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Plants, people and culture in the villages of Oikull and Ibobang, Republic of Palau

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Introduction

Ethnobotany is the investigation of the interaction between plants, people and culture (Jones 1941; Arvigo and Balick 1998; Balick and Cox 2005). The body of knowledge and practices developed and maintained by people interacting with their natural environment over time is known as traditional knowledge. This can include information on plants used for food, shelter, medicine, tools, arts and crafts, aesthetic beauty and spiritual purposes. Due to its dynamic nature, traditional knowledge is difficult to quantify (Lee et al. 2001). The loss of traditional practices is a threat to biodiversity globally (Balick and Cox 2005) and to Palau's communities (Palau National Biodiversity Strategy and Action Plan 2004). Lee and colleagues (2001) found that in Pohnpei traditional knowledge had significantly eroded within three generations for such daily tasks as planting taro, fermenting breadfruit, using plants for fish poison, making canoes and catching turtles. To counteract this threat in Micronesia, the Biodiversity and Human Health Project was initiated in Pohnpei in 1997 (Balick 2009), and as of 2007, has been ongoing in Palau and Kosrae. The goal of this project is to establish a link between ecosystems and human health.

Traditional medicines have been used for thousands of years worldwide. It is probable some of the canoe plants that arrived with Palau's early settlers 3000–4000 years ago were transported due to their medicinal properties. Healers still refer to the ca. 1700-year-old Chinese text *Materia Medica*, attributed to Shen Nong, that describes the medicinal properties of 252 plant species. India has made use of more than 7500 plants (Kapoor 1990; Mukherjee and Wahile 2006). The World Health Organisation estimates that 80% of the world's inhabitants continue

to rely significantly on traditional medicine systems for their primary health care. The remaining 20% of the population depends on pharmaceutical medicines – and one in four of these contain plant extracts or active chemicals derived from 90 different plant species (Farnsworth et al. 1985). Although Western health care is available to varying degrees in many parts of the world, including the Pacific, traditional medicine is still widely practised in Oceania (Whistler 1992, 1996; Balick 2009). These traditional medical systems employ native tropical island plants, some of which are found nowhere else in the world. Health care based on traditional practices that are consistent with international standards of quality control is now being advocated in the worldwide medical community, including Micronesia (Lee 2009).

Ethnobotanical studies in the Palauan archipelago in western Micronesia have focused on the medicinal uses of plants (Okabe 1941; Black 1968; Salsedo 1970; Salsedo and Smith 1987; Defilippis et al. 1988; Friend and Tabak 1995; Palau Society of Historians 2000, 2001; Machiko 2002; Del Rosario and Esquerria 2003) and construction of the *bai*, the traditional men's meeting house (Telmetang 1993). The medicinal studies in Palau have documented more than 80 plant species with more than 235 medical uses, with the most recent study showing activity against the Hepatitis C virus for several native Palauan plant species (Kitalong 2007). Palau's early ethnohistorical sources (Krämer 1917, 1919, 1929) address plant use in Palauans' daily lives. These early studies lack records crediting the informants and do not detail the step-by-step processes for the use of many species. There may be several reasons for this, including the lack of translators, a society that was more protective of its knowledge, and a lack of understanding the value and significance of this information for future studies.

Previous studies of Palau's flora include Kanehira (1933) and Fosberg and his colleagues' extensive 45 years of floristic surveys and systematics (Fosberg 1946, 1947, 1957, 1960; Fosberg and Sachet 1975a, 1975b, 1977, 1979, 1980a, 1980b, 1981, 1984, 1987, 1991; Fosberg et al. 1979, 1982, 1987, 1993; Fosberg et al. 1980; Fosberg and Raulerson 1990). Palau's other vegetation studies consist of descriptions of wetland communities including mangrove forests (Stemmermann 1981), a comprehensive vegetation survey (Cole et al. 1987), a rapid ecological study of the Ngeremeduu Bay Drainage (Canfield et al. 1992) and a botanical reconnaissance of Babeldaob (Raulerson et al. 1997). Palau's forests have been systematically inventoried (Donnegan et al. 2007) and important forest areas, long-term vegetation trends and species diversity were studied (Hillmann Kitalong and Holm 2004; Costion and Kitalong 2006; Hillmann Kitalong 2008; Hillmann Kitalong et al. 2009).

Palaeoenvironmental studies using charcoal and palaeobotanical remains are reconstructing Palau's ancient landscape (Athens and Ward 2001, 2002, 2005). Palau's lowland forests cover 87% of the land, of which 75% is native forest. Prehistoric earthworks cover a minimum of 20% of Babeldaob and impact an area double that size due to the intensive erosion resulting from their construction (Liston 2009). This erosion may explain the alluvial soils of the lowlands (Athens and Ward 2005; Liston and Tuggle 2006; Masse et al. 2006). Integration of ethnobotanical and archaeological studies provides a better understanding of long-term changes in plant communities and their impact on human culture over time.

This ethnobotanical study was initiated at the Belau National Museum (BNM) in partnership with the New York Botanical Garden and the National Tropical Botanical Garden. The goal of the program is to document the traditional knowledge and practices regarding the use of plants through life's passage from birth to death. Presented here is a preliminary ethnobotanical study of the villages of Oikull and Ibobang on Babeldaob.

