb and concentrate elements present in the water (Madlener, 1977). Benthic marine algae as a whole are very safe to consume. Only one genus of macroscopic alga, *Desmarestia*, is considered to be harmful (Turner and Szczawinski, 1991).

Seaweed is a valuable source of food, containing the full spectrum of required nutrients: proteins, fats, carbohydrates, vitamins and minerals. All marine algae are rich in vitamins A and E, even more than that found in cod liver oil (Madlener, 1977).

Concentrations vary with the season, usually being highest during the spring and summer.

The protein found in seaweed is a complete protein in that it contains all the eight essential amino acids, but has virtually no calories (Webb, 1997). Dulse (*Palmaria*

palmata (L.) O. Kuntze), for example, contains high amounts of protein 20-25%, compared to beef's 25%, canned salmon's 20% and soybean's 30%. Protein in algae can account for as much as 25% of the total dry weight although these percentages depend on the species, time of year and age of the specimens. Green algae are high in B vitamins and folic acid, found in quantities similar to fruits and vegetables. Some green algae have even higher amounts of B12 than animal liver (Morgan et al., 1980; Webb, 1997).

Chapman (1950) records that coastal peoples have long used algae for medicinal purposes. Irish used "scrofula" (*Laminaria* and *Fucus*) for irritations of the alimentary canal and for cases of diarrhea and dysentery. Seaweeds were used the world over for the prevention of goiter, and evidence exists to suggest that algae was regularly traded into the interiors of such diverse places as India, South America, British Columbia and the Himalayas (Chapman, 1950; Aaronson, 1986; Turner, 1995; 2003). Chapman notes that *Sargassum* was used in India in cases of bladder disorder, and the British naturalist Turner (1950) recorded that in the 18th century, "dulse" (*Palmaria palmata*) was used in Kkye as a means of inducing sweating during a fever. The seaweed was boiled in water, a little butter was added and it was ingested.

Japanese believe "hijiki" (*Sargassum* sp.) in your diet will normalize blood sugar levels, improve skin complexion and produce pliant skin that is free of wrinkles. It also promotes glossy hair. The Japanese also believe that natural antibiotics found in seaweeds will clear up minor infections and promote a feeling of well being (Surey-Gent, 1987). In Hawaii the red seaweed *Hypnea nidifica* was used for stomach troubles (Abbott, 1992). The Native Americans of Sitka Alaska (probably Tlingit) reportedly took

the stipe of the bull kelp (*Nereocystis luetkeana*) and placed the thin end in an ear. The bulb was then placed on a hot stone so that generated steam would pass up the hollow stipe into the ear. This would reportedly relieve headaches (Chapman, 1950). Another traditional use of seaweed was recorded in Maori lore from New Zealand. They used “rimuroa” (*Durvillaea antarctica*) to treat worms and skin diseases. Bull kelp (*Nereocystis luetkeana*) was hung outside to serve as a barometer or rain gauge. When the kelp was dry, the weather was nice, when it swelled, rain was coming (Williams, 1996). Seaweed has been used as: “...vermifuges, anesthetics, antipyretics (fever relief), cough remedies, wound healing compounds, thirst quenching remedies; treatments for gout, gallstones, goiter, hypertension, diarrhea, constipation, dysentery, burns, ulcers, skin diseases, lung disease, and semen discharge” (Stein and Borden, 1984: 493).

Seaweed can also be applied to the outside of the body. Brown and red algae can be used for burns and cuts. The algin that brown algae contains is extracted to make burn bandages for use in hospitals. Many types of seaweed also contain compounds that are antibacterial (Novaczek, 2001; Turner, 2003).

Since seawater contains an almost identical proportion of mineral content as human blood, and marine algae gains its nutrients directly from the water (Guiry, 2003), the historical nutritional value of seaweed as a resource for food and medicine is unquestioned. Seaweed contains micronutrients such as boron, iron, manganese, potassium and calcium. Boron is essential for proper brain function. Iodine found in seaweed prevents thyroid conditions and calcium aids in building strong bones and teeth (Novaczek, 2001). As noted previously, many vitamins are also found in seaweed. While the amount can vary from season to season and from plant to plant, most types of

seaweed are a good source of B vitamins and folic acid. Vitamins A, C and E are also present in all seaweed (Novaczek, 2001).

Today, millions of tons of seaweed are harvested and processed annually worldwide (7 million tons in 1993), of which about 65% is food-grade (Guiry, 2003). Japan, Korea and China are the biggest producers, with the Pacific Islands, Europe and North America coming in far behind the Asian countries (Trono, 1986). When “seaweed” is entered into an internet search engine, hundreds of websites promoting the benefits of seaweed come up. Presently there is a booming industry using seaweed additives for everything from cosmetics to body creams and lotions to soap and even dietary supplements. 188 such items with names such as: Seaweed Blemish and Cleanser, Wild Seaweed Detoxification Capsules, Aqili Seaweed Soap, Bliss Seaweed Task Mask, Seaweed Defat Soap – for losing weight, Seaweed Liposome Gel, Slimming Seaweed Soap Kit, Revlon Seaweed Mud Paraffin Face Mask, Anti Aging Seaweed Soap and Seaweed Aromatic Bath Gel came up on the *ebay* site when I did a web-search for seaweed on August 18, 2003.

Historically, across the globe, the collecting and harvesting of marine algae has often taken place by the poorer disadvantaged sector in communities, and most commonly by women (Guiry, 2003; Briand, 1991, FAOSTAT, 2003). However, as traditional harvesting practices give way to modernized, mechanized and commercialized seaweed production, men enter the picture as the leading harvesters (Briand, 1991). Nevertheless, non-mechanized harvesting of seaweed continues worldwide, especially among the poorer sectors of society (BBC, 2002). Globally within this more traditional activity, females outnumber men 70:30 in the harvesting of seaweed (Nayak, 2000). Tongans are

no exception; members of the poorer sector of the population rely on *limu* as part of their dietary needs, and women are the prime collectors.

There are no ancient records and few references from the first European visitors to Tonga regarding the use of *limu*. The first written sources regarding Tonga come from European explorers looking for new sailing routes and new continents. There are some problems associated with these accounts that may have influenced their lack of documentation regarding *limu* and women's marine gathering. First of all, they barely spoke the language, they relied heavily on translators from other islands, who also did not speak Tongan (Beaglehole, 1967). Thus they were unable to converse with any depth. Although they did record valuable information from their observations and in some cases produced detailed drawings, most, although not all, of their in-depth interactions took place with high-ranking nobility. As a result, the explorer's observations were, in general, based upon what the elite upper-class people were doing not the lower ranking individuals who were the most likely to have collected *limu* (Beaglehole, 1967). There is some evidence, through illustrations and descriptions, that early explorers noticed women gathering from the tidal flats (two drawings of women gathering mussels by Juan Ravenet, who came to Tonga with Alejandro Malaspina, a Spanish explorer, in 1793, shown in Malm's *Shell Age Economics*, 1999, pages 52 and 154). While no direct mention was made about the actual gleaning of tidal flats, William Anderson, Cook's surgeon on the *Resolution*, describes the reef and inner tidal area in some detail, mentioning several types of shell fish that were highly esteemed in Europe (Beaglehole, 1967). However, this is the extent of knowledge we have from them concerning gleaning from tidal areas. No edible seaweeds were collected from any of Cooks voyages, nor any

mention of eating or collecting *limu* by either themselves or native islanders (Pond, W. 1983. Schouten and Le Maire at Tafahi, 1616. *Faifava*, 9: 22-30; Sharp, A. 1968. *The Voyages of Abel Janszoon Tasman*, Oxford University Press, London; Beaglehole, J.C. 1961,1962,1967. (editor) *The Journals of Captain James Cook on his Voyages of Discovery*: I, II, III. Cambridge University Press, for the Hakluyt Society, Cambridge; Forster, G. 1777. *A Voyage round the World, in His Britannic Majesty's Sloop, Resolution, Commanded by Captain James Cook, during the Years 1772, 3 4 and 5*. 2 vols. White, Robson, Elmsly & Robinson, London; Ebes, H. (compiled by) 1988. *The Florilegium: Cook, Banks – Parkinson, 1768-1771*. Ebes Douwma, *Sotheby's Australia*, Editions Alecto Limited and British Museum, Natural History; Forester, J.R. 1996 (1778). *Observations Made during a Voyage round the World*. Thomas, N., Guest, H., and Dettelbach, M. editors. University of Hawaii Press, Honolulu; Kaepler, A.L. 1978. *Artificial Curiosities: Being an exposition of Native Manufactures Collected on the Three Pacific Voyages of Captain James Cook, R.N.* Bishop Museum Press, Special Publication No. 65, Honolulu).

One of the best sources of information regarding Tonga in the 1800s comes from William Mariner, a young clerk, who was the only survivor from the crew from the *Port au Prince*, an English ship of war (Martin, J. 1991 (1817). *Tongan Islands: William Mariner's Account*, 5th edition. Vava'u Press Limited, Tonga). The rest of the crew was massacred in the Ha'apai islands in 1806. Mariner spent the next four years living in Tonga as the adopted son of the warrior king Finau 'Ulukalala. While Mariner offers much in the way of daily life, religious practices and warfare, the only time he mentions women gathering shell fish is in the context of war. "Finow had, for a long time past,

entertained the idea of seizing upon several of the enemy's women, who were in the habit of assembling at a certain part of the inlet, to gather shellfish" (pg. 138). From Mariner's description, or lack of one, it seems as if this was a common scene, not one to be noted upon. However, this is the only mention in his entire account of women's gleaning activities.

Accounts from early Christian missionaries (Rutherford, N. 1996. *Shirley Baker and the King of Tonga*. Pasifika Press, Wellington, New Zealand) in the latter 1800s sheds light on the uniting of Tonga and the establishment of modern government. Other accounts from this time frame come from Elizabeth Bott, who interviewed the late Queen Salote in the early 1900s about ancient life in Tonga (Bott, E. 1982. *Tongan Society at the Time of Captain Cook's Visits: Discussions with Her Majesty Queen Salote Tupou*. The Polynesian Society Inc. Wellington, NZ). The aim of the paper is to describe the social and political organization of Tonga at the time of Captain Cook. Queen Salote helps clarify the roles, responsibilities and obligations of mostly chiefly or high ranking women. She illuminates customs, rituals, and ceremonies as well as everyday practices and regimes. Along with Bott there are several other writers who address this same time frame. Edward Gifford, the pioneer of Tongan anthropology, first arrived in Tonga in 1920 with the Bayard Dominick Expedition. He stayed in Tonga for nine months interviewing knowledgeable individuals about the past. His work published in 1929, *Tongan Society*, Bernice P. Bishop Museum, Bulletin 61, is important for a general understanding of Tongan society in the past. Despite his extensive documentation of early Tongan life, he does very little to document women's fishing and gleaning activities, only briefly mentioning shell fish gathering with no accompanying descriptions

or explanations. The husband and wife team of Ernest and Pearl Beaglehole document life in an ordinary Tongan village during the 1940s (Beaglehole, E. and Beaglehole, P. 1941. *Pangai: Village in Tonga*. Memoirs of the Polynesian Society Vol. 18). Their work is unique in that it documents ordinary village life, rather than focusing on upper-class society. However, once again, even though they focus on common villagers, they mention very little about women's fishing and gleaning activities.

Contemporary ethnographic records, too, are generally void of information regarding *limu* usage. Only two masters or doctoral theses out of 120 written about Tonga from all over the world deal with any sort of fishing practices, and none cover *limu* or other inshore marine exploitation (Malm, 1999). While much of the ancient and contemporary knowledge of *limu* may not have been recorded, Tongan women today still serve as a repository for traditional and contemporary knowledge of marine algae and its environment. Much of the information for this research comes directly from them.

1.2 Literature Review

As I began my research, I assumed that the knowledge of *limu* harvesting was a well-documented subject throughout the Pacific. However, my first forays into the seaweed literature of the South Pacific resulted in only a few articles and books on the general subject. I found nothing on the subject of *limu* in Tonga. The closest region covered in depth was Asia (in particular Japan and the Philippines). There is a real paucity in the

literature regarding *limu* usage (ancient or contemporary) throughout the Pacific and in particular Tonga. Information that does exist regarding *limu* practices in the Pacific focuses primarily on Hawaii (Abbott, 1974; 1988; 1991 and 1992) and Fiji (South, 1993 and 1995), with only brief mentions of uses elsewhere in the South Pacific (Miller, 1971 (1927); Lamour, 1995; Taniera and Mitchell, 1995; Novaczek, 2001). Recognizing the scarcity of documentation on *limu* and its uses in the South Pacific, I decided to expand my search to other areas.

My survey of the literature revealed some important patterns. All sources that did mention *limu* reported that *limu* gathering is associated with women and their fishing practices such as shellfish collecting or tidal gleaning. Because of this I broadened my search to include “women’s fishing” and shellfish collecting in particular (see Whippy-Morris, 1995, for a listing of recent literature on marine gathering and women’s fishing in the South Pacific). This broader category enabled me to accrue an abundance of information related to, but not always directly connected with, *limu* use.

This literature review is divided into five sections. *Section I* covers the relevant archaeological literature. The goal is to assess subsistence patterns of the first inhabitants of Tonga, primarily relating to women’s fishing practices. *Section II* focuses on Tonga in the early contact period (1700s – 1800s). Drawing on early explorers’ journals, botanical records and botanical and cultural art I show that very little documentation of women’s fishing and gleaning practices took place, and I found no descriptions or evidence of *limu* practices. *Section III* covers pertinent anthropological and sociological

data gathered from ethnographic literature particularly from the early 1900s. *Section IV* refers to the botanical and ethnobotanical literature of Tonga and the South Pacific region. Finally, *Section V* addresses contemporary literature on the status of women's fishing practices, including *limu* knowledge, in Tonga as well as other South Pacific islands.

Section I – Archaeological Records

There is a major body of archaeological literature (Burley, 1994, 1996, 1999, 2000; Dalzell, 1998; Dye, 1988, 1990; Dye and Steadman, 1990; Davidson, 1979; McKern, 1971 (1929); Kirch, 1978; Poulsen, 1987; Spennemann, 1987; and Steadman, 1993) that covers a range of issues related to Tonga. According to the first archaeological studies in the region (Mckern, 1929), Tongan prehistory dates back to approximately 3500 yrs BP. The original settlers migrated to Tonga from western Melanesia or Southeast Asia (Burley, 1994; Dye and Steadman, 1990). These early people known as Lapita settlers, because of their distinctive type of stamped pottery called Lapita, had already developed the ability to raise pigs and cultivate edible roots such as taro (*Colocasia esculenta*) (Burley, 2000; Poulsen, 1987). The first settlers also relied heavily on fish and invertebrates from inshore reefs and lagoons (Dalzell, 1998; Spennemann, 1987); these resources have been continuously exploited for many centuries (Poulsen, 1987). These scholars conclude that over-exploitation of inshore molluscs (especially *Anadara antiquata* and *gafarrarium tumidum* and *G. gibbosium*) (Dalzell, 1998; Spennemann, 1987), led to the expansion of agricultural crop production, pig consumption and intensified exploitation of reef fish by the late-Lapitoid population (Dalzell, 1998). Archaeologists

have noted that continual long-term exploitation of marine shellfish can markedly reduce the average size of shellfish populations, as reflected in quantitative analyses of shellfish middens existing over long time periods (Poulsen, 1987; Spennemann, 1987).

One of the most significant works among this archaeological literature, in terms of my own study, is Dirk Spennemann's *Changing Gender Roles in Tongan Society: Some Comments Based on Archaeological Observations* (1996). Spennemann is studying the changing roles of common women (non-high-ranking women, constituting the majority of Tongan women) in order to reconstruct gender roles in the prehistoric period of Tonga. His studies "... supply a conceptual framework for the interpretation of prehistoric gender-related data" (Spennemann, 1996:101). Spennemann examined skeletal remains from several archaeological sites located in Tonga, noting that many of the male skeletons displayed a high intensity of osteoarthritis in the neck region and almost no arthritis in the lower spine region. He found this pattern to be consistent with excessive use of the arm in a forceful downwards and backwards motion of the upper arm, i.e. paddling/canoeing (Houghton, 1980). In contrast, female skeletons showed a high concentration of arthritic vertebrae in the lower spine and hardly any in the lower neck region. According to Spennemann such patterns are due to the carrying of heavy loads and frequent bending consistent with a number of different activities, or a combination of these, most notably gardening work, *tapa* cloth production, shellfishing and/or transporting heavy loads. He examines each of these activities, eventually eliminating *tapa* cloth production because the action of beating the bark would not have resulted in such a condition. While work loads and expectations of gender roles may have changed

over time there are accounts from early explorers of Tonga noting that women did not generally participate in gardening activities and especially not in heavy work (Martin, 1967 (1817)). While there is no clear evidence on this, in many excavated archaeological sites, shellfish (turbo shells, *Tridacna*, *Cerithium*, *Anadara antiquata* and *Gafrarium tumidum* and *G. gibbosium*) makeup one of the largest components, thus inferring the importance of shellfishing to prehistoric peoples (Poulsen, 1987; Dye and Steadman, 1990). Archaeologists (Dalzell, 1998; Burley, 1994, 2000; Spennemann 1987; Poulsen 1987; and McKern 1929) have uncovered significant evidence suggesting the importance of shellfish in the diets of early Tongan settlers; much of this focuses on the importance of women as the collectors of shellfish (Dalzell, 1998; Kirch and Dye, 1979; Spennemann, 1987). Therefore, Spennemann concludes, the skeletal arthritic patterns would seem to implicate habitual shellfish harvesting, and related activities by women.

Although archaeologists do not report directly on *limu* harvesting per se, they do provide a background scenario of early resource use that supports *limu* use. However, due to the organic nature of *limu*, and the simple tools inherent in the collecting of it, namely hands and plant fiber baskets, there is no archaeological evidence that would indicate whether *limu* was also a part of peoples' diets or whether women were in fact harvesting *limu* in these early times. We can only assume that, like today, women of the past collected a variety of marine resources while gleaning in the tidal flats, and that these would have included seaweed, or *limu*. In fact, seaweed may have played an important role in the diets of Lapitoid populations as a source of essential vitamins, minerals, dietary fiber and even protein, particularly given the lack of, or very limited existence of, cultivated crops.

Section II – Early Historical Sources

There are few references to Tongan use of *limu* in the records of the early European explorers and traders. This is not surprising given that these initial visitors to the South Pacific Islands could not communicate with Tongans except through translators from other islands, who also did not speak this language (Beaglehole, 1967). As the anthropologist Thomas Malm (1999) notes, they were unable to converse on most subjects with any depth. Although they did make valuable observations, including detailed drawings, most of their in-depth interactions were with high-ranking nobility. As a result, explorers' observations were, in general, based upon feedback from elite upper-class people rather than the lower ranking individuals who were the most likely to have collected *limu* (Beaglehole, 1967). As Patricia Howard notes, one of the major flaws of research, and especially early research, is that "it often takes the plant knowledge of a few people, particularly of men, to be representative of the knowledge of entire cultures, in spite of the fact that the knowledge and use of plants is everywhere gender-differentiated" (2003:19).

While there is no direct evidence in this early literature on *limu*, there are illustrated written accounts of women gathering from the tidal flats. For example, Thomas Malm, who has studied women's shellfishing in Tonga and associated historical records in depth, notes that there are two drawings of women gathering mussels by Juan Ravenet, who came to Tonga in 1793 with Spanish explorer Alejandro Malaspina, (Malm,

1999:52, 154). Additionally, William Anderson, Captain James Cook's surgeon on the Resolution, describes the reef and inner tidal area in some detail, mentioning several types of shellfish that were highly esteemed in Europe, but makes no direct mention of women gleaning in the tidal flats (Beaglehole, 1967). Overall, the information from early explorers concerning gleaning from tidal areas is limited. It appears that the naturalists collected no edible seaweeds from any of Cook's voyages, nor did they mention eating or collecting *limu* either themselves or by native islanders (Pond, 1983; Sharp, 1968; Beaglehole, 1967; Forster, 1777; Ebes, 1988; Forester, 1996 (1778); Kaeppeler, 1978).

One of the best nineteenth century sources on Tonga comes from William Mariner (Martin, J. 1991 (1817), *Tongan Islands: William Mariner's Account*). Mariner was a young clerk who was the only survivor from the crew of the *Port au Prince*, an English ship of war. The rest of the crew was massacred in the Ha'apai islands in 1806. Mariner spent the next four years living in Tonga as the adopted son of the warrior chief Finau 'Ulukalala. Unlike other European explorers of the day, Mariner was completely immersed in the culture for four years. While Mariner offers much description in the way of people's daily life, religious practices and warfare, he makes only scant reference to women and the gathering of shellfish. Interestingly, the reference occurs in the context of a discussion of war: "Finow had, for a long time past, entertained the idea of seizing upon several of the enemy's women, who were in the habit of assembling at a certain part of the inlet, to gather shellfish" (Martin, 1991 (1817):138). The reference suggests this was a common scene.

Another account documenting this time period comes from Elizabeth Bott, who interviewed the late Queen Salote in the early 1900s about ancient life in Tonga (Bott, 1982. *Tongan Society at the Time of Captain Cook's Visits: Discussions with Her Majesty Queen Salote Tupou*). Bott's objective was to describe the social and political organization of Tonga at the time of Captain Cook. Queen Salote helps clarify the roles, responsibilities and obligations of mostly chiefly or high-ranking women. She illuminates customs, rituals, and ceremonies as well as everyday practices and regimes. However, no information is included about women's fishing/gleaning techniques. The fact that *limu* was not included in ceremonial giving associated with *inasi*, the traditional offerings of food given to the high chiefs and kings, may account for the lack of reference to food gathered from the tidal flats in her narrative.

Section III – Early Anthropology and Sociology Accounts

The early anthropological record for the region consists of two excellent anthropological and sociological accounts from the early 1900s. Edward Gifford, known as the pioneer of Tongan anthropology, first arrived in Tonga in 1920 with the Bayard Dominick Expedition based out of Hawaii. He spent nine months in Tonga interviewing knowledgeable individuals about the past lifeways. His book, entitled *Tongan Society*, published in 1929, remains one of the most comprehensive general overviews of early Tongan society. His work is significant for establishing a general awareness of Tongan society in the past. Even though Gifford visited Tonga in the 1920s, he was caught up in the salvage ethnography paradigm that was so prevalent during that time. This was the

heyday of salvage ethnography. The view was that indigenous cultures were expected to die out in the face of European colonization. The role of anthropology was to document the “old” ways before they disappeared, ignoring the contemporary cultural traditions as they considered these too westernized. Thus, despite his extensive documentation of early Tongan life, Gifford recorded little about what life was like during the 1920s, including women’s fishing and gleaning activities. He only briefly mentions shellfish gathering [“The gathering of crustacea and shellfish which is done chiefly by women, was under the supervision of a petty chief with the title Tovi” (Gifford, 1929:106); “A number of girls from the convent at Maufanga, Tongatabu, were gathering shellfish at Anana, in the lagoon at Tongatabu” (Gifford, 1929:341)], with no accompanying descriptions or explanations. Again, it may be a gender problem as many early anthropologists focused mainly on discussions with and observations of men and often well-placed or elite men. James Duke (Duke and Vasques, 1994:iv) noted that most early ethnobotanical, and I would argue historical, anthropological, and sociological, writings on female issues “were by foreign men, interpreting native men in turn interpreting native women” (c.f. Howard, 2003:17).

Ernest and Pearl Beaglehole (1941) followed Gifford with a study of ordinary Tongan village life in the 1940s, as described in their book *Pangai: Village in Tonga*. Their work is unique in that it documents ordinary village life, rather than focusing on upper-class society. But once again, even though their focus was purposefully on common villagers rather than the upper-class elite, they made very little mention about women’s fishing and gleaning activities, and no reference to *limu* harvesting.

By the middle of the twentieth century there began to be a group of native Tongan writers, writing about history, sociology, Tongan philosophy and culture. These writers who were born in Tonga and understand Tonga culture and traditions intimately, but were educated abroad in the Western tradition, offer invaluable insights and perceptions that we as outsiders may never have completely understood. Among these scholars there are four that stand out: Futa Helu, Sione Latukefu, Epeli Hau'ofa and Konai Helu Thaman.

Futa Helu was born in Tonga and educated in both the Western and Pacific traditions. He is a philosopher and one of the most highly respected men in Tonga. He is the founder and Director of the 'Atenisi Institute in Tonga. He has published extensively on the views of nature and culture, socio-political situation and the criticism, analysis and development of the Tongan culture. See, for example, the following works: *Thinking in Tongan Society* (1983); *Now the King Wants a Party* (1995); *Identity and Change in Tongan Society since European Contact* (1993); *Tradition and Good Governance* (1997); *Changing Values and Changed Psychology of Tongans During and Since World War II* (1998). He works very hard to empower his own people by encouraging them to become the experts in Tongan history, culture and traditions, as well as addressing modern concerns of development, politics and the environment.

The late Sione Latukefu (1922-1995) dedicated his life to teaching and documenting Tongan history. He founded the Tongan History Association and served as its president until he passed away in 1995. He wrote prolifically on Tonga history (e.g. 1966, 1967, 1972, 1973, 1974, 1975, 1980, 1988 and 1993) and his work entitled *Church and State in Tonga* (1974) is still considered to be a classic in Pacific literature.

Epeli Hau'ofa, a professor in anthropology and sociology at the University of the South Pacific is the founding director of Oceania Centre for Arts and Culture. He writes about myths, legends, oral traditions and cosmologies of Oceania people (e.g. 1977, 1978, 1979, 1983, 1994, and 1998). He is a gifted observer of colonialism and nations, offering unique insights into life in the South Pacific, especially regarding the transitions between traditional and modern ways.

Konai Helu Thaman is a well-known Tongan writer of the Pacific Islands. Dr. Thaman's poems reflect cultural contact situations facing Pacific Islanders today. Her poems portray the problems and issues faced by Pacific Islanders regarding development and cultural conservatism against modern liberalism (Ravuvu, 1993). Her works reflect life as a Pacific Islander today (e.g. 1974, 1981, 1985, 1993, 1995 and 1997).

While none of these native Tongan authors contributes directly to the knowledge of *limu* uses and practices in Tonga, what they do offer is a comprehensive background and understanding of Tongan tradition and culture, along with important and relevant issues facing Tongans today. This information, when combined with other anthropological, sociological and historical documents, allows us to better understand the feelings and views of Tongans from the late 1800s to today.

Section IV- Botanical and Ethnobotanical Knowledge

The leading authority on seaweed use of Pacific Island peoples is Isabella Abbott who has published extensively on traditional Hawaiian uses of plants, including *limu*. In fact, she has one publication devoted entirely to *limu* (Abbott and Williamson, 1974; Abbott, 1988, 1991; 1992). She maintains that while all Polynesian peoples ate seaweed, none of them exploited *limu* to the same extent as the Hawaiians (Abbott cites ethnobotanical sources, but is unclear as to which ones relate to which information). Hawaiians were even known to cultivate *limu* in nearby fishponds in order to have easy access to their favorite varieties, as well as to feed the fish they were raising (Abbott, 1992; Na Maka o ka 'Aina, 1992). Abbott has documented little ethnobotanical information regarding *limu* from Tonga. Robin South, the Director of the Marine Studies Programme, University of the South Pacific (USP), has researched seaweeds and their uses, primarily in Fiji, but also other South Pacific locations (1989, 1993, and 1999). His focus is documenting species of seaweed, the collecting and selling of seaweed, including who is collecting seaweed, and who is selling it in the local markets. Unfortunately his study neglects the important issues of labor, rank, and the status of those who are intimately involved with seaweed harvesting. He also makes no mention of seaweed harvesting or usage in Tonga.

Ethnobotanical work in general in Tonga has been limited. The major work on this area has been undertaken by the following: E. and P. Beaglehole (1941), Weiner (1971), Croft and Tu'ipulotu (1980), Singh et al. (1985), Bloomfield (1986), George (1989), Whistler (1991, 1992abcd) and Ostraff et al (2000). Paul Cox, a leading ethnobotanist, also studies Polynesian medicine (Cox, 1991), adding much to our knowledge of general

Polynesian medicinal practices. However, most of his work is centered in Samoa, only briefly touching upon Tongan medicinal practices. Of these ethnobotanical works, Arthur Whistler's is the most significant. Focussing mainly on medicinal ethnobotany, Whistler has provided an overall general foundation to ethnobotanical research in the region.

Drawing from extensive fieldwork in Samoa, Tonga, Tahiti, The Cook Islands and Hawaii, with comprehensive reviews of the ethnobotanical literature over the past 20 years, Whistler has produced an impressive ethnobotanical inventory for Tonga and much of the South Pacific. Admitting that he covers only the most commonly used species, and that his work is not "sufficiently detailed to give the complete picture of the medicinal practices of any one Polynesian culture" (Whistler, 1992b:viii), he does provide a general foundation for ethnobotanical studies. Given his inventory approach and his focus on mainstream plants, it is not surprising that Whistler does not include *limu*, other than to say that *limu* is the general name for seaweed, mosses and lichens (1991:68). *Limu* is not a mainstream medicinal category of plant, nor is it an especially salient one, given that *limu* species are mostly collected and eaten by women in the field or at home; this is especially the case in Tonga. Thus, he could easily have easily overlooked *limu* as a medicinal and food plant of Tonga.

Three other studies should also be noted in this section. T.G. Yuncker's (1959) *Plants of Tonga*, while somewhat out-dated, continues to remain the most comprehensive botanical source on Tongan flora published to date. He occasionally includes brief ethnobotanical information in this volume. For example, he mentions a terrestrial fern (*Nephrolepis hirsutula*) noting the following: "Various parts of plant are used in preparing medicines"

(Yuncker, 1959:27). His inventory contains 750 species and varieties of plants. Strangely, Yuncker does not include marine algae species. *Limu vai*, is mentioned, but as the local name for a seagrass, *Ruppia maritima*, rather than as a marine algae (Yuncker, 1959:51). The work of Hideo Ohba, from Tokyo University, (1996) *A Report of the Investigation and Research of Marine Algae in Tonga*, was most valuable for filling in the gap on algae species in Tonga. In fact, this work is the most comprehensive report of marine algae in Tonga today, identifying 185 species. Ohba's work is strictly botanical; it does not include any ethnobotanical information or even local names of alga species.

Dr. Irene Novaczek of the University of the South Pacific Marine Studies Programme is also a key figure in the documentation of *limu*. Her three booklets about seaweed (Novaczek, 2001abc), *Sea Plants, A Guide to the Common Edible and Medical Sea Plants of the Pacific Islands and Sea Vegetable Recipes for the Pacific Islands*, increase the knowledge of uses for seaweed and help people identify edible and medicinal seaweed in the Pacific area. This work was particularly important to my study as Novaczek focused on the women of the Pacific Islands, with five major objectives in mind:

1. To share knowledge about sea plants.
2. To provide information on how to use sea plants for food, medicine, agricultural aids and for economic purposes.
3. To promote the use of sea vegetables in communities where fresh vegetables are difficult to obtain.
4. To raise awareness of sea vegetables as healthy and nutritious foods, and

5. To enable readers to develop workshops on sea plants in their own communities.

Drawing on interviews with local women throughout the Pacific, Novaczek includes descriptions of 25 of the most common species found in the Pacific, with their local names and uses. Her work is not comprehensive - only two species of algae are listed from Tonga - but it does provide a good basis for general knowledge of South Pacific marine algae, with helpful information for locating, harvesting and using the most common species.

Section V- Contemporary Studies and Women's Fishing

Throughout the past decade there has been some major work undertaken on the role women play in local fisheries. Among the most important is that of Lyn Lambeth, a community fisheries officer for the Secretariat of the Pacific Community (SPC). Lambeth has written an extensive series of field reports for the SPC assessing the role of women within fishing communities throughout the South Pacific. The major objectives of her field reports are to review the social and economic role of women in the fisheries sector, including activities such as harvesting, processing and marketing of marine resources. She also provides details on both government and non-government services available to support the interests of fishing communities and identify support services specifically aimed at women in the small-scale fisheries sector. One of her major goals is to outline the problems faced by the small-scale fisheries sector, with particular attention to those problems faced by women, and in so doing provide guidelines to assist government and

interest groups in finding solutions to these problems. Her work is extremely relevant to my research, because many of her objectives directly correlate with mine.

The problem with Lambeth's project is that the scope of her work is very diffuse in nature, not allowing her to spend sufficient amounts of time in the field observing and participating on a grassroots level with the actual women fishers and gleaners. Instead, the majority of her interviews and consultations take place with community leaders, group leaders, government officials and administrators from other organizations (average 42 interviews per report, with an average of only 24% from untitled individuals). Yet despite this, her work still represents a major effort, averaging 42 interviews per location, and covering a wide area across the South Pacific.

There are several other scholars whose work contributes to the growing scholarship on women's knowledge regarding traditional and contemporary fishing and management of marine resources. Dr. Mecki Kronen, SPC (Secretariat of the Pacific Community) Community Fisheries Scientist, has examined the role and magnitude of women and children's involvement in fishing activities in the South Pacific. In her article, *Women's fishing in Tonga: Case studies from Ha'apai and Vava'u islands* (2002), she addresses the issue of underestimating and undervaluing women's roles in fishing. She does so by conducting socioeconomic surveys administered in four villages, two from Ha'apai and two from Vava'u. While Kronen comes up with some interesting and valuable information, her particular methodology, which is not backed up with personal observations or interviews, has skewed her data in a direction not consistent with others.

Nola Tonga and her colleagues from the School of Pure and Applied Sciences at the University of the South Pacific (USP), have reported on local marine biological knowledge and management practices in Ha'apai (2000). Since Nola Tonga grew up in Ha'apai, she was able to rely on her personal knowledge for this work. She also drew on extensive interviews with local men and women who regularly fish from the local waterways. Her results, while still preliminary, reflect a basic understanding of local fishing and management practices in the Ha'apai island group. However, Ha'apai is comprised of small atoll islands, offering few of the extensive estuaries and mangrove ecosystems where *limu* is so prevalent. While *limu* is collected on occasion in Ha'apai, the collection and consumption of *limu* there is minimal in comparison to Vava'u and Tongatapu. This may account for the fact that despite Tonga's local knowledge and the team's personal observations, *limu* gathering, which is normally an intricate part of women's fishing and gleaning practices, was not mentioned.

Penelope Schoeffel, an economic anthropologist from the New Zealand Institute for Social Research and Development, has written numerous articles about the role of women and women's knowledge in current fisheries development projects throughout the Pacific. Schoeffel provides a provocative and insightful look at women's fisheries development in Australia, Papua New Guinea, Fiji, Cook Islands, Solomon Islands, Vanuatu, and Samoa (1995). Her focus is on women's roles, the reactions of fisheries officers to her studies, and recommendations for including women more thoroughly in fisheries development in the region. She concludes that it is of "great importance that

Pacific Island people learn about the threats to their marine resources and work out solutions to conserve them. Pacific Island women are particularly knowledgeable about inshore resources and involving them in the development of sound conservation strategies will be of great value” (Schoeffel, 1995:17).

Among the scholars undertaking anthropological, sociological and ethnobotanical studies in Tonga, there is an increasing awareness of the importance of women’s knowledge and participation, not only in subsistence fishing, but also in the management of inshore marine resources [The first world’s compilation of papers on women and gender relations in biodiversity management was based on the proceedings of a conference held at Harvard University only in 1991 (Howard, 2003:xvi)]. The recent rise of critical feminist approaches is evident in the scholarship (see for example Whippy-Morris, 1995, and the works of C. Slatter, E. Matthews, V. Ram-Bidesi, A. Vunisea, and M. Chung in *Fishing for Answers: Women and Fisheries in the Pacific Islands*, 1995, organized for the Women and Fisheries Network, edited by Elizabeth Matthews). Clair Slatter, Department of History and Politics, USP, focuses her research on the role of women in agriculture and marine resources for foreign exchange. Elizabeth Matthews, Ocean Resources Management Programme, USP, writes about conservation issues and the role women play in Pacific Island fishing. She also shows how many inshore species of invertebrates, especially those important to women’s non-commercial harvest, have been neglected by fisheries conservation and management projects. Vina Ram-Bidesi, from the Ocean Resources Management Programme of USP, discusses how trends in fisheries development in the South Pacific have affected women’s activities in the fisheries sector.

Aliti Vunisea discusses changes in the subsistence activities of women in a village in Fiji and how these changes affect their lifestyles and livelihood. Margaret Chung uses a case study in Fiji to show the connections between gender, increasing population and the need to protect environmental quality. While these authors make little mention of *limu* per se, they do offer us an overall picture of the contemporary issues affecting women fishers in the South Pacific. These are issues that are critical to my study of *limu*, women and Tonga.

One of the key contemporary anthropological studies on women's marine gathering and fishing is by Thomas Malm, an anthropologist and biologist (Lund University, Sweden), who has studied marine gathering in Tonga (1999, 2001) with an emphasis on integrating traditional management schemes with modern ones. Malm's doctoral dissertation (*Shell Age Economics: Marine Gathering in the Kingdom of Tonga*, 1999) explores women's knowledge of shellfish gathering. He also produced a comprehensive literature review covering the history of Tonga. This gives a more complete understanding of the history, background and actual shellfish gathering in Tonga than any other works to date. While his history and literature review is exceptional, there is only minimal reference to actual fieldwork with women gleaners. Malm's findings on tidal flat gleaning, are characteristic of the body of knowledge common to both men or women from the general populist, lacking the depth indicative of extensive field work on site with the women experienced in these matters. Malm records the names of the shellfish and other marine organisms with an emphasis on traditional conservation systems, while excluding documentation of the abundance of knowledge women hold regarding shellfish gathering. He almost totally

ignores the aspect of *limu* in his work, only briefly mentioning it in an appendix, and even then inaccurately identifying several species and erroneously naming others. Even so, Malm laments, and justifiably so, that women's knowledge is neglected in historical and contemporary documents and how tragic it is that so much information has been lost or overlooked.

Even contemporary ethnographic records are generally void of information regarding *limu* usage. Only two graduate theses out of a total of 120 on Tonga deal with any sort of fishing practices, and none covers *limu* or other inshore marine exploitation (Malm, 1999). This suggests that there may be a built-in bias in much of the early literature, perhaps deriving from the fact that all of the early accounts came via male explorers. Tongan studies at large have been dominated, even through much of the 20th century, by male researchers. As Patricia Howard states in her work on *Women and the Plant World*, "the domestic realm is largely non-monetized, and the women-plant relationships within it are largely invisible to outsiders" (2003:5). She goes on to say "up until at least the 1980s, Western sciences . . . were dominated by a 'Man the Hunter' model. This portrayed women's contributions to subsistence through plant gathering as part of the domestic realm and as insignificant." She also quotes Fedigan (1986:33):

. . . Men are still seen as actively and aggressively engaged in procuring food and defending their families, whereas women are seen as dependants, who remain close to home to trade their sexual and reproductive capacities for protection and provisioning . . . [These models] effectively omitted the female half of the human species from any consideration whatsoever (c.f. Howard, 2003:5).

More recent studies have displayed a feministic approach, which has become more validated in scientific literature, bringing to light valuable information that has been overlooked by men, such as women's reef and tidal area gleaning techniques and practices. However, even the recent feministic approach to research is sadly lacking when it comes to actual *field* research. The majority of research accomplished today in the South Pacific regarding *limu*, or women's fishing techniques, is accomplished through methods other than participant observation in the field. My research, which is heavy in both ethnography and participant observation, helps fill the gap in the area of women's fishing/gleaning knowledge in Tonga and in particular regarding *limu* knowledge.

My work fits into a growing body of knowledge focusing on women and fisheries in the Pacific Islands. There are two main agencies that directly deal with these issues. The first is the Secretariat of the Pacific Community (SPC) which put out a bulletin entitled, *Women in Fisheries*. The second agency is called the *Women's and Fisheries Network*, supported by the University of the South Pacific in Suva, Fiji. The aim of both agencies is to advance women's development in the fisheries sector throughout the Pacific Islands, thus empowering Pacific Island women to:

- Achieve recognition of the importance of women's fisheries activities in subsistence communities and in domestic food markets;
- Acquire access to fisheries development resources and training;

- Seek representation in fisheries decision making;
- Promote sustainable forms of development in the Pacific; and
- Engage in research and analysis on issues concerning fisheries and women (Tuara, 1995; Des Rochers, 2002).

Throughout the Pacific Islands women perform many activities associated with the harvesting, processing and marketing of marine resources. Although women have a long history of gleaning/fishing activities, their contribution to the development and management of fisheries programs and ventures continues to be underestimated and undervalued, especially in the scientific community (Why Gender Matters, 2003; Lambeth, 2001a; 2001b; 2000a; 2000b; 1999; Malm, 1999; Vunisea, 1997; Tuara, 1995; Schoeffel, 1995; Ram-Bidesi, 1995). Women involved in tidal gleaning are predominantly from the lowest economic strata (Guiry, 2003; FAOSTAT, 2003; Briand, 1991). Exclusion of these women in commercial development works is a retardant to the progress of a large percentage of the population. Unless policy makers consider the role of all marine resource users, the promotion of sustainable resource use cannot be realized. By establishing links, fisheries departments have the opportunity of drawing on the valuable knowledge women gleaners/fishers can offer concerning marine biological data, effective harvesting/fishing techniques and significant knowledge that can serve as the basis for resource assessment, management and development.

I feel that my research contributes to the above body of work. It documents specific marine biological knowledge of Tonga, which has not been previously documented, and it elaborates on the processes, techniques and knowledge base of the women collector/gatherers. It also elucidates the socio-economic status of the women who are not only the expert collector/gatherers of marine resources, but also heavily rely upon marine resources for their family's nutritional needs. It also shows that, like Patricia Howard's findings (2003:2), "there is a relationship between women's specialized knowledge and skills in relation to plants, their contribution to subsistence, and their social position and status within their communities." My research, when combined with that of other scholars, should lead to a greater respect and understanding of the contribution skilled women gleaners/fishers can add not only to the scientific community, but also to their own families, communities and country.

1.3 The Objective of My Work

There is a "complex reciprocal relationship between the human and natural world" (Pollan, 2001:xvi). Desirable characteristics and distinctive features present in notable plants are intrinsically linked with our own destinies. The symbol for beauty in Tonga is represented by the Polynesian introduced *heilala* (*Garcinia sessilis*), which is highly revered for its fragrant flowers. The *heilala* is so highly esteemed in Tonga that it is featured in many songs, poems and festivals (Thamen, 1993; Ministry of Education, n.d.). It is also used for medicinal purposes (Whistler, 1992). Tongan people use *kava* (*Piper*

methysticum) as their drink of choice for all ritual, official or ceremonial occasions (Gifford, 1929). The grated, crushed or chewed roots are mixed with water to form a drink, which is a mild narcotic producing an euphoric, but clear-minded, state (Whistler, 1992). Early settlers introduced *kava* to the Pacific Islands, from Micronesia. Another powerful plant in Tonga is the *ufi* or yam (*Dioscorea alata*). *Dioscorea alata* is cultivated for its edible tubers. Early settlers also distributed this plant throughout Polynesia. *Ufi*, along with barkcloth, woven mats, large pigs and *kava* are the appropriate gifts for high ranking chiefs or kings (Gifford, 1929). *Ufi* is given at important ceremonies such as the *inasi* or harvest festival, weddings, births and deaths. *Ufi* is the most expensive root item sold in the markets today. Not only does the harvested tuber, if kept dry, last for months, but it also has the most desirable texture and taste of all the root crops.

All of the above plants are mentioned in legends, songs, poems and Tongan lore. Their long-standing, yet complex, association with Tongans is well documented. Each of these species is well represented in all four island groups in Tonga. All Tongans, including small children, can easily identify each species. Most of these crops now require human intervention in the form of planting, cultivating and harvesting. There are many parables and legends about these plants (Ministry of Education, n.d.). All of them have been well documented as well by Europeans, from the first explorers to Tonga, who recorded information about them in their journals (Beaglehole, 1967), to photographs where they are prominently displayed, dating from 1916 to the 1990s (During, 1990), to anthropologists (Gifford, 1929; Beaglehole and Beaglehole, 1941), historians (Bott,

1982; Campbell, 1989) and even ethnobotanists (Whistler, 1992). These plants have been central to Tongan society from the beginning of its history.

In contrast to the above plants, *limu* is indigenous to Tonga, is rarely mentioned in historical and contemporary literature, is not mentioned in any legends and does not require human intervention to grow. Does this lack of documentation and saliency within the Tongan community suggest a lack of importance? Or is there an underlying significance to *limu* and associated *limu* practices that would suggest the validity and salutary nature of *limu* to Tongan culture? Is there, in fact, significance to the absence of information regarding it?

In light of the above questions, there are two main objectives in my work. The first is to assess the current uses and cultural roles of *limu* in Tongan society. The second is to explore the relationship among *limu* knowledge, women's indigenous knowledge, and people's sustainable use of the tidal areas. The following research questions were asked in order to meet these objectives:

1. What species of *limu* are found in Tonga?
2. What are their current uses? and,
3. Is there any connection between women's traditional knowledge regarding the collection and uses of *limu* and the sustainable use of the tidal areas?

In this dissertation, I explore the relationship between *limu*, its status among women, its uses and cultural roles and its place in the Tongan diet. By examining this relationship, I have learned not only the current state of *limu* harvesting in Tonga, but also the status of women's indigenous knowledge of the tidal flat area and the trends in recognition this knowledge has taken. My research has indicated that neither *limu* nor women's traditional knowledge is considered vital or essential to the affluent populace of Tonga. Yet, each is extremely valuable in its own right and cannot be completely replaced with Western knowledge or goods.

1.4 Overview of Dissertation

My dissertation is divided into six chapters. Chapter 1 introduces the research. Chapter 2 presents a brief history of Tonga. It also examines *limu* uses in the larger context of the Polynesian Islands.

Chapter 3 explains the methodology underpinning my research, within the context of an ethnobotanical research project that incorporates ethnography. It describes the interview process and the surveys/studies I undertook along with providing profiles of the participants in the study.

The results of the study are presented in Chapter 4. Here I address the nature of edible species of *limu* in Tonga, as well as distribution patterns and relevant environmental

issues affecting the plant. I follow this information with a discussion of current food uses and medicinal applications, and I conclude with a description of current commercial ventures of *limu* in Tonga.

In Chapter 5 I discuss factors that influence *limu* harvesting, for example gender issues related to *limu* harvesting and use and educational trends. I also examine contemporary mores that play a factor in the everyday use of *limu*. The concluding chapter, Chapter 6, summarizes the key findings of my research and outlines questions for future research.

Chapter 2 Background and Context

2.1 A Brief History and Context of Tongan Society

Based mostly on oral traditions, seaweeds have a long tradition of human use and cultural traditions in Tonga as elsewhere in the South Pacific region (Abbott, 1991; Chapman, 1987; Lamour, 1995; South, 1995). In this chapter, I outline the history of human settlement in Tonga, emphasizing the ancient beginnings of human relationships with the sea and with *limu*. I also explain my own background in relationship to undertaking *limu* research in Tonga, and some of the factors that influenced the course of my research.

The Kingdom of Tonga is Polynesia's only remaining monarchy. The Tongan archipelago is located in the South Pacific at 15 - 23° south and 173 - 177° west (Figure 1). It is spread out over 362,000 km², and it consists of 170 islands, of which 36 are occupied. The islands are divided into four major geographical groups: Tongatapu, Ha'apai, Vava'u and the Niuas (Stanley, 1999).

Early ethnographic records (Bott, 1982; Gifford, 1929) report myths proclaiming Maui, a Polynesian demigod, fished the Tongan Islands from the sea, and then walked on them and made them flat and suitable for living and farming. The first known human occupants were descendants from the Lapita People, dating from approximately 1500 BC (Burley,

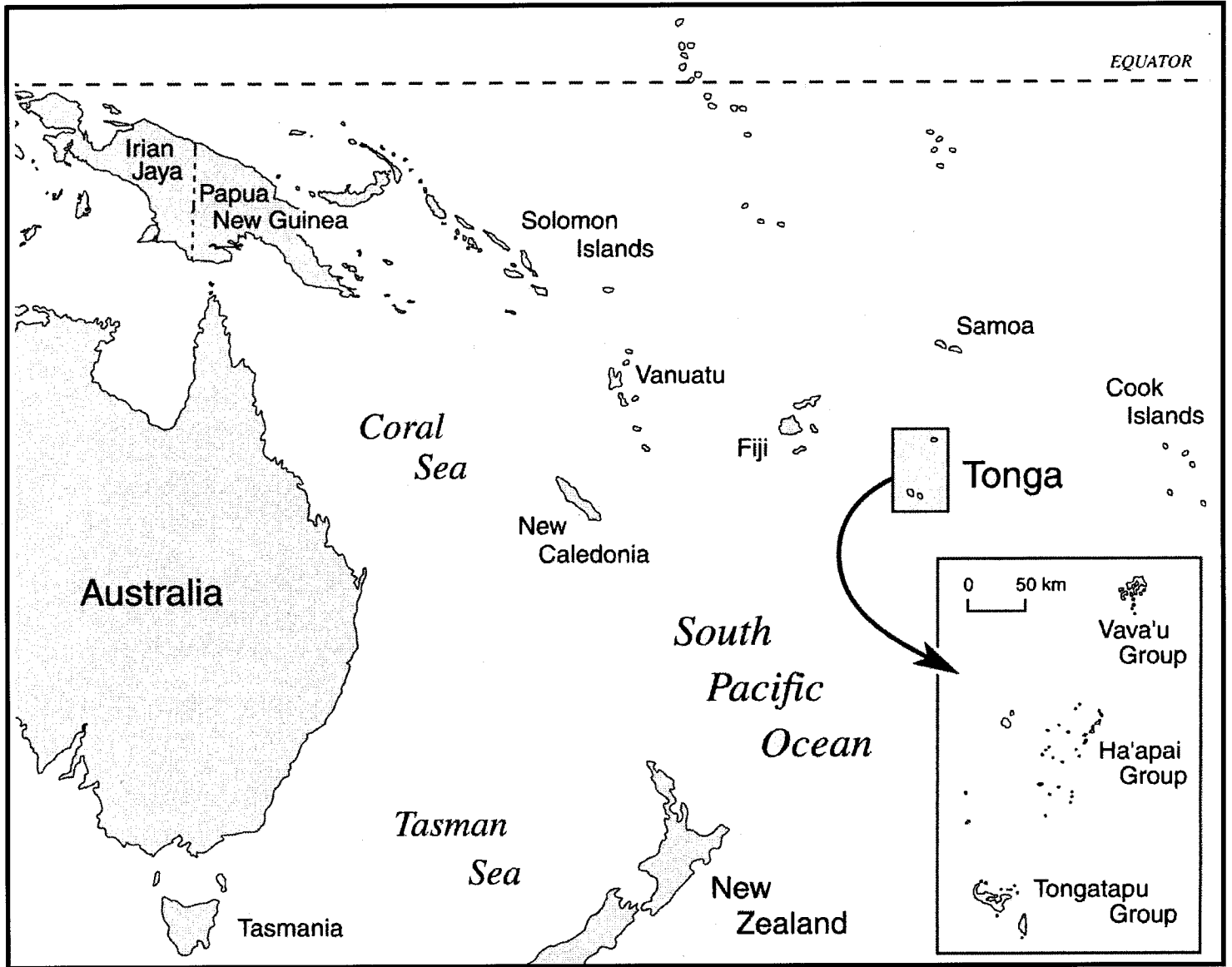


Figure 1. Map of the South Pacific, with a close-up view of Tonga.

1999, 1994; Spennemann, 1996; Kirch and Ellison, 1994, 1978; Poulsen, 1973). During this time, Tongans became fierce warriors who dominated the Eastern Pacific (Burley, 1999; 1994). They traveled throughout the Pacific Ocean in large double-hulled canoes that could carry up to 200 people. Their domain extended from Rotuma in the west through the Lau group of Fiji, to Samoa and Tokelau and Niue in the east. Gifford (1929) notes that communication at this time was achieved by calling to one another from farm to farm. It is described as *fanongonongo tokoto* (making proclamation when reclining). According to Spennemann (1996), who analyzed osteoarthritis in male and female skeletons dating from this era, the majority of gardening and raising of food crops along with reef gleaning was accomplished by women. Men's primary responsibilities included fishing, trading and warfare. Gifford (1929) estimated through early records and oral traditions that the population of Tonga throughout these eras never exceeded 25,000. However, Maude (1965) estimates the early population of Tonga to have been approximately 30,000, while Green (1973) believes it to have been nearer 40,000. Green also feels that by the early 1800s, 40 to 50% of the population was eradicated due to the introduction of diseases by early explorers. Wilkes (1985 (1845)), who visited Tonga in 1840, received a report from local missionaries that the population of Tonga was 18,500 at the time of his visit, which would seem to support Green's earlier statement.

The first European encounters with Tonga occurred in 1616 when the Dutchmen Schouten and Le Maire sighted Niutoputapu. In 1643 Abel Tasman visited Tongatapu and Ha'apai. Captain James Cook arrived next in 1773, 1774 and 1777 naming Tonga the "Friendly Islands", because of the friendly manner in which he and his crew were

received (Beaglehole, 1967). There is an irony in this naming since Finau Ulukalala and other chiefs had planned to kill Cook and his crew. A disagreement regarding the plans allowed Cook to sail away none the wiser (Martin, 1991 (1817)). Early explorers were impressed with the beautiful gardens and plantations covering the land. In the journal of Abel Tasman, (compiled by Sharp, 1968) he writes of “plots or gardens in which the beds were made neatly in squares and planted with all sorts . . . all standing so straight in line that it was a pleasure to behold (c.f. Moengangongo, 1986:89). Cook was often regaled with mountains of food. On many occasions he received piles of food reaching 30 or more feet high consisting of yams, bread fruit, kava, roasted pigs, fish and turtles (Beaglehole, 1967). These gifts of food were so numerous and extensive that he mistakenly noted that “the people seemed to live almost effortlessly off the fruits of nature without any . . . toil (Collingridge, 2002: 267).” He was also very impressed with the roads and plantations he came across. He reports in his journal that

. . . this road which was a very publick one, was about (16) feet broad and as even as a B(owling) green, there was a fence of reeds on each side and here and there doors which opened into the adjoining Plantations; several other Roads from different parts joinde this, some equally as broad and others narrower, the most part of them shaded from the Scorching Sun by fruit trees. I thought I was transported into one of the most fertile plains in Europe, here was not an inch of waste ground, the roads occupied no more space than was absolutely necessary and each fence did not take up above 4 inches and even this was not wholly lost for in many of the fences were planted fruit trees and the Cloth plant, these served

as a support to them, it was every were the same, change of place altered not the sene (Beaglehole, 1967: 252).

Christian missionaries first arrived in Tonga in the late 1700s, establishing schools and converting members to their religion. One of the early converts was Taufa'ahau, Chief of Uiha, Ha'apai, who had family ties to Kanokupolu, Tongatapu. Taufa'ahau eventually defeated two rival lines and became King George Tupou I, uniting all of Tonga in 1845 (Rutherford, 1996). Key marriages solidified the Taufa'ahau line as the ruling line right up to the current King of Tonga, His Majesty Taufa'ahau Tupou Fa. Men most usually held power. However, alliances through marriage, and complex orders of rank in which sisters outranked brothers, and mothers were more important than fathers in determining the rank and political status of the next generation, were prevalent throughout the islands (Ralston, 1996). Differing from the previous era, men now seemed to be in charge of the plantations, along with fishing, house construction, canoe construction and, of course, warfare. It is speculated that the lessening of warfare, along with new expectations introduced by missionaries contributed to this change (Spennemann, 1996). Women were expected to produce goods such as baskets, mats and tapa cloth (Ostraff, 2002; 2000). They were also in charge of childcare, shellfish and *limu* collection as well as some gardening (Bott, 1982). But overall, their workloads became lighter than in earlier times, inspiring natives from Samoa, Tahiti and Fiji to comment on the easy workload the Tongan women had (Martin, 1991 (1817): 370-371). Early accounts state that there were differences not only in gender roles, but also differences in peoples' roles and activities due to rank and status. High-ranking individuals were not under the same obligations as commoners. Reeson (1985:180) reports that in 1823 a missionary wife recorded in her

diary "the most important women will often be the most gifted artists because they don't have to spend so much time in the gardens" (c.f. Spennemann, 1996: 106). Significantly, men were in charge of cooking, except for special dishes prepared by women, which were served exclusively to Chiefs (Gifford, 1929).

Up until 1862 commoners were subject to the will of the chiefs to whom they belonged. But in 1862 all Tongan people, male and female, became free individuals. When King George Tupou I was confirmed as the sole ruler of Tonga, he claimed all of the land as his (Moengangongo, 1986). However, the land act of 1882 allotted each male over 16 years of age a town lot and 3.34 hectares of farmland (Bott, 1982). A constitutional government was established at this time as well.

The current King of Tonga, Taufa Ahau Tupou IV, continues to rule absolutely. However, he also appoints 12 members of the Cabinet who sit in a 30-seat Legislative Parliament, nine members of which are elected every three years to represent Tonga's 100,000 commoners (Stanley, 1999). As in the past, common women still spend time gardening and growing crops such as taro and yams, raising their children, gleaning from the tidal areas and creating traditional art forms such as mats and tapa cloth. The biggest contribution women in Tonga, like those in other island nations, make to their family's diet comes from their comprehensive fishing and gathering along reefs and inshore lagoons where they collect *limu* and shellfish (Ram-Bidesi, 1995). Presently women's roles in Tonga, especially regarding contributions to the family's diet, are similar to those in islands throughout the Pacific (Lambeth, 2001a,2001b, 2000a,2000b,1999).

2.2 *Limu* Use Throughout the Pacific

Limu is the general term used for edible algae in Hawaii, Samoa, Tuamotu Islands, Society Islands and Tonga. *Imu* is the name used in the Marquesas; *rimu* is the term used in New Zealand (Abbott, 1991). Although the name *limu* and its variants are common throughout Polynesia, very few species of seaweed are currently used in Polynesia (Abbott, 1991; Madlener, 1977). Very little data exist documenting ancient uses of *limu* throughout Polynesia. There also exists a paucity of information in contemporary literature regarding prevailing *limu* uses and practices.

Handy (1923), an early ethnologist reported that, due to a lack of terrestrial greens available in the Tuamotus, *limu* was eaten in greater amounts than in many of the other island. He noted that Tuamotuans are of “fine stature, their diet consists of coconut, fish, *limu*, and hala fruit” (c.f. Miller, 1927). Miller (1927) reported that *limu* is a fairly good source of vitamin A and provides small amounts of calcium and ash to the diets of Polynesians as well as bulk, and its spicy aromatic flavor adds variety to a somewhat monotonous diet.

Beatrice Segal (personal communication, 2003) reports that in Western Samoa *Caulerpa racemosa* (*fuofua*) is collected and wrapped in bundles of breadfruit leaves. It is then sent to American Samoa where it is sold in her parent’s store for \$5 a bundle. Her parents purchase 20 bundles a week and they sell it all the same day. She also reports that

elderly people are the biggest customers. Toaga Seualo, a nurse, recalls *fuofua* having been recommended as part of an organic diet for cancer patients (personal communication, 2003). Older women generally collect *limu*, usually only one per family, during the day. Most *limu* is consumed at home, with only small amounts being sold in the market. As in other Pacific Islands, *limu* makes up only part of the days harvest, along with clams, oysters, fish and other edible marine species (May Neli, personal communication, 2003). The two most common species of *limu* collected in Samoa are *Caulerpa racemosa*, known as *fuofua*, and a red sea-lettuce, *Halymenia sp.*, called *a'au* in Samoan (Peterson, personal communication, 2003; Novaczek, 2001).

In Fiji, seven species of marine algae are harvested and eaten on a regular basis:

Caulerpa racemosa, *C. racemosa* var. *occidentalis*, *Codium bulbopilum*, *Hypnea pannosa*, *Gracilaria verrucosam*, *Solieria robusta*, and *Acanthophora spicifera*. The most commonly eaten species are those in the genera *Caulerpa*, *Hypnea* and *Gracilaria* (South, 1995).

Roviana women from the Solomon Islands gather *Caulerpa racemosa* in the fringing and barrier reef areas of the Solomon Islands (Lamour, 1995).

The Maoris of New Zealand used to use several species of green seaweed in salads and soups (Williams, 1996). They also continue to use *Porphyra columbina*. "Quantities were sent to Maoris serving in the Middle East during World War II, where *Porphyra* was reported to be more thirst quenching than chewing gum on desert marches" (Chapman, 1980: 98).

Hawaiians utilized - and continue to use - by far the greatest diversity and quantity of algae - at least 29 edible types. While all Polynesian societies had taboos associated with hierarchy, social and spiritual events, and mythology, especially regarding women (Hanson, 1982), Hawaii had many dietary forms of *kapu* (taboo) that limited what women could eat. Women were not allowed to consume or touch anything that was used sacrificially. Unlike in Tonga where women regularly ate with men (Beaglehole, 1976), Hawaiian women were not allowed to eat with men, or to prepare men's food. Hawaiian women were even constrained from eating basic food items such as yam, taro, coconut and pig, which were staples to most Polynesians. Phycologist and ethnobotanist Isabella Abbott theorizes that because so many foods were *kapu* to women in Hawaii, Hawaiian women exploited a more extensive array of seaweed than any other Polynesian group (Abbott, 1992).

Seaweed gathered and eaten in Hawaii is consumed in a variety of ways. Some species are chopped and used as a relish in combination with other foods such as fish, *kukui* nuts (*Aleurites moluccana*) and salt, or cooked and used as a thickening agent, while others are consumed raw because of their spicy flavor. Fresh water algae were also gathered and consumed. Heavy salting allowed for preservation of some species of seaweed; salted *limu* could be kept at room temperature for several months (Abbott, 1974; 1991; 1992; Schoenfeld-Leber, 1979). According to Abbott and others, there are 14 commonly eaten algal species with validated scientific names that are still currently in use in Hawaii (Abbott, 1992; Schoenfeld-Leber, 1979). Of those 14 species, three (*Enteromorpha prolifera*, *Sargassum echinocarpum* and *Asparagopsis taxiformis*) exist in Tonga.

However, based on my research, none of these three species are ordinarily eaten in Tonga at this time (see Table 1).

Table 1. Common edible marine algae found in various Pacific Islands.

	Scientific Name	Local Name	References
Hawaii	<i>Enteromorpha prolifera</i>	'ele'ele	Abbott (1992)
	<i>Ulva fasciata</i>	palahalaha	Abbott and Williamson (1972)
	<i>Codium edule</i>	wawe'ioli	Schoenfeld-Leber (1979)
	<i>Codium reediae</i>	'a'ala'ula'	
	<i>Dictyopteris plagiogramma</i>	lipoa	
	<i>Sargassum echinocarpum</i>	kala	
	<i>Porphyra</i> sp.	pahe'e	
	<i>Asparagopsis taxiformis</i>	kohu	
	<i>Grateloupia filicina</i>	huluhuluwaena	
	<i>Gracilaria coronopifolia</i>	manauea	
	<i>Ahnfeltia concinna</i>	'aki'aki	

	<i>Laurencia dotyi</i>	<i>lipe'epe'e</i>	
	<i>Laurencia nidifica</i>	<i>mane'one'o</i>	
Fiji	<i>Caulerpa racemosa</i>	<i>nama, nama levulevu</i>	South (1995) Novaczek (2001)
	<i>Caulerpa racemosa</i> var. <i>occidentalis</i>	<i>nama, nama wawa,</i> <i>nama balavu</i>	
	<i>Codium bulbopilum</i>	<i>totoyava, sagati</i>	
	<i>Hypnea pannosa</i>	<i>lumicevata,</i> <i>lumivakalolo</i>	
	<i>Gracilaria</i> <i>verrucosum</i>	<i>lumiwawa, lumiyara</i>	
	<i>Solieria robusta</i>	<i>lunitmana</i>	
	<i>Acanthophora</i> <i>spicifera</i>	<i>lumikaro</i>	
Samoa	<i>Caulerpa racemosa</i>	<i>fuofua</i>	Novaczek (2001), Toaga Seumalo, Beatrice Sega, Christine Peters, May Neli (2003, personal communication)
	<i>Gracilaria</i> sp.	<i>limu aau</i>	
	<i>Halymenia</i> sp.	<i>a'au</i>	
	<i>Sargssum</i> sp.	<i>limu vaova;</i>	
	<i>Turbinaria</i> sp.	<i>limu lautalatala</i>	

New Zealand	<i>Durvillaea antarctica</i>	<i>rimuroa</i>	Williams (1996)
	<i>Caulerpa racemosa</i>	<i>rimu kai</i>	Novaczek (2001)
	<i>Hydroclathrus</i> sp.	<i>rimu oma</i>	
	<i>Sargassum</i> sp.	<i>rimu akau</i>	
	<i>Turbinaria</i> sp.	<i>rimu taratara</i>	
Tonga	<i>Caulerpa racemosa</i>	<i>toke</i>	
	<i>Caulerpa serrulata</i>	<i>kaka</i>	
	<i>Caulerpa cupressoides</i>	<i>kaka</i>	
		<i>palalafa</i>	
	<i>Caulerpa scalpeliformis</i>	<i>fuofua</i>	
	<i>Caulerpa racemosa</i> var. <i>clavifera</i>	<i>fuofua</i>	
	<i>Caulerpa peltata</i>	<i>louniu</i>	
	<i>Caulerpa sertularoides</i>	<i>limu vai</i>	
		<i>tanga'u</i>	
	<i>Hypnea charoides</i>		
	<i>Cladosiphon</i> sp.		

In early times, women in Tonga also endured restrictions relating to food production and other activities. Gifford (1929: 344) states that “it was *tapu* for a woman to step over a growing yam vine, presumably lest the plant be blighted.” The Beagleholes (1941) also report that Tongan women wouldn’t carry out certain activities such as washing, cooking, or working during menstruation. Historically, however, there are no reported *tapus* for food consumption specific to women in Tonga. Tongan women’s favorite type of *limu*, *fuofua* (*Caulerpa racemosa*), has always been abundant and easily accessible; this may be one factor that lessened the need for women in Tonga to extensively exploit diversity in the types of marine algae consumed as food.

Before going any further, I will provide some background information on my own work and experiences in Tonga. Participation in Tonga as a researcher requires establishing relationships with local families and communities, to fit oneself into the cultural norms of Tongan society.

2.3 My Background

My husband Joseph Ostraff spent two years, from 1977 to 1979, living in Tonga as a missionary for the Church of Jesus Christ of Latter Day Saints. During his stay he associated exclusively with Tongans, eating, drinking, and living with them, and speaking only Tongan. As a result of his Tongan immersion, he not only became fluent in the Tongan language, but he also gained many friends and contacts throughout Tonga.

After our marriage in 1982 we traveled to Tonga on several occasions, at first to visit friends, and later for study and research. After receiving a B.S. in mathematics in 1994, I decided to pursue my life long interest in people and plants, and my familiarity with Tonga led me once again to Tonga. Over the last ten years we have visited Tonga extensively, staying for up to six months at a time, and visiting 25 islands encompassing all four major island groups in Tonga. During that time I interviewed over 80 healers and numerous individuals who are proficient in various traditional crafts such as basket and mat weaving, tapa cloth making and carving. My husband and I, along with a small film crew, wrote and shot two documentary films (Ostraff and Ostraff, 1997; 1999) , encompassing women's traditional *tapa* cloth making skills and knowledge and current traditional healing practices in Tonga.

In 1998 I made the decision to undertake doctoral research in Tonga. I have always incorporated my family (six children) into my research. This association is very important in Tonga, as family plays an important role in society. Each individual, for example, knows where he/she fits in, how he/she ranks according to those around them and who his/her ancestors are. Families, communities, islands and even the entire nation are small enough to allow the identity of almost every individual - or at least for every family - to be known to each other. The first question always asked of visitors is where they are from and who their family members are.

As an outsider coming to Tonga to conduct research, it is extremely valuable to me to bring my family along - because I bring with it a substantial part of my identity.

Everyone wants to know who my family is and how we fit in to their society. The types

of interactions in Tonga that I am able to participate in because my family is with me would never be achieved if I were there as a single individual. As a matter of fact, single women are highly suspect in the eyes of Tongans, because, in their society, it is unacceptable for single women to be on their own. Women, and especially unmarried women, are always expected to be accompanied by other women, or to have a brother or cousin escorting them. Those who choose to be on their own are regarded as acting highly inappropriately, and as having loose morals and standards. And while single foreign women who choose to undertake research in Tonga are not held to the same standards as locals, they are still looked upon and treated with some skepticism. Thus, as a woman, it is much more appropriate to conduct research with one's husband and family present.

Tonga is a highly religious country where religion plays an active role in everyday life. The unbelievable impact Christianity had upon Tonga is manifest even today in the reality that ninety-nine percent of the country is Christian, and most Tongans are active Christians. Missionization is still part of their world and in many regards plays a part in how they construct their everyday lives. Missionaries, of any faith, are for the most part, treated with respect and honor by all Tongans. While our first introduction to Tonga began through missionary work, and indeed in many ways it greatly facilitated my research, we have made a conscience effort not to be exclusive to our own faith. We often attend religious meetings and events other than from our own faith. The consultants that I work with come from many different backgrounds that reflect the current demographics of Tongan society. In many ways the manifestation that we are a large family, we are

practicing Christians, and we associate non-exclusively within their communities helps to further integrate us into Tongan society.

The research on *limu* described in this dissertation is thus situated in the context of my own history and presence in Tonga. It is only due to this history, and to the respectful participation in Tongan society by my entire family, that this research was possible.

2.4 General Botany of Algae

The world's phytoplankton – microscopic marine and aquatic plant life - incorporate 80 - 100 billion tons of carbohydrates - primary production that equals the sum total production of all land plants. Algae make up the largest group of carbon-fixing plants on the earth, and yet they reside in marine shelf areas, which make up less than 8% of the total ocean area (South and Whittick, 1989). Because algae are photosynthetic, they can only survive in the layer of water penetrated by sunlight. In the tropics of the South Pacific, due to the clarity of the water, algae can grow at depths of a hundred meters or more, but in other areas where the water is much more turbid, few algae occur in depths over 30 meters (South and Whittick, 1989).

The Algae are a large and varied botanical group whose predecessors date to 2 billion years ago. In size they range from microscopic specimens to the giant kelps (*Macrocystis* spp.) that can grow up to 65 meters in length (Chapman, 1950). As noted previously, the

larger, easily visible macroscopic types are commonly known as seaweed. Most seaweed needs a firm substrate in order to become established. Rocky shores, or coral reef areas, especially those with extensive shallows and tide pools, are the best environments for seaweed growth.

Algae are characterized by their lack of conducting tubes, or vascular tissues, for water and nutrients. All the cells in seaweed carry out the same functions. All parts of the alga must be in contact with the water because it is directly from the water that the organism obtains not only its required fluids, but also all the nutrients needed for growth and reproduction. Algae often have leaf-like, root-like, and stem-like parts; but they do not function like real leaves, stems and roots. For example, holdfasts, which are root-like in appearance, function only to anchor the plant, not to adsorb nutrients from the substrate. The frond, or lamina, is the main part of the seaweed body. It varies in form from a flat and blade-like structure to fine filaments that resemble hair. The fronds can be simple, or branched into complex shapes. The stipe, or stalk, is a stemlike structure that bears the fronds and reproductive structure and attaches them to the holdfast. The whole organism is called the thallus.

Benthic marine algae (seaweed) - macroscopic attached algae that live in the ocean - are divided into three main subdivisions: Phaeophyta - Brown Algae, Rhodophyta - Red Algae, and Chlorophyta - Green Algae. Chlorophyta absorb the long wavelengths of light (red) and reflect green. They grow where they are exposed to the strongest light, or in other words, in shallow areas. Most of the marine green algae are tropical or subtropical. Brown algae are the largest and most visible types of seaweed and are

mainly temperate. They are very common, for example, along the Northwest Coast of North America. They absorb medium, or green, wavelengths. Green light can penetrate further into the water, so this allows the brown algae to grow at greater depths.

Rhodophyta absorb the blue and ultra violet light waves and they can live at depths of up to 200 meters (South and Whittick, 1989). Red algae are the most common group of marine algae. Algal species grow in one of two zones: intertidal - meaning they can exist where they are periodically covered and uncovered by the tide as it rises and falls; and subtidal - where they are never exposed to the atmosphere, even at low tide. Most of the *limu* harvested in Tonga and elsewhere in the world are intertidal.

For reproduction, seaweeds produce spores that can swim or move in the currents, from special parts of the frond called sporangia. The spores are asexual. New plants will grow from these spores into male or female plants. Female plants will then develop egg cells, which remain fixed in the frond, and males develop swimming sperm cells. Both eggs and sperms are released into the sea, sometimes through disintegration of the ends of the fronds or thallus, where fertilization takes place and a new plant grows from the resulting zygote (Figure 2). Algae also spread vegetatively by extending their thalli, or sometimes fragments of algae can break off from established plants and reattach themselves to the substrate in new locations. When *limu* are harvested, they can likely regenerate themselves from the remaining tissues at the base.