Materials and methods

The Republic of Palau, located within latitudes 08°12' to 2°48' and longitudes 131°07' to 134°44', is the westernmost archipelago of the Caroline Islands in Micronesia (Figure 1). The study sites are located on Babeldaob, Palau's largest island, in the village of Oikull in Airai state, and in the village of Ibobang in Ngatpang state. Oikull, in southeast Babeldaob, has volcanic, limestone and mangrove forests and freshwater wetlands and grasslands. Due to Oikull's unique transitional location on both volcanic and limestone soils, it contains a diverse assemblage of plants. Although with a similar habitat, Ibobang, on the shores of Ngaremeduu Bay in southwest Babeldaob, is on volcanic soils so does not have the limestone forest habitat of Oikull.

Oikull and Ibobang were chosen as study sites by the Belau National Museum Board based on a number of considerations, including local interest, accessibility, the level of cultural knowledge and the presence of plant diversity. These two villages are considered 'proof of principle' sites, where development of methodologies and training for studies elsewhere in Palau will be undertaken.

Earthworks complexes, pottery scatters and abandoned stonework villages connected by a network of stone paths attest to the fact that Oikull is an ancient village area that was once densely populated. Many people can trace their roots to Oikull as it plays a significant role in Palau's migration stories. The original settlers came from Metuker Rikull, a small rock island near Oikull where fishermen were famous for their shark-hunting skills.¹ Today few residents live in the village due to lack of adequate roads providing access to schools. The villagers have moved to locations that are more convenient and closer to schools although they would like

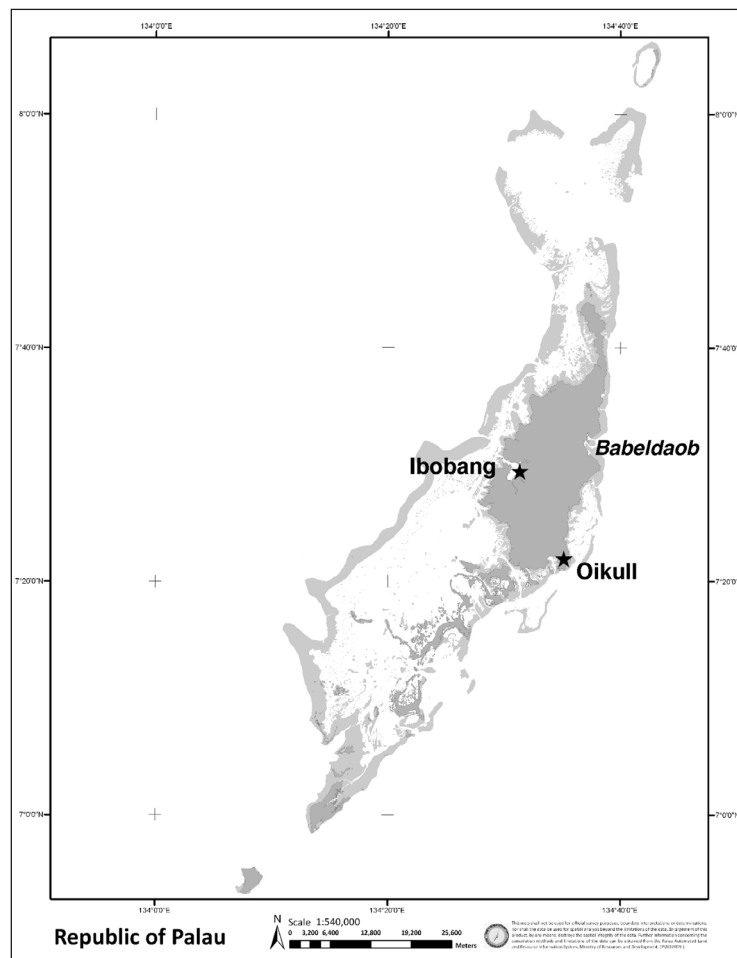


Figure 1. Study sites on Babeldaob, Republic of Palau (Source: PALARIS).

to move back to Oikull. Oikull was chosen for study due to the large number of community members who originated from this village with potential knowledge of traditional skills.

Ibobang, a village established in the recent historic era, is the centre of the Modekngai religion whose followers believe in the ancient gods and follow customary rituals and healing practices (Machiko 2002). Ibobang was donated by the Inglii clan to the founder of the Modekngai religion, Tamadad, who came from Choll, a village on Babeldaob's northeast coast. Ibobang was chosen for the study due to the large number of community members who are active practitioners of traditional skills.

A preliminary meeting was held with village elders at the Belau National Museum to explain the project's purpose and obtain informed consent. After community meetings in the two states, informal interviews were set up with those villagers recommended by the elders as knowledgeable about the use of plants. Interviews began by obtaining background information about the individuals, including age, place of birth, time in villages, migrations between villages and the activities they participated in or observed during childhood and adulthood. Specific questions focused on recreation, food preparation, medicine for primary care, building and special customary practices. Several interview approaches were used, although the preferred method was to walk in the informant's neighbourhood forest as the informant indicated specific plants for a given purpose. Replicate voucher specimens could then be collected on site.