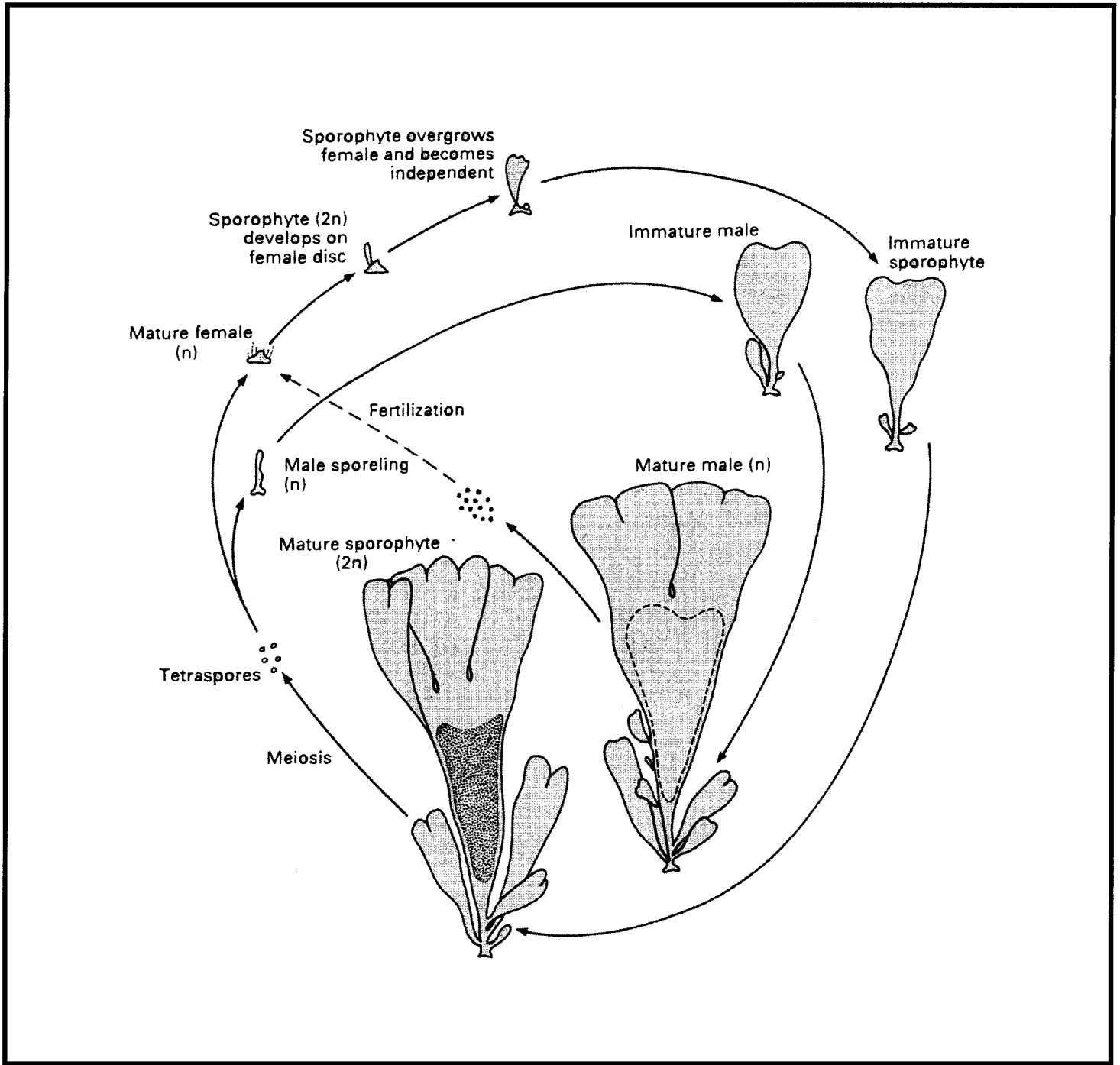


Figure 2. Life cycle of *Palmaria palmata* (South and Whittick, 1989).

2.5 Ecology

Non-articulated coralline algae form a barrier that buffers wave action and helps prevent erosion of the delicate corals and softer organisms of reef communities. A diverse group of calcified green algae of the orders *Caulerpales* and *Dasycladales* produce the aragonite form of calcium carbonate which is responsible for much of the sand within the lagoons and reef areas (Littler and Littler, 1988).

Seaweeds that exist in shallow waters or along reef edges are vulnerable to hurricanes or other tropical storms. Heavy rough seas and high winds tear the seaweed from the substrate and wash them ashore. Types such as *tanga 'u* and *limu vai* are especially vulnerable because they often attach themselves to other plants such as seagrass (*Syringodium* sp.) instead of directly to the reef or other secure substrates. It has been reported by informants (Paoline Moalae, Luisa Vailea, Fane Lomu, Ana Tapa'atoutae, 'Aliefa Tukuafu, Faleula Taulangi) that after a big storm *limu vai* and *tanga 'u* can be gathered by the armfuls from the shore around their island.

Caulerpa is a stenohaline marine alga - meaning it is very susceptible to salinity changes in the water. During heavy rains the influx of fresh water can cause the lagoons to become less saline. Whenever the salinity drops below 30 parts per ton *Caulerpa* will begin to die (Trono, 1986). Edible seaweed thrives in cooler water (20° - 25° C.).

Tanga 'u and *limu vai* will die if the water temperature reaches above 26° C. (Lovell, 1997). *Limu fuofua* and the other common types of edible *limu* can survive at higher

temperatures (up to 29° C), but they do not thrive as well as when the average temperatures are lower. Thus the most productive time of year for *limu* harvesting occurs in the cooler months of May through September.

Seaweed forms the basis of an intricate food chain involving all the organisms living within a marine ecosystem. Through the process of photosynthesis, marine algae, like other chlorophyll containing organisms, convert the energy of sunlight into usable chemical energy by binding together CO₂ and H₂O with other molecules into energy rich hydrocarbons and other organic compounds, and releasing oxygen into the water and atmosphere. *Limu* harvesters, for example Vai and Elita Tupou, report that turtles, fish, molluscs, and crustaceans eat the *limu*; but they do not clarify which species of *limu* are being eaten. Capon et al. (1983) report that herbivorous fish and invertebrates avoid consuming seaweed from the *Caulerpaceae* and *Codiaceae* families. This may be due to the slightly toxic substance called *caulerpicin*, which contributes a slightly peppery taste to *limu* from these families (Doty, 1966). *Limu* is important in providing shelter and protection for other lifeforms, especially serving as a nursery for many organisms such as sea urchins (Kikuchi, 1980). Macro algae and epiphytic algae provide shelter and refuge for numerous small invertebrates (Den Hartog, 1979) as well as organic carbon from decomposition (Brouns and Heijs, 1991).

Chapter 3 Methodology

3.1 An Ethnobotanical Approach

In order to understand all aspects of *limu* harvest in Tonga, I followed methods commonly used in ethnobotanical research. An ethnobotanical approach to research is a humanistic approach - requiring extensive verbal descriptions and explanations (Atkinson and Hammersley, 1998). The approach is a multidisciplinary one combining the skills and methods used by anthropologists and archaeologists and incorporating both the biological and sociological sciences (Cotton, 1996). Along with field techniques such as participant observation, collection of qualitative and quantitative data, taxonomic methods, linguistic analysis and interviews, it involves the study of behaviors (what people do and say), as well as the tension between what they do and what they say (Cresswell, 1998; Spradley, 1980).

While ethnobotanical work incorporates both quantitative and qualitative methods a significant part of most research is accomplished through a qualitative approach. Denzin and Lincoln describe qualitative research as

... multimethod in focus, involving an interpretive, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them. Qualitative research involves the studied use and collection of a variety of empirical materials - case study, personal experience, introspective, life story, interview, observational, historical,

interactional, and visual texts - that describe routine and problematic moments and meaning in individuals' lives (Denzin and Lincoln, 1994: 2).

In essence, ethnobotany focuses on human experience, memory, and the contextualization of indigenous knowledge regarding the use and perception of plants. It is a process that seeks innovative quantitative methods to verify and substantiate qualitative data. The strength of this approach is in the holistic examination of plant uses, with an emphasis on indigenous knowledge. One of the major areas of study within the field of ethnobotany focuses on sustainable use of natural resources as these are linked to the preservation of said knowledge.

3.2 My Ethnobotanical Approach

While I have spent time throughout all of the island groups of Tonga, my family and I consistently spend more time in Vava'u. In the process we have established many valuable contacts and friendships throughout all the islands in Vava'u. The Vava'u island group consists of 34 islands, 21 of which are inhabited. The population of Vava'u was 15,715 in 1996, with almost equal numbers of men and women, 7660 females and 8055 males. I chose to focus my study on the Island group of Vava'u not only because of these contacts but also because it is one of the more rural island groups. There are a considerable number of waterways and inner tidal flat areas on Vava'u, and for all but one village there is direct access to a tidal area where gleaning of *limu* and women's fishing can occur. A majority of families in Vava'u exist at a near subsistence level,

farming and fishing; of the 5681 people economically active in Vava'u, 3679 (65%) are involved in farming, fishing or crafts (Statistics Dept., 1999). The Vava'u group of islands is located north of the other two main island groups in the country.

In 1995, while pursuing a Masters degree in Ethnobotany from Brigham Young University, I was studying traditional healing practices in Vava'u (Ostraff et al., 2000) when I first came in contact with Sina Feituani. In the years that followed I learned that not only was she one of the leading healers in Vava'u, but she was also an active collector of food from the tidal flats and that she possessed an extensive knowledge of *limu*. Subsequently, Sina extended an invitation to me to come and study *limu* with her. However, upon our arrival in January of 2001, we found Sina terminally ill with cancer. She was unable to leave her bed, and passed away within a month of our arrival. I was left with the dilemma of how to proceed with my research without my key consultant.

Starting at square one, I began a purposive or theoretical sampling method aimed at identifying and developing informants with pertinent information (Strauss and Corbin, 1990). I visited the local market in order to develop a list of key sellers of *limu* and to locate tidal areas where *limu* was being harvested most extensively. I then spent several days observing these tidal flat areas, making note of the number of people collecting, gender of collectors and the conditions that seemed most conducive to harvesting such as time of day and height of the tide. I contacted friends, who in turn introduced me to women living in proximity to selected tidal areas, who were active collectors of *limu*. After formal introductions, which included explaining the purpose of my visit, I received multiple invitations to join with these women in collecting *limu* from selected tidal flats.

A wide range of relevant data was gathered at this time. Working alongside them, I learned how to locate, identify, collect, and properly store many types of *limu*. At times when weather, tidal movements, and other factors limited harvesting, I conducted formal and informal interviews with the harvesters until I felt universal harvesting/gleaning issues had reached the saturation point and I had developed a knowledge base that allowed me to define categories of more specific and relevant information. Once I had established these categories, that helped me to distinguish collectors with superior knowledge of *limu*, such as phases and cycles of *limu* growth, number of *limu* species known and used, preparation methods for various *limu* species, parallel cycles of marine and land plants and specific harvesting techniques, I was able to increase my depth of focus to those I felt were “experts” in the field. By systematically narrowing my sampling field to “experts” I was able to maximize opportunities for verifying information and for further development and clarification of the above categories. I also pursued areas of investigation that shed light upon general knowledge people not considered “experts” held regarding the tidal flats. I accomplished this by interviewing people who were not considered “expert” gleaners, those who collected from the tidal flats only occasionally and those who never collected.

I carried out research from January through June of 2001, with a follow-up visit from June to August of 2002. I conducted the following types of interviews: structured with a set of open-ended questions, (Appendix 1), semi-structured, unstructured (more free flowing), focus groups, and formal interviews. I organized focus groups with women from four villages (Appendix 2) to discuss *limu* harvest and use. I interviewed people who sold and bought *limu* in the market. I also administered and developed several

written surveys (Appendices 5 – 8). Finally, in order to better understand the overall usage and understanding of *limu* knowledge island-wide, I interviewed government fisheries personnel, high school age school children, those who grow and sell *limu* commercially, and families living near tidal flat areas.

Documentation of the research was accomplished through a variety of techniques. I kept a field journal, which included interview and daily notes. I also recorded many interviews, including focus groups, with a DAT tape recorder. While I kept written notes during the interviews, Wendy Wilcox, a sound technician, recorded them with the DAT machine. This allowed me to focus on the women's responses and questions I wanted to ask rather than on the recording equipment. On several occasions I recorded sessions visually with a 16-mm film camera, with the help of a technical assistant. I also collected voucher specimens for each type of edible *limu*, as well as some major types that are not eaten (Appendix 3). The voucher specimens are currently being stored in the Brigham Young University Herbarium in Provo, Utah. Isabella Abbott, from the University of Hawaii, helped in correctly identifying my specimens.

Within the reciprocal nature of fieldwork there exists the potential for reciprocal exploitation. I have selected certain people to work with, having assessed their qualifications to address the topic of my research. They in return have assessed the personal value of investing in such a relationship and have also determined, for a variety of reasons, that I am qualified to learn from them.

The women I worked with may have gained recognition within their own communities as their expertise at gleaning was validated by a foreign scientist. It is possible that my interest in them enhances their esteem within their community, thus raising their *mana* or status (see Chapter 5 section 5.6 for a more in-depth discussion of *mana*). While, this phenomenon is a natural by-product of human interaction, there are several aspects and residual effects that may have an adverse impact on data collection and the long-term health of a relationship between the people I work with and myself.

In a society where no two individuals have the same rank and status, and everyone knows to whom they owe deference (Bott, 1982), it was not always easy for my consultants to assess their obligation or responsibility to me. In my own community I am considered middle-class. However in Tonga, my status is more elusive. I am a married woman with children, which established some common ground, but I am also an educated member of a community most Tongans consider to be economically advanced, with the opportunity and luxury to travel, when most people residing in Tonga rarely travel beyond their own island group. My ambiguous status, and confusion as to how much deference should be paid me, has sometimes led to slanted or biased information.

My interest and mere presence has on occasion altered normal routines, creating an asymmetrical perspective. When I first began working with two women from Okoa, they would go to the sea several times a week to glean, taking me with them. However, after I continued to work with them for several months, they became much more accustomed to my presence, and eventually their normal routine of going only once or twice a week, or

sending out their daughters to glean in their place, was reestablished. The women eventually felt comfortable enough to send me out with their daughters, instead of always feeling that they needed to be the ones accompanying me to the sea (The one-month family survey completed by the Tupou family indicated that during times of weaving, it was the daughters that did most of the food harvesting from tidal flats). Thus, until I had returned often enough, and established a long-term relationship with these women, the information I was receiving may have been skewed to some point by my presence.

I was amazed to discover that one of the expert gleaners I had been working with for many months (Vai Tupou) was also a traditional healer. When I asked Vai about this she said, “I thought you were only interested in *limu*.” I came to realize that the single-minded nature of my research in and of itself had also skewed information, as the abstract nature of such research tends to place certain aspects of their lives into a contrived context of my creation.

Reciprocity and fieldwork go hand-in-hand. However, reciprocity is, at best, complicated and even more so when the interaction occurs between different cultures. In Tonga it is not usually customary to directly pay informants for their knowledge and services; it is however, culturally appropriate to offer some sort of reciprocity. Reciprocity can occur in many different forms. Food was – and generally still is – the primary medium for the expression of social and ritual obligations (Thomas, 1991). Reciprocity can also take other forms such as service, household items, school supplies for children or transportation to other parts of the island. Often a more diffused, sometimes delayed

pattern of transaction is apropos (Thomas, 1991). It is often more appropriate to separate the help and information people have given from “payments” made for services rendered, as it is culturally offensive to be paid for providing assistance in certain situations.

However, when reciprocity comes later and is unassociated with the original deed, it is very much appreciated and the consultants then save face.

Nicholas Thomas, who has written extensively on anthropological issues including exchange, reciprocity, debt and hierarchy in the Pacific (e.g., 1989, 1991, 1994, 1997), notes that giving has a social effect and mistakes made in giving have consequences. He notes for example, “the presentation of an extravagant gift implying a relationship of intimacy or commitment which the receiver or others present feel is entirely lacking, could only lead to embarrassment or mistrust” (1991:15). Thus, we must be aware of the meanings of our gifts of reciprocity to those who receive them. An asymmetrical relationship, rather than one of equality (Thomas, 1991), is the most typical background for transactions within Tongan society. Due once again to my ambiguous status within their community, informants were often befuddled as to their social obligation to me, sometimes giving disproportionately of their time and resources. For example, upon learning of our leaving early the next morning, the Tupou family stayed up all night preparing a lavish meal for us. They then left their homes at 4:00 am and walked for several hours to arrive at our home with the meal before we left.

Nicholas Thomas (1991) refers to the problematic nature of fieldwork when he states; “Exchange relations seem to be the substance of social life. Inequality is often expressed

through unfairness in distribution or contempt in giving, just as egalitarianism is manifested in careful reciprocity and parity” (pg. 7). These difficulties are ubiquitous within all interactions and communities. However, as stated earlier, they are much more pronounced when the interactions take place between individuals of differing cultures. While there is no way to alleviate the difficulties inherent within cross-cultural research, an awareness of the problems and a commitment to long-term relationships seems to be the best compromise.

3.3 Interviews and Surveys

Over the course of two years, I conducted interviews that could be categorized in three phases. *Phase I* consisted of four organized discussion groups across Vava’u Island. *Phase II* was comprised of formal interviews of women in which specific questions were prepared and presented along with a ten-village survey, a one-month family use survey, and a survey of the public market. *Phase III* combined informal interviews with participant/observation. Interviews were recorded by several means - including journal entries, audio recordings and some filming and videotaping. Decisions regarding the selection of a specific recording mode were based on a sense of what would be appropriate given existing circumstances.

Phase I - I conducted interviews with four focus groups of four to seven women each, brought together by friends and acquaintances. These women were recognized for their

skills in collecting food from the tidal areas. Many of the women interviewed had married into Vava'u but had grown up in other villages that spanned all four island groups in Tonga. The villages in which these women were located ranged across Vava'u from Koloa to Mataika to Tu'anuku and to Oloua, a small outlying island (see Appendix 3). Not only were they vital in developing my foundation of understanding regarding tidal areas of Vava'u, but they also shared knowledge of techniques and varieties of foods collected from their home islands and villages. On several occasions I used the "artifact/interview" method (Figure 3) established by Brian Boom of the New York Botanical Gardens (Balick and Cox, 1997). Five voucher specimens of the most common types of *limu* were brought to the interview. I asked the women if they were familiar with these species of *limu*, and what they knew about them. This method proved to be extremely helpful. The women were excited to see the plant specimens and immediately recognized them. It brought them together and they good-naturedly began speaking about different types of *limu*, and sharing stories or information they knew about them. It also allowed women who were not very comfortable speaking to be more easily involved in the discussions. I also asked them to point out on a map of Vava'u, which I provided, where each of the species could be found. Locations of current collection areas were noted along with areas where the women no longer lived or had access to, but where they had collected *limu* sometime in their past.

Phase 2 - Formal interviews were arranged and conducted with approximately 10 women (Appendix 1). I also formally interviewed government fisheries personnel and commercial farming managers and directors. Several surveys were also conducted during



Figure 3. Focus group discussion using the artifact/interview technique.

this phase. The quantity of *limu* consumed by an individual or family during any given time period was very difficult to assess.

Asking people about seaweed consumption in Tonga is like asking a typical North American how many times a year they or their family eat grapes. While you can respond affirmatively to eating grapes, it is very difficult to determine retrospectively the exact quantity or the exact number of occasions whereon you have eaten them. In order to determine a quantitative amount of *limu* being consumed in Vava'u, I conducted a survey of 200 women throughout Vava'u (Appendix 5). This survey was conducted in March of 2001 and again in September of that same year. Women between the ages of 20 and 50 (the prime years to do *fangota*) were queried about their weekly habits of fishing and food gathering in the tidal areas. Ten women from each of ten villages on Vava'u were interviewed in March and a different ten women from the same villages were similarly interviewed in September.

I also completed a study with the Tupou family in the village of Okoa (Appendix 6). This family is particularly notable because they exist on a near subsistence level from their land and the sea. In this case study, they kept a journal for one month (October 2001), recording everything they collected from the sea. They also kept notes as to what was collected, who collected it and harvest weight in kilograms. The journal was kept in Tongan, but one of the older daughters, who reads and writes English very well, transcribed it into English before turning it over to me.

In May of 2001 I surveyed 96 high school children about their eating habits in order to see what role traditional foods play in their everyday diets (Appendix 7). In July of 2002 I conducted a survey of the local market (Appendix 8), noting numbers of sellers (if any), where the *limu* was collected, and how many packets of *limu* were sold each day. I also questioned buyers of *limu* as to how often they purchased *limu* from the market and their reasons for doing so.

Phase III - Many informal interviews were conducted which led, along with information obtained in *Phases I* and *II*, to invitations to join with women in their work, allowing me to observe methods of collection, to collect specimens, to map tidal areas, and to witness and document social interactions associated with groups of people working together throughout the Vava'u Island Group. I then was able to focus my research on two women who are sisters-in-law and neighbors living in the village of Okoa. Vai and Elita Tupou spend 10-20 hours each week collecting myriad of seafood, including *limu*, from three characteristically different tidal areas (reefs, sandy lagoons and mangrove swamps) near their homes. I spent approximately 4-6 hours twice weekly for six months working with them, either out in the field or in their homes. Not all of the hours I spent with them were directly related to *limu* activities. Instead, we spent time together participating in household chores, church activities, family endeavors or other projects. After working with Vai and Elita and their families for several months and establishing a good rapport with them, not to mention friendship, I felt much more comfortable in asking them to be interviewed on film. Interviews were recorded using both a 16mm camera and a beta video camera. We gathered film footage documenting the different tidal areas and specific techniques used in the collection and cleaning of marine algae.

3.4 Profiles of Interviewees

While I do not give histories or profiles for all of the people I interviewed, I shall provide profiles of a cross-section of contributors, from those I spent the most time with, considered expert gleaners, to a woman who has more general knowledge of *limu* who only occasionally gleanes, to one who does not glean at all, but only purchases *limu* from the market or from friends (Table 2). They are as follows:

Table 2. Summary of the five women profiled.

Name	Year born	Location of Village	Average Gleaning hours p/week	Edible <i>Limu</i> species familiar with	Socio-economic status
Sina	1950	Tu'anequivale	2 – 3	14	Poor
Vai	1961	Okoa	1 – 2	9	Poor
Matelita	1952	Okoa	1 – 2	9	Poor
Lamona	1952	Mataika	< 1	3	Poor
Luisa	1939	Neiafu	0	1	Middle-class

Sina Feituani - (1950 - 2002) Born in Te'ekiu, Tongatapu, Sina originally stimulated my interest in *limu*. She had learned all of the skills necessary for being a good wife and mother from her own mother. Not only did she learn those skills, but she also apprenticed with her mother, who in turn learned from her mother, to become a traditional healer. As customary, Sina married and moved to her husband's village in Tuanekivale, Vava'u, where she raised her large family, and began her own healing practice. Her family is not considered wealthy, they rely extensively on the land and sea to provide for their needs.

Sina was known as an exceptional traditional healer who was able to treat a broad range of illnesses. She had a variety of treatments for illnesses and problems including, but not limited to, the following: breast cancer, liver difficulties, stomach cramps, morning sickness, congestion, constipation, sores in the mouth, diarrhea and vomiting. Not only did Sina treat people for illnesses, but she also advised them on good nutrition and healthy lifestyle choices. One of her major concerns was "imported food". She felt that many people were becoming sick because of their diets heavy in imported foods. She stressed eating naturally from the land and sea. She regularly advised her patients to eat *limu* because of its nutritional content as well as its ability to lower high blood pressure and high cholesterol levels.

When I first met Sina in 1995 she was considered the foremost collector of *limu* in Vava'u. She was so well known and proficient that the King of Tonga asked her on several occasions to collect his favorite types of *limu* and send them to him. Her knowledge was extensive, covering habitat location, ecology, growing seasons, collection

methods and uses. She would collect *limu* on a weekly basis, sometimes selling it at the market when she had more than her family could use. She identified more species of *limu* than any other informant (14 types in all).

Vai Tongatu'a Tupou - (1961 -) Born in Longomapu, Vava'u, Vai was raised in a family that spent a lot of time at the sea. As there was no *limu* near her village, she learned to hunt for crabs, clams and other types of fish; she even went to the reef at night, which is very unusual for a girl. She went to public school until her first year of high school, then she dropped out because of lack of money. She did not learn about *limu* until after she got married and moved to Okoa, Vava'u. She went along with the women of the village who taught her all about *limu* harvesting. Vai, her husband and ten children are a poor family, with no regular source of income. Thus they gather or raise all of their own food. Vai contributes substantially to the family's food resources by collecting and gathering food from the sea (Figure 4). She goes to the sea at least once a week and sometimes more, depending upon the tides and her schedule. She says her children all enjoy eating the *limu*. It is a good thing to eat, she says, because it is healthy. Vai says that when there is no meat, she will go to the sea and get *limu*. She rarely buys food from the stores or markets. No one in her family has been to the hospital. She attributes this good health to the fact that they eat lots of seafood.



Figure 4. Vai Tupou in the tidal area near her home of Okoa, Vava'u.

Vai's knowledge of *limu* is extensive. She knows nine different types of *limu* that are eaten. She is familiar with their habitats and environments, and knows where and what species are available at any time of the year. Her skills are highly developed and she can quickly and efficiently locate and harvest a variety of *limu*, not to mention other types of seafood. Vai and her sister-in-law Elita occasionally collect enough *limu* to sell at the market. They will usually collect enough *limu* to make up ten bundles. Each bundle is wrapped in papaya leaves, which is then sold at the market for \$2 per bundle. Besides being an expert gleaner and harvester of marine foods, Vai is also a part-time healer, a weaver, a dancer, and an active member of her church and a mother of ten. Vai's children attend local government schools. However, since they do not have much money to pay the school fees, some of her children have dropped out of school at an early age. All of them have been taught traditional skills along with their western style education. One of Vai's daughters, Meliane, quit going to school when she was 13 to stay at home and to help her mother. She is proficient in many of the traditional arts such as cooking, weaving, and dancing and especially in collecting food from the sea. Meliane regularly accompanies her mother and aunt to the sea. She has become so proficient at it that upon our return in 2002, she had become one of the main suppliers of seafood for her family. Due to the regularity of Meliane's efforts and the wide range of her collection, the elder women all rely upon Meliane's knowledge as to when and where different types of *limu* are growing.

Matelita Tukutukua Tupou - (1952 -) Born in Ha'alaufuli, Vava'u, Matelita's mother died when she was two years old. So her aunt raised her. Her grandparents are the ones

who took her to the sea and taught her how to collect seafood. She attended middle school but did not continue on to high school because of a lack of money. Upon marrying, she moved to her husband's ancestral village of Okoa. Elita has lived her entire life in close proximity to one or other of the main collecting sites of *limu*. She has 14 children, seven from her husband's first marriage, and seven of their own. She feeds them with seafood, especially *limu* - both Elita and Vai say that all their children are extremely healthy because of the type of food they eat. In 1999 there was an outbreak of typhoid in their village and neighboring ones, but none of their children got sick - Since they are poor, Elita and her husband Siteti do not buy any of their food; instead they grow it or get it from the sea. Elita goes to the sea for gathering three times a week and Siteti goes fishing almost everyday.

Elita's knowledge of the tidal flats is extensive. She spends many hours weekly collecting and knows the environment well. She has a very cheerful and friendly disposition and is willing to share her knowledge with those around her. Vai and Elita live next door to each other. Elita was one of the ones who taught Vai how to harvest the *limu* when she first came to the village. They will often go to the sea together, and share the yield from their work. Elita's eyesight is fading, due to cataracts on her eyes. But even with her poor vision, she still provides a major portion of her family's food from the sea.

Elita and her husband place a high value on public education and work very hard not only to encourage their children to do well in school, but also to pay their fees. While their

children know many of the traditional skills, most of their free time is spent doing schoolwork rather than learning traditional skills.

Lamona Anitoni Tongia- (1952 -) Born in Ta'anea, Vava'u, Lamona was part of a large family of ten children. Her mother was a very well known and respected traditional healer. The children were all taught traditional skills and most also attended the local primary school. Lamona learned how to collect food, including *limu*, from the tidal flats near her home from her mother. She also apprenticed with her mother to become a healer. When she married she moved to her husband's ancestral village of Mataika (see figure 9). After moving to the new village she went out with her mother-in-law and neighbors in order to locate the waterways near her new home. She continued to practice traditional methods to support her family, including gleaning from the tidal areas.

Lamona raised her family as she had been raised. Her children learned traditional skills and also attended local public schools. She practices traditional healing among her neighbors and local villagers. She spends many hours in women's organizations weaving pandanus mats to sell, which allows her to make enough money to pay school fees and other household expenses. On occasion (once a month or so) Lamona will go to the tidal flat area near her home and glean for seafood. Although her knowledge of *limu* is limited, she knows where and how to collect three common species (*fuofua*, *louniu* and *palalafa*).

Luisa Pota Tu'iniua - (1940 -) Born in Neiafu, Vava'u, Luisa was raised in a traditional Tongan home. To most contemporary Tongans, a "traditional" home means: living in

Tonga; raising most of your own food; knowing - and passing on to your children - a discernment of your place and role in the community; and an awareness of appropriate societal expectations or *kavenga*. She also learned skills for being a good homemaker from her mother. She highly valued her western style education, and after graduating from secondary school, she went to Nuku'alofa to train as a nurse. She, along with her family, placed much more value on her schooling and career than on traditional skills and practices. She later returned to Vava'u where she married, and began working in the local hospital as a nurse. Her three children were also encouraged to gain as much western-style education as possible. Her daughter is currently a nurse, working in Nuku'alofa; her sons attended University in Australia where they now reside.

Luisa is now retired as a nurse, and she is also a widow. She has turned her former large home into a guesthouse in order to earn a living. She does not grow her own food; instead she purchases it from the local markets with the money she earns. She enjoys eating *limu*, but never collects it herself. She will occasionally purchase it from the market, but more often when she wants *limu* for a special occasion she will ask one of her friends, or relatives, who regularly collects *limu* to collect it for her.

These women exemplify a range or cross-section of those who harvest and use *limu* in Vava'u. Their experiences and backgrounds are fairly representative of those of many others in Tonga.

3.5 Wrapping-up Methodology

While botanical and biological methods were important to my work, the bulk of my research came from ethnography. Not only did I systematically interview people from a variety of backgrounds, ranging from government officials educated abroad, those considered expert in collection of *limu* educated via traditional methods, and those who consume *limu* but know little regarding it, but I also spent many hours observing and participating with collectors/gleaners. As evident in Chapters 4 and 5, traditionally trained people retain extensive knowledge about *limu* and its environment. They not only know where, when and what types can be collected and utilized to feed their families, but they also understand the interaction and symbiosis within and between species. They know environmental patterns and signs that not only allow them to accurately predict weather conditions, but also, to some extent, seasonal and yearly fluctuations within *limu* biomass and presence. They are the ones who can understand and make sense of environmental issues, changes and problems occurring around them. When their knowledge is combined with that of government officials and commercial growers it allows for a more comprehensive and thorough understanding of *limu* and its environment.

Chapter 4 Results

4.1 Collection and Identification of Common Edible *Limu* in Tonga

There are over 500 species of seaweed growing in the South Pacific. While approximately 100 of them are recognized as being edible, only about 25 - 30 of them are consistently eaten (Novaczek, 2001; Abbott, 1992). Dr. Hideo Ohba (1996) from the University of Tokyo has produced an extensive, but not exhaustive, list of marine algae found in Tonga, both eaten and not eaten. He records 185 taxa, 77 Chlorophyta, 29 Phaeophyta and 79 Rhodophyta. (For a complete list, see Appendix 3). In his work on marine gathering in Tonga, Thomas Malm (1999) records 18 names of seaweed. However, he provides Latin binomials for only five of them, and of those five, two are incorrectly identified. *Limu tanga'u* (*Cladosiphon* sp.) is incorrectly identified as *Nemacystis decipiens*, and *limu vai* (*Hypnea* sp.) as *Ruppia maritima* var. *pacifica*, which is not an algae, but a flowering plant. Several of the names he has listed, *te'epuaka*, *te'emoa*, and *alako*, are all names for the same species of *Caulerpa racemosa*. *Caulerpa*'s appearance changes subtly due to differences in the environment (more or less light, rocky vs. sandy substrate, more or less wave action), the above names reflect those changes. He also lists as two distinct species *louango* and *louniu*, which are both names for *Caulerpa sertularoides*. Many of the names he has listed reflect differing common names, associated with different villages or regions, but representing the same species.

I have identified nine taxa (Table 3) (seven Chlorophyta and two Phaeophyta) commonly eaten in Tonga. But of those nine, seven are from the *Caulerpaceae* family and the genus *Caulerpa*, with by far the most common and favorite variety eaten being *Caulerpa racemosa*, known locally as *fuofua* (Figure 5).

Table 3. Common edible types of *limu* found in Tonga.

Name	Tongan Name	Ecosystem	Uses M=medicinal F= food	Frequency eaten C=common R= rare
<i>Caulerpa racemosa</i> (Forsskal) J. Agardh [var. <i>Clavifera f. macrophysa</i> (Sonder ex Kützing) W.R. Taylor]	<i>fuofua</i>	Coral reef flats, reef, sandy lagoons, mangrove swamps, submerged coral gardens	F, M	C
<i>Caulerpa serrulata</i> (Forsskal) J. Agardh [var. <i>serrulata f. lata</i> (Weber-Van bose) C.K. Tseng]	<i>Kaka</i>	Sandy lagoons, coral reef flats	F	R
<i>Caulerpa racemosa</i> (Forsskal) J. Agardh	Toke, Alako Te'epuaka, Te'emoa	Sandy lagoons, coral reef flats	F, M	C

<i>Caulerpa cupressoides</i> (Vahl) C. Agardh [var. <i>lycopodium</i> f. <i>amicorum</i>]	<i>Kaka</i>	Sandy lagoons, coral reef flats	F	R
<i>Caulerpa scalpeliformis</i> [var. <i>denticulata</i>] (Decaisne) Weber-Van Bosse	<i>Palalafa</i>	Sandy lagoons, coral reef flats	F	R
<i>Caulerpa sertularoides</i> (S.G. Gmelin) Howe	<i>Louniu, Louango, Tu'aniu</i>	Sandy lagoons, coral reef flats	F	R
<i>Caulerpa peltata</i> [var. <i>peltata</i>] J.V. Lamouroux	<i>Fuofua</i>	Submerged coral gardens	F	R
<i>Cladosiphon</i> sp. possibly <i>Cladosiphon novae-caledoniae</i>	<i>Tanga'u</i>	Sandy lagoons, coral reef flats	F	C (in season)
<i>Hypnea charoides</i> J.V. Lamouroux	<i>Limu vai</i>	Sandy lagoons	F	C (in season)

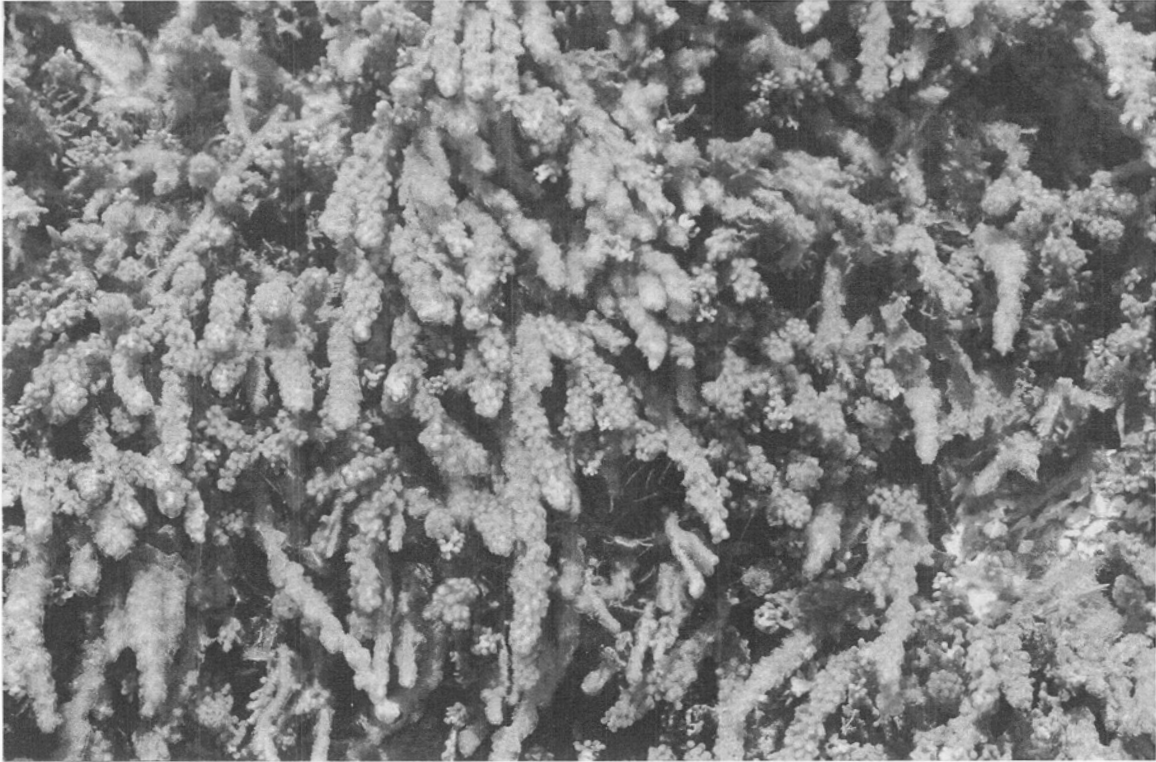


Figure 5. *Caulerpa racemosa*, called *fuofua* in Tonga.



Figure 6. *Hypnea charoides*, called *limu vai* in Tonga.

Caulerpa is known as “sea grapes”. The plant has basal runners up to 3mm wide and its upright branches can grow up to 10 - 15 cm tall and bear grape-like branchlets (Littler and Littler, 2003). It is bright green in color. Branchlets vary in shape and size from round and sparsely spaced (*fuofua*) to tightly clustered (*toke*), to trumpet-shaped (*fuofua*) to hook-shaped (*palalafa*). *Caulerpa* can also have branchlets that are shaped like a feather (*louniu*), or three-sided (*kaka*).

Limu vai is a light brown or yellowish, highly branched plant (Figure 6). It creeps along the bottom of intertidal zones and forms tangled mats. It is usually floppy and entangled in clumps. The cylindrical branches are about 1 mm wide. Branchlets are short and stubby. It looks like clumps of light brown hair. *Tanga'u* is slender and pale to dark brown in color. It is slippery to the touch and jelly-like. Branches are 1 - 2 mm wide and the plant is about 30 cm in length. It grows in tangled masses (often covered in sediment) and commonly attaches to seagrass or to other seaweed rather than the sea floor.

Caulerpa species are found all year long, however they are found in the greatest abundance during the cooler winter months, from May through October. *Caulerpa* species are preferably eaten raw. *Caulerpa* contains a substance called *caulerpicin* which contributes a slightly peppery taste to the *limu* (Doty, 1966). *Caulerpa* contains compounds that reduce high blood pressure and they are high in folic acid, vitamins A, B₁ and C (Novaczek, 2001). *Limu vai* (*Hypnea charoides*) is usually cooked before being eaten. It is used to make a gelatinous type of soup or “pudding”.

Hypnea is high in carrageenan, which is good for thinning the blood and lowering cholesterol. It can also be used for preventing diarrhea, and compounds have also been found in *Hypnea* that stop the growth of tumors (Novaczek, 2001). *Tanga'u* (*Cladosiphon* sp.) can be eaten raw but is preferred by most Tongan people roasted over an open fire. It is eaten seasonally as a delicacy in Tonga, but it is now being harvested, salted and shipped to Japan where it is known as *Mozuku*. *Cladosiphon* contains algin, micronutrients and compounds that are good for prevention of heart disease (Novaczek, 2001). *Limu vai* and *limu tanga'u* are seasonal algae, and can only be found in the cooler months from about June through January, with the most profusion occurring from September to October.

4.2 Distribution

While seaweed can be found in depths of over a hundred meters, as in Tonga, most edible algae are collected from shallow inter-tidal areas (Littler and Littler, 1988). This is mostly due to the difficulty of harvesting algae that reside in deeper waters in Tonga. The substrate for edible *limu* varies from coral and sand to soft silty bottoms of mangrove swamps. In Vava'u, there are six types of environments where *limu* are located: coral reef flats, mangrove swamps, sandy lagoons, reefs, rocky cliffs, and deep-water coral gardens (Figure 7). These ecosystems and the edible algae they support are itemized in Table 4.

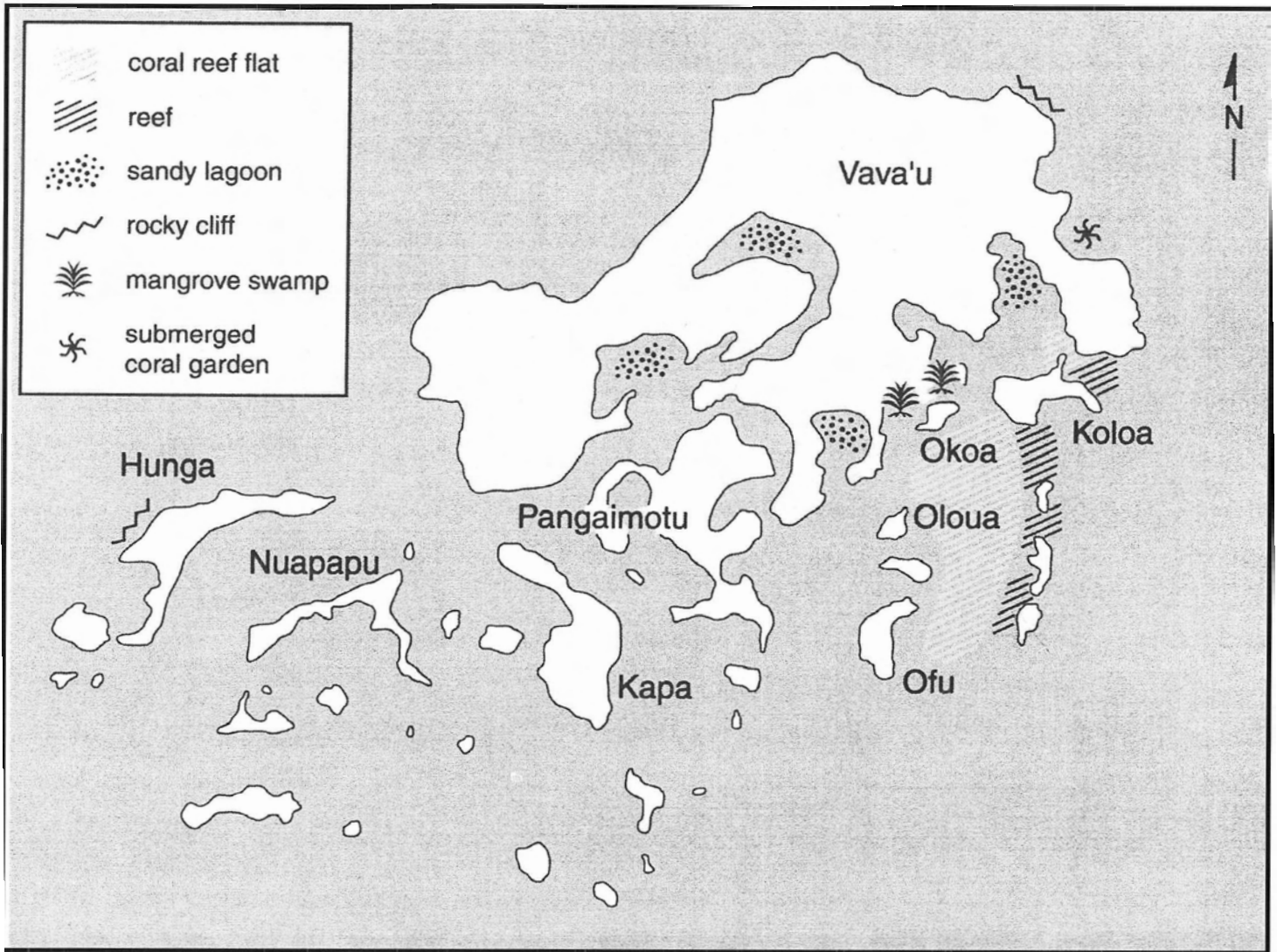


Figure 7. *Limu* habitats and location in Vav'u.

Table 4. Limu Habitats in Vava'u

	Location	Substrate	Examples	Notes	Limu
Coral Reef Flats	Found on the inside of the reef, protected from wave action by an outer reef	A mixture of eroded coral, sand and rocks	North-east of Okoa and Koloa islands, around and between Ofu and Umuna islands	Very common and abundant, limu normally grows in thick clusters and forms large beds	<i>Caulerpa</i> species, <i>Hypnea</i> and <i>Cladosiphon</i>
Man-grove Swamp	Found along the edges of islands in protected inner bays or lagoons	Dark and silty and abounds with organic materials	Between the inner side of Okoa and Vava'u islands and along some of the edges of the inner waterway called Vaipua	Limu grows attached to the mangrove roots rather than on the floor of the swamp; it grows in scattered groupings and each individual section is loosely grouped, rather than compact	<i>Caulerpa</i> species
Sandy Lagoon	Located in protected inner bays	Sand with a scattering of rocks and coral	The inner bay between Koloa and Okoa islands, the bay in front of Neiafutahi, the inner bay of Vaipua and the inner bay between Tefisi and Tu'unuku	Often home to abundant seagrass beds (<i>Syringodium isoetifolium</i>) intermingled with limu, individual plants grow large and spread out over vast areas	<i>Caulerpa</i> species, <i>Hypnea</i> and <i>Cladosiphon</i>

	Location	Substrate	Examples	Notes	Limu
Reefs	Coral reefs found along the outer edges of islands	Coral reefs with a limestone base	The outer reef on the east between Okoa island and Nukumalolo and the outer reef between the islands of Kenutu and Umuna	The outer edges receive heavy surf and the surface has constant water motion, plants are smaller and have extensive root-like structures to secure them from turbulent movement	<i>Caulerpa</i> species
Rocky Cliffs	The northern coast of Vava'u, and the Northeast coast of Hunga island	Limestone cliffs	The eastern tip of Koloa island, the North side of Vava'u and the Northeast coast of Hunga	The cliffs are constantly buffeted with heavy surf, plants grow in small dense clusters	<i>Caulerpa</i> species
Submerged Coral Garden	Completely submerged areas along the coasts of islands	Coral or sand	Keitahi beach on the northeast side of Vava'u	These gardens are never exposed to the air, branchlets are larger and rounder, than in areas that are exposed to intense water movements and changes	<i>Caulerpa</i> species

4.3 Collecting of *Limu*

In the past in Tonga, as in many other parts of the world, indigenous knowledge, especially women's knowledge, was an essential component to a family's survival (Gifford, 1929). While this knowledge is still valued, and continues to be important in the sustenance of the common family in Tonga, its role in contemporary life has diminished. For example, knowledge relating to seaweed is no longer considered prestigious or even necessary by those who can afford to purchase goods at local markets. Presently, women collect *limu*, which was once commonly eaten and used by everyone in the community, on a much-reduced scale. Most adults interviewed about *limu* recalled fond childhood memories of frequently collecting and eating *limu* in their youth. The majority of interviewed persons today, however, consume *limu* only on special occasions. It has become a specialty food, eaten at festive events or during periods of environmental or financial stress. While *limu* serves as a specialty food for the majority of Tongans, others rely on it more extensively. *Limu* today is recommended by both western-trained doctors and by traditional healers for medicinal purposes, such as to treat high blood pressure or diabetes or to stimulate mothers milk production. However, for the most part, only poorer families who reside near tidal areas and rely mostly on ocean resources for their nutritional needs, eat *limu* as part of their regular diet. Elita Tupou, a participant in my study and a regular consumer of *limu*, states that when her family does not have meat to eat, she will go to the tidal area to collect *limu* so that her children will have something to eat together with their cultivated roots (taro, yams and manioke). This is why *limu* is commonly considered to be the "poor man's meat".

Throughout Polynesia Kirch and Dye report that “shell-fish gathering on the reef flats at low tide, is considered a lowly task to be left to the women and children” (1979:68). In Tonga, not all women gather food from the tidal flats. Historically, the women involved in subsistence fishing activities have been those of lower status. High-ranking women did not participate in any sort of food growing/gathering. According to Queen Salote, chiefly or high-ranking individuals relied on commoners to provide their food (Bott, 1982). Today it is much the same, usually only those women living near tidal areas, who are economically poor, are the ones who glean for their own families and to sell to others at the market. Schoeffel, an economic anthropologist interested in gender relations in the Pacific island region, has noted that the act of wild plant gathering continues to be associated with poverty, simplicity and lack of specialized skills (Schoeffel, 1995). Gathering, in fact, requires extensive ecological knowledge. For example, a *limu* gatherer has the skills and much of the knowledge of a botanist, ecologist, ethnobotanist and oceanographer. Such an individual must know plant properties, weather patterns, cultural uses, and cultivation strategies (Anderson, 1993). Margaret Chapman (1987: 281) notes that not only do the collectors/gatherers need many physical skills and techniques to gather their food, but also “. . . as the contact of traditional Oceanian women with the marine environment is in most cases a daily one, they have had the opportunity to accumulate considerable knowledge.” This knowledge also includes the daily and seasonal cycles which affect marine organisms (Johannes, 1981).

Aliti Vunisea, from the University of the South Pacific, describes women’s fishing methods in Fiji, and I would argue that they apply to Tongan women as well, as simple with simple tools and techniques. She goes on to say that “women’s fishing methods

may sound and look simple, but in reality they are complicated; they require extremely adroit use of the senses and skilful utilisation of fisheries knowledge” (1997:11). For example, Vai and Elita Tupou, with whom I worked extensively, know the location of many specific types of *limu*, what time of year they can be found (for example, *fuofua* is abundant when the breadfruit is ripe), and how to harvest, clean, prepare and preserve them. They also know how different environments can change the appearance of the same species of *limu*. When it is growing on the reef edge *limu fuofua* grows very tightly bunched and condensed with small round branchlets, but when it grows in a protected inner bay, with very gentle water movements, it grows spread out with larger trumpet shaped branchlets. The women’s knowledge of other marine resources is just as detailed. They can locate clams (*Kaloa’ a*, *Anadara antiquata* and *A. cornea*; *to’o*, *Gafrarium timidium* and *G. pectinatum*) through the substrate by simply feeling with their feet. They can identify and locate specific species of molluscs (there are over 80 species used for food), crab (*paka*, the most commonly eaten species are *Scylla serrata*, *Calappa hepatica* and *Carpilius maculatus*) and fish (the general word for fish is *ika*) by merely noting subtle changes in the sand or seagrass bed. They are able to fairly accurately predict short term, as well as long term, weather patterns. These skills have allowed them to become experts in reading and understanding the environment around them, which in turn enables them to better satisfy their family’s needs. While a few men do collect *limu*, the majority of *limu* collecting takes place by women.

Studies completed on Fiji and other areas of the South Pacific indicate that in early and current times, men fished with tools considered masculine in nature (Poulsen, 1987; Dye and Steadman, 1990; Schoeffel, 1995; Ram-Bidesi, 1995) and inappropriate for women's

use (Schoeffel, 1995; Ram-Bidesi, 1995). However, women have been more successful at providing abundance and variety of marine foods from tidal areas on a regular basis for family needs (Ram Bidesi, 1995; Schoeffel, 1995; Slatter, 1995; Rodman, 1993). These observations are also consistent within Tonga. Today in Tonga, while both men and women participate extensively in procuring food from tidal areas, from my observations men are more likely to use nets, diving gear, spears, and a variety of lines with hooks and lures. In contrast, women undertake *fangota* fishing - that is they reach, grope and/or search with their hands or feet. While male Tongan fishers are aware of edible marine algae, or *limu*, found in the tidal areas, this food is almost exclusively collected by women at present, and probably long into the past.

The majority of women collectors range in age from 20 to 50 years, and the most active collectors live adjacent to tidal areas. An exception to my findings of predominantly women collecting *limu* occurs with its recent commercialization. I learned that men are the primary collectors when it comes to collecting, working or selling *limu* on a commercial or industrial level. Even though women are extremely knowledgeable about the collection of *limu*, they are rarely involved on the industrial level of *limu* harvesting. I will discuss this aspect more fully in Chapter 5.

Based upon my interviews and observations, as well as others (South, 1993; 1995; Lamour, 1995), those who collect *limu* rarely collect it exclusively. They usually spend several hours "fishing" the tidal area. Gleaning is usually opportunistic with all edible or marketable species of animals and plants being collected as they are encountered. Each woman usually carries with her a large knife or machete, a collecting bucket or basket,

usually made of woven coconut fronds, and sometimes a large stick for poking into holes and to aid in turning over large rocks. All collected specimens are stored in the collecting basket until she returns home.

While *fangota* activities are not necessarily communal in nature, they can never the less still be part of a social activity. I often observed groups of women, each gleaning on her own, bantering back and forth with her neighbors, joking, gossiping and sharing community news. On particularly hot afternoons, I would see women gathered together in small groups, sitting up to their waists in the water, nonchalantly searching for clams with their hands or washing and sorting *limu* while visiting with their friends. And on one occasion I even witnessed a young married couple gleaning hand-in-hand from the tidal flats together at sunset.

In interviews with Vai and Elita Tupou they informed me that in Tonga [as in most places in the Pacific (South, 1995)] those who harvest *limu* usually collect only the upper shoots of the plants, leaving the stolons to regenerate. Sometimes the entire plant is collected, but during the cleaning process the stolons are broken off and returned to the sea. While they could not come up with an exact schedule for rotating harvesting sites, they felt that most *limu* areas were harvested on a rotating basis with approximately 3 - 4 weeks between each cycle in order to allow regeneration of shoots. This information is similar to South's data gathered in Fiji about crop rotation (South, 1993; 1995).

From the days and months I spent in the tidal flats observing women gleaners, I perceived the following factors that seem to affect the number of women fishing/gleaning on any

given day: time of day of the low tide (associated with the highest number of women fishing), and high tide (when there is the lowest number); weather conditions; and day of the week. Low tide occurs on a 12-hour cycle occurring approximately 50 minutes later each day. When the low tide coincides with early morning hours, or other times of day that are normally spent on meeting family needs, there are few women gleaning. On the other hand, when low tide occurs later in the morning or after family obligations are met, a higher number of women are able to participate in *fangota* (Figure 8). As noted, *fangota* is a highly social activity and many women find this time convenient to associate with friends and promote camaraderie among neighbors. When low tide occurs in late afternoon or evening the tidal flats frequently become the location for family gatherings and picnics. Young children, both male and female, accompany their mothers and join them in their gathering activities or simply play along the beach while their mothers work. Fathers/husbands also occasionally accompany their wives and children to the tidal areas and spend their time fishing using nets and spears. Children learn the ways of their parents by following along and participating with them in their various activities. For example, on several occasions I observed Siteti Tupou's young sons accompanying him to the tidal areas where they helped him deploy the fishing net, beat the water driving the fish into the net and then gather in the net and kill the captured fish by biting their heads.

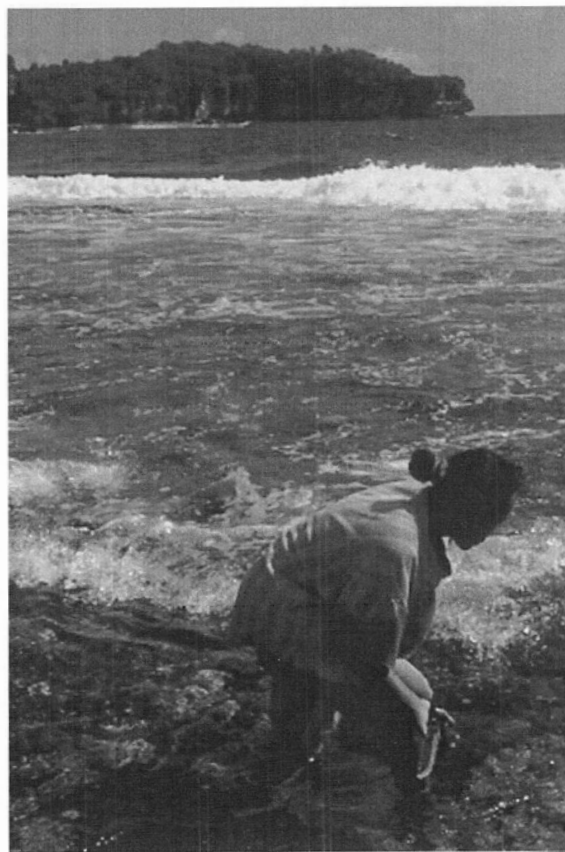


Figure 8. Women doing Fangota.

Pauline Fakahua Moalae, from Oloua, reported that it is not good to go too early in the morning because “there is a fish called *nofu* (stone fish), it can sting you and it hurts badly. Sometimes around noontime the *nofu* has gone elsewhere and that is when most people go to get *limu*.” Weather also affects the numbers of people gleaning or fishing. Obviously, if the weather is poor people stay home, and vice-versa if it is good weather. The day of the week also is a factor in determining numbers of fishers. On Sunday, it is a national law that the Sabbath is strictly observed and no work-type activities occur – even the travel books warn travelers that no work takes place on Sundays and to be prepared for everything to be shut down (Stanley, 1999). Saturday mornings are usually spent at the public market in the main town of Neiafu. Most of the morning is spent in some sort of shopping or selling activity. However, by noon the entire town is closed down and families return to their homes to prepare for Sunday. If the tide is right in the afternoon this will be a good time for fishing and gleaning activities, otherwise no fishing will take place on that day.

In 1875, when Tonga’s first constitution was written, there were no specific laws drafted regarding the use of tidal areas, other than to declare all beach frontage from 50 feet of high water mark belongs to the government of Tonga (Constitution of Tonga, Clause 119; c.f. Malm, 1999:363). According to all of my informants, the use of any waterway or tidal flat area for fishing is open to anyone from anywhere. However, despite this information, my interviews and direct observations indicate that there are distinct social rules associated with use of tidal flats. Villagers living adjacent to tidal areas possess a social right to glean food there. People coming from other villages to fish or glean must

normally be accompanied by relatives or friends from the nearby village. Hill (1978) reports similar actions from American Samoa. He notes that even though all submerged lands and reefs belong to the government, Samoans act as if the water areas near their villages are their own property, and fishing by outsiders takes place only on the outskirts and even then only with approval from the adjacent village.

4.4 A Change in Women's Roles

Prior to the establishment of western models for education, young women would work alongside their mothers, grandmothers, aunts and elder women of the village, learning not only how to *fangota*, but also all the skills deemed necessary to becoming a good wife and mother. These skills would include weaving, washing, cooking, traditional dances and etiquette. Throughout the formative years of 5-16 this form of education would be the equivalent of an intensive apprenticeship. The accumulated observations of many generations would be passed on to the next generation. In contrast to the past, young women today spend most of their time incurred in "western style" schools with a British-based curriculum. While many young women will still *fangota* with the elder women of their family, the regular and more intensive time for harvesting in tidal flats has been interrupted by attendance in government and private schools six to eight hours a day five days a week.

Although the majority of young women gain an academic education with the hopes of furthering their economic status and earning potential, very few actually achieve this goal. There were 7660 females in Vava'u in 1996. 1958 females were employed during this year, but only 5% of these were employed in jobs requiring an education, other than on-site training. Typical jobs are low paying such as clerking, sales and service industry. A staggering number (70.4%) of female employees worked exclusively in tourism or the traditional craft industry (S.D., 1999).

Sela and Ofa Lisala, 21 and 19 years of age respectively, are sisters who each attended school until they graduated. Both attained first class scores (A's and B's). While they were each trained in traditional household chores and methods, the majority of their time was spent doing school homework. Upon graduating from high school each secured a job at a local store, earning 92 cents an hour. Both girls work in the store from 7 a.m. until 4 p.m., six days a week. Sela, who has been working at the store for three years, earns \$88 a week, while her sister Ofa, who has been working for one year, earns \$50. Both sisters contribute most of their weekly pay to their parents in order to help with family needs. When interviewed about their jobs, each girl mentioned that she had attended school so that she could get a good paying job. Sela and Ofa both agreed that upon marrying, they would quit their jobs in order to be good wives and mothers.

I have observed over the past decade while researching in Tonga that most of Ofa and Sela's responses typify the majority of young single women. There are several factors that may influence this situation. First of all, as mentioned earlier, it is inappropriate for young single women in Tonga to be on their own. Second, not only is the wage earned

by single women meager to begin with, but also it is rarely their's alone to deal with. Instead, most if not all, of a young woman's wages will go to her family. And finally in Tonga young women's identity and self-respect is gained through accomplishing traditionally affirmed activities, such as schooling and marriage. Thus, the need for continual learning of the traditional arts, such as *limu* harvesting, is still a valid and necessary skill for many young women to learn.

4.5 *Limu* as Food

While *limu* are very nutritious, relatively abundant and easily harvested, my interviews and surveys indicate that in Tonga *limu* consumption does not really play a significant role in the diets of most Tongans. The families who rely on *limu* the most live near tidal flat areas and have easy access. It is these families that consider the tidal flat to be what Matelita Tupou referred to as a "living seafood banquet." Most adults throughout Vava'u seem to have fond memories of collecting and eating many varieties with their mothers on a regular basis. Several informants remembered eating a different type of *limu* as "famine" food during times of drought or environmental stress, but unfortunately they were unable to identify the exact species they relied on. However, this seems to have changed as the increase of imported goods and the expanding capital market impact Tongan culture. Whereas traditionally Tonga was completely self-sufficient on food, nowadays Tonga imports millions of dollars worth of food (Kingdom of Tonga, 1991). Much of the imported food is high in fat, sugar, salt and calories. In 1989, 196 tons of

canned fish , 502 tons of corned beef and 2,036 tons of mutton flaps were imported (Kingdom of Tonga, 1991).

The same families that consider the tidal flats as a banquet, refer to *limu* as the “poor man’s meat” because usually only the poorer sector relies on it as an important part of their families’ diet. Others, like Luisa Tu’iniua, eat it only occasionally as a delicacy.

In order to assess the amount of *limu* consumed in Vava’u, I conducted a survey with 200 women between the ages of 20 and 50 (the prime age to *fangota*) from ten villages (Figure 9) (see Appendix 3 for the complete “ten village” survey). Results of the “ten village” survey indicate that of the 200 women questioned, 88 women went to the tidal flats 114 times the previous week. Out of 114 trips made to the sea, *limu* was collected 24 times or 21% of the time. The average amount of *limu* collected during a trip to the tidal areas was approximately 1 kg for family use. An average of 44% of the women polled went to the sea to *fangota* the previous week. Since there are 2634 women between the ages of 20 and 50 in Vava’u (S.D., 1999) and 44% of them went to the sea each week (1159), 21% of them would gather a kilo of *limu*. This would be 12,656 kg of *limu* per year. In addition to purely subsistence consumption, fresh *limu* was also sold in the markets on weekends (only *Caulerpa racemosa* is sold regularly in the market). Approximately 20, 2-kg packages were sold each week for \$1-2 Tongan *pa’anga*. If you add the 40 kg sold every week in the market (1180kg/p/year), this translates into an average of 13,836 kg of *limu* consumed per year in Vava’u. The population of Vava’u is 15,715, and assuming each person were to consume an equal amount of *limu* they would average .88 kg/year per person (Figures 10 and 11).

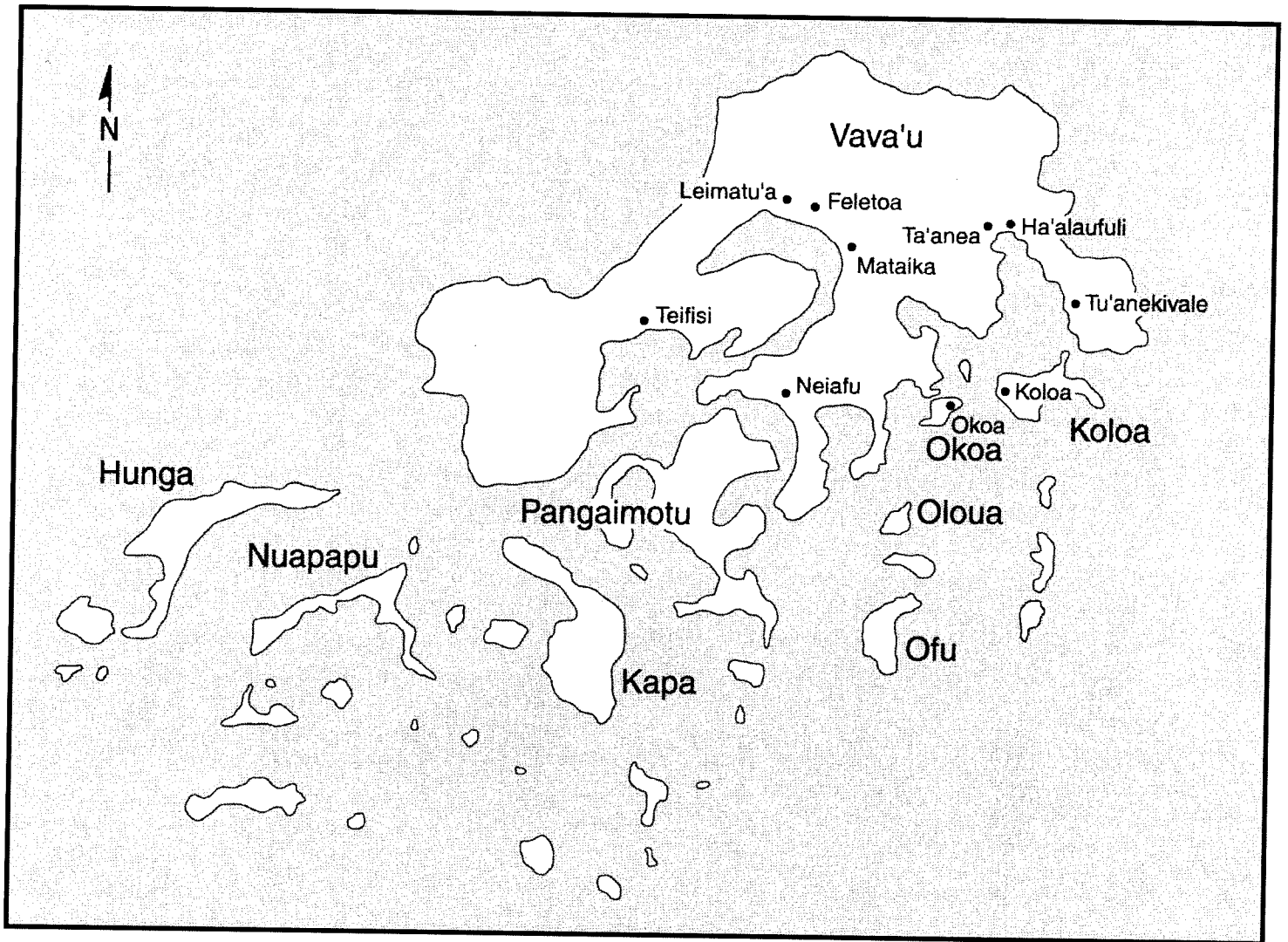


Figure 9. Map of Vava'u showing the name and locations of the ten villages surveyed.

Gleaners and Limu Collectors

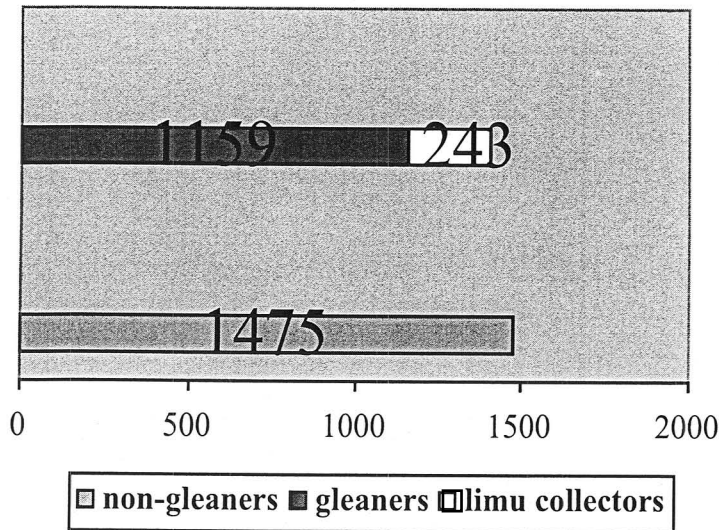
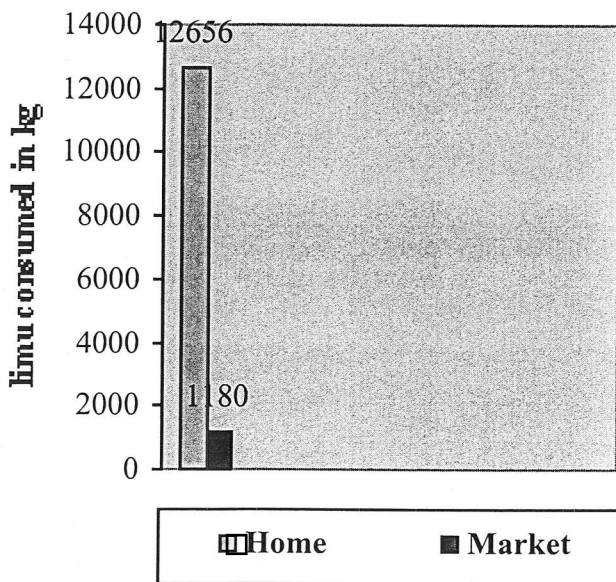


Figure 10. Numbers of women (age 20–50) who gleaned the 1st week of March, 2001 or the 1st week of Sept. 2001, and those who also collected *limu*.

a. Home vs. Market



b. General Public vs. Family near Tidal Area

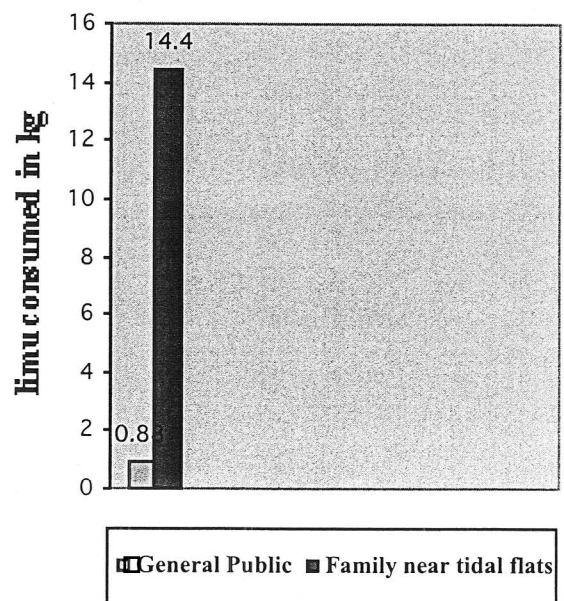


Figure 11. The amount in kg. of *limu* consumed a. at home vs. purchased at the market and b. the amount in kg. of *limu* consumed per/person per/year by the general public vs. a family near the tidal flats.

The above information is calculated for the entire population of Vava'u, but if a family who relies on the tidal flats for their nutritional needs is the focus, the results are slightly different. I directed my study to *limu* harvest and use by one particular family in the village of Okoa. The Tupou family, which is actually two families, consists of two brothers and their families living next door to each other. Siteti and Elita have ten children. Some of the older children are not always at home, but cousins or friends occasionally live with them as well. Tahiuia and Vai also have ten children, but again, some of their children are not living at home. The two households combined usually consist of roughly 20 members. They occasionally supplement their diets with commercial foods but exist almost entirely on a subsistence level. Both brothers farm the land, and Siteti, the older brother, is also proficient in net fishing. The wives and some of the older daughters often work together to gather and collect food from the tidal flat areas. For the most part, all of the food collected is shared between the two families. The Tupous chronicled all of the food they gathered from the tidal-flats for one month. They indicated what was collected, who collected it and how much it weighed in kilograms (Appendix 6).

For the entire month of October 2001, the Tupous reported collecting a gross weight of 286.2 kg of seafood. This included fish, molluscs, crabs, shellfish and *limu*. *Limu* accounted for 8% of the total weight. When one considers only the portion collected by the women (molluscs, shellfish and *limu*), *limu* accounted for 17%. However, these percentages are skewed because the gross weight includes shell, bones and other non-edible portions of the shellfish, whereas the entire quantity of *limu* collected can be consumed. The family gathered a total of 23.9 kg of *limu* during the month. If this

amount were projected over the entire they would collect approximately 288 kg of *limu* per year. Since the family consists of approximately twenty members, this translates into 14.4 kg of *limu* consumed per person per year living near tidal flats. Compared to the general public overall average, from the Ten Village Survey of 1.1kg per person per year, this represents a significant increase (Figure 11). However, we must keep in mind that *limu* collection and consumption is not always consistent. Some months when *limu* is abundant and easy to locate and harvest (May through September), more is eaten; and in the warmer months (December through February) when it is sparsely distributed it is eaten less. Preparation of noontime meals for school aged children, rough weather, tidal cycles, or other commitments may also effect the amount of *limu* harvested and consumed at any given time. Since October is in a shoulder season – neither high nor low – it is a fairly average representation of the entire year.

While seafood gathering from the reef continues to be an important part of many families' lives the number of people relying on it for their family's nutritional needs is dropping. A survey conducted in 1982 (Fleming and Tukuafu, 1986) shows that nearly all women in the rural areas living near tidal flats went reef fishing and gleaning on a regular basis. However, in 1986 when the same survey was repeated, only 79% of the women surveyed carried out gleaning activities with any regularity. Women surveyed in my studies as of 2002, show only a 44% activity rate for gleaning and fishing (Figure 12).