Some elders preferred that plants be brought to them for verification, while others came to the BNM herbarium for interviews and voucher species were presented for authentication. The interviewer would ask whether a given species had a use, but did not state a use or ask for confirmation of a use for a given plant. Most interviews were carried out in one session, although time constraints required some informants to have several interviews. Both individual and group interviews were conducted. In the latter interviews, it is difficult to attribute information to a single person, so information was accredited to the group. Attributing information to specific people documents ownership of their intellectual property, their rights for its use and any benefits derived from this knowledge under the principles of the Convention of Biological Diversity. It also establishes the concept of prior art and prior knowledge to identify the source of the information.

During field interviews, voucher specimens were collected in a field press and the site was georeferenced using a Garmin GPS unit. Specimens were processed in the BNM herbarium within 24 hours of collection and results were entered into the herbarium database. GPS points were downloaded, analysed and mapped using Arcview© software. Transcribed field notes provided data for voucher specimen labels that list the name(s) of the informant(s), the identification of taxa, the description of the plant, the plant habitat and associated plants, and the documented uses provided by the informant(s). The voucher specimens were distributed to regional and international herbaria for specialists to confirm their identification. The informants reviewed and modified interview summaries. Below, the names of individuals who contributed information appear in parenthesis following specific use data. The information collected in the project was shared with the village communities in a series of PowerPoint presentations.

Plant uses

A total of 43 interviews were conducted: 27 in Oikull (17 women, 10 men) and 16 in Ibobang (nine women, seven men). In Oikull, interviewees provided 448 uses for 170 plants, while in Ibobang, informants provided 271 uses for 127 plants. Medicine, food and construction were the top three categories of recorded plant usage. Other categories included in the study were menstruation and childbirth, recreation, ropes and ties, firewood, cleaning, fishing and hunting.

A list of 28 categories of uses was derived from the information given by the interviewees during this study (Appendix 1). The frequency of reported plant uses divided into major use categories is listed in Table 1. These plants are commonly found throughout Palau's urban landscape.

Table 1. Frequency of reported plant uses by major categories.

Major categories	Total	Oikull (n=27)	Ibobang (n=16)
Medicine	248	123	125
Food	198	132	66
Construction	104	54	50
Toys	43	27	16
Tools	28	20	8
Cleaning	26	15	11
Rope	22	14	8
Fishing	21	14	20
Canoe Building	18	8	11
Total	708	407	315

The main categories of usage and the number of plant species used according to the male (Table 2) and female informants (Table 3) indicated that men are more knowledgeable about plants used for construction, firewood, fishing, and fashioning tools, canoes and rope. Women provided more information about plants used for food preparation and medicinal plants used in childbirth. Both men and women are knowledgeable about plants used for food, toys and general-purpose, primary-care medicines.

First menstruation

In one clan, a ritualistic cleansing using *Pandanus tectorius* (*ongor*), *Areca catechu* (betel nut, *buuch*) and *Citrus maxima* (pomelo, *malchianged*) is performed after the first menstruation (F. Wasisang). Another clan in Ibobang uses *Cymbopogon citratus* (lemongrass, *keskus*), *Citrus* sp. (*cheluchau*), *Decaspermum fruticosum* (*kertaku*), *Eurya japonica* (*cheskiik*) and roasted *Cocos nucifera* (coconut, *lius*) for the cleansing (G. Emesiochel).

Childbirth

After giving birth to their first child, women undergo a complex bathing process (*omengat*) that lasts from four to 10 days. The ritual's purpose is to heal the new mother and celebrate her first child. At least two months of preparation are needed for this event. Activities include constructing the bathing and steam hut, gathering firewood, gathering herbs, preparing ginger and coconut oil for the bath, preparing food, and making the traditional skirt and accessories for the mother for the last day of celebration. This ceremony culminates in a final bath and display of the young mother in her traditional dress for the father's family. The mother's family prepares a banquet of food, the father's family provides money, and a life-long bond is then established.

A variety of herbs is used in the ritual to energise and heal the new mother. There is no single prescribed set of plants used in the first bath ceremony and many clans have their own particular formula. Twenty plant species were listed as being used during the hot-bath process by the female interviewees from Oikull (16 species) and Ibobang (13 species) (Table 4). The most commonly listed plant (n=11) is *Curcuma longa* (turmeric, *kesol*), with the remaining plants described by at the most only two informants each.

Table 2. Main plant uses and number of plant species given by the men interviewed.

Use category	Number of species	Oikull (n=10)	Ibobang (n=7)
Food	25	17	8
Medicine	67	41	26
Construction	81	38	43
Toys	23	17	6
Fishing	19	9	10
Canoe building	10	4	6
Rope or tie	16	12	4
Total	241	138	103

Table 3. Main plant uses and number of plant species given by the women interviewed.

Use category	Number of species	Oikull (n=17)	Ibobang (n=9)
Food	26	17	9
Medicine	95	45	50
Construction	6	1	5
Toys	12	6	6
Fishing	6	4	2
Food wrap	12	5	7
Total	157	78	79

Recreation

Men and women, mostly elders, described different types of recreational activities in which they participated from an early age. Some of these activities employing plant products are practised by children today. A total of 22 plant species were used for childhood games and recreation according to the interviewees. Seven plant species were frequently described by the interviewees to make blowguns, spin wheels, balls, jump rope, bean bags and puzzles (Table 5). The three most frequently described plant species are *Heterospathe elata* var. *palauensis* (*demailei*) used to fashion blowgun bullets, *Schizostachyum lima* (*lild*) used to make the blowgun spears, and *Merremia peltata* (*kebeas*) used for jump ropes. Both *Flagellaria indica* (*bangernguis*) and *Leucaena leucocephala* (*telentund*) were made into bean bags. Balls and spin wheels were created from *Cocos nucifera* and puzzles were assembled from *Xylocarpus granatum* (*meduulokebong*).

Traditional food and food preparation

Thirty-two plant species were recorded as sources of food and useful in food preparation with 27 species being classed as important foods. As this list focused on the elders' favoured traditional food types, the actual number of food plants is under-represented. Documentation of plants used as traditional foodstuff will be expanded on in future interviews.

The most frequently mentioned plant species described as a source of traditional food are two types of taro, *Colocasia esculenta* (wet taro, *dait*) and *Cyrtosperma chamissonis* (giant swamp taro, *prak*), *Manihot esculenta* (tapioca, *diokang*), *Cocos nucifera* and *Inocarpus fagifer* (Tahitian chestnut, *keam*). Tapioca is believed to have been introduced by the Germans in the early 20th century (Mayo 1954).

Table 4. Plants used in the first-birth bath and ceremony.

Species (Palauan name)	Oikull (n=17)	Ibobang (n=9)
<i>Curcuma longa</i> L. (kesol)	8	3
<i>Cocos nucifera</i> L. (lius)	1	2
<i>Cassytha filiformis</i> L. (techellela chull)	1	1
<i>Melastoma malabathricum</i> L. var. <i>mariannum</i> (Naudin) Fosb. and Sach. (matakui)	1	0
<i>Phaleria nisidai</i> Kaneh. (ongael)	1	1
<i>Dianella carolinensis</i> (kobesos)	1	0
<i>Limnophila chinensis</i> (Osborn) Merr. subsp. <i>aromatica</i> (Lam.) (iaml)	1	1
<i>Phyllanthus palauensis</i> Hosok. (dudurs, udoud)	1	0
<i>Melicope denhamii</i> (Seem.) T.G. Hartley (kertub)	1	1
<i>Pandanus tectorius</i> Parkinson ex Du Roi (ongor)	1	1
<i>Cymbopogon citratus</i> (DC. ex Nees) Stapf (keskus)	1	1
<i>Cinnamomum carolinense</i> (ochod)	1	0
<i>Citrus maxima</i> (Burm. ex Rumph.) Merr. (malchianged)	0	2
<i>Cananga odorata</i> (Lam.) Hook. F. and Thomson (irang irang)	1	0
<i>Syzygium samarangense</i> (Blume) Merr. and Perry (rebotel)	2	0
<i>Millettia pinnata</i> (L.) Panigrahi (kisaks)	1	1
<i>Eurya japonica</i> Thunb. var. <i>nitida</i> (kertaku)	2	0
<i>Eugenia reinwardtiana</i> (Blume) DC. (kesiil)	0	1
<i>Pouteria obovata</i> (R. Brown) Baehni (chelangel)	0	2
<i>Derris trifoliata</i> Lour. (kemokem)	0	1
Total	25	18

Table 5. The most frequently named plants with recreational uses.

Species (Palauan name)	Use	Total interviewed (n=43)	Oikull (n=27)	Ibobang (n=16)
<i>Heterospatha elata</i> Scheff. var. <i>palauensis</i> (Becc.) (demailei)	Blowgun bullet	7	3	4
<i>Schizostachyum lima</i> Merr. (liild)	Blowgun	5	1	4
<i>Cocos nucifera</i> L. (lius)	Spin wheel, balls	2	2	2
<i>Merremia peltata</i> (L.) Merr. (kebeas)	Jump rope	5	1	4
<i>Flagellaria indica</i> L. (bangernguis)	Bean bags	2	1	1
<i>Leucaena leucocephala</i> (Lam.) de Wit (telentund)	Bean bags	2	2	0
<i>Xylocarpus granatum</i> Koenig (meduulokebong)	Puzzle	2	1	1
Total		25	11	16

The main starch of customary significance is *Colocasia esculenta*. The plant is referred to as *dait* and the cooked corm is referred to as *kukau*. Traditionally, taro is the most important and most revered (prestige) food and crop in Palau. It is included in all rituals and customs and features prominently in Palau's legends, stories, songs, chants and proverbs. Taro is the most important starch used in Palau's customary exchanges. The cultivation of taro is the main role

of women and a source of pride for women and their families. The inheritance of taro gardens is through the women (Figure 2).

Both the foliage and the root of the taro plant are used as a food source. *Colocasia* and *Cyrtosperma* can be prepared in different ways: the corm can be simply boiled (*meliokl*), boiled and cooked with coconut milk (*cheluit*), boiled and ground (*belsiich*), or ground and mixed with sugar and baked as a dessert. The leaves can be mixed with coconut milk and other ingredients to make a favourite Palauan soup (*demok*) and the stems can be cooked with sugar for a dessert (*chelang*).