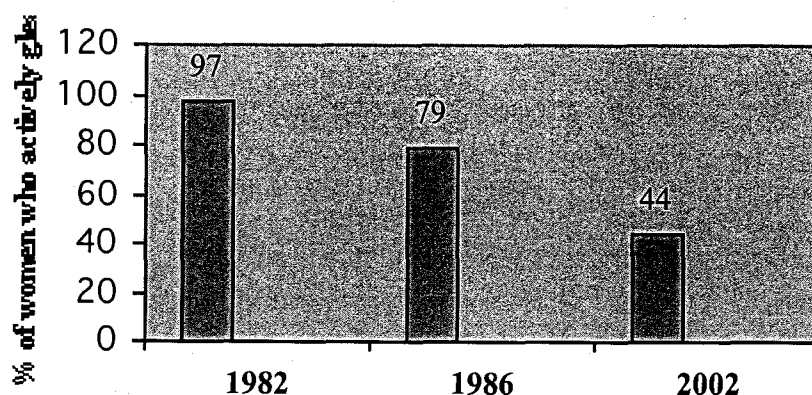


Figure 12. Percentage of women in Vava'u regularly carrying out gleaning activities over the past twenty years. Data sources: Fleming and Tukuafu, 1986; Ostraff Ten Village survey, 2001.

In order to establish what types of food are being consumed by young adults in Vava'u, I surveyed ninety-six high school students' about their eating habits. Data were recorded for one week during the school year in 2001 (Appendix 5). The survey indicated that the majority of students consumed imported fast foods and sweets during the weekdays, but ate a considerably more traditional diet of foods from the family farm on the weekends. When considering a full week, students from this survey attending secondary schools consumed 47% traditional Tongan foods and 53% imported foods. Twenty-six percent of the imported foods consumed could be classified as "junk food" (chips, ice cream, soda pop etc.). The results from this survey indicate that while traditional foods continue to play an important role in the staple Tongan diet, traditional foods such as *limu* are being overshadowed by the popularity of imported foods.

Upon my return to Tonga in June of 2002, I undertook a study of the outdoor market in Vava'u (Appendix 8). I recorded the name and village of each seller of *limu* and how many packets they brought to sell each day. A few buyers (14) were interviewed, noting

their reasons for buying *limu* and frequency of purchases. A surprising increase, compared to the previous year, in the marketing of *limu* was noted at this time. An average of 21 packets of *limu* was sold every day, as compared to the previous year when only 20 packets per week were sold. Two reasons were given by sellers/buyers for this increase. First, it was between the months of May and September, the peak season for *limu fuofua*, and second, due to the recent heavy destruction caused by a major cyclone that hit Vava'u in January of 2002, most residents of Vava'u were short of money. When money is short, more people consume *limu* because it is a healthy, inexpensive substitute for meat.

The most common method for consuming *limu* is raw, but there are also other methods for preparing *limu* (see Appendix 9 for some samples of recipes). While each type of *limu* can be eaten plain, the most common manner of eating *limu*, other than raw, is prepared in some sort of a simple recipe, often in combination with coconut milk. An example of one such method follows. On one occasion we (my husband, two research assistants and myself) spent the afternoon with Pauline Moalae from the island of Oloua. We spent the morning looking for and collecting *limu vai*. Upon our return to the island we accompanied Pauline to her outdoor kitchen. She demonstrated how to wash and prepare the *limu* for cooking. She filled a large pot about half full of water, and then added the freshly washed *limu* until the pot was full. The pot of *limu* was then placed over the fire and brought to a boil. The brown *limu vai* slowly turns to a bright avocado green color as it cooks. Pauline added a chopped onion and about two tablespoons of curry powder. When the *limu* was completely dissolved in the water and had turned to the consistency of thick soup, it was removed from the fire. The thick avocado green

mixture was immediately poured into a dish to cool. We were served the *limu vai* “soup” for lunch accompanied by boiled taro roots. It was a very simple but delicious and memorable meal. Pauline said that the mixture is either eaten hot like soup, or cooled and cut into individual portions and served as a “pudding” (Figure 13).

4.6 Medicinal Applications

D.M. Kaaiakamanu and J.K. Akina (1922), employees of the Board of Health of the Territory of Hawaii, reported some early medicinal uses of algae from the early 1900s. They recorded seaweed being used for menstruation problems, mouth sores or ulcers, the removal of white blotches on the skin, congestion, muscle sprains or soreness, prevention of miscarriage, asthma and to make children stronger. While we may make the assumption that marine algae may have been used for these or similar purposes in early Tonga, no documentation exists to substantiate this. Consultants familiar with current medicinal uses of *limu* in Tonga were only aware of using *limu* to strengthen young children and babies, but none of the other above remedies were mentioned

Over the past 50 or so years the diets of Pacific Islanders has been shifting away from their traditional healthy diets based on food crops grown, animals raised and fresh fish and shellfish caught from the nearby sea (Martin, 1991 (1817); Dalzell, 1998; Spennemann, 1986; Coyne, 1984). In general their diet was low to moderate in calories, moderate to high in protein, high in carbohydrates and fiber and adequate in vitamins and

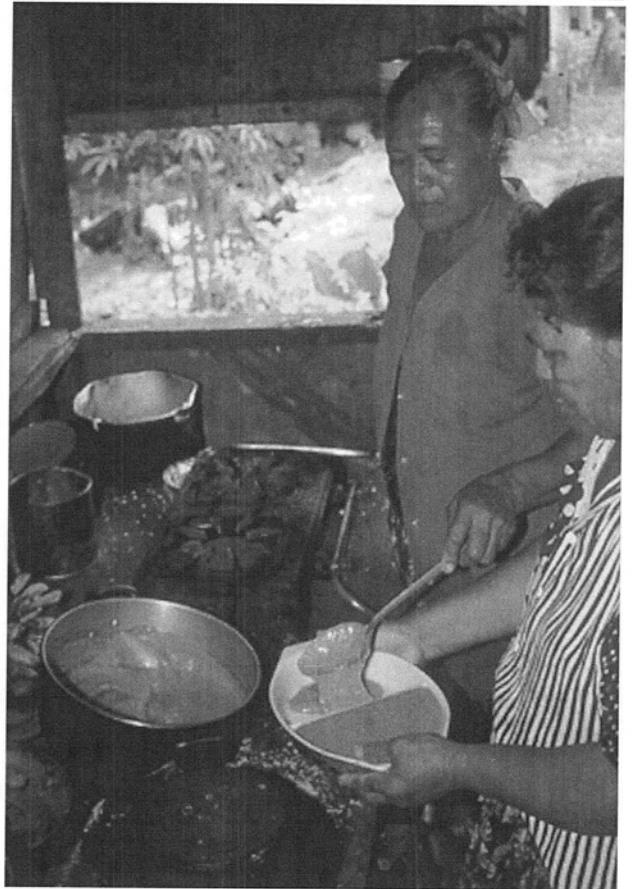
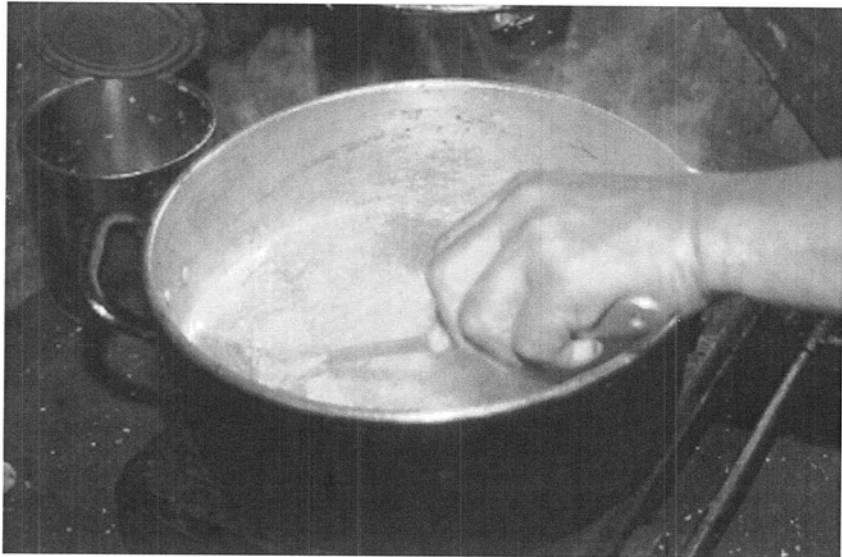
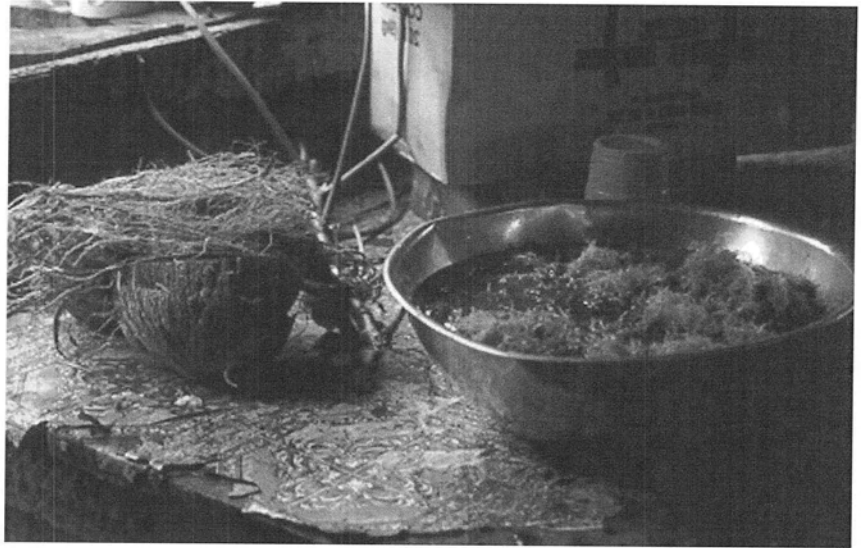
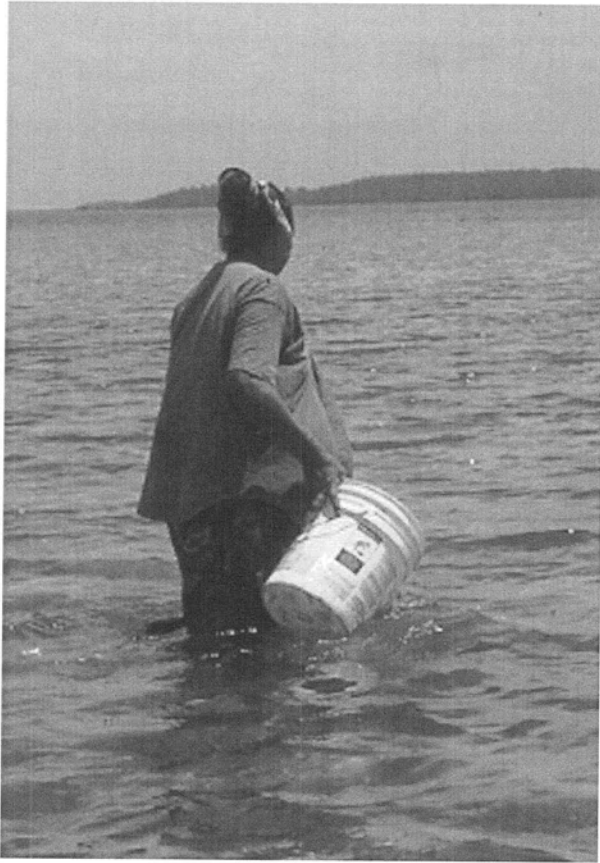


Figure 13. Limu vai being prepared and cooked into custard.



minerals (Coyne, 1984). Captain James Cook noted in his journals from his visits to Tonga,

they seem to be as free from disease as any Nation whatever, I neither saw a sick or lame person among them, all appeared healthy and strong, a proof of the goodness of the climate in which they live. They had fine eyes and in general good teeth even to an advanced age (c.f. Coyne, 1984:7).

Today in Tonga, many islanders are shifting their diets away from the traditional root crops of taro, yam and sweet potatoes and replacing it with low fiber substitutes like white flour and rice. Canned meats are replacing fresh seafood and the consumption of sugar, salt and fat has increased tremendously (Coyne, 1984). With this shift in diet patterns, comes an increase in degenerative diseases such as diabetes mellitus, hypertension and coronary heart disease. The Kingdom of Tonga is well aware of the problems associated with this change in diet. Health authorities are promoting increased exercise and a diet low in salt, sugar and fat, but high in fiber (Kingdom of Tonga, 1991) in the hope that the incidences of obesity, which is a leading factor in all of the above health issues, can be lowered.

Today there is a slow upswing in the popularity of *limu* in Tonga as a nutraceutical (plants used for both food and medicine) due to information being circulated by Western trained medical personnel about the benefits of seaweed to those with high blood pressure, diabetes and heart conditions. Taufa Ahau Tupou Fa, King of Tonga, who suffers from

all of the above health problems, quite often requests that women in Vava'u pick his favorite varieties and send them to him (Sina Feituani, personal communication, 1997). Traditional healers and midwives continue to recommend the consumption of *limu* to those with low iron and new mothers whose milk has not come in and/or to stimulate greater milk production (Mele Mahi; Sina Feituani; Kolo Tonga; Kiu Anitoni; Lamona Tongia). Healers have also recommended *limu fuofua* to help cure hepatitis (Sina Feituani). See Table 5 for a list of medicinal uses of seaweed common to the South Pacific.

Table 5. Medicinal Uses of *Limu* (adapted from Novaczek, 2001, with my own research incorporated).

Condition	Prevention or Remedy	<i>Limu</i> used *known Tongan name	Tongan name
Anemia (lack of iron)	Eat <i>limu</i> rich in iron	<i>Ulva</i> , <i>Acanthophora</i>	
Blindness from Vitamin A deficiency	Eat green <i>limu</i> rich in vitamin A	* <i>Caulerpa</i> , <i>Codium</i> , <i>Enteromorpha</i> , <i>Ulva</i>	<i>fuofua</i>
High blood pressure	1) Eat <i>limu</i> containing blood pressure lowering compounds such as laminine 2) Substitute dried, crushed <i>limu</i> powder for salt (it has more	1) * <i>Caulerpa</i> , <i>Dictyota</i> , <i>Sargassum</i> 2) <i>Sargassum</i> , <i>Turbinaria</i> , * <i>Padina</i> , <i>Dictyota</i>	1) <i>fuofua</i> 2) <i>telinga</i>

	has more potassium and less sodium)		
High blood cholesterol	Eat sources of carrageenan, fucosterol and alginate	<i>Sargassum, Turbinaria, Dictyota, *Padina, Colpomenia, *Cladosiphon, Eucheuma, Acanthophora, *Hypnea</i>	<i>telinga, tanga'u, limu vai</i>
Bronchitis and chronic chest infections	Drink a tonic made with carrageenan jellies	<i>Eucheuma, Acanthophora, *Hypnea</i>	<i>limu vai</i>
Burns (or coral scrapes, cuts and other wounds)	1) Apply a compress made of large brown <i>limu</i> : crush or chop the dried plant; moisten and mix with a small amount of fresh, clean water until it feels slippery; and apply as a compress to the wound (fresh <i>limu</i> may be used - without the added water - if dried plants are unavailable) 2) Use a compress of <i>limu</i> with antibiotic properties to reduce risk of infection	1) <i>Sargassum, Turbinaria, *Padina, Dictyota</i> 2) <i>Ulva, Enteromorpha</i>	<i>telinga</i>

Cold or flu	1) Drink fruit juices boiled with <i>limu</i> that contain carrageenan 2) Eat <i>limu</i> rich in vitamin C.	1) <i>Eucheuma</i> , <i>Acanthophora</i> , * <i>Hypnea</i> 2) * <i>Caulerpa</i> , <i>Gracilaria</i> , <i>Ulva</i>	1) <i>limu vai</i> 2) <i>fuofua</i>
Constipation	Eat any <i>limu</i> containing agar or algin	<i>Gracilaria</i> , <i>Gelidiella</i> , <i>Sargassum</i>	
Diarrhea	Eat any carrageenan containing <i>limu</i>	<i>Eucheuma</i> , * <i>Hypnea</i>	<i>limu vai</i>
Diabetes	Eat <i>limu</i> that lowers blood sugar	<i>Eucheuma</i>	
Goiter, gout	Eat or make tea from <i>limu</i> having a high iodine content	<i>Asparagopsis</i> , <i>Sargassum</i> , <i>Turbinaria</i> , <i>Hydroclathrus</i> , * <i>Padina</i> , <i>Colpomenia</i> , <i>Ulva</i>	<i>limu vai</i>
Heart disease	1) Reduce blood pressure using natural sources of anti-hypertensive compounds 2) Reduce blood cholesterol by eating sources of carrageenan and alginate 3) Eat <i>limu</i> with vitamin B12 to help prevent hardening of the arteries 4) Thin the blood by eating natural	1) * <i>Caulerpa</i> 2) <i>Eucheuma</i> , <i>Acanthophora</i> , * <i>Hypnea</i> , * <i>Padina</i> , <i>Dictyota</i> 3) <i>Codium</i> , * <i>Caulerpa</i> , <i>Enteromorpha</i> , <i>Ulva</i> 4) <i>Sargassum</i> , <i>Turbinaria</i> , * <i>Padina</i> , <i>Dictyota</i>	1) <i>fuofua</i> 2) <i>limu vai</i> , <i>telinga</i> 3) <i>fuofua</i> 4) <i>telinga</i>

	sources of fucans and laminarin	<i>*Padina, Dictyota, Colpomenia</i>	
Memory loss, mental confusion	Eat <i>limu</i> rich in micronutrients	<i>All species</i>	
Obesity	1) Eat <i>limu</i> rich in iodine, to stimulate the metabolism 2) Make tea from brown <i>limu</i> containing iodine 3) Eat carrageenan and agar jellies that fill you up but provide few calories 4) Use carrageenan to thicken gravy and stews	1) <i>Sargassum, Turbinaria, Dictyota, Asparagopsis</i> 2) <i>Sargassum, Turbinaria</i> 3) <i>Eucheuma, Acanthophora, *Hypnea, Gracilaria</i> 4) <i>Eucheuma, Acanthophora, *Hypnea</i>	3) <i>limu vai</i> 4) <i>limu vai</i>
Osteoporosis	Eat <i>limu</i> rich in calcium	<i>*Padina, Enteromorpha, Gelidiella</i>	<i>telinga</i>
Poisoning by heavy metals or radioactivity	Eat large brown <i>limu</i> containing algin	<i>Sargassum, Turbinaria</i>	
Pregnancy	Eat <i>limu</i> rich in folic acid to avoid birth defects	<i>*Caulerpa, Colpomenia, Dictyota, Hydroclathrus</i>	<i>fuofua</i>
Rheumatism	Eat <i>Caulerpa</i>	<i>*Caulerpa</i>	<i>fuofua</i>
Shellfish poisoning	Eat <i>limu</i> containing carrageenan to	<i>Eucheuma</i>	

	remove saxitoxin		
Skin conditions	Improve skin health by eating <i>limu</i> rich in vitamin E	<i>Enteromorpha</i> , <i>Ulva</i>	
Sore throat	Drink fruit juices boiled with <i>limu</i> that contains carrageenan	<i>Eucheuma</i> , <i>Acanthophora</i> , * <i>Hypnea</i>	<i>limu vai</i>
Stress	1) Eat <i>limu</i> rich in B vitamins 2) Put steamed <i>limu</i> in your bath and soak in the minerals	1) * <i>Caulerpa</i> , <i>Enteromorpha</i> , <i>Ulva</i> 2) <i>Sargassum</i> , <i>Turbinaria</i> , <i>Dictyota</i>	<i>fuofua</i>
Stroke or blood clots tumor, cancer	1) Thin the blood by eating <i>limu</i> rich in carrageenan. 2) Eat <i>limu</i> known to contain compounds with anti-tumor activity	1) <i>Eucheuma</i> , <i>Acanthophora</i> , * <i>Hypnea</i> 2) * <i>Hypnea</i> , <i>Codium</i> , <i>Colpomenia</i>	1) <i>limu vai</i> 2) <i>limu vai</i>
Urinary disorder or infection	Eat carrageenan jellies	<i>Eucheuma</i> , <i>Acanthophora</i> , * <i>Hypnea</i>	<i>limu vai</i>
Ulcer	Eat bland, soothing carrageenan jellies	<i>Eucheuma</i> , <i>Acanthophora</i> , * <i>Hypnea</i>	<i>limu vai</i>
Worms	Eat <i>limu</i> containing de-worming compounds	<i>Codium</i> , <i>Ulva</i>	

4.7 Commercial Farming and Exportation of *Limu*

Three commercial *limu*-farming ventures have taken place in Tonga since 1981.

Eucheuma farming was tried unsuccessfully in the past, but is now being reintroduced as a possible commercial product. An American company recently (2001) launched a full-scale promotion of a new health food product they are calling “Royal Tongan *Limu*” (now called *Limu* Moui). It is an elixir made from seaweed found in Tonga, *limu vai* (*Hypnea* sp.). They claim their elixir fortifies and protects the body against a whole host of diseases including acid reflux, diabetes, high blood pressure, cancer and even insomnia (Seekamp, 2003). However, due to conflicts between the Tongan government and “Royal Tongan *Limu*,” they were shut down and not allowed to operate in Tonga. The third and most successful enterprise is the harvesting and farming of *limu tanga’u*.

Limu tanga’u has been harvested in Tonga and sent to Japan, where it is known as *mozuku*, since 1996. Until 1998 it was only exported on a trial basis, with only a few tons being dispatched. After 1998 it became a full-fledged endeavor. Government records show that in 1999 and 2000, 272,188 kg and 313,515 kg respectively of *limu tanga’u* was exported to Japan. Mr. Chinchoe, managing director of Seastar Fishing industry, reported that in 2001, due to a drop in the market, only 100,000 tons of *limu* was collected. There are currently two companies in Tonga that farm *tanga’u* on a commercial basis: H and H company and Seastar Fishing Industry. H and H Company is relatively small, producing only 100,000 – 200,000 kg per year, while Seastar is a bit larger, usually averaging 200,000 - 400,000 kg per year. In March, lines are put out in the water to collect “seeds”. The lines are then brought back to an incubating area where

they are immersed in flowing water for 10 days. Once the “seeds” have grown to a certain stage, they are attached to nets, which are then put back into the sea. *Tanga'u* grows only during the cooler season. Water temperatures must not exceed 26° C. Harvesting usually takes place in September, approximately 90 days from the time the nets were first put into the sea. Seastar's farm is located just off the shore of Navutoka. It meets all the parameters for “a good farm” (Taniera et al., 1994). The area is somewhat isolated; it has good wave action, but not at the destructive level. It is conveniently located, and easily accessed at low tide. Predators such as rabbit fish and sea turtles are scarce and it has a low level of epiphytes (other types of seaweed that would grow on and contaminate the crop). Unlike many inner-reef areas, it is not known for its rich abundance of marine plant and animal species. This area is however, ideal for growing *tanga'u*, producing *limu* that is smaller but denser than other areas (Holomesi Teumohenga, Seastar local director, personal communication, 2002). This denser *limu* is ideal for harvesting, storing and shipping to the Japanese markets because the denser *limu* yields a superior product once it is dried. The harvested seaweed is salted and stored in large containers, until it is shipped to Japan where it undergoes drying and processing.

Seastar Industries, owned by the Crown Prince of Tonga, farms most of their product, but also purchases gathered seaweed from locals. In the past (1996 – 2001), local collectors were paid 17.5 cents/kg for cleaned seaweed and 7 cents/kg for unclean seaweed. Seastar sells it to Japan for US\$ 10 dollars/kg. The product is then processed and packaged and sold to global markets for US\$ 3 dollars/4.8oz. Which is equivalent to T\$ 29.40 dollars/kg, or about 117 times the value paid to local collectors (FSR, 1998). Holomesi

Teumohenga, local director for Seastar, says that they now (2002 – 2003) pay local collectors 60 cents/kg for cleaned *limu*.

Very little research has been done to date on the impact harvesting may have had or may yet have upon the environment and future growth of *tanga'u*. A preliminary survey was conducted in 1996 to estimate the standing biomass of *tanga'u* in Tongatapu, Ha'apai and Vava'u (FSR, 1998). However, this survey took place during the off-season and in the end was only conducted to assess *Cladosiphon* crop distribution rather than abundance or productivity. A more detailed survey was supposed to be conducted during the next growing season, but for unknown reasons was never undertaken and thus there is no good estimate as to the abundance or sustainability of this resource (FSR, 1998).

Seaweed farming in Tonga is not new. *Eucheuma* farming was tried in the early 1980's, but was unsuccessful due to low market prices, fish grazing and a disease called "ice ice" (FSR, 1998). Despite past failures, Silika Ngahi, Officer in Charge of Fisheries in Vava'u, is conducting a new feasibility study for the farming of *Eucheuma cottonii* and *Eucheuma spinosum*. The variety of *limu* they are working with comes from Fiji, where it has been successfully grown for commercial production. Small pieces are tied onto a rope at about 30-cm intervals (Figure 14). The rope is then submerged, allowing the plants to grow for several months until they are harvested. Harvested pieces are sun dried until they are flat and completely dry. The dried pieces are bailed and sent to Asia where they are boiled and processed for the agar. During the course of my conversation with Silika Ngahi, she mentioned that with the higher market prices for commercially grown vanilla and *kava*, people have shown little interest in farming *Eucheuma*. As of yet they

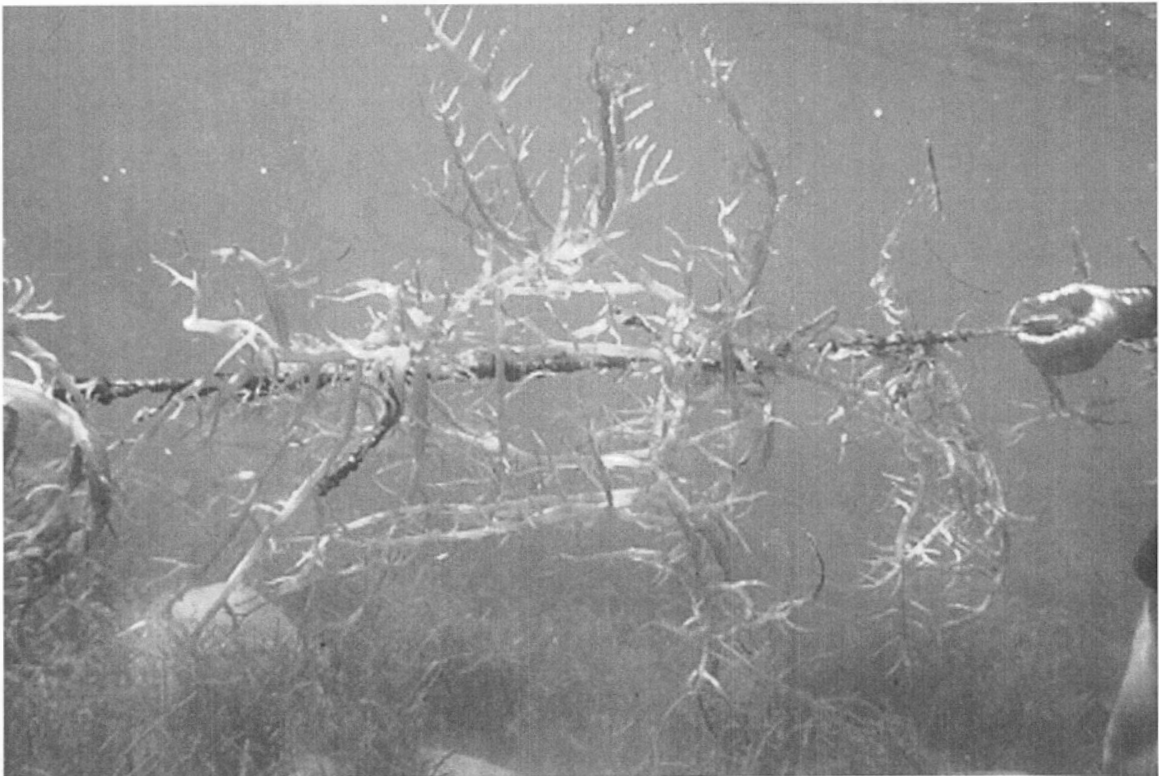


Figure 14. *Eucheuma cottonii* farming in Vava'u.

do not have a regular buyer, but the Director is pursuing leads. The Fisheries Department will be in charge of the farm, until it becomes developed enough to turn it over to a private company. The successful commercialization of *limu* is a relatively new phenomenon in Tonga. The sustainability issues and the impact on the environment need to be assessed and evaluated, especially in the context of the lives of those families who, we saw from above, depend on the tidal flats for their daily needs. The next chapter outlines influences that affect *limu* harvesting not only on a commercial basis, but also on an individual level.

Chapter 5 Discussion

Tonga is unique among Pacific Island communities as it has the only existing monarchy with chiefly bloodlines that can be traced, orally, to the time of Captain Cook and found in written form from then on, through particular high-ranking family lines from the first Chiefs to the present day King (Bott, 1982; Campbell, 1992). The duality of such long standing authority and respect, combined with changing and adapting views as a result of: the introduction of Christianity, the introduction and increasing presence of western commodities, and the large number of Tongans living and being educated abroad, impacts all aspects of life in Tonga today, including *limu* harvesting and use.

In this Chapter I link data and information presented in previous chapters with the above factors, as they impact gender, education, conservation, contemporary mores and commercial farming, and ultimately how they impact my two main research objectives which are: To assess the current uses and cultural roles of *limu* in Tongan society, and to explore the relationship among *limu* knowledge, women's indigenous knowledge, and sustainable use of the tidal areas.

5.1 Gender Roles and Issues

In a recent article about the socioeconomic status of fisherwomen in Tonga, Kronen (2002) documents, through information gathered in a survey, that a very high percentage

of men do reef gleaning activities (56%), and in one village (Mataika) more men reported reef-gleaning activities than women (90% vs. 82%). These results would seem to contradict my findings. In considering these extraordinarily high results, it is important that Kronen's particular methodology be considered. Her methodology consisted of administering surveys in several villages. She calculated her results based solely upon the outcome of these surveys. No personal observations were cited as part of her research. It is difficult to assess actual fishing/gleaning activities from a survey that does not complement survey findings with field observations. It has been my experience that answers to direct questions are influenced by several factors, including a desire to please, under or over-statement based on memory, and the ideal over reality.

In the case of men and women gleaning from tidal flats, there is no question that both are involved in such activities. Observation over the course of months and years places survey information into context. When asked if they participate in gleaning activities, men would often respond positively. This was the case in both Kronen's research and in my interviews. My observations indicate, however, that while men expert in fishing are aware of edible marine algae found in the tidal areas and occasionally reef glean, women are the real experts and are the almost exclusive collectors of *limu*. An example that illustrates the difference in knowledge levels between male fishers and local expert women gleaners occurred one day when a male Fisheries officer took me out in a boat to search for a particular type of *limu*. Pauline Moalae, a local women expert in collecting *limu*, accompanied us. Tekiteki, the Fisheries officer, said he knew where to go to collect the *limu*. He drove around and around looking for it. He would occasionally stop and point to a species of *limu* he thought was the correct species only to have Pauline shake

her head and tell him this was not the correct species and to keep looking. This went on for sometime until Pauline finally told Tekiteki where to stop the boat so she could get out of the boat and search on foot. It was not long before she had located the proper species of *limu* and we were then able to gather a whole bucketful.

Although my findings indicate a significantly lesser role of men in seaweed harvesting and gleaning, Kronen's findings do support the idea that such divisions of labor are fluid, with unique variations from person to person, family to family, and from village to village.

During a focus group discussion held in Oloua (Appendix 2), several of the women mentioned that the area around their island was ideal for growing *tanga'u* (*Cladosiphon* sp.). All of them have been harvesting and preparing *tanga'u* for most of their lives and all know when, where and how to gather and process it efficiently. They were shocked to learn via the radio, that Seastar Industries was hiring only men to harvest and sell *tanga'u*. The women voiced their concerns and frustrations about the fact that as women, they were being excluded from the commercial *limu* industry, while men, who generally know very little about actually harvesting *limu*, were being offered the opportunity to earn extra cash by collecting and selling it. Even though this initiative was not brought forward by their own husbands, women were especially offended because, as Matelita Tupou stated, not only were they the experts, but they knew all too well that quite often when men earn extra cash it is not spent on household or family needs. In contrast, when women earn extra money it is usually used for the good of the family.

In 1862 the King officially freed all Tongans, and all men were given hereditary land allotments. However, women were cast as homemakers or caretakers, active only in social matters; therefore, they ostensibly had no need of legal rights to land (Moengangongo, 1986; Pulu, 1980). Along these same lines, the policy to involve men and exclude women in commercial aquaculture ventures seems to be consistent throughout the South Pacific Islands. Information and techniques for cash products are consistently offered first to men by male fisheries officers and only much later, if at all, to women (Taniera, 1995; Slatter, 1994). On par with the rest of the South Pacific, local Tongan women continue to be excluded from the commercial *limu* industry. While a few men do collect *limu* in the wild (in the two years that I was doing research I only saw two men doing *fangota*), women carry out the majority of wild *limu* harvesting. Even though this is the case, and the Tongan Fisheries office has recommended via a published report (FSR, 1998), that women collect *tanga'u* because of their ability to collect the most suitable portions, Seastar Industries only advertises to men, and encourages men to go out and harvest *tanga'u* (Pauline Moalae, personal communication, 2001). This has resulted in a large percentage of material collected being deemed unsuitable and subsequently discarded, up to 70% in some cases (Fisheries Department official, personal communication, 2001).

In Tonga as well as throughout the entire Pacific, there has been an increase in the awareness of the significance that women play in any socio-economic system. However, “. . . women’s roles, particularly rural women’s roles are rarely taken into account in

planning and policy of governments and development organizations” (Fleming and Tukuafu, 1986:1). Throughout all of Polynesia, both men and women are, and were, involved in fishing activities. However, masculine fishing events throughout the Pacific, especially those involving nets, spears, canoes, lines and hooks, have traditionally had *tapu* associated with them, i.e. they were considered sacred, and women were not allowed near these items because they would have neutralized the *tapu* (Handy, 1932). Tueting (1940) reported this for the Lau Fiji people, where there were traditionally many *tapus* against women and fishing. He reports that during a big communal fishing event there were not as many fish caught as expected. The master fisherman’s excuse was that a pregnant woman had participated. If a pregnant woman within the first 100 days of a pregnancy participates, they believe, she would spoil any fishing. Currently men’s fishing activities also include commercial activities covering everything from small-scale artisanal fishing to industrial level fishing for export to large foreign markets. Women’s fishing activities are still usually considered to have little economic significance (Tuara, 1995) and are limited to subsistence and small-scale fisheries as well as invertebrates such as molluscs, crabs and sea cucumbers. They are also almost exclusively the collectors of marine algae (Matthews, 1995; South, 1993; Schoeffel, 1995). There is a substantial lack of women’s involvement in the development and running of projects such as aquaculture or other fishing/gleaning projects. Usually government/commercial projects involving fishing of any kind focus on deep-water fishing and ignore inner reef areas where traditionally women are the main users and harvesters (Fleming and Tukuafu, 1986; Slatter, 1994). Haniteli Fa’anunu, Director of Agriculture, Forests and Fisheries in Tonga gave the keynote address in a Report of a Consultation on the Role of

Women in Small-scale Fisheries in the South Pacific, Rural Development Center, USP in October of 1989. He states,

In the field of agriculture, particularly in Asian and African countries, we have a group of farmers called the “forgotten farmers.” There are poor farmers who are struggling for a living but never receive any direct assistance from Government and they are left to do their own thing. I am inclined to think that in fisheries there are also the “Forgotten Women Fishermen” or “Forgotten Fisherwomen.” In our economic endeavours to develop our fisheries, we think of big boats, sophisticated equipment, deep sea fishing, and now extending to “tuna fish wars” but forgetting our reefs where women are the main exploiters. They fish for shells, octopuses, sea urchins, sea cucumbers, seaweeds and many others for food and income. Many families with little or no land rely on our reefs for their livelihoods (Fa’anunu, 1990: 61-62, c.f. Malm, 1999:53).

All people in Tonga are ranked according to three categories: older is superior to younger; maleness is superior to femaleness; and sisterhood is superior to brotherhood (Gailey, 1987). The unusual custom of ranking sisters above brothers is called the “*fahu*” system. All of these categories combine into a unique arrangement, which entitles no two Tongans to have the same rank. In the past while the Tu’i Tonga or actual male leader has the greatest authority, he was out-ranked by his older sister and her eldest daughter. The Tu’i Tonga was not even allowed to sit while in the presence of his older sister nor eat with her or her eldest daughter (Beaglehole, 1967; Oliver 1989). Not only was this the case in the Royal family, but it was also the case for each family in Tonga; the oldest

sister outranked the oldest brother. This ranking system allowed women to be relatively autonomous. While wives were supposed to defer to husbands, sisters had authority over brothers; thus a wife could obtain something requested from one of her brothers' wives or from lower ranking sisters. A Chiefly man's title was inherited through his mother and was inferior to that of his sisters and their sons. Consequently, rank was more the issue than gender (Ralston, 1996). James Cook (Beaglehole, 1967: 108) recorded that to this utter astonishment, "a couple of lusty wenches step[ped] forth and without the least ceremony [fell] to boxing, and with as much art as the men." While lower ranking Tongan women were required to provide food and other services to women of status, those with higher status were allowed freedoms and privileges not accorded to many women of Polynesia.