Traditionally, Palauan food is often boiled, steamed or baked inside a leaf casing. This not only imparts the flavour of the leaf to the food, but also holds the food together during cooking and protects it from exposure to adjacent contaminants such as charcoal or sand. Once cooked, the leaf package is easily portable and can be stored as is. The plants used to wrap food were given as *Cordyline fruticosa* (*sis*), *Cocos nucifera* and *Areca catechu*.

Taro patch

The majority of *Colocasia* grows in prepared wetland plots (*mesei*). Production systems relied on less frequently include damp gardens (*dechel*) and dryland gardens (*sers*). *Mesei* are paddy-like systems with channels and dikes used for water control, to divide the gardens into functional sections indicating the ultimate use of the taro grown, and to isolate plots from diseases. The *mesei* serve as an agroforest, with various useful trees and shrubs grown on the dikes and perimeter, mainly for food, green manure, medicine and ceremonies.



Figure 2. Ellen Adelbai preparing her wetland taro garden (*mesei*).

Leaves from many species of trees can be used as green manure for the taro patches, including *Osmoxylon oliveri* (*kesiamel*), *Musa* spp. (banana, *tuu*), *Cocos nucifera*, *Areca catechu* and the large leaves of the giant taro, *Cyrtosperma merkusii* (*prak*). In Ngatpang, the women also use *Elaeocarpus joga* (*dekemerir*) and *Cerbera manghas* (*chemeridech*) as fertiliser (G. Emesiochel). Fertiliser, most commonly green manure, is both placed in the planting hole and spread on the top of the prepared beds as mulch to promote soil fertility.

Taboo food

Dietary taboos in Palau are most often associated with fish and other sea creatures. Papaya or *Carica papaya* is considered a taboo food during menstruation (F. Wasisang). Women who are either pregnant or breast feeding should avoid pineapple (*Ananas comosus*, *ongor ra Ngebard*) because it irritates the baby and gives a bad odour (E. Singeo).

Construction

A total of 41 species of plants were described as construction materials (Table 2). Metal tools have replaced the traditional shell or stone adzes once used to fell and shape the tree. Tool handles continue to be fashioned from Palauan wood species, including *Calophyllum inophyllum* (*btaches*) (C. Kitalong, R. Emesiochel, V.R. Tadeo), *Cocos nucifera*, *Hibiscus tiliaceus* (*chermall*), *Macaranga carolinensis* (*bedel*), *Rhizophora mucronata* (*tebechel*), *Terminalia catappa* (*miich*) and *Syzygium samarangense* (*rebotel*) (C. Kitalong).

Structures

Those plant species most frequently named by the informants as used to build structures are listed in Table 6. *Intsia bijuga* (*dort*) is a very heavy and strong hardwood used to build houses (C. Kitalong), house frames (T. Tesei) and flooring (T. Belchal). *Stemonorus ammu* (*ngmui*) is used for beams and posts (R. Emesiochel), crossbeams (H. Nabeyama) and flooring (S. Ubedei). *Gmelina palawensis* (*blacheos*) is used for posts (S. Ubedei), flooring and walls. Flooring is also constructed from *Bruguiera gymnorhiza* (*kodenges*) (H. Nabeyama), *Bambusa vulgaris* (*bambu*) and *Serianthes kanehirae* (*ukall*). Trees used to build the main frame of the house include *Lumnitzera littoralis* (*mekekad*) and *Calophyllum pelewensis* (*chesemolech*) (S. Ubedei). *Lumnitzera littoralis* is also used for a structure's posts and the upper house, as is *Campnosperma brevipetiolata* (*kelelacharm*) (R. Emesiochel) and *Sonneratia alba* (*urur*) (H. Nabeyama). Trees used to construct the frame of a dock and for posts include *Rhizophora mucronata* and *Sonneratia alba* (R. Emesiochel, T. Belchal). *Ceriops tagal* (*buit*) is also used for construction (C. Kitalong, T. Tesei, R. Alii), to build canoe houses (*diangel*) (W. Metes), for posts (T. Belchal) and for house frames (H. Nabeyama).

Canoe building

The men interviewed provided information about 10 trees that produce wood suitable for crafting canoes (Table 2). The most common species reported (Table 7) is *Serianthes kanehirae* (T. Belchal, R. Bausouch, S. Yano, C. Kitalong, R. Emesiochel, H. Nabeyama, S. Ubedei). Other wood taxa for canoe construction are *Artocarpus atilis* (*meduu*) (C. Kitalong, S. Ubedei), *Artocarpus mariannensis* (*chebiei*) (C. Kitalong, R. Emesiochel), *Calophyllum inophyllum* (C. Kitalong, H. Nabeyama, J. Emesiochel), *Calophyllum inophyllum* var. *wakamatsui* (*btachesked*) (T. Belchal), *Terminalia catappa* (C. Kitalong) and *Campnosperma brevipetiolata* (C. Kitalong).

Five species of trees are specifically used for making the hulls of canoes. *Gmelina palawensis* is used to make canoe sides or covers (Ucheldekes Rebluud). *Lumnitzera littoralis* wood is good for the canoe outriggers, with its curved branches straightened by heating (S. Ubedei). The sides, body and covering of canoes can be made from *Gmelina palawensis* (E. Rebluud).

Table 6. Tree species most frequently mentioned by males for use in construction of structures.

Species (Palauan name)	Use	Males interviewed (n=17)	Oikull (n=10)	Ibobang (n=7)
<i>Gmelina palawensis</i> H.L. Lam var. <i>palawensis</i> (blacheos)	Posts, flooring, walls	8	4	4
<i>Bambusa vulgaris</i> Schrad. ex Wendl. (bambu)	Flooring	7	4	3
<i>Lumnitzera littoralis</i> (Jack) Voigt (mekekad)	Main frame, posts, upper and lower house	7	2	5
<i>Rhizophora mucronata</i> Lam. (tebechel)	Frame of dock, beam	6	2	4
<i>Ceriops tagal</i> (Perr.) C. B. Robinson (biut)	Frame	5	2	3
<i>Serianthes kanehirae</i> Fosb. var. <i>kanehirae</i> (ukall)	Flooring	4	4	0
<i>Sonneratia alba</i> J.E. Sm. (urur)	Frame of dock, posts	4	2	2
<i>Stemonorhus ammu</i> (Kaneh.) Sleumer (ngmui)	Posts, crossbeams,	4	1	3
<i>Intsia bijuga</i> (Colebr.) O. Kuntze (dort)	Frame, flooring	2	2	0
<i>Calophyllum pelewenis</i> P.F. Stevens (chesemolech)	Main frame	2	0	2
Total		49	23	26

Table 7. Tree species most frequently mentioned by males to construct a canoe.

Species (Palauan name)	Males interviewed (n=17)	Oikull (n=10)	Ibobang (n=7)
<i>Serianthes kanehirae</i> Fosb. var. <i>kanehirae</i> (ukall)	6	4	2
<i>Calophyllum inophyllum</i> L. (btaches)	3	1	2
<i>Calophyllum inophyllum</i> L. var. <i>wakamatsui</i> (Kaneh.) Fosb. and Sach. (btachesked)	3	1	2
<i>Artocarpus atilis</i> (Parkinson) Fosb. (meduu)	2	1	1
<i>Terminalia catappa</i> L. (miich)	2	1	1
<i>Artocarpus mariannensis</i> Trécul (chebiei)	2	1	1
<i>Campnosperma brevipetiolata</i> Volk. (kelelacharm)	1	1	0
Total	19	10	9

Trees used to make canoe paddles include *Terminalia catappa*, *Campnosperma brevipetiolata*, *Syzygium samarangense*, *Hibiscus tiliaceus*, *Dolichandrone spathacea* (rriu), *Inocarpus fagifer*, *Swietenia mahogany* (mahogani) and *Cerbera manghas*. Canoe sails (yars) are fashioned from woven *Pandanus* leaves.

Cordage

Rope is used in construction, to carry loads, to tie food packets and for numerous other everyday tasks. Rope is made from fibres (C. Kitalong) of the bark of *Wikstroemia elliptica* (tebudel), *Hibiscus tiliaceus*, *Commersonia bartramia* (chermalluang), *Ambroma augustata* (lab), *Trichospermum ledermannii* (chelsau) and the *Cocos nucifera* husk (E. Singeo). Fibres from the stems of *Cyrtosperma merkusii* and *Musa textiles* (blantalos) are used to wrap light loads (C. Kitalong, E. Ridep, M. Rehuher). The leaves of *Draceana multiflora* (orredakl) are used for general tying (K. Tesei), while the vine of *Derris trifoliata* (kemokem) is used to tie bamboo together for rafts (S. Ubedei) and to tie packages of food items (C. Kitalong). *Canavalia*

cathartica (*kldelleland*) and *Merremia peltata* (*kebeas*) are used to tie light items (C. Kitalong), as is *Nepenthes mirabilis* (*meliik*) (D. Otobed).

Firewood

The best firewood is *Maranthes corymbosa* (*bkau*), although *Rhizophora mucronata* and *R. apiculata* (*bngaol*) are also good because they burn slowly (T. Belchal). Other trees used as firewood include *Casuarina equisetifolia* (*ngas*), *Cocos nucifera*, *Rhus taitensis* (*eues*), *Pouteria obovata* (*chelangel*), *Alphitonia carolinensis* (*chelebiob*) and *Macaranga carolinensis*. *Excoecaria agallocha* (*ias*) is used for firewood, but is also known to be poisonous to the eyes (V.R. Tadeo).