British Methodist missionaries introduced a foreign God to Tongans and new forms of appropriate attire, family rituals and male and female relationships and behavior (Lockwood, 1993). Along with this they also established a new social and political hierarchy. On many levels the introduction of British values was complementary to traditional Tongan hierarchies. Politically, the introduction of Christianity lent support to King Tupou I's efforts to unify the three island groups and solidify his family line as the sole inheritor of the King's throne. For women, a complicated and traditional hierarchy found within the *fahu* system, which allowed women social authority and personal autonomy, shifted to the newly formed more restricted one. Not only were they considerably more confined, they also became generally subordinate (Gailey, 1987). They became more aligned with the rest of the Pacific in that a woman's status and

position was determined by her father or husband. A women's title no longer passed on to her children; and the *fahu* system was officially banned, removing a women's autonomy and forcing her to become dependent on her husband or father for her sustenance.

Women were also not allowed to be involved in high-level decision-making. They were only allowed to make decisions that directly involved their own homes and families (Bolabola, 1986).

These restrictions placed upon women over the course of the last two centuries have created a male-female hierarchy that exists to this day. Most women assume that because they are married, their husbands own everything, including their wives (Fonua, 2001).

"Tonga is the only Pacific Island country in which land legislation expressly discriminates against women . . . in order to retain a life interest in her deceased husband's [land] allotment, a widow is not permitted to remarry or to engage in sexual relations" (Fonua, 2001: 17). The Tonga Development Bank has a policy that states: "we do not approve loans for individual women as the only security they can offer are moveable assets," and if a woman applies for a loan it will be referred to her husband (Fleming and Tukuafu, 1986: 47). Thus women usually do not have access to money from lending institutions.

Pesi Fonua, a well educated female Tongan who is also a publisher and award-winning journalist, held an interview with Princess Nanasipau'u Tuku'aho, President of the Pan Pacific South East Asia Women's Association and a Patron of the Center for Women and Children in Nuku'alofa. In the interview, the Princess stated that she felt that women

should be involved in all levels of decision making (i.e. village, church, community and especially government). Women have different views and ideas from men; and yet these are never raised in the parliament. Women not only want to discuss issues, they want to do something about them (Fonua, 2001).

There is a high concentration of women in Nuku'alofa, the capital city of Tonga, from families with the means to educate their children abroad (most often New Zealand, Australia and the United States). These women have returned to Tonga with feminist ideals and standards gained abroad. In Nuku'alofa, the capital city, many of these women have organized into women's groups that focus on and reinforce pertinent concerns and issues regarding women's rights and roles in the community. Their three main areas of focus are: land tenure, physical abuse of women and business opportunities for women. They publish articles, hold community meetings and distribute pamphlets and questionnaires (Fonua, 2001). Nevertheless, once one is outside the capital, and especially off of the main island of Tongatapu, their views hold little weight and very little public discussion takes place concerning the roles and rights of women. Women living in these villages exhibit a discursive space between themselves and their husbands, expressed by subtle humor amongst other women while doing their work. This seems to be the only indication that there is any concern about these issues in the outlying areas.

Piecing together historical materials and comparing these findings with current trends indicates that there quite likely has always been a division between Tongan women who gather seaweed and those who don't. In the past, those with sufficiently high rank

required those of lower rank to provide *limu* for them. Today, it is not so much an issue of rank, but rather an issue of economic status. Those who can afford to purchase their food from others do so; and those who cannot afford it must collect their own. While it is extremely difficult to separate traditional Tongan culture from the influence of Christian missionization, first introduced in the early 1800's, it does seem that many rights held by women prior to western contact were altered or lost outright at that time. Historically, it was the high-ranking men who orchestrated official meetings with foreign visitors. It is hard to say whether or not western trends and the adjustments made regarding the *fahu* system through Christian missionization and other colonial processes have contributed to the current exclusion of women in commercial enterprises. In terms of commercialization and cultivation of seaweed, the privileging of men in the industry reflects the predominant situation in Tongan society, in which men predominate.

5.2 Education

As we will see in this section, there are many educational factors present in Tonga that can lead to the loss of traditional knowledge and the value placed upon them. Ohmagari and Berkes (1997), from their research among the Cree, have coalesced varying educational factors into four elements, which work against traditional knowledge acquisition. These elements seem to be ubiquitous to the loss of traditional knowledge not only amongst the Cree, but also in Tonga and quite likely globally as well. The four elements are:

- Changes in the educational environment and peer influence;
- Effects of the diminished time available to spend on traditional skills due to formal schooling and wage employment;
- Problems related to learning traditional skills at later ages, or delayed transmission; and
- Effects of changes in value systems.

Changes in the educational environment and peer influence

Meliane Tupou, the daughter of Vai and Tahiuva Tupou, dropped out of school when she was 14 because of lack of interest and funding. Meliane now spends most of her time with her mother and aunts gaining an intensified “traditional” education (Figure 15). This form of home schooling includes all the skills deemed necessary for becoming a “good wife” and “mother” someday. She has taken over many of the household responsibilities in her parent’s home, including food gathering from the tidal area. When I returned to Tonga in 2002, a year from the time when I first met the Tupou families, Meliane, now 15, had evolved from being her mother and aunts’ assistant in gathering seafood, to being considered a primary gleaner. Now when someone wants to locate a specific type of seaweed or other seafood, Meliane is the “expert” to whom they turn. She has also advanced in other traditional skills such as dancing, weaving and cooking. In social situations, which involve traditional skills, Meliane exhibits a superior level of grace and poise in comparison to her cousins who excel at “western” education. While some of her abilities may be attributed to her personality, I was able to observe a marked



Figure 15. Meliane collecting fod in the tidal area with her mother, Vai.

change from one year to the next. She had grown much more confident and self-assured as she gained more respect at home as well as amongst her peers. This seems to indicate that her traditional education allows her to find valid applications of her training, and thus is a positive force in her growth and development.

Effects of the diminished time available to spend on traditional skills due to formal schooling and wage employment

In Tonga, as elsewhere, children learn what is considered traditional knowledge by watching their parents and other adults around them. They imitate what they see. In this way, traditional knowledge is passed on from generation to generation. Children accompany their mothers and join them in their gathering activities or simply play along the beach while their mothers work. Children are taught where to look for marine organisms; they are also taught about the various environments they live in and specific habits or sites associated with each of them. They spend many hours with their mothers and fathers in the tidal flat areas, becoming expert gleaners and fishers in their own right. Throughout the formative years of 5-16 this form of education is the equivalent to an intensive apprenticeship. The observations of many generations are carried forward to the next generation. It is only as they mature into young adulthood (12 – 18), when a genuine knowledge of what they are doing can truly be acquired, that many no longer have the time or interest in the traditional ways of their parents. I have noted, through many conversations and my own personal observations, that while many young women will still occasionally *fangota* with the elder women of their family, the regular and more

intensive time for harvesting in tidal flats has been interrupted by attendance at government and private schools eight hours a day, five days a week. As a child becomes older and spends less and less time practicing traditional food gathering techniques, the knowledge he/she gained as a young child becomes subordinate to knowledge gained in a public school system. Thus, decreased rates in traditional skills and knowledge transmission may be attributable in part to the decline in traditional education modes (learning by watching and apprenticing) (Ohmagari and Berkes, 1997).

From numerous conversations and my own observations over the past twenty years of visiting Tonga, I have come to the realization that the majority of young Tongan women want to go to school and learn skills that they can use in an office job or other types of paying jobs. Very few have the time or put forth the effort to learn traditional methods from their mothers or grandmothers while they are still young. Those girls who do not excel at academia, or those whose families can not afford to pay the tuition for further western education, take advantage of being home among relatives and are able to gain a thorough traditional education, including weaving, cooking, food gathering and home maintenance. Although the majority of young women gain an academic education with the hopes of furthering their economic status and earning potential, very few actually achieve this goal. As previously stated, there were 7660 females in Vava'u in 1996. Of those, 1958 females were employed but only 5% of those working were engaged in jobs requiring an education, other than on-site training. A staggering number of those employed (70.4%) were exclusively involved in the traditional craft industry. Other typical jobs females held were in clerking or the sales and service industry (S.D., 1999).

Consequently the perseverance of time spent in western education proves not to be useful to most women once they graduate. A young woman from the village of Fuamotu illustrates this. In 1995 when I first met Hingango she was in her last year of formal schooling. She refused to participate in the traditional *kautaha* or tapa cloth organization that her mother belonged to, because she was adamant that through her western education she would be able to help support her family with a good paying office job. However, despite her disdain for traditional knowledge, in recent years, as Hingango married and became a mother, she changed her opinion and now actively participates in a traditional *kautaha* making tapa cloth.

Problems related to learning traditional skills at later ages, or delayed transmission

It is generally not until a young Tongan woman marries and begins her own family that she really gains an interest in traditional methods of collecting food from the sea. And more often than not, this interest stems from need. Most women move to their husband's village when they marry. Consequently they are not always able to learn traditional gleaning, fishing or gathering techniques from their mothers and grandmothers. Most newly married women will learn these skills from a mother-in-law, or other knowledgeable women in their new village.

While traditional skills such as how to *fangota* continue to be passed on to young women by their new relations, edification of this type can possibly lead to a loss of information. Young women learning techniques from a mother-in-law or others in a new village will

not have a solid foundation of specific environmental information upon which to base or compare current conditions. If she has not been gleaning or doing *fangota* since she was a young child, she will have a more difficult time recognizing variations in the tidal flat environments and may not be aware of fluctuations and variations among marine species or organisms. As Berkes et al. (1995:297) point out, "There is great potential value in a historical series of observations about particular areas, based on cultural transmission of knowledge from generation to generation." While young married women do learn traditional skills, such as how to *fangota*, their level of mastery of the skills tends to be low compared to that of the older generation (Ohmagari and Berkes, 1997).

Berkes and his colleagues make a good point, but I have also observed that there are always exceptions to the rule. While most women would be hindered by the late start, some women are highly motivated to learn a specific body of knowledge, such as how to *fangota*, and they will overcome all obstacles and challenges that western education may create towards traditional knowledge. For example, Ana Tapa'atoutae from the island of Oloua spent her growing-up-years focusing on western style education. She excelled at schooling and even continued on after graduation until she had received a degree in nursing. She worked for several years in the local hospital, but has since retired. While she received very little training regarding *fangota* activities in her youth, she later had a strong desire to be able to better provide for her family. Due to her dedication and hard work, she has since become known on her island as one of the leading experts in *fangota*.

Therefore, excluding those individuals that will excel regardless of conditions, most women may be adversely affected through a synergistic affect of less emphasis being placed upon traditional knowledge, in comparison to western education, and from the displacement of the women through marriage and moving to their husband's village. An example of knowledge of marine resources being lost or forgotten may be shown in Tongan dictionaries from 1845, 1959 and 1992. In Rabone's 1845 dictionary he lists about a dozen names of shellfish, which are not found in Churchward's 1959 version. Churchward also lists names of marine organisms that are not listed in Tu'inukuafe's 1992 dictionary (Malm, 1999). In Patricia Howard's work entitled, *Women and the Plant World; An Exploration* (2003) she notes that traditional knowledge, and especially plant knowledge, is gender based, thus reiterating the importance of transmission of this knowledge to the next generation in order to maintain biological and cultural diversity.

Effects of changes in value systems

In Tonga, nearly all people place a high priority on obtaining a "western education". Most discern the benefits of receiving an academic education. Paying jobs become obtainable and the status of a family can be boosted with an expanded income. Whereas in the past a family's standing relied almost entirely upon bloodlines and could only be increased through marriage, today it can be advanced with an education, and more importantly, with money. The more economic resources a family has the more their position is elevated. Western education also allows greater opportunities abroad, which in turn can yield greater remittances sent home to Tonga. Many families are becoming

increasingly dependent upon subsidies sent from family members abroad (Lockwood, 1993). Approximately 80% of all domestic obligations and expenditures are covered by remittances from abroad (Pulu, 1990). The lowest strata in Tonga today are those families that are totally dependent on the Government and its limited resources without any overseas options at all. In contrast, those with the most income (both old and new elite) have not only the greatest potential options abroad, but also the most access to resources and capitalistic opportunities in Tonga (Marcus, 1993).

5.3 Conservation

The worldly view of the “Polynesian Myth” consists of high volcanic islands, white sandy beaches, blue lagoons and a life of leisure where no problems exist (Kiste, 1993). Early perceptions of European explorers promoted the ideology of tropical paradise throughout the South Pacific. Lush tropical islands were looked at as being “Gardens of Eden”. However, in the early 1770's Johann and George Forster, a father and son team of natural historians on Captain James Cook’s 2nd voyage, worried that these islands were not natural “Gardens of Eden” and that native islanders had in some cases, such as in Easter island, profoundly affected the natural environment (Grove, 1995). Early inhabitants also affected the environment in other locations. For example, the exploitation of marine and terrestrial animal resources, particularly flightless birds, in New Zealand by early inhabitants led to the depletion or extinction of many species (Davidson, 1984; Grey, 1994). David Steadman (1989; 1993; 1995) has uncovered evidence that numerous

bird species were driven to extinction by early Pacific Islanders, including over 5 bird and iguana species in Tonga alone – whose extinction was caused by early Polynesians. However, when populations increase, the demand on natural resources increase, and resources can be depleted despite traditional or customary conservation practices (Chung, 1995).

Indigenous peoples were not the only ones to have negative effects upon the environment. Johann Forester not only documents the changed environment due to indigenous inhabitants, but he also records evidence of early European destruction:

A Bermuda sloop had been here and taken a great number of turtles and besides these had turned and killed more than a hundred of them, merely for the wanton gratification of having their eggs, leaving the meat to rot on the shores of which some had been seen by us . . . cruelty hardly to be believed if the performer had not bragged of it himself, and several had seen the vestiges of this cruel epicurism; which must, of course, vastly diminish the numbers of these creatures useful to navigators (Resolution journal, entry for 1 June 1775, c.f. Grove, 1995).

In more recent times, most examples of damage are associated with commercial ventures, for example, the sea cucumber or *beche-de-mer* industry (Campbell, 1989), that extend beyond subsistence (Robinson and Bennett, 2000). Paul Dalzell from the South Pacific Commission states that,

the prehistoric record shows that subsistence exploitation can have a noticeable influence on sessile invertebrates, but that these can continue to be productive over many centuries. But the scale of commercial exploitation during the 19th century demonstrated how susceptible sessile invertebrates over a wide area could be to very heavy levels of exploitation (1998: 248).

Disruption of food supplies and natural environments has occurred when subsistence economies were infused with new commerce, producing food for sale rather than consumption (Campbell, 1989). For example, in the Torres Strait, foreigners began exploiting valuable marine species such as the snail *Trochus niloticus*, pearl oyster, gold lip (*Pinctada maxima*) and silver lip (*Pinctada margaritifera*), and Trepang (*beche-de-mer*) to the point of near extinction. Japanese and other foreigners were the principal traders and marketers, while local islanders served as collectors and laborers (Oliver, 1989). Arjan Heinen, from the Pipuli Foundation, notes that during the 1980s sea cucumbers were so dense in Danao Bay of the Philippines that they almost covered the sea floor. But due to the increased demand from Asian markets for the cucumbers and the resultant increase in market price, locals and outsiders began harvesting the cucumbers by the boatload. It took only two years before this abundant resource was nearly depleted. He felt that the community must have seen the drastic decline in numbers, but failed to act (Heinen, 2003).

Degradation brought on by economic demands of colonial rule and capitalistic driven economies, combined with the needs of indigenous populations, has spurred some

attempts throughout the Pacific to control the environmental or ecological consequences (Grove, 1995).

Many Pacific island communities had methods of conserving marine resources and had extensive knowledge of fish behaviors, concentrations, feeding habits, spawning and other biological and geographic facts. In some Pacific islands, closed seasons have been declared by the government or by local leaders to protect diminishing stocks of various species, such as crayfish, giant clam and others. Regulations have also been made in many island countries against harvesting some species when immature. For example in 1987 the Federated States of Micronesia legislated to restrict the harvesting of *trochus* under spawning size and to restrict the harvesting period to one month of the year (Schoeffel, 1995: 16).

In the Cook Islands a council of traditional leaders recently organized a *ra'ui* (traditional reserve) in order to restore and protect five marine areas in Rarotonga. There are no legal laws governing the *ra'ui*, but instead it is monitored and maintained by local communities. Their approach is to conserve not through fear, but through respect (Mataiapo, 2000).

In Tonga, only vague recollections of past conservation practices relating to marine resources survive today. When cross-referenced with records from other Pacific Island communities, we can only assume that Tonga may have had similar conservation type

tapu practices as evident from neighboring regions. Clarke (1994:256) explains the way Islanders interacted with the environment stating that “the Islanders did what all peoples, especially pioneers, do: in their efforts to make a living, they manipulated, modified, and, at times, degraded the ecosystems in which they lived, producing environmental changes that in turn required ecological adaptations and social adjustments” (c.f. Malm, 1999:356). Spennemann (1987) documents that early inhabitants of Tongatapu relied heavily on shellfish from adjacent tidal areas. However, he also notes a decrease in size and Poulsen (1987) documents a decrease in numbers of shells in middens over time. Poulsen also notes an increase in agriculture coinciding with the decrease of shell size and numbers. He speculates that due to over-exploitation of marine resources, the inhabitants were forced to shift to a more horticulturally based economy (1987).

As stated previously, early ethnographic records indicate that the population of Tonga prior to the 19th century was somewhere around 30,000 to 40,000 (Maude, 1965; Green, 1973) inhabitants. But by the early 19th century the population had decreased, most likely due to introduced diseases, to about 20,000 (Wilkes, 1845), covering all four island groups. The fact that these islands have sustained people for hundreds and even thousands of years may have more to do with a relatively small population and corresponding levels of exploitation, rather than from any established indigenous conservation systems. During the early 1900’s the growth rate of Polynesia was around 4%, whereas during the 1970’s the population of the Pacific Islands in general increased by about 23% in that decade alone. Yet, due to extensive emigration, Tonga’s population has stayed at about the same level (100,000) for the last 30 to 40 years (Campbell, 1989).

Even though population levels have been fairly stable over the past 40 years, recent commercial exploitation of a variety of species from tidal areas and surrounding waters is putting a much higher demand upon local marine resources. This suggests that conservation practices may be needed now more than ever before. While no specific policies or community efforts have been enacted to insure the continuation or sustainability of *limu*, a few laws have been declared regarding other marine species. It is no longer legal, for example, to collect for commercial sale the *beche-de-mer* (sea cucumber). The Tongan Fisheries Department has also set limits on the mesh size of fishing nets in order to prevent catching of fish that are too small. However, there is very little enforcement of these laws (Tonga et al, 2000). The *beche-de-mer* industry is held in check simply because collectors no longer have an outlet in which to sell their catch. The fishing net regulation is disregarded by many fishermen who fish for their livelihood (anonymous fishermen, personal communication, 2001); and no one is in a position to enforce the ordinance. The commercial fishing industry is showing the greatest effects of over-fishing. While just a few years ago local fishermen were able to fill their boats by fishing nearby underwater seamounts, today they have to travel nearly 100 km off shore in order to get the same amount of fish (Fisheries officer, personal communication, 2001).

Interviews and observations from local Tongans indicate that amounts of *limu* have remained fairly consistent over the last 20 to 30 years. There are no specific rules or laws restricting the amounts of *limu* that can be gathered; nor are there laws establishing a gathering season that would limit when *limu* can be gathered. In many ways,

conservation is practiced on an incidental level in Tonga, meaning that conservation takes place mostly in the context of other associated factors such as women's schedules, weather patterns or times of affluence. Women's schedules are often such that they do not allow for an extended amount of time for harvesting *limu*. Weather patterns also affect the amount of *limu* that is harvested. During the rainy season, or at times of bad weather, less time is spent in the field collecting seafood. While most all individuals in Tonga consume *limu* occasionally, it is a staple food only for the poor. However, when people, for one reason or the other, cannot afford to spend a lot of money on expensive imported food items, the demand for *limu* increases.

While there are no official programs establishing conservation efforts, some of the practices incorporated by women who regularly collect *limu* are in fact conservation measures in and of themselves. First of all, the women collector/gatherers regularly rotate collection sites. Vai and Elita Tupou informed me that they do not collect from the same *limu* site day after day. Instead, after collecting from any given site they will rotate to a new location, not returning to that given site for several weeks. This allows the *limu* to regenerate and replenish itself. Thus, by rotating harvesting locations, no one site is over-exploited and harvested to the point of absolute depletion. A second conservation method practiced by the gatherers/harvesters occurs during the actual harvesting process. The normal method of harvesting *limu* is to pick only the upper shoots. The process of leaving the stolons behind allows the regeneration of new shoots, thus enabling the *limu* colony to continue growing. A third conservation technique occurs during the harvesting and cleaning process. While the women wash the *limu* by vigorously rinsing, shaking

and dunking the shoots in the seawater, small fragments of the *limu* break off and are redistributed, often coming to rest in bare areas, not yet established with *limu* growth. This practice allows the fragments to reattach themselves to the substrate, thus beginning a new colony, or extending an existing one.

Between the incidental factors such as women's schedules, weather factors and economic issues and the above-mentioned harvesting practices, conservation practices, while evidently not extensive or well developed, do exist on a small-scale level. Whether or not these limited measures will be sufficient for the future, especially where commercialization of *limu* takes place, remains to be seen. However, we must remember that when considering the conservation of natural resources factors that affect the local users must also be weighed and taken into account. Fikret Berkes (1999) purports that the key to biodiversity conservation lies within self-interest, and local customs and social sanctions must also be addressed. If the natural marine resources are to be sustainably used, by locals as well as by commercial companies, then the interest of those who rely on the tidal-flat resources to sustain their families must be addressed. Or stated another way, "to preserve much of the world's biological diversity, . . . the benefits of such conservation should accrue principally to those who help to create and sustain it" (Howard, 2003:3).

Any conservation scheme has to allow for continued access by locals. When "outsiders" come into an area and take over control of natural resources, the locals lose their incentive for wise use and protection of an area. In 1995, Leslie Bolick a graduate

student in geography from Sandiego State University, reported that in 1993 Tonga established a reserve on Mount Talau in Vava'u. Once the reserve was established, no harvesting of natural resources was allowed. Prior to the establishment of the reserve, locals adjacent to the area had access to it for their local needs. These users had felt responsible for it and took care of all the surrounding area, insuring it was properly maintained and cared for. However, after the reserve was established, and locals were denied access, the area became run down and misused. No longer did the local people feel responsibility for the area, and as a result, people from all parts of the island came in and harvested materials, even though it was now illegal. As a result of establishing a reserve, where locals no longer had access to natural resources and no one claimed "ownership" or responsibility, the area lost many of its valuable resources, and was no longer an unspoiled natural resource worth preserving. Locals were hostile to the preservation effort and hindered it in many ways (Leslie Bolick, personal communication, 1995). A wiser plan -- one similar to an indigenous controlled reserve in Western Samoa (Cox, 1999) that not only allows for continued traditional use, but is also administered, controlled and managed by local villagers -- would most likely not only have worked well here for the people, but also for Tonga's valuable inshore marine resources.

5.4 Contemporary Mores and Issues that Impact Harvesting in Tidal Areas

Gifford (1929) reports that historically in Tonga there were no lands that were expressly communal. Fishing grounds were the closest thing to communal property, because those people living along the shore had the right to fish all along the waterfront. But people living inland did not have the right to fish; they would instead exchange food products such as fruit, yams or taro for fish. It seems as if residents of different islands within Tonga had contrasting opinions about fishing rights. Gifford also reports that informants in Okoa, Vava'u declared that anyone living on their island could fish anywhere in Vava'u. Today, villagers in Okoa (Tupou families) still concur that anyone can fish glean or gather *limu* anywhere in Vava'u. However, convention dictates otherwise.

While there are no legal restrictions that limit the use of waterways in Tonga, there are social mores in place that dictate the use of local tidal areas. There seem to be two main factors defining the use of marine resources. The first is that those who live adjacent to tidal flats are the ones most likely to utilize them. Family members related to people in a village adjacent to a gathering area, but not living in the immediate vicinity, are also accepted users. Individuals are recognized even from great distances. No one goes unnoticed whether on land or in tidal areas. The most substantial factor against having outsiders come into the local tidal flats and waterways is *fakama* (disgrace, reproach, shame) or the unspoken factor of the embarrassment of not belonging. It is an accepted practice for an outsider to approach an individual in a village near the waterway and ask

them to collect specific seafood items. The practice of asking someone else to collect for you prevents unwanted embarrassment while at the same time showing respect for those skilled at gathering food from a specific site.

The second factor limiting use of an area is the simple problem of logistics. For those people living near a tidal area it is simple to walk to the area and begin doing *fangota* or gleaning. However, for those living further away, the problem of how to get there becomes an issue. Fuel for cars is expensive, and the bus system is not extensive enough to allow for convenient transportation to and from the ocean. Therefore, those that have a nearby easy approach to a tidal-flat will use this area much more frequently than those whose access requires greater time and effort.

Over the past twenty-year period there has been a decrease in the activity of fishers and gleaners in the local tidal areas (Figure 12). The notable decrease in activity may be due in part to the increased reliance upon imported foods and also the decline in variety and abundance of marine organisms found in the tidal flat areas. A survey conducted in 1983 by the Pacific Islands Development Program (PIDP) questioned housewives from seven villages (Houma, Ha'akio, Ta'anea, Ha'alaufuli, Tuanekivale, Holeva and Koloa) surrounding the tidal flats near their homes. PIDP's inventory included items of collection, for example: *limu*, sea cucumbers, shellfish, jellyfish, crab and several varieties of fish, which is consistent with items currently being collected. Most of the families contacted collected their own seafood, which they used in combination with commercial goods obtained from the market. PIDP found that the area provided

supplemental protein and additional monetary support for a considerable number of people, making it a vital component of the villager's lives (Kunatuba and Uwate, 1983). The Pacific Islands Development Program (PIDP) noted that most villagers at the time of the survey (1983) felt that there was an overall decrease in the variety and number of food items being harvested from the area. They felt that decreases were caused by fishing pressure, and the environmental impact of the causeway [built by Australia in 1981, connecting Vava'u and Koloa islands (Kunatuba and Uwate, 1983)]. However, even within the PIDP survey differing opinions were noted as to the overall changes in the tidal area. Almost as many informants felt that there was an increase in tidal resources, as those who felt there was a decrease. The claim of decreased resources may also be contradicted by the fact that species listed in early surveys and those lists of species collected more recently indicate that all the foods collected today from the tidal area through *fangota* activities in days past are much the same. Furthermore Kunatuba and Uwate (1983) report an average of 10.89 kg of shellfish consumed per household per week. My surveys indicate, for the same tidal area, a slight increase (12.05-kg) in shellfish consumption per household per week over Kunatuba and Uwate's results. Even though, as stated earlier in Chapter 4, it seems as if fewer numbers of women are going out to *fangota* each week, it would appear that their harvest is greater for each trip. This measure would indicate that the varieties and numbers of species, including *limu*, have not really decreased in the last 20 years.

5.5 Commercial Farming of *Limu*

Trono, who works with aquaculture projects all over the Pacific, states “culturing seaweed is one of those possibilities, which offer substantial additional income for coastal populations without destructing valuable habitats of commercially important marine fish and shrimp species” (1986: v). Aquaculture of seaweed has been successfully practiced in Asia for centuries (Turner, 2003). It has been practiced in the Hiroshima Bay area since between 1596 and 1614 (Trono, 1986). However, until recently, very little culturing of seaweed has taken place outside of Asia. The world seaweed industry has been growing at phenomenal rates of 20 - 30% per year (Trono, 1986). Abbott (1988) reports successful aquaculture production in places other than Asia such as Nova Scotia, the Philippines, Chili, the Caribbean and California. The major seaweed genera that have successfully been farmed include *Porphyra*, *Undaria*, *Laminaria*, *Caulerpa*, *Euclima* and *Gracilaria*. Farmed seaweed is used for food, animal food, fertilizer and colloids. Colloids make up by far the biggest money making markets. 176,000 tons of raw and dried seaweed produced an annual carrageenan market of over 100 million U.S. dollars and the gel business produced over one billion U.S. dollars in 1983 (Trono, 1986).

In developing seaweed culture, Tonga could gain much from exposure to successful aquaculture projects such as in the Philippines where *Caulerpa lentillifera* is farmed. The final product is sold for local consumption as well as being exported to Japan and Denmark in fresh, brine-cured or salted form. No extensive processing is required and

the actual farming techniques are simple and affordable. The cultivation of *Caulerpa lentillifera* began in the early 1950s. The alga was first introduced into ponds as food for milkfish and shrimp. Then because of low production of fish and shrimp and high production of *Caulerpa*, the farmers eventually shifted from fish and shrimp farming to *Caulerpa* as their major crop. Now several tons of *Caulerpa* are shipped to Manila every month and nearly 1000 tons are exported to Japan and Denmark yearly (Trono, 1986). Because the farming of *Caulerpa* is confined to ponds and “seeding” takes place from seed stocks or from vegetative cuttings, wild stocks are not being depleted, inner reefs and bays are not being detrimentally affected and sustainable harvests are reaped every two to three months. Methods for successful farming of *Caulerpa* have been developed and refined over the past 50 years. Documentation of planting techniques, water management, harvesting and post-harvesting activities exist (Trono, 1986) and this information can allow others in similar situations and environments to more easily establish a similar industry.

The Regional Office for Asia and the Pacific (RAPA), Food and Agriculture Organization (FAO) of the United Nations feels that seaweed resources have much to offer developing countries of the Pacific. However, they feel that seaweeds are considered low priority crops and the lack of policy directions and incentives are a major problem in developing the industry. In order to resolve these problems in Tonga the following issues must be addressed by national authorities (Trono, 1986):

- lack of expertise, facilities and funding support;

- lack of information on the seaweed resources and their potentials, on the biology, ecology and natural products of different seaweed species;
- lack of production research and development; and
- unfavorable business practices.

If the above issues are adequately addressed seaweed resources can contribute significantly to the economic development of Pacific Island nations, including Tonga.

In the Fisheries Sector Review - Issue Paper # 30 (FSR,1998) farming of *tanga'u* was compared to past attempts of seaweed farming in Tonga, specifically *Eucheuma spinosum* and *E. cottonii*. In 1981 trials were conducted in Vava'u. While production eventually increased, the trial was never much of a success because of fish grazing, diseases, and low market prices (FSR, 1998). However, the Fisheries Division acknowledged five lessons learned from the experience in regard to *Cladosiphon* farming:

1. Rabbit-fish (*Siganus spinus*) grazing on seaweed resulted in reduced production and income. In the case of *Eucheuma* the rabbit-fish problem was confined to Vava'u, and peaked in March-April, which is before the growing season for *Cladosiphon* gets under way. These features may protect *Cladosiphon* from the intense rabbit-fish predation experienced with *Eucheuma*. Sea urchins and other organisms are also known to feed on *C. okamuranus*. The possibility of grazing problems, whether by rabbit-fish or by other species on aquacultured *Cladosiphon* in Tonga, should thus not be ruled out entirely until trials have been undertaken.

2. Insufficient supplies of “seed” (spore-bearing material), as these are over-exploited prior to the rabbit-fish season. At present there is no information on the prospects for natural seeding of aquaculture nets by *Cladosiphon* in Tonga. Until good seeding grounds are found through a process of trial and error, seeding of nets will need to be done under artificial conditions at the Fisheries Mariculture Center. Unless the capacity of the Center is greatly expanded it is doubtful that seeding of more than a small number of nets can be done in this way. Farmers themselves may carry out seeding by collecting young wild plants early in the season and attaching them to nets where they can grow. However so far there is no information on the effectiveness of this technique with the Tongan species. Shortage of seed stock may thus be a constraint to culturing substantial volumes of *limu tanga'u*.
3. Seaweed farming became a very unstable means of livelihood because of market uncertainty, inconsistent supply of seed and other factors. In the case of *Eucheuma*, marketing was through a single company, Coast Biologicals, which began to experience financial difficulties that then affected its operation in Tonga. In the case of *Cladosiphon*, marketing is similarly only practiced by a single company at the moment. If [it] withdrew from Tonga or went out of business, there will be serious difficulties in disposing of the product. In addition, when a single buyer has a monopoly then price manipulation can become a problem that producers can do very little about. Under the present circumstances, therefore, the marketing arrangements for *Cladosiphon* are comparable to those that existed for *Eucheuma*, in that they are

somewhat unstable, non-competitive, and unlikely to be advantageous to the seaweed farmers.

4. Biological and environmental factors such as fouling, disease, bad weather, and low water temperature are out of the control of the farmers. These problems are equally likely to be experienced with *Cladosiphon*. In the case of fouling, it is worth noting that fouling by another alga, *Ectocarpus* sp., was a serious problem in the early days of *Cladosiphon* culture development in Okinawa. Poor weather and unsuitable water temperatures are other factors that are almost certain to be experienced from time to time.

5. Seaweed farming is not economically attractive when compared to other forms of subsistence fisheries such as hand-line fishing and shellfish collecting. After allowing for the fact that *Eucheuma* was sold dried, and for inflation over the intervening period, it seems that prices for wild-harvested *Cladosiphon* today are in the same range as those offered for *Eucheuma* ten years ago . . . at these prices, *Cladosiphon* farming may prove unattractive to farmers in the same way that *Eucheuma* farming did, and uptake of this activity by Tongan people may be low (FSR, 1998: 4-5).

While there are barriers to the farming and exporting of *Cladosiphon*, the Fisheries Division (1998) feels that there is also the potential for a sustainable income-earning

opportunity for large corporations and through them the Tongan people, especially women, if suitable strategies are pursued and developed. These strategies include:

- imposing a quota on harvests;
- arranging for ongoing surveys of *limu tanga'u* resources in order to establish new quotas in the years to come;
- investigating *tanga'u* resources in other areas of Tonga, with the idea of promoting wild gathering or to establish aquaculture;
- discussing with the exporting company the possibilities of developing a processing plant in Tonga in order to further the income earning potential of Tongan workers; and
- developing *limu tanga'u* aquaculture trials in order to assess technical difficulties and possible solutions with the idea that future decisions as to the viability of the commercial enterprise would be re-evaluated after the trials were complete (FSR, 1998).

Although the Fisheries Department made the above recommendations, few, if any, of the guidelines were actually put into place. No quotas have been established and no restrictions enacted. Each year following these recommendations a greater amount of *limu tanga'u* was exported: 272,188kg in 1999 and 313,515kg in 2000 (Dept. of Fisheries, personal communication, 2001).

Without proper monitoring and restrictions this enterprise could easily go the way of the *beche-de-mer* (sea cucumber) commercial industry in Tonga. The *beche-de-mer* is

another easily collected marine resource. During the mid-1990s *beche-de-mer* were fished to commercial extinction in just a few years' time (Oliver, 1989). While little is known about the impact of nearly wiping out an entire marine species, we do know that sea cucumbers rake up sediments which make nutrients available to seagrass and seaweed, which then become healthier and more abundant, and in turn more accessible to fish and other marine species (Heinen, 2003). If the Ministry of Fisheries had imposed restrictions or sanctions as recommended by specialists who surveyed the industry during the early stages (FSR, 1998), there might still be a *beche-de-mer* industry today.

Methods of documenting the role of humans in changing the earth's environment, or as it is now called, the human dimensions of global environmental change (CIESIN, 1992), are now being developed and practiced globally (Stoefle et al., 1994). Interdisciplinary research combining satellite imagery, physical, biological, and social sciences is being used to document the causes of changes in marine ecosystems, including coral reefs (Stoefle et al., 1994). If procedures such as the above were to be used in Tonga to show changes, if any, in the marine environment, including seagrass and macroalgae densities, the impact of commercial projects such as the harvesting of *tanga'u* could be monitored. Not only could the effects of such commercial projects be monitored, but so also could the impact of harvesting by local peoples, such as fishermen and reef foragers. Stoefle et al. (1994: 375) feel that:

Perhaps the most significant aspect of the utility of satellite imagery . . . [is] its policy relevant usefulness as a catalyst for government action leading to

recognition of the rights of local people to defend their community territory, and formally empowering them to do so.

It seems to me that if low-tech extensive community based knowledge, gained by local experts, was combined with the above high-tech methods this would lead to an ideal situation. Information gained via such methods would allow Tonga, through its Fisheries Department and local communities, to devise and execute practices that would help balance conservation with sustainable resource use.