Cleaning

Many plants are used in personal hygiene, for cleaning the body, teeth, hair and clothes, and to produce a nice smell. *Barringtonia racemosa* (*koranges*) is used as soap (W. Metes, C. Kitalong). *Ceratopteris thalictroides* (*tiela uek*) produces suds and is used as shampoo (I. Ngiraibai). The *Colubrina asiatica* (*derikel*) stem is pounded until suds appear and is used both to wash clothes and as bathing soap (I. Ngiraibai). *Limnophila aromatica* (*iaml*) is used to wash after working in the taro patch (N. Kitalong, B.S. Chiokai). The tendril of *Nepenthes mirabilis* is used to clean teeth (M. Ngirametuker, C. Kitalong, E. Rebluud). *Averrhoa bilimbi* (*imekurs*) fruit is used to clean teeth, as well as boats, as it acts as a bleaching agent (C. Kitalong). The leaves of *Cananga odorata* (*irang irang*), *Cymbopogon citratus* and *Melicope denhamii* (*kertub*) produce a fragrant odour and are used to wipe the body (E. Rebluud). *Macaranga carolinensis* and fibres from *Cocos nucifera* are used as a natural tissue paper (C. Kitalong, T. Belchal, R. Bausouch, S. Yano).

Fishing

Fishing is a key activity for Palauan males, who practise such traditional fishing techniques as line fishing, netting, poisoning and spearing (Masse 1989; Johannes 1992). Fish are also caught in basket traps and fish weirs and propagated in fish ponds. Fishing techniques vary with the fish taxa being sought and the habitat being exploited.

Bamboo and wood basket traps (*bub*) are commonly used in Palau. Basket traps vary depending on the type of fish to be caught. Smaller basket traps like the *kosekl* and *bub el dech* are used in shallow water to catch small goatfish, sea bass, surgeonfish and wrasse. Larger traps such as the *techioll* and *bub el komud* are lowered into deeper water to catch bumphead parrotfish, humphead wrasse, large sea chup, sea bass, sharks and turtles. Fish traps (*semael*) are made with *Bambusa vulgaris* and lashed together with the *Derris trifoliata* vine, which is also used to tie bamboo rafts (S. Ubedei). *Loeseneriella macrantha* var. *palauica* (*kerrangel*) is also used to tie fish and crab traps (S. Ubedei, T. Belchal).

Traditionally, a large variety of fishing nets was used in Palau. As with baskets, the net and the mesh size varies according to the prey sought. Palauans created nets that could be operated by an individual, nets for a small fishing party, or extremely large nets (*direkorek*) necessitating a group. Some of the smaller, single-person nets include the *derau a mekebu*, *derek*, 'aikurs', *kual a chemang*, 'garn' (*charm?*), *kual a ngoaol*, *mangidab* and *methilab*. The *bilokl*, *ruul* and *sab* are some of the nets that can be operated by a single individual or a small group. Typically, net types are used for specific prey; for example, 'aikurs' nets are reported to catch sea bass, emperor and rabbitfish, while *direkorek* was used primarily for humphead wrasse, bumphead parrotfish, surgeonfish and rays.

Smaller nets were generally made from *Cocos nucifera* husk fibre (S. Ubedei). Larger fish nets (*ruul*) are made with *Heterospathe elata* var. *palauensis* leaves (H. Nabeyama), which are preferred over coconut leaves because they are stronger (S. Ubedei). The leaves are tied using

either *Derris trifoliata* or *Hibiscus tiliaceus* (S. Ubedei). The frame for a small hand net (*derau*) is fashioned from *Allophylus timoriensis* (*chebeludes*) (R. Bausouch, S. Ubedei) and *B. vulgaris* (T. Belchal). *Macaranga carolinensis* is used to make light wooden floats for the net (S. Ubedei). The prop roots (*raod*) of the mangrove trees *Rhizophora mucronata* and *R. apiculata* are used to lure fish out of the rocks (H. Nabeyama) before they are caught by a net, spear or natural poison.

Spearing is a common Palauan fishing technique. Ethnographically, there were two main spear types, the *klebiskang*, with a single hardwood point, and the *taod*, with a cluster of barbed points. The *klebiskang* is used to catch taxa such as large species of parrotfish, triggerfish and wrasse, as well as rays and sharks. The *taod* is used on such fish as cornetfish, jacks and needlefish. Spears are made with *Areca catechu* (E. Singeo) and *Schizostachyum lima* (C. Kitalong, T. Belchal). *Lumnitzera littoralis* is used to make spear handles (S. Ubedei). *Intsia bijuga* is used for spear guns (C. Kitalong, V.R. Takeo).

Plants are not only employed to make fishing nets, traps and spears, but provide cues to signal the appropriate time to catch particular species. When *Melastoma malabathricum* var. *mariannum* (*matakui*) is in full bloom, sea urchins and clams are ripe and ready to be harvested (M. Ngirametuker). When *Serianthes kanehirae* are in full bloom, there will be many fish, especially during the high tide (R. Alii).

Hunting

Few terrestrial animals contributed significantly to the traditional diet. In the ethnohistorical records, terrestrial protein sources are limited to crabs, bats and birds, such as the duck and pigeon and the eggs of the Micronesian megapode (*Megapodius laperouse senex*) and the white tern (*Gygis alba pacifica*) (Kubary 1892). Archaeological evidence exists for the consumption of pigs as a status food (*Sus scrofa*), although they were apparently extirpated by the first substantial Western contact with the islands in 1783 (Masse et al. 2006). Today, men hunt for birds, bats and wild pigs and set traps for wild chickens and crabs.