5.6 The Relationship between *Limu*, Women's Indigenous Knowledge and the Sustainable Use of the Tidal Areas

Along with loss of traditional knowledge and culture comes environmental degradation (Turner, 1996). In the past, women's indigenous knowledge was an essential component of a family's survival. A Tongan woman had to know how to glean, harvest and prepare food, and how to process plant materials into clothing and other household items. She was expected to be knowledgeable in all of the appropriate social situations and capable of providing the necessary gifts of food, bark cloth or other material goods. If she needed something for her home, she knew how to make it or acquire it from elsewhere. Not only was she required to be proficient in all of the above aspects of daily life, but as a mother, she was also responsible "for the training of the children and transmitting to them the

things necessary for the preservation of their status in the societal structure” (Paongo, 1996: 135), for example, family genealogies and knowledge of status and rank within the family and community. While much of this knowledge is still essential today, and continues to be important in the sustenance of the common family, its value in society has become complicated to the point that retaining this type of knowledge is no longer considered prestigious or even necessary in the case of those who can afford to purchase goods at local markets.

According to early explorers (Beaglehole, 1967), Tonga's economy was based solely on local resources and trade, barter, and payment of tributes or acquisition of materials through conquest. The introduction of western materials and goods in the 1800's, and the change from a bartering system to a monetary one, created new objects of status. Some of the new status symbols began appearing in traditional Tongan art forms. Representations of such objects as telephone wires, airplanes and imported pine trees appeared in traditional bark cloth designs. These symbols of western objects became “modern visual symbols of the chiefs” (Kaepler, 1995: 7) and served as visual signifiers of status. Today in Tongan society the quickest avenue to elevate a family's status is to acquire material wealth and goods, as well as associated opportunities such as travel and foreign education. Wealth and status are usually accumulated through non-traditional skills or from over-seas remittances. The decline of traditional knowledge and the value placed upon it can be attributed in part to factors such as commercialization, change of technology, pressures due to population growth, and changing views and perceptions (Berkes et al., 1995).

One of the factors linking women's indigenous knowledge with *limu* can be located in the Polynesian worldview. According to Tongan belief, there are two qualities that define an individual: *mana* and *mafai*. *Mana* is power associated with talent, character and the nature of a person. It can be increased or decreased through certain acts. *Mafai*, on the other hand, refers to authority; it deals with rank and status received through bloodlines or by appointment (Gifford, 1929; Bott, 1982). The following excerpt is an example of two women, each holding one of the above forms of authority and status within their community.

During an interview with the Minister of Fisheries in Vava'u, I mentioned having some difficulty locating a certain species of *limu* due to the unseasonably warm weather. He mentioned that his mother was expert at collecting *limu* and would know where to locate it in the tidal areas surrounding their small island. He made contact with his mother and an invitation was extended to us to visit Pauline Moalae of Oloua Island. We worked with Pauline for an afternoon collecting *limu vai* and then made our way to Oloua to prepare the *limu* for our evening meal. Upon our arrival, the Mayor's wife, Lu'isa, informed us that we would be staying with her because Pauline's home was not suitable for visitors. That evening we met together at Lu'isa's home for a focus group discussion with several women from the island. Lu'isa sat to our immediate right. A group of five women sat directly in front of us, while Pauline sat to our left, separate from the group by several feet, leaning against the support to the front door. The Mayor's wife, who is an appointed women's representative of the island, took charge of the meeting. Formal introductions were made and a general explanation regarding the gathering of food from local tidal areas followed. During this time Lu'isa conducted each aspect of the formal discussion.

The other women showed deference to Lu'isa, often speaking to her with lowered eyes and a contrite nature. As the discussion developed into detailed explanations regarding the specific species of *limu* found in the waters surrounding Oloua, all the women, including Lu'isa would defer to Pauline. The other women openly and enthusiastically supported and concurred with her decisions. Lu'isa holds a certain position of authority, one by appointment, most likely connected directly to the position of mayor held by her husband. Pauline also holds a position of authority within their island community, based in the knowledge she has acquired and the practical use of that knowledge.

In the past there were only a few means available to lower ranking families' to raise their social status *mana* and ranking *mafai*: first, by marrying someone of higher rank, and second, by excelling in skills and talents central to the everyday life of a villager (e.g. fishing, farming, weaving, healing). Individuals who were exceptional at a particular skill were admired and honored by fellow islanders, thus increasing their *mana*. Individuals of high rank and status did not engage directly in the production of foods or other manual labor; instead they sought out highly skilled commoners to provide for them (Bott, 1982). These commoners gained important positions in villages or islands, and in so doing acquired greater respect within their own communities. Edward Gifford, a member of the Bayard Dominick Expedition to survey Tonga in 1920 (Dieudonne, 2002), noted that on rare occasions a specific title (one that was retained and passed down from generation to generation) was bestowed upon those who provided the best items to the Chiefs or members of a Chiefly family. For example: *Tei* was the title given to the official salmon catcher and *Ngalu Haatafu* for the man who brought fish to the Tui Tonga (Gifford, 1929). While it is unclear as to when this practice first started, many of the titles,

although no longer with the specific responsibility of providing food to the King, have carried forth to this day (Campbell, 1992).

Mana has many definitions within Tongan society today. It refers to thunder, and is used to define miraculous and unexplainable events (Tu'inukuafe, 1992). The aspect of *mana* that is most relevant to my research is the development of individual self-esteem and the maintenance of value within the community. Most commonly Tongans seek *mana* for three reasons, ranked in the following order: welfare of the family, good of the community and finally, for the benefit of self. While many aspects of *mana* are intangible and are associated with an individual's character and demeanor, other aspects can be acquired through action and deed. Whereas in the past one relied almost solely on exceptional traditional skills and talents to increase one's *mana*, today one of the most common methods of raising one's level of *mana* is through other means, such as education and migration abroad (Cowling, 1996). Mike Evans, an anthropologist studying Tongan tradition in a transnational context, feels that educational success is what allows contemporary Tongans access to resources, employment, standing in church hierarchy and the opportunity to go abroad (Evans, 2001), thus increasing one's *mana*.

Mana is still ubiquitous throughout the South Pacific. Outside of Tonga, in places such as Hawaii and New Zealand, *mana* represents an effort to restore power and authority to indigenous populations. The word *mana* is often used to title their magazines, radio stations, journals etc., and is a means for self-determination. In his book on the Politics of Maori self-determination, Mason Durie, Head of the department of Maori Studies at Massey University in New Zealand, has defined *mana* in a more contemporary mode as

“authority and control” (Durie, 1998). This post-colonial application is less common in Tonga, due to the fact that they have retained both ancestral lands and language. However, contemporary issues are transforming the basic concepts and priorities. As mentioned, traditionally the idea of *mana* was achieved in three general ways: the intangible facets of personality and character, deeds and actions, and what one can acquire and with whom it can be shared. While today a great deal is still the same, certain aspects of *mana* have changed in regards to scope and specifics with whom acquisitions are shared. In the past, acquisitions were shared, on ceremonial occasions, with the extended family and community, with a focus on those that were of higher rank than the giver (Bott, 1982; Gifford, 1929). Today acquisitions are still shared, but usually within a smaller, tighter grouping of immediate family members.

Today in Tongan society, as well as throughout the world, the quickest avenue to elevate a family's status is, as mentioned above, to gain a Western style education and/or more importantly, to acquire material wealth and goods. Wealth and status are accumulated through skills attained in Western education or from over-seas remittances rather than through indigenous knowledge such as how to successfully catch or gather food from the ocean. Traditional knowledge is no longer essential to sustain a family, since everything integral to maintaining a family can be purchased with money. Only those without the means of paying cash for their goods must rely more fully upon ancestral knowledge to provide for their needs, and hence, are more likely to rely on *limu* and other local resources.

When considering fisheries management systems and practices, “women’s concerns, interests and contributions are typically considered unimportant. It is not simply a matter of neglect but rather an issue of perceived irrelevance” (Jentoft, 1999: 1). Despite the long tradition of women’s involvement in gleaning/harvesting from inshore marine resources, their activities and knowledge have continued to be overlooked, especially by outside researchers, scientists and government agencies. As stated previously, “the domestic realm is largely non-monetized, and the women-plant relationships within it are largely invisible to outsiders” (Howard, 2003:5).

If unpublished notebooks containing the detailed observations of a long line of biologists and oceanographers were destroyed, we would be outraged. But when specialized knowledge won from the sea over centuries by formally unschooled but uniquely qualified observers – fishermen [and fisherwomen] – is allowed to disappear as the westernization of their cultures proceeds, hardly anyone seems to care (Johannes, 1981:ix).

Fisheries departments continue to be staffed almost entirely by men and development projects are directed toward men while women’s concerns, interests and contributions are generally overlooked (Jentoft, 1999). As Berkes et al. (1995) point out, local people are usually the ones who are the most familiar with a given area and the species within. Their knowledge is usually based on a longer time-series of observations and broader contextual understanding of the environment. By failing to enlist local co-operation in biodiversity conservation efforts and policies regarding use of tidal areas, businesses or government agencies may make the local people indifferent and perhaps even hostile to

their efforts. Perhaps even more importantly, by excluding the people who possess the greatest knowledge of the tidal flat environment, businesses and other agencies are relinquishing their capacity to thoroughly comprehend the environment they are working in and the impacts they are generating. In terms of *limu* harvest and culture the women who are expert gleaners/gatherers hold a vast body of knowledge, that if properly accessed could contribute greatly to the scientific knowledge base of what species of *limu* are present in Tonga, where and when they grow and in what abundance as well as the relationship among *limu* and other contiguous marine species. Until the role of all marine resource users is appreciated and considered, the goal of promoting sustainable resource use and development cannot be reached (Tuara, 1995) (Figure 16).



Figure 16. Tidal area between Okoa and Koloa Islands.

Chapter 6 Conclusion

The objectives of this dissertation were two-fold: first to assess the current uses and cultural roles of *limu* in Tongan society, and second to explore the relationship among *limu* knowledge, women's indigenous knowledge, and sustainable use of the tidal areas. I focused on three over-riding questions regarding Tongan use of *limu*: What species of *limu* are found in Tonga? What are their current uses? And is there any connection between women's traditional knowledge regarding the collection and uses of *limu* and the sustainable use of the tidal areas? Through participatory observation, interviewing, qualitative and quantitative data collection and taxonomic methods I was able to address these questions.

What species of limu are found in Tonga?

Nine taxa of marine algae are commonly eaten in Tonga. *Caulerpa racemosa* is the favorite edible species and is known locally as *fuofua*. Other *Caulerpa* species are as follows: *Caulerpa serrulata* (Tongan name *kaka*); *Caulerpa cupressoides* (also called *kaka* in Tongan); *Caulerpa scalpelliformis* (Tongan name, *palalafa*); *Caulerpa racemosa* [var. *laetevirens*] (Tongan name, *toke*); *Caulerpa sertularoides* (called *louniu* in Tongan); and *Caulerpa peltata* (also known as *fuofua*). Two other species of algae are also eaten, *limu vai* (*Hypnea charoides*) and *limu tanga'u* (*Cladosiphon* sp.).

Currently there are at least 185 species of marine algae in Tonga (Ohba, 1996). The Tongan Fisheries Department has published some informational documents listing some of the seaweed species present (Bell et al., 1994), and in conjunction with the FAO, a more extensive document surveying and observing the growth of *limu tanga'u* (*Cladosiphon* sp.) (Lovell, 1997). While there are a few documents that were available to me listing some of the marine algae species present, I do not have an exhaustive list, nor do I have comprehensive information documenting abundance and locations of species.

What are their current uses?

Today there is a slow upswing in the popularity of *limu* in Tonga as a nutraceutical. This phenomenon is due to information being circulated by western trained medical personnel in Tonga and family relatives who have lived abroad and experienced the benefits of seaweed for high blood pressure, diabetes and heart conditions. Traditional healers and midwives continue to recommend the consumption of *limu* to those with low iron and to new mothers whose milk has not come in and/or to stimulate greater milk production. Healers have also recommended *limu fuofua* to help cure hepatitis.

The primary use of *limu* is for food. It is eaten in a variety of ways, including raw, in salads, roasted, and cooked into a pudding or as an accompaniment to root crops. While usually only those families living adjacent to the tidal areas rely on *limu* as a regular part of their diet, the majority of Tongans eat it occasionally. *Limu* is sold in the local

markets, and is a common dish at feasts and on special occasions. It is also clear that environmental and/or economic stresses influence the amount of *limu* that is consumed. In the year 2001, a non-stressful year, an average of 20 packets of *limu* were sold in the Vava'u market each week. But, in 2002, after a major hurricane devastated the environment and economy of Vava'u, an average of 140 packets of *limu* were sold in a week.

As mentioned, there are no records documenting *limu* usage in Tonga prior to western contact, making it difficult to assess what percentage of the Tongan population relied on *limu* as an important part of their diet in the past. The absence of Tongan legends regarding *limu*, especially compared with several Hawaiian legends in which *limu* are mentioned (Schoenfeld-Leber, 1979), may indicate relatively lower salience of *limu* in Tonga compared with Hawaii.

Today in Tonga *limu* consumption does not play a significant role in the diets of many people. The families who rely on it the most live near tidal flat areas and have easy access to *limu* and other tidal resources. It is these families that consider the tidal flat to be what they refer to as a "living seafood banquet." These same families refer to *limu* as the "poor man's meat" because usually only the poorer sector relies on it as an important part of their families' diet, and it can serve as a nutritious substitute for more expensive foods. Most people, those interviewed formally and those interviewed informally, maintain memories of collecting *limu* with their mothers and grandmothers. These recollections almost always evoked a fond memory; yet when asked if they consumed

limu as part of their regular diet, far fewer could remember the last time they had even consumed *limu*. There has been a steady increase in imported commercial foods into Tonga as indicated in annual statistics kept by the government. It would appear that in the last two decades *limu* has lost some of its importance as a dietary component due in part to the increase of imported goods, the expanding capital market, and the status and convenience associated with the capacity to purchase such goods.

The collection of *limu* is primarily within the domain of women's work. Existing data, archeological findings, and oral history indicate that this has been the case for some time, even prior to first contact. Historians support the idea that women within the chiefly ranks would not be involved in such activities, but would have relied on lower ranking women and commoners from their *Ha'a* to perform such duties. While Taufa'ahau Tupou Fa, the current King of Tonga, himself continues to request *limu fuofua* be collected by low ranking relatives, those with an extended western education, and associated elevated economic status, have replaced chiefly individuals in requesting *limu* as a delicacy for ceremonial occasions.

Is there any correlation between women's traditional knowledge regarding the collection and uses of limu and the sustainable use of the tidal areas?

In the past, resources from the land and sea were generally sufficient to support local populations (Dalzell, 1998). However, disruption of food supplies and natural environments occurs on a much greater scale when subsistence economies are infused with new commerce, producing food for sale rather than consumption (Dalzell, 1998;

Campbell, 1989). When I first began visiting Tonga in the early eighties, the majority of families in Tonga lived mainly off the land and sea. However, today only the poorest sectors are doing so, and even they are supplementing their diet with imported goods. Nearby fishing grounds have been over-fished to the point that fishermen must go further and further offshore in order to fill their boats. Their catch has become so valuable that they will not sell fish to their neighbors or other local islanders. Instead they sell their entire catch in the capital city of Nuku'alofa where they can acquire a lot more money for it (Sitileki Fonua, personal communication, 2003). Inshore fisheries, depleted of large fish, provide the only option for locals to acquire affordable marine resources. "Involving women and their considerable knowledge of inshore resources could well be a key to meeting [the protection of inshore fisheries resources] challenge" (Slatter, 1995: 145).

Women have been involved in traditional modes of conservation, developed via generations of gleaners handing down methods of collection that would support the continued and sustainable use of resources. But, current factors regarding global pollution, commercialization of resources, increased turbidity from power boat activity, and conditions such as unseasonable warming of the ocean waters have a dramatic impact on *limu* beds that goes far beyond traditional conservation practices. With this in mind, it would be unrealistic to assume that the inclusion of women in the participation and planning of government and commercial ventures regarding the collection of *limu* from tidal areas would lead to a utopian model of conservation. On the other hand women gleaners represent one of four groups, each holding a unique body of knowledge

regarding tidal areas. The other three groups include local fisherman, Tongan Fisheries Department personnel, and employees of commercial operations such as Seastar Corporation. As confirmed by the Tongan Fisheries Department, we do know that the inclusion of women in subsistence collection, local marketing sales, and exportation of *limu* would greatly improve the efficiency and timely collection of these resources from tidal areas. Furthermore, businesses or government agencies that continually fail to enlist local cooperation in biodiversity conservation efforts and policies regarding use of tidal areas may cause the people to feel indifferent and perhaps even hostile towards their efforts. Perhaps even more importantly, by excluding the people who possess the greatest knowledge of the tidal flat environment, and whose lives will be most directly impacted, policy makers are relinquishing their capacity to comprehend thoroughly the environment in which they are working or to understand the impacts they are causing. And finally, we must bear in mind that any realistic conservation schemes or commercial operations need to take into account the self-interest of locals and social sanctions of the surrounding communities.

As mentioned in Chapter 4, *limu tanga'u* (*Cladosiphon* sp.) is now being harvested/farmed in Tonga for export to Japan. While Seastar Industries farms a large portion of their product, they have also purchased seaweed from local fishermen, while excluding women gleaners. The commercial industry of *limu* harvesting and men's lack of knowledge regarding the subtleties of *limu* harvesting has in some instances resulted in a large percentage of material collected being deemed unsuitable and subsequently discarded (up to 70% in some cases) and would seem to confirm the need for the

inclusion of women gleaners. But in a strange twist of fate, farming of *limu tanga'u* has for the most part replaced the collection of wild growing *limu tanga'u*. The farming methods employed and the location selected for farming seems to be aiding the long-term sustainability of this resource. In the Philippines, wild gathering of *Eucheuma* depleted the easily accessible natural stocks within four years. The industry survived only by establishing farms, and relocating stocks to outlying locations (Trono, 1986). In the case of Tonga, extensive research has provided a location with ideal conditions for farming *limu tanga'u* that will satisfy the Japanese market. It would appear that farming is a salient conservational replacement for wild gathering. Upon close investigation one will notice the complete absence of women as new farming techniques are taught exclusively to male employees, rendering women gleaners and their knowledge obsolete.

Historically, *limu* collection was left to women for subsistence and more recently for sale within the local markets. Documentation indicates that women may have been involved in this activity for over a thousand years as the primary participants (Spennemann, 1996). It was not until the 1980's, when Japanese businessmen formed a partnership with the Crown Prince of Tonga to export *limu* to Japan, that the traditional female role of *limu* collecting was altered. In considering these trends of change one may question how an activity, clearly within the domain of women for over a thousand years, could be altered so completely, so quickly, and without any apparent conflict within Tongan society.

As discussed in Chapter 2, all people in Tonga are ranked in three categories: older is superior to younger; maleness is superior to femaleness; and sisterhood is superior to

brotherhood. Unlike women of Eastern Polynesia, who were excluded from all temple ceremonies, Tongan women were present and participated in all major religious ceremonies (Ralston, 1996). Ralston argues (1996:117) “notions of hierarchy and kinship relations were more central to Tongans’ systems of belief and action than considerations of maleness and femaleness.” Schoeffel (1995) supports Ralston’s opinion, stating, that unlike Melanesia, Polynesia, and Tonga and Samoa specifically, did not consider females as intrinsically inferior to males; rather it is an issue of hierarchy not gender. However she goes on to state “husbands are usually considered to have rights to command the services of their wives, an attitude which was reinforced by the teachings of the Christian church in the 19th century” (1995: 9). It appears that within this seemingly contradictory system, Tongan society afforded a matriarchal role to women, unique within the Pacific, providing the means of distribution of power, status, and rank between both genders. However, the commercialization of a traditional female enterprise, such as *limu* harvesting, reveals vulnerabilities within these social structures.

In this situation it appears that the Crown Prince, as the second highest-ranking male in Tonga, has exercised power and authority to redefine the traditional male/female roles in relationship to gleaning *limu*. Traditionally men held the authority to act in matters beyond the borders of the home and/or the village (Ralston, 1996). Men would also assess the quality and appropriateness of offerings given at ceremonial occasions (Gifford, 1929). Thomas Malm feels that:

fishing at the open sea, without any doubt, is the potentially most dangerous of all subsistence (or cash generating) tasks and that the open sea is the zone in which

one is most critically exposed to forces beyond one's own control. This might be a major reason why the "outside" has become related to masculinity and power. Tonga is only one of many societies, found worldwide, where work requiring long absence from home and travel over long distances is a male prerogative (1999:160).

In turn it was the women who would determine the redistribution of material wealth (Bott, 1982). Negotiations in politics and warfare, traditionally seen as male roles, may appear today as synonymous to commercial opportunities, due to the nature of negotiations found common within such activities.

But the problem is systemic in nature, in that one can't really point to an exact reason or cause for excluding women. While men acknowledge women's superior knowledge about *limu* harvesting, they are still able to exclude them from meaningful business opportunities on the commercial level. The complex system of rank and privilege found in Tonga may allow them to do both. There is an irony in the transformation of *limu* collection and the associated traditional male/female roles, as each is undermined by the third entity of commercialization.

In Thomas Malm's (2001) article "The tragedy of the commoners: The decline of the customary marine tenure system of Tonga", he declares the use of commons – resources held by an identifiable community of interdependent users – was used by local communities to regulate usage and actually exclude some users. He believes that the Tongan government, by assigning common lands to the Crown or the state, has resulted

in a breakdown of the traditional marine tenure systems within local communities. As has already been noted, those living adjacent to tidal flats are most likely to utilize them. Individuals are recognized and no one goes unnoticed in the adjacent tidal flats and waterways. So an aspect of the “commons” is that locals, while not exactly policing the area, are aware of users, both accepted locals and outsiders. *Fakama* (disgrace, reproach, shame) plays a major role in determining who is an acceptable user and who is not. When the Crown or state takes over a marine resource and limits access, excluding even local nearby residents, the prohibition against *fakama* is somewhat diminished. Local community members no longer consider the adjacent marine resources to be theirs in common, thus no responsibility is taken towards preserving the area from outside users. In 1976 the Tongan government set aside several marine reserves. There are prohibitions against all fishing, gathering seafood of any kind and against removal of any natural marine resources. The idea of these national reserves is to protect vulnerable areas, and allow the safeguarding of natural resources where fish and other marine organisms can breed and grow in safety. However, by not considering the interest of locals who depend on local marine resources for their families needs, the government is condemning these reserves to failure. As Malm states,

It might be argued that if the island people’s use of resources is to be managed in a way that is economically sufficient, socially satisfying and ecologically sound, a sustainable scenario must be founded upon community-based biodiversity conservation where traditional knowledge and modern ecological understanding are combined in a neo-traditional system (Malm, 2001:10).

Most researchers agree with Thomas Malm's (2001) philosophy that the way to establish community-based biodiversity conservation is to educate island people in biodiversity, ethnobiology and biodiversity conservation schemes. Community out-reach programs to help local peoples understand and appreciate the role biodiversity plays as a foundation for environmentally sustainable development is also advocated. While I agree in principal with Malm about education being imperative for local peoples, I do not believe that this alone will solve the over-exploitation problems facing many island communities. I believe that a major cause for over-exploitation of resources stems from the fact that most gleaners and fishers of tidal areas are unaware of the crisis that is building in their local waterways.

None of my consultants felt that there has been a decline in the variety and number of food items being harvested from the tidal areas. However, in my opinion there are some indications for concern. In the two years I was doing research, I was repeatedly told that sea turtles eat the *limu*; but I only observed one sea turtle in that time, and it was in a deeper channel that was not a prime location for gathering seaweed. Over those two years I heard no reports of anyone catching any sea turtles, which are prized for their delicate meat. In the past, there are records and memories of men catching fish in their nets measuring an arm's length while fishing in the tidal areas. Today the average size of fish caught in the same tidal areas is about 15 cm (6 inches) (Siteiti Tupou, personal communication, 2003). According to Poulsen (1987) and Spennemann (1987), popular clam species *kaloa'a* (*Anadara* spp.) and *to'o* (*Gafrarium* spp.) are smaller today than in the time of the first Tongan colonists. But when asked about size differences, or amount

differences local collectors insist there is no change. This may be because local gleaners and fishers have no basis for comparison. Their memories only go back so far, and they have no records from generations past as to the size or abundance of harvests and catches. Most of the people I work with travel very little, having never left their own island, let alone traveling out of the country. Consequently their basis of knowledge is limited, with no other sources of information to compare their own experiences and observations with. Thus education schemes, while good, are not enough to achieve the goal of community based ecological management and conservation. Fishers and gleaners of the tidal flats need to be made aware of changes, subtle or otherwise, occurring in their surrounding marine environments. Until they are able to actually see concrete evidence of damage within their own backyards so to speak, local resource management will continue to be ineffectual.

Community-based action research, involving community members seeking to improve local marine environments, may provide grass-root ideas regarding issues of sustainable use and conservation. By allowing gleaners and fishermen from several local communities to actively participate in research projects, aimed at identifying, quantifying and analyzing marine resource use in their areas, they are receiving knowledge that empowers them to make better decisions regarding marine resources.

Future research directions and questions

1. Community-based action research. Set up a program where expert women gleaners become the researchers, collaborating with university students, outside researchers and local Fisheries personnel to measure and record all marine resources collected from nearby tidal areas. Data would be recorded for several years, with conferences scheduled each year where local researchers would present their data and comparisons among neighboring communities could take place.
2. There are keystone species, which are critical in certain habitats because of all of the things they do in complex inter-tidal habitats. On the Pacific Coast of North America, sea otters, hunted almost to extinction on the Alaskan coast, and on Haida Gwaii and Vancouver Island, and along the southern coastal areas of Washington, Oregon and California, apparently played a major role in kelp production in the Pacific Northwest, by feeding on sea urchins that browse on kelp. When the sea otters disappear, so does the kelp over-exploited by an exploding urchin population. And when the kelp beds disappear, the herring and other fish lose their habitats, and in some cases are not able to deposit their eggs. In this way, the people who hunted the sea otter are impacted by losing important food sources. Thus the question arises, what, if any, are the keystone species that are critical in the inner-tidal ecosystem, especially regarding *limu*?

3. What is the ecological relationship of *limu* in the tidal environment? *Limu* forms the basis of an intricate food chain, involving all the organisms living within a marine ecosystem. What would happen if *limu* is distressed or destroyed altogether? Can other marine organisms survive without *limu* as a primary producer in the ecosystem? What role, other than as the basis for a food chain, and as a nursery and habitat provider, does *limu* serve? These questions have not been dealt with in the tidal flat environments in Tonga. We do not know what the ultimate impacts would be if certain species of *limu* were over-exploited or if *limu* in general were to become stressed to the point of endangerment.

4. Is there a relationship between the productivity of *limu* and the activities of women collectors – or, stated a different way, are gleaning activities beneficial to the *limu* environment? M.K. Anderson (1993, 2003) and others (c.f. Deur and Turner, 2003) have shown that indigenous peoples' harvesting techniques have in some cases actually been beneficial to the plants they are harvesting. We do not know if the activities of women gleaners of *limu* offer any sort of benefit to the growth and production of the *limu* beds. Do the women harvest from specific *limu* sites because they are more productive, or are the sites more productive because the women repeatedly harvest from them?

5. What do children, both male and female, know about the tidal-area? I often observed children "fishing" in the tidal areas, either with their parents or alone. As noted earlier, children often accompany their mothers and fathers to the tidal

flats. They spend many hours learning to glean and fish all edible organisms from the tidal area. From an early age, children in Tonga are given many family responsibilities, including working on the farm, childcare and procuring food for household consumption. Children's involvement in fishing and gleaning activities have been undervalued and overlooked not only for household consumption, but also in supplementing their own nutritional and hunger needs.

6. And finally, are there archaeological data regarding ancient village life and the surrounding marine environment in Tonga that could shed light on patterns of usage of inner-tidal areas and the exploitation of marine species by early Tongans, including *limu*?

As mentioned previously in this document, there is a noticeable absence of observations made by first contact explorers and the scientists that followed, regarding women gleaning food from the tidal flats. More recent archeological findings indicate that women would have been involved heavily in such activities prior to first contact and in the years following. I am convinced that the low level of interest, and presumably low value placed on women gleaners reflects mainly the disposition of the Western observers and carries little or no relevance when considering the value of these activities within the originating culture. Nancy Turner, who has conducted extensive research on North American First Nations Peoples, concurs with the above statement claiming, "women's work and knowledge were highly valued and considered as equal to men's in these societies, scientific researchers often make wrong assumptions about the importance of women's activities for subsistence" (c.f. Howard, 2003:21). Current trends in Western

commercialization of resources, once found within what was once the sole domain of these women, indicates that the same prejudices brought to the shores of Tonga by European explorers and researchers are ever present. However, Europeans were not the only ones to have neglected the mentioning of *limu* in their records. Tongans make no mention of *limu* in their legends, songs, poems or lore. While there are several plants, specifically the *heilala* (*Garcinia sessilis*), *kava* (*Piper methysticum*) and *ufi* (*Dioscorea alata*), that represent beauty and power in Tonga, *limu* does not represent anything other than the “poor man’s meat”.

Does this lack of documentation and saliency within the Tongan community suggest a lack of importance? In order to understand the place *limu* holds within Tongan society, we must leave *limu* in the collection basket of the women who glean. In that collection basket a variety of foods will be found, such as clams (*Kaloa'a*, *Anadara antiquata* and *A. cornea*; *to'o*, *Gafrarium timidum* and *G. pectinatum*); other molluscs (there are over 80 species used for food), crab (*paka*, the most commonly eaten species are *Scylla serrata*, *Calappa hepatica* and *Carpilius maculatus*); fish (the general word for fish is *ika*) and of course *limu*. *Limu's* value should be considered through the broader activity of *fangota* (tidal/reef fishing/gathering by hand). Most of the foods collected in that basket are rarely mentioned in Tongan folklore and song, and while many of those items, including *limu*, maybe found at feasts, none will be offered ceremonially to royalty.

When comparing the characteristics of *limu* with other plants in Tonga, it is apparent that the value of *limu* does not include the symbolic status in connecting people to their high chiefs, such as *kava* and *ufi*. *Limu* does not carry ideals of beauty with its taste, aroma, or

form, such as *heilala*. In fact high levels of salt, iodine and other trace minerals found in *limu* make it difficult to consume in large quantities during one setting. However, a small portion of *limu* consumed with the rather bland flavors of most roots and tubers is rather delicious, making a diet based on roots and tubers more palatable. *Limu* is consumed at some level by almost everyone living in Tonga. To some it is only a novelty food while to others it is a critical part of their diet, adding flavor to a limited fare. Consistent with many Pacific Islanders, Tongans also consider *limu* an important food following droughts and hurricanes.

Is there an underlying significance to *limu* and associated *limu* practices that would suggest the validity and salutary nature of *limu* to Tongan culture? Once again we must not isolate *limu*, but rather keep it in context with the broader base of women's knowledge, including the marine environment. The implications for the exclusion of women and maintenance and sustainable *limu* practices and use of tidal flat environments have been addressed in some detail throughout this document. What has not been addressed is the effect modernization and commercialization may have on how women of Tonga bear their *kavenga* (obligation and burdens) towards their family and community. For women from families with few economic resources, beyond their capacities in subsistence farming and fishing and limited access to education, *fangota* (gleaning) has provided the means for them to contribute their share to their families' needs. Along with the ability to provide food, there is the maintenance of identity and socialization between women as they collect from the tidal flats and share news of the village. While difficult to quantify, there is a distinct thread connecting the maintenance of ecosystems and

maintaining the quality of human life. At the end of the day we will feel a certain way about ourselves, and that will in turn impact the decisions we make tomorrow regarding our fellow humans and the other life-forms of the earth. Commercialization offers little to replace what is lost in regards to the strength women have found in the knowledge of the tidal flats. "A world that is culturally poor is likely to be biologically poor, and the reverse is likely to be just as true" (Howard, 2003:3).

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Appendix 1. Structured Interview Questions

- 1 What is your name?
- 2 Where do you currently live?
- 3 Where were you born and raised?
- 4 Do you know how to “fangota”?
- 5 How often do you go to the sea?
- 6 Where do you most often go to the sea?
- 7 Do you go by yourself or with others?
- 8 How did you learn to “fangota”?
- 9 What types of “limu” do you collect?
- 10 What type is your favorite?
- 11 How do you collect “limu”?
- 12 What do you do with the “limu” once you have collected it?
- 13 Are there things in the tidal areas that you use to collect as a small child that you can no longer find in the tidal areas?
- 14 Have collecting or “fangota” methods changed since the time of your grandmother or mother?
- 15 Do you think there are less numbers or types of fish, clams, limu etc. in the tidal areas now than there use to be?

Appendix 2. Focus Groups

Village Women in the Meeting

Oloua – Pauline Moalae
Luisa Vailea
Fane Lomu
Ana Tapa'atoutae
'Aliefa Tukuafu
Faleula Taulangi

Tuanuku - Kati Fusitu'a
Matila Finau
'Akihelou Fieilo
Eloni Tauaika

Koloa - Akanesi Fusitu'a Fotu
Mele Lolohea
Sulieti Fifita
Me'afua Fifita
Vake 'Otuvaika
Mele Mahe
'Ailine Teumohenga

Siupeli Lona

Falanesi Malani

Mataika - Lamona Tongia

Ma'ele Feke

Tilesa Tu'a

Saane Katoa

Appendix 3. Dr. Hideo Ohba's list of seaweeds collected from Tongatapu Island and its vicinity, 1996. Taxa marked with an asterisk (*) are new to the Tonga Islands.

Chlorophyta

Chlorophyceae

Monstromataceae

**Monostroma nitidum* Wittrock

Ulvaceae

Ulva sp.

**Enteromorpha prolifera* (Muller) J. Agardh

Enteromorpha compressa (L.) Nees

Cladophorales

Cladophoraceae

**Rhizoclonium grande* Borgesen

**Cladophorafascicularis* (Mert. Ex C. Ag.) Kützing

**Cladophora meridionalis* Sakai et Yoshida

**Cladophora Patentiramea* (Mont.) Kützing]

**Cladophora sibogae* Reinbold

Cladophora sp.

Anadyomenaceae

**Microdictyon japonicum* Setchell

Microdictyon sp.

Siphonocladales

Boodleaceae

Boodlea coacta (Dick.) Murray et De Toni

Boodlea composita (Harv.) Brand

**Struvea anastomosans* (Harv.) Piccone et Grunow

Struvea sp.

Siphonocladaceae

Cladophoropsis herpestica (Mont.) Howe

**Cladophoropsis zollingerii* (Kütz.) Reinbold

**Boergensenia forbesii* (Harv.) Feldmann

Valoniaceae

Valonia aegagropila c. Agardh

Valonia fastigiata Harvey ex J. Agardh

**Ventricaria ventriocosa* (J. Ag.) Olsen et West

Dictyosphaeria cavernosa (Forsk.) Borgesen

**Dictyosphaeria versluisii* W.-v. Bosse

Dasycladales

Dasycladaceae

**Neomeris annulata* Dickie

Neomeris vanbosseae Howe

Neomeris sp.

*Bornetella sphaerica (Zanard.) Solms-Laubach

Bornetella nitida Munier-Chalmas ex Sonder

*Acetabularia parvula Solms-Laubach

Codiales

Caulerpaceae

Caulerpa fastigiata Montagne

Caulerpa verticillata J. Agardh

*Caulerpa filicoides Yamada

*Caulerpa webbiana Montagne f. Tomentella (Harv.) w.-v. Bosse

Caulerpa serrulata (Forsk.) J. Agardh var. Serrulata

Caulerpa cupressoides (Vahl) C. Agardh

Caulerpa urvilleana Montagne

*Caulerpa taxifolia (Vahl) C. Agardh

Caulerpa sertularioides (S.G.Gmel.) Howe

*Caulerpa racemosa (Forsk.) J. Agardh var. Chemnitzia

Caulerpa racemosa (Forsk.) J. Agardh var. Clavifera

Caulerpa racemosa (Forsk.) J. Agardh var. Lamourouxii

Caulerpa racemosa (Forsk.) J. Agardh var. Peltata

Caulerpa racemosa (Forsk.) J. Agardh var. Uvifera

Caulerpa nummularia Harvey ex J. Agardh

Caulerpa sedoides (R. Br. Ex Turn.) C. Agardh

Bryopsidaceae

Bryopsis harveyana J. Agardh

Codiaceae

Chlorodesmis fastigiata (C. Ag.) Ducker

*Chlorodesmis hildebrandtii A. et E.S. Gepp

Avrainvillea (?) sp,

Rhipilia sp. (Large type)

*Rhipiliopsis echinocaulos (Cribb) Farghaly

*Udotea geppii Yamada

*Udotea javensis (Mont.) A. et E.S. Gepp

Udotea sp. (1) (large, thick)

Udotea sp. (2) (small)

Udotea sp. (3) (middle, thin)

*Tydemania expeditionis W.-v. Bosse

*Halimeda copiosa Goreau et Graham

*Halimeda cylindracea Decaisne

*Halimeda discoidea Decaisne

*Halimeda fragilis Taylor

*Halimeda hederacea (Barton) Colinvaux

Halimeda macroloba Decaisne

Halimeda macrophysa Askenasy

*Halimeda micronesica Yamada
 Halimeda opuntia (L) Lamouroux
 *Halimeda simulans Howe
 *Halimeda taenicola Taylor
 *Halimeda velasquezii Taylor
 Halimeda sp.
 *Codium arabicum Kutzing
 *Codium divaricatum Holmes
 *Codium minus (Schmidt) Silva
 *Codium repens (Croun) Vickers
 Codium spongiosum Harvey
 Codium sp.

Phaeophyta

Ectocarpales

Ectocarpaceae

*Hincksia mitchellae (Harv.) Silva

Hincksia sp.

Ralfsiaces

Ralfsiaceae

Ralfsia sp.

Scytosiphonales

Scytosiphonaceae

Hydroclathrus clathratus (C. Ag.) Howe

*Rosenvigea intricata (J. Ag.) Borgesen

Chnoosporaceae

*Chnoospora implexa J. Agardh

Sphacelariales

Sphacelariaceae

Sphacelaria sp.

Dictyotales

Dictyotaceae

*Dictyota apiculata J. Agardh

*Dictyota bartayresii Lamouroux

*Dictyota friabilis Setchell

Spatoglossum sp.

*Dictyopteris repens (Okam.) Borgesen

*Distromium decumbens (Okam.) Levring

Zonaria sp.

Lobophora variegata (Lamx.) Womersley

*Stypopodium zonale (Lamx.) Papenfuss

*Padina australis Hauck

*Padina japonica Yamada

*Padina minor Yamada

Padina pavonica (L.) Thivy

Fucales

Cystoceiraceae

**Hormophysa cuneiformis* (Gmel.) Silva

Sargassaceae

Trubinaria ornata (Turn.) J. Agardh

**Sargassum crassifolium* J. Agardh

Sargassum echinocarpum J. Agardh

**Sargassum duplicatum* (J. Ag.) J. Agardh

**Sargassum ilicifolium* (Turn.) C. Agardh

Sargassum polycystum C. Agardh

**Sargassum polyporum* Montagne

Sargassum sp.

Rhodophyta

Rhodophyceae

Memaliales

Dermonemataceae

Yamadaella caenomyce (Decsn.) Abbott

Liagoraceae

**Liagora setchellii* Yamada

Balaxauraceae

Scinaia sp.

Actinotrichia fragilis (Forsk.) Borgesen

**Galaxaura cuculligera* Kjellman

**Galaxaura fasciculata* Kjellman

**Galaxaura fastigiata* Decaisne

**Galaxaura filamentosa* Chou ex Taylor

Galaxaura marginata Lamouroux

**Galaxaura obtusata* (Ell. et Sol.) Lamouroux

**Galaxaura robusta* Kjellman

Bonnemaisoniaceae

Asparagopsis taxiformis (Delilie) Trevisan

Gelidiales

Gelidiaceae

**Gelidium pusillum* (Stackh.) Le Jolis

Gelidium sp.

Pterocladia sp.

Gelidiellaceae

Gelidiella acerosa (Forsk.) Feldmann et Hamel

Corallinales

Corallianaceae

**Porolithon craspedium* (Fosl.) Foslie

- *Porolithon onkodes (Heydr.) Foslie
- *Neogoniolithon frutescens (Fosl.) Setchell et Mason
- *Hydrolithon reinboldii (W.-v. Bosse et Foslie) Foslie
- *Lithophyllum kotschyannum Unger
- *Lithophyllum moluccense Foslie
- *Lithophyllum pallescens Foslie
- *Amphiroa foliacea Lamouroux
- *Amphiroa fragilissima (L.) Lamouroux
- Amphiroa sp.
- *Jania capillacea Harvey

Cryptonemiales

Peyssonneliaceae

- *Peyssonnelia obscura W.-v. Bosse
- Peyssonnelia orientalis (W.-v. Bosse) Cormaci et Furnari

Dumontiaceae

- *Gibsmithia hawaiiensis Doty

Halymeniaceae

- Halymenia durvellaei Bory
- Cryptonemia sp.
- *Carpopeltis maillardii (Mont. et Mill.) Chiang
- Carpopeltis sp.

Gigartinales

Schizymeniaceae

- *Titanophora weverae Borgesen

Rhizophyllidaceae

- Portiera hornemannii (Lyngbye) Silva

Solieriaceae

- Eucheuma sp. (1) (thick)
- Eucheuma sp. (2)

Caulacanthaceae

- *Caulacanthus okamurae Yamada

Phacelocarpaceae

- Phacelocarpus sp.

Sarcodiaceae

- *Trematocarpus pygmaeus Yendo

Plocamiaceae

- *Plocamium telfairiae (Harv.) Harvey

Hypneaceae

- *Hypnea charoides Lamouroux
- Hypnea pannosa J. Agardh

Gracilariaceae

- *Gracilaria arcuata Zanardini
- Gracilaria edulis (Gmiel.) Silva

- **Gracilaria parvispora* Abbott
- **Gelidiopsis intricata* (C. Ag.) Vichers
- **Gelidiopsis repens* (Kütz.) Schmitz
- Gelidiopsis* sp.

Rhodymeniales

Rhodymeniaceae

- **Asteromenia peltata* (Taylor) Huisman et Millar
- **Halichrysis coalescens* (Farlow) R.E. Norris et Millar
- **Chrysimenia glebosa* Abbott et Littler
- **Botryocladia skottsbergii* (Borg.) Levring
- **Coelothrix irregularis* (Harv.) Borgesen

Champiaceae

- **Champia parvula* (C. Ag.) J. Agardh
- Champia* sp.

Ceramiales

Ceramiaceae

- Anotrichium* sp.
- Wrangelia argus* (Mont.) J. Agardh
- **Haloplegma duperreyi* Montagne
- Spiridia filamentosa* (Wulf.) Harvey
- Ceramium* sp.
- Centroceras* sp.

Delesseriaceae

- Acrosorium* sp.
- Hypoglossum* sp.

Rhodomelaceae

- Polysiphonia* sp.
 - Tolypocladia glomerulata* (C. Ag.) Schmitz
 - Chondria tenuissima* (Gooden. et Woodw.) C. Agardh
 - Chondria* sp. (1) (middle size)
 - Chondria* sp. (2) (small, creeping)
 - Chondria* sp. (3) (small, thin, creeping)
 - Laurencia flexilis* Setchell
 - Laurencia carolinensis* Saiato
 - Laurencia* sp. (1) (thinner, reddish)
 - Laurencia* sp. (2)
 - Acanthophora spicefera* (Vahl) Borgesen
 - Levillaea jungermannioides* (Mart. et Hering) Harvey
-

Appendix 4. List of all seaweed collected in Tonga by Melinda Ostraff

Collection #	Latin binomial	Authority	Tongan name
401	<i>Caulerpa racemosa</i> var. <i>clavifera</i>	(Forsskal) J. Agardh (Turner) Weber-van bosse	<i>Fuofua</i>
402	<i>Caulerpa serrulata</i> var. <i>serrulata</i>	(Forsskal) J. Agardh	<i>Kaka</i>
403	<i>Caulerpa scalpelliformis</i> var. <i>denticulata</i> <i>lafa</i>	(Brown ex Turner) C. Agardh (Decaisne) Weber-van Bosse	<i>Pala</i>
404	<i>Caulerpa racemosa</i>	(Forsskal) J. Agardh	<i>Fuofua</i>
405	<i>Caulerpa serrulata</i>	(Forsskal) J. Agardh	<i>Kaka</i>
406	<i>Caulerpa sertularioides</i>	(S. G. Gmelin) M.A. Howe	<i>Louniu</i>
407	<i>Caulerpa racemosa</i>	(Forsskal) J. Agardh	<i>Fuofua</i>
408	<i>Caulerpa cupressoides</i> var. <i>lycopodium</i>	(Vahl) C. Agardh Weber-van Bosse	<i>Kaka</i>
409	<i>Hypnea</i> sp. possibly <i>H. charoides</i> , but unconfirmed	Lamouroux	<i>Vai</i>
410	<i>Caulerpa racemosa</i> var. ?	(Forsskal) J. Agardh	<i>Toke</i>
411	<i>Caulerpa peltata</i> var. <i>peltata</i>	J. V. Lamouroux	<i>Fuofua</i>
412	<i>Caulerpa racemosa</i>	(Forsskal) J. Agardh	<i>Fuofua</i>
413	<i>Halimeda opuntia</i>	(Linnaeus) J.V. Lamouroux	<i>Kane</i>
414	<i>Hypnea valentiae</i>	(Turner) Montagne	<i>Limu</i>

415	<i>Enteromorpha intestinalis</i>	(Linneaus) Link	<i>Limu</i>
416	<i>Sargassum</i> sp.		<i>Limu</i>
417	<i>Halimeda</i> sp.		<i>Limu</i>
418	<i>Hypnea</i> sp.		<i>Limu</i>
419	<i>Boergesonia forbesii</i>		<i>Limu</i>
420	<i>Caulerpa verticillata</i>	J. Agardh	<i>Limu</i>
421	<i>Padina gymnospora</i>	Kutzing	<i>Telinga</i>
422	<i>Gracilaria</i> sp.		<i>Limu</i>

Appendix 5. Ten Village Survey

Survey of 200 Vava'u women between the ages of 20 and 50. Twenty women were chosen from each of ten main villages on the island of Vava'u (Mataika, Okoa, Koloa, Tu'anekeviale, Ha'laufuli, Ta'anea, Leimatu'a, Feletoa, Tefisi, Neiafu). Ten women were asked questions from each of the villages in March, 2001, and ten different women were asked questions from each village in September, 2001.

Each woman was asked the following questions:

1. Name
2. Did you *fangota* (fishing with one's hands, reaching, groping and searching along the tidal flat areas) last week
3. If yes, how many times did you *fangota*, and
4. If yes, what was collected each trip

The results of the survey are as follows:

200 surveyed

88 women had been out to *fangota* the previous week for a total of 114 times. *Limu* was collected on 24 of those trips, which equals 21% of the time.

100 women surveyed during the first week of March, 2001.

49 women said yes they had been out to *fangota* the previous week, a total of 62 times.

14 trips included *limu* collection, in other words 23% of the time that women went to *fangota*, they also collected *limu*.

100 women surveyed during September of 2001.

39 women said yes they had been out to *fangota* the previous week, a total of 52 times. 10 trips included *limu* collection, or 19% of the time.

Mataika (T=10; Y= 8; N=2; L=2)*

* T = Total # of times to *fangota*

Y = Total # of yes answers

N = Total # of no answers

L = Total # of times *Limu* was collected

1. Name: Mapa 'Alofaki

Age: 33

Did you *fangota* last week yes

- If yes, how many times did you *fangota* 2 times
- If yes, what did you collect on each trip
1st time: *kaloa'a*
2nd time: *to'o, kaloa'a, ika*
2. Name: Lataisia Tongia Age: 34
- Did you *fangota* last week yes
- If yes, how many times did you *fangota* 2 times
- If yes, what did you collect on each trip
mulione
1st time: *limu, sea cucumbers, lomu,*
2nd time: *jellyfish, limu, finemotu'a*
3. Name: Sela Lisala Age: 20
- Did you *fangota* last week yes
- If yes, how many times did you *fangota* one time
- If yes, what did you collect on each trip
sea cucumbers, *mulione, lomu*
4. Name: Mele Tuliakiono Age: 50
- Did you *fangota* last week no
- If yes, how many times did you
- If yes, what did you collect on each trip
5. Name: Ana Liueli Age: 20
- Did you *fangota* last week no
- If yes, how many times did you
- If yes, what did you collect on each trip
6. Name: Asi Te'ekafa Age: 50
- Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip jellyfish, *tengange*, *to'o*

7. Name: 'Ana Kalama Lavemai Age: 27

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *koloa'a*, *to'o*

8. Name: Ma'ele Feke Age: 27

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *lomu*, *muli'one*, *finemotu'a*, *te'efihifihi*

9. Name: Vika Leka Age: 24

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip jellyfish, *to'o*, *tengange*

10. Name: Lotom'ua Lavemai Age: 26

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip jellyfish, *tengange*, *to'o*, *lomu*

Okoa (T=8; Y=6; N=4; L=2)

1. Name: Vika Vakapuna Age: 46

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Kalati Halatoa Age: 46

Did you *fangota* last week yes

If yes, how many times did you two times

If yes, what did you collect on each trip
1st time: *to'o, limu*
2nd time: *kaloa'a, to'o*

3. Name: Lope Line Age: 50

Did you *fangota* last week yes

If yes, how many times did you two times

If yes, what did you collect on each trip
1st time: *to'o, kaloa'a*
2nd time: *lomu, sea cucumbers*

4. Name: 'Ema Faletau Age: 24

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip
te;efihifihi *kaloa'a, fai'ahu, lomu, mulione, ia,*

5. Name: Vaima'ali Tupou Age: 39

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip
kaloa'a, to'o, kuku, pipi, lomu, loli, mulione

6. Name: Kaveinga Funaki

Age: 33

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *limu, feke, jellyfish, ika, toke, fai'ahu*

7. Name: Pauline Tuiake

Age: 27

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

8. Name: 'Evaleti Tupou

Age: 23

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

9. Name: Malia Faletau

Age: 43

Did you *fanota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a, to'o, kuku*

10. Name: Mele Tupou

Age: 30

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

Koloa (T=9; Y=4; N=6; L=1)

1. Name: 'Ana 'Atu Ekaho Age: 33

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Mele Mahi Age: 50

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a*

3. Name: Vake 'Otuvaka Age: 26

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a*, sea cucumber

4. Name: Nehusita Age: 35

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

5. Name: Uini Fifita Age: 36

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

6. Name: 'Elenoa Siale Age: 26

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

7. Name: Fatai Hala'ufia Age: 22

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

8. Name: Me'afua Fifita Age: 46

Did you *fangota* last week yes

If yes, how many times did you two times

If yes, what did you collect on each trip 1st time: *lomu, kaloa'a, to'o, kuku, mulione*
2nd time: same as above

9. Name: Akanesi Futu Age: 45

Did you *fangota* last week yes

If yes, how many times did you five times

If yes, what did you collect on each trip 1st time: *limu*
2nd time: *lomu, loli, vilivalo, 'elili*
3rd time: *lomu*
4th time: *lomu*
5th time: *kaloa'a, tengange*

10. Name: Mele Moungaite Langi Age: 25

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

Tu'anequivale (T=8; Y=8; N=2; L=4)

1. Name: Ngalo'afi Afu Age: 24

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Faleula Taulangi Age: 40

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *limu, vana, lomu, finemotu'a*

3. Name: Lusiane Moala Age: 46

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

4. Name: Kasimea Hikila Age: 46

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a, to'o, lomu, limu*

5. Name: 'Ana Paasi Age: 54

If yes, how many times did you

If yes, what did you collect on each trip

5. Name: Lose Naiata

Age: 20

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

6. Name: Kalo Kolomalu

Age: 34

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

7. Name: 'Alema Satini

Age: 40

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *feke*

8. Name: Lulama Pauni

Age: 27

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip sea cucumber, *mulione*, *kaloa'a*

9. Name: Patisua Afu

Age: 29

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *ika, 'elili*

10. Name: Ma;u Afu Age: 42

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

Ta'anea (T=1; Y=1; N=9; L=0)

1. Name: Hainite Tavake Age: 46

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Tatila Samani Age: 46

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

3. Name: Lesieli 'Anitoni Age: 21

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

4. Name: Kapuana Vake Age: 45

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

5. Name: Malia Naeata Age: 30

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

6. Name: Lesieli Vaea Age: 20

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

7. Name: Losa Pakei Age: 31

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

8. Name: Fifita Fasai Age: 38

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

9. Name: Fualupe Tamaini Age: 47
 Did you *fangota* last week yes
 If yes, how many times did you one time
 If yes, what did you collect on each trip *kaloa 'a, to 'o, sea cucumbers, lomu*

10. Name: Mele Sika Age: 48
 Did you *fangota* last week no
 If yes, how many times did you
 If yes, what did you collect on each trip

Leimatu'a (T=6; Y=6; N=4; L=1)

1. Name: 'Elesili Kavai Age: 24
 Did you *fangota* last week no
 If yes, how many times did you
 If yes, what did you collect on each trip

2. Name: Lose Kata Age: 48
 Did you *fangota* last week yes
 If yes, how many times did you one time
 If yes, what did you collect on each trip *kaloa 'a, to 'o, fole, sea cucumber*

3. Name: Vaisioa Tupou Age: 36
 Did you *fangota* last week yes

If yes, what did you collect on each trip

9. Name: Sila Finau Age: 36

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

10. Name: Mele Lautolu Age: 40

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip jellyfish

Feletoa (T=9; Y=5; N=5; L=4)

1. Name: Akanesi Latu Age: 50

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Ofa Kauvaka Age: 50

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a, to'o*

3. Name: Liekina Velingatoni Age: 26

Did you *fangota* last week yes

If yes, how many times did you five times

If yes, what did you collect on each trip
 1st time: *to'o, kaloa'a, jellyfish*
 2nd time: *kaloa'a, to'o, jelly fish, limu*
 3rd time: *jelly fish, lomu, to'o*
 4th time: *jellyfish, kaloa'o, to'o*
 5th time: *limu, jellyfish, kaloa'a, to'o*

4. Name: Anamanu Vailea Age: 41

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a, to'o*

5. Name: Kalafi Latu Age: 31

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

6. Name: Suliana Vaha Age: 32

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *limu, lomu kaloa'a, ika*

7. Name: Vika Lalakai Age: 23

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *lomu, kaloa'a, limu*

8. Name: Losaline Latu Age: 23

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

9. Name: Latai Latu Age: 26

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

10. Name: Sini Latu Age: 28

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

Tefisi (T=3; Y=3; N=7; L=0)

1. Name: Malia Puloka Age: 20

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Mele Katoa Age: 27

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

3. Name: Akosita Ranoll Age: 46

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a, kuku, tengange*

4. Name: Mapa Maile Age: 27

Did you last week no

If yes, how many times did you

If yes, what did you collect on each trip

5. Name: Meleane Hakalo Age: 20

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

6. Name: 'Esefa Kolope Age: 29

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

7. Name: Meliame Fonua Age: 35

Did you *fangota* last week yes

2. Name: Tina Mahanga Age: 24

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

3. Name: Supiesi Longani Age: 22

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

4. Name: 'Ailine Fifita Age: 50

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *loli, muli'one, lomu, fiahu*

5. Name: Lepolo Tukuafu Age: 24

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

6. Name: Tamutamu Vaiaku Age: 28

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

7. Name: Piuela Fa'onelua Age: 22

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *fai'ahu, te'epupulu, ika*

8. Name: Leotisia Tulikihakau Age: 23

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

9. Name: Lile Tu'ifua Age: 25

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *finemotu'a, lomu, fotu'ohua, faiahu*

10. Name: Nonga Tu'ifua Age: 27

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *lomu, fai'ahu, finemotua*

Survey completed in September of 2001

Mataika (T=6; Y= 3; N=7; L=0)

1. Name: Vika Leva Age:25

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Tesei Taufa

Age: 32

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

3. Name: Lesieli Te'ekafa

Age: 22

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

4. Name: 'Ana Vehi

Age: 46

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

5. Name: Ma'ele Feke

Age: 30

Did you *fangota* last week yes

If yes, how many times did you four times

If yes, what did you collect on each trip
finemotu'a,

1st time: *lomu, mulione, te'efihifihi,*
kaloa'a

2nd time: *lomu, mulione, finemotu'a, fi'ahu,*
fotu'ohua

3rd time: *lomu, mulione, finemotu'a,*
kaloa'a

te'efihifihi,

te'efihifihi,

4th time: *lomu, mulione, finemotu 'a,*
faia 'hu, kaloa 'a

6. Name: Kalsita Taliauli Age: 38

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

7. Name: Toakase Tuliakiono Age: 29

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

8. Name: Tilesa Tu'a Age: 40

Did you *fangota* last week yes

If yes, what did you collect on each trip *fotu'ohua*

9. Name: Talavao Fifita Age: 27

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

10. Name: Saane Katoa Age: 42

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a, to'o, tengange*

Koloa (T=7; Y=6; N=4; L=3)

1. Name: Akanesi Fusitu'a Fotu Age: 46

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: 'Ailine 'Ana Teumohenga Age: 23

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *limu*

3. Name: Teuila Fotu Age: 50

Did you *fangota* last week yes

If yes, how many times did you two times

If yes, what did you collect on each trip
1st time: *ngou'a, mulione*
2nd time: *ngou'a, mulione, kele'a*

4. Name: Mele Lolohea Age: 25

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

5. Name: Siupeli Lona Age: 50

If yes, how many times did you

If yes, what did you collect on each trip

Okoa (T=9; Y=5; N=5; L=1)

1. Name: 'Alilia Tafutafu Age: 32

Did you *fangota* last week yes

If yes, how many times did you two times

If yes, what did you collect on each trip
1st time: *kaloa'a, lomu, ika*
2nd time: *kaloa'a, lomu*

2. Name: Makeleta Saluni Age: 44

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip
lomu, hulali, feku, ufu

3. Name: Tokilupe Manoa Age: 30

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

4. Name: Ana malia Age: 43

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

5. Name: Kasanita Hautau Age: 42
- Did you *fangota* last week yes
- If yes, how many times did you two times
- If yes, what did you collect on each trip
1st time: *angoango, paka, kaloa 'a*
2nd time: *paka, kaloa 'a, lomu, mulione*
6. Name: Meliana Lauaupelu Age: 35
- Did you *fangota* last week no
- If yes, how many times did you
- If yes, what did you collect on each trip
7. Name: Supiesi Mafile'o Age: 38
- Did you *fangota* last week no
- If yes, how many times did you
- If yes, what did you collect on each trip
8. Name: Meleseini Finau Age: 42
- Did you *fangota* last week yes
- If yes, how many times did you three times
- If yes, what did you collect on each trip
1st time: *kaloa 'a, to'o, mulione, ika*
2nd time: *kaloa 'a, to'o*
3rd time: *kaloa 'a, to'o, mulione, lomu*
9. Name: 'Emeline Faletau Age: 38
- Did you *fangota* last week yes
- If yes, how many times did you one time

If yes, what did you collect on each trip *fai'ahu, lomu, limu*

10. Name: Mele Lautolo Age: 21

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

Tu'anekivale (T=2; Y=2; N=8; L=1)

1. Name: Puli Kioa Age: 40

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Vakaola Lolo Age: 30

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

3. Name: Lepeka Maola Age: 28

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

4. Name: Seini Hifo Age: 26

Did you *fangota* last week yes

If yes, how many times did you

If yes, what did you collect on each trip

10. Name: Sisifa

Age: 23

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

Ha'alaufuli (T=5; Y=5; N=5; L=4)

1. Name: Meleane Velata

Age: 26

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: 'Ana Na'a

Age: 32

Did you *fangota* last week yes

If yes, how many times did you ne time

If yes, what did you collect on each trip *limu*

3. Name: Melelili 'Otuafi

Age: 28

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

4. Name: Apipasia Lutui

Age: 31

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

10. Name: Tahi Hafaka Age: 38

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *limu*

Ta'anea (T=4; Y=4; N=6; L=0)

1. Name: Losana 'Ala Age: 33

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Vika Ta'aki Age: 50

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *'elili*

3. Name: Kalisi Valahulu Age: 32

Did you *fangota* last week yes

If yes, what did you collect on each trip *kaloa'a, to'o*

9. Name: Pla 'Otuafi Age: 34

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *'elili*

10. Name: Hehenga Vatikani Age: 20

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

Leimatu'a (T=3; Y=3; N=7; L=0)

1. Name: Mekinolia Finau Age: 31

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Noame Tonga Age: 20

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

3. Name: Vea Telesia Finau Age: 21

If yes, how many times did you

If yes, what did you collect on each trip

9. Name: Velonika Vea

Age: 32

Did you *fangota* last week

yes

If yes, how many times did you

one time

If yes, what did you collect on each trip

kaloa'a, kuku, paka, to'o, tengange, tafola

10. Name: Silakivai Tau

Age: 35

Did you *fangota* last week

no

If yes, how many times did you

If yes, what did you collect on each trip

Feletoa (T=2; Y=2; N=8; L=0)

1. Name: Petulisi 'Ahofono

Age: 28

Did you *fangota* last week

no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Sela Fetuli

Age: 30

Did you *fangota* last week

no

If yes, how many times did you

If yes, what did you collect on each trip

3. Name: Temalisi Finau Age: 34

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a, to'o, tengange*

4. Name: Feofa'aki Tangataevaha Age: 27

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

5. Name: Fatima Simote Age: 50

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

6. Name: 'Oli'ila Leao Age: 38

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a, to'o, tengange, fole*

7. Name: Mele Taufui'I Age: 48

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

8. Name: Ma'ata Kauvaka Age:50

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

9. Name: Luseane Taufu Age: 29

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

10. Name: Fifita Loto'ahea Age: 47

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

Tefisi (T=10; Y=6; N=4; L=0)

1. Name: 'Asena Fusitu'a Age:36

Did you *fangota* last week yes

If yes, how many times did you three times

If yes, what did you collect on each trip
 1st time: *kaloa'a, te'epupulu, kuku, mulione*
 2nd time: *kuku, kaloa'a, tokanoa*
 3rd time: *kaloa'a, kuku, tokanoa, mulione*

2. Name: Kasa Mahina Age:39

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

3. Name: Siutu Leha'uli Age: 21

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

4. Name: Vika Lavaka Age: 35

Did you *fangota* last week yes

If yes, how many times did you two times

If yes, what did you collect on each trip
1st time: *kaloa'a, to'o*
2nd time: *kaloa'a, to'o*

5. Name: Palasa Tulikihakau Age: 25

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

6. Name: Lolongo Timote Age: 50

Did you *fangota* last week yes

If yes, how many times did you two times

If yes, what did you collect on each trip
1st time: *kaloa'a, to'o, kuku, tokanoa, lomu*
2nd time: *kaloa'a, to'o, te'epupulu, tokanoa,*
kuku

7. Name: Mele Taufono Age: 35

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

8. Name: Asi Vakameilalo Age: 45

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *to'o, te'epupulu*

9. Name: Viviena Lavaka Age: 35

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *mulione, finemotu'a*

10. Name: Lose Fusitu'a Age: 40

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *kaloa'a, to'o, kuku, paka*

Neiafu (T=4; Y=3; N=7; L=1)

1. Name: Lealofi Tutoe Age: 29

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

2. Name: Lou Fetokai Age: 41

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

3. Name: 'Asena Tapa'atoutai Age: 48

Did you *fangota* last week yes

If yes, how many times did you one time

If yes, what did you collect on each trip *lolulalu, lomu, kuku, limu, kaloa'a*

4. Name: Laveni Mahanga Age: 45

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

5. Name: Meleane Uasila'a Age: 50

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

6. Name: Talolo Puta Age: 35

Did you *fangota* last week no

If yes, how many times did you

If yes, what did you collect on each trip

7. Name: Sinitalela Hopoi Age: 38
- Did you *fangota* last week yes
- If yes, how many times did you two times
- If yes, what did you collect on each trip
angaanga 1st time: *ngou'a, lolulalu, lomu, kuku,*
2nd time: *fai'ahu, hulali, to'o, kaloa'a, lomu*
8. Name: Haitelenisia Paea Age: 23
- Did you *fangota* last week no
- If yes, how many times did you
- If yes, what did you collect on each trip
9. Name: Melesungu Fononga Age: 24
- Did you *fangota* last week no
- If yes, how many times did you
- If yes, what did you collect on each trip
10. Name: Sela Lomu Age: 31
- Did you *fangota* last week yes
- If yes, how many times did you one time
- If yes, what did you collect on each trip *lomu, fai'ahu, hulali, pule, fotu'ohua*

Appendix 6. Tupou Survey
(Seafoods collected by the Tupou family during the month of October, 2001).

Date Collected	What was Collected	Amount Collected	Who Collected it
Sept. 31	fish	6.0 kg	Siteiti
Oct. 1	fish	4.5kg	Siteiti
Oct. 4	shell fish	15.6kg	Vai
Oct. 4	shell fish	12.4kg	Elita
Oct. 5	fish	2.4kg	Siteiti
Oct. 6	fish	6.9kg	Siteiti Jr.
Oct. 7	fish	5.0kg	Siteiti
Oct. 10	fish	11.8kg	Siteiti
Oct. 10	limu	4.0kg	Louleni
Oct. 10	limu	3.5kg	Elita
Oct. 11	fish	6.1kg	Siteiti
Oct. 11	limu	4.0kg	Louleni
Oct. 11	molluscs	10.0kg	Louleni
Oct. 12	fish	3.7kg	Siteiti
Oct. 12	shell fish	10.6kg	Elita
Oct. 13	fish	6.0 kg	Siteiti
Oct. 15	shell fish	19.4kg	Vai
Oct. 15	fish	6.0kg	Siteiti
Oct. 18	fish	6.7kg	Siteiti
Oct. 18	limu	9.3kg	Louleni
Oct. 18	limu	.1kg	Elita
Oct. 18	shell fish	2.0kg	Louleni
Oct. 20	shell fish	3.0kg	Louleni
Oct. 20	fish	4.4kg	Siteiti
Oct. 20	molluscs	5.9kg	Louleni
Oct. 21	fish	4.5kg	Siteiti
Oct. 22	fish	6.0kg	Siteiti
Oct. 23	shell fish	4.3kg	Elita
Oct. 24	crabs	4.7kg	Siteiti
Oct. 25	fish	5.0kg	Siteiti
Oct. 26	fish	11.1kg	Siteiti
Oct. 26	molluscs	3.0 kg	Elita
Oct. 26	crabs	2.6kg	Siteiti
Oct. 27	shell fish	5.7kg	Elita
Oct. 27	fish	2.0kg	Siteiti
Oct. 28	fish	18.8kg	Siteiti

The total gross weight of all the seafood collected during the month was 286.2kg. Siteiti or Siteiti Jr collected 51% of the total weight. The women collected 140.2kg of seafood including shellfish, molluscs and *limu*. *Limu* made up 17% of the amount the women collected, and 8% of the total weight.

Appendix 7. High School Survey

Ninety-six science students from Sainiha High School were asked to record everything they ate for one week. Foods were correlated into two categories, Traditional Foods and Imported Foods. Within each of these categories five sub-categories were noted.

Traditional Foods: fruits, vegetables, other farm produce and local meats
 Imported Foods: bread, meat, dairy, other starch, junk

The results of the survey are as follows:

Traditional Foods	48%	Imported Foods	55%
Fruits	79	Bread	391
Vegetables	39	Meat	245
Roots	600	Dairy	34
Farm Produce	47	Other Starch	83
Local Meats	<u>119</u>	Junk	<u>257</u>
Total	884	Total	1010

Appendix 8. Market Survey

In July of 2002 I conducted a survey of the local market (Market Survey). I noted numbers of sellers (if any), where the *limu* was collected, and how many packets of *limu* were sold each day. I also questioned buyers of *limu* as to how often they purchased *limu* from the market and their reasons for doing so.

Results of the survey: 288 packets of *limu* sold over a two-week period. The average number of *limu* packets sold per day is 20.57. All of the sellers during the two-week period came from the villages of Koloa or Holeva.

Sellers

Seller Name	Age	Village	Packets of <i>Limu</i>
July 17 No <i>limu</i> for sale			
July 18 Kalo Kaofusi	60	Koloa	13
July 19			
Kalo Kaofusi	60	Koloa	20
Fisi'iahi Taufu	49	Holeva	15
Susana Finau	37	Holeva	27
Susana Vaiangina	45	Holeva	10
July 20			
Tukufuka Otaota	52	Holeva	12
<i>Manatu</i> Kitaniti	38	Holeva	40

Kava Moala	59	Holeva	18
Silia Tutone	30	Holeva	10
Matau Taufa'ao	42	Holeva	4
Fisi'iahi Taufa	49	Holeva	10

July 21

Sunday - market closed all day

July 22

No limu for sale

July 23

No limu for sale

July 24

No limu for sale

July 25

Kalo Kaofusi	60	Koloa	24
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July 26

Kalo Kaofusi	60	Koloa	10
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Susana Finau

37	Holeva	28
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July 27

Susana Vaiangina*	45	Holeva	8
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Kalo Kaofusi

60	Koloa	20
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July 28

Sunday - market closed all day

July 29

No limu for sale

July 30

No limu for sale

*Susana said that a woman in the village of Koloa came down with Typhoid yesterday, so the doctor said that the people from Koloa can not sell *limu*, or other food products so the sickness will not spread.

Sampling of Buyers

Gender Reason for Purchasing Limu

Female	She bought it to eat, she eats it plain
Female	She bought 20 packets, which she then sent to her relatives in Samoa
Female	She has high blood pressure and the doctor told her to eat things from the ocean, and she likes it
Male	He is a vegetarian, he eats <i>limu</i> and fish, when he has money he will buy <i>limu</i> , he really likes it
Female	Her relatives from overseas are here and she is making limu with coconut milk, tin fish and tomatoes
Male	He buys <i>limu</i> once a week because he likes it
Female	She says it is good for her health, it has iodine , she buys it every week and if she does not have money to buy it she will collect it herself. She teaches at a primary school and she tells the kids to eat a lot of <i>limu</i>
Female	She likes to eat it, along with other things from the sea
Female	She buys it for her mother
Female	She buys it because she likes it and its better for her than meat
Male	He buys it because his family likes it and it has vitamins
Female	She likes it

Appendix 9. *Limu* Recipes

Limu Salad

2 kg fresh cleaned *limu* (*Caulerpa* species)

1 small onion, chopped

2 cups coconut milk

1 small chili pepper, chopped (optional)

1 can tinned fish

Mix all of the above ingredients except the tinned fish. Carefully toss the tinned fish into the *limu* mixture. Serve immediately.

Limu Salad (Ana Tapa'atoutae)

2 kg fresh cleaned *limu* (*Caulerpa* species)

1 small chopped chili pepper

Juice from 2 to 3 limes

Mix the *limu* and chopped chili pepper. Toss lightly with the lime juice. Serve immediately.

Limu and Coconut Salad (Akanesi Fotu)

2 kg fresh cleaned *limu* (*Caulerpa* species)

2 cups coconut milk

2 small onions, chopped

1 tomato, chopped

1 8oz can fish (mackerel)

Wash and clean *limu fuofua*. Place the *limu* in a dish and add the coconut milk, onion, tomato and canned fish. Toss until well mixed. Serve with cooked taro or yams.

Cooked Limu Vai (Paulini Moalae)

2 to 3 kg of *limu vai*

1 - 2 quarts water

2 cups coconut milk

1 small onion, chopped

1 tablespoon curry powder

Carefully rinse the *limu vai* in fresh water. Place the cleaned and washed *limu* in a large saucepan and cover with the water. Bring to a boil. Add the coconut milk, chopped onion and curry powder. Continue cooking until the *limu* turns a bright avocado green color and the mixture begins to thicken. Serve immediately as a soup or cool mixture until it has thickened into a "pudding" or "gelatin". Cut the cooled mixture into small squares and serve.

Cooked *Limu Vai* (Vai and Elita Tupou)

2 kg fresh cleaned *limu vai*

2 cups coconut milk

2 onions, chopped

2 T. curry powder

25 - 30 cooked small clams (*Kaloo'a*)

Put cleaned *limu vai* into a large cooking pot. Mix the curry powder into the 2 cups of coconut milk. Add the coconut milk mixture to the *limu vai*. Stir in chopped onions. Remove the meat from each clamshell and discard the shells. Mix the clams into the *limu vai* mixture. Cover the pot and place over medium hot fire. Cook stirring occasionally for about 20min or until the *limu* has dissolved and turns a bright green color. Pour into a dish to cool. When cool, cut into small squares and serve.

Roasted *Limu Tanga'u* (Vika Na'a Kaufusi)

1 to 2 kilos of *tanga'u*

Ti leaves (enough to wrap the *limu* in)

Wash the *limu* carefully. Then wrap the *limu* in fresh *Ti* leaves. Roast over an open fire.

Seaweed Jelly (Novaczek, 2001)

1 cup *Eucheuma* seaweed that has been bleached, dried and then soaked in rice water

2 cups water

1 T. fresh lemon juice

Chop the seaweed and place it in a pot. Add the water and bring it to a boil. Add the lemon juice and cook over low heat, stirring occasionally, for about 30 min. or until the seaweed dissolves. Remove from the heat and pour the mixture into a jar. Allow to cool completely.