Land traps (*bedikl*) are made with the flexible stem of *Ixora casei* (*kerdeu*) (S. Ubedei, T. Belchal, C. Kitalong, V.R. Takeo) and *Cocos nucifera* fibre (S. Ubedei). Once the chicken takes the bait, it trips the trap and is caught in the fibre snare as the stem springs backwards (C. Kitalong). *Symplocos racemosa* var. *palawensis* (*chebtui*) is used to make the slingshots used in bird and bat hunting (T. Belchal).

Medicine

The medicinal plants category contains the greatest number of species for a given task. Informants provided a medicinal use for 95 plant species. Oikull interviewees described 80 medicinal plant uses, with 41 provided by the men and 39 by the women. In Ibobang, 52 medicinal plant uses were described, with men and women each giving 26 uses. Frequently mentioned uses were pain relief from toothaches, earaches and headaches; cures for diarrhoea, bleeding and boils; and overall cleansing and healing (Table 8). *Premna serratifolia* (*chosm*) and *Phaleria nisidai* (*ongael*) were the two species most commonly referred to as providing a medicinal value.

Premna serratifolia is used to stop cuts from bleeding (C. Kitalong, M. Rehuher) – one young chewed leaf is applied to small cuts and the inner slimy bark to deeper cuts (F. Wasisang, J. Emesiochel, S. Ubedei, V.R. Tadeo, M. Besebes, G. Emesiochel). The bark is peeled and drops of the clear inner sap are placed on stings or wounds caused by sea urchins or fish spines, to ease the pain. Another preparation method for *P. serratifolia* as a pain medication is to place the extracted sap into a spoon with hot coconut oil and put the infected area into the resultant steam or smoke (T. Belchal, R. Bausouch, S. Yano). *Premna serratifolia* also stops bleeding from

Table 8. Most frequently mentioned medicinal plants.

Species (Palauan name)	Use	Total interviewed (n=43)	Oikull (n=27)	Ibobang (n=16)
<i>Premna serratifolia</i> L. (chosm)	Cuts, weight loss, asthma, mosquito repellent, pain reliever	16	10	6
<i>Phaleria nisidai</i> Kaneh. (ongael)	Cleansing, flushing, build immunity, aches and pain, heart ailment, diarrhea and abortion	15	6	9
<i>Morinda citrifolia</i> L. (ngel)	Cuts, weight loss and boils	9	6	3
<i>Curcuma longa</i> L. (kesol)	Medicinal ointment for skin and stretch marks	9	6	3
<i>Cocos nucifera</i> L. (lius)	Cleansing, earache, external ointment strengthening immune system, boils, diarrhea	8	3	5
<i>Syzygium samarangense</i> (Blume) Merr. and Perry (rebotel)	Cuts, sore throats, colds stretch marks, herbal bath, external rash or itch	7	5	2
<i>Millettia pinnata</i> Panigrahi (kisaks)	Use in herbal bath after first born	6	2	4
<i>Calophyllum inophyllum</i> L. (btaches)	Asthma, strength	5	3	2
<i>Epipremnum carolinense</i> Volk. (toilalech)	Menstruation, abortion	5	5	0
<i>Barringtonia racemosa</i> (L.) Spreng. (koranges)	Heartburn, stop bleeding, abortion	4	4	0
<i>Casuarina equisetifolia</i> L. (ngas)	Toothaches, abortion	4	3	1
Total		88	53	35

head injuries (R. Alii, C. Kitalong) and is used in combination with other plants for weight loss (O. Belaio). The leaves are mashed and placed on the body to act as a mosquito repellent (H. Yuri). Four leaves of *P. serratifolia* and four leaves of *Codiaeum variegatum* (*kesuk ianged*) are boiled for one minute and drunk as tea to treat asthma (E. Rebluud).

Phaleria nisidai heals many illnesses and is used in combination with other plants for bodily cleansing and flushing (C. Kitalong, M. Ngirametuker, T. Watanabe, N. Kitalong). Its leaves are boiled into a tea drunk in specific amounts to build immunity and relieve aches in the stomach (M. Ngirametuker) and body (H. Nabeyama, G. Emesiochel). *Phaleria nisidai* is used for headaches, menstruation pain and to strengthen the body (M. Rehurer, F. Wasisang, M. Besebes). The plant acts as an energiser (B.S. Choikai) and is used for heart ailments (I. Spesungel). Combined with *Psidium guajava* (*kuabang*) leaves, *P. nisidai* is a remedy for diarrhea (M. Besebes). It is also one of the plants used during the first birth ritual and ceremony (F. Wasisang).

As part of the Modekngai religious ritual, its members gather on special dates to worship and share a herbal drink that cleanses the body. Some of the plant species in this drink are *Dianella carolinensis* (*kebesos*), *Phaleria nisidai*, *Melastoma malabathricum* L. var. *mariannum*, *Nepenthes mirabilis*, *Lycopodiella cernua* (*olechuila beab*) *Dicranopteris linearis* var. *ferruginea* (*itouch*), *Cassytha filiformis* (*tellelachull*), *Trema cannabina* Lour. (*chelodechoel*) and *Hedyotis korrorensis* (*chemudalech*) (M. Ngirametuker).

Two keystone plants

The elders provided 39 separate uses for *Cocos nucifera*, making it the study's most useful plant species (Table 9). Due to its importance, as reflected in the number of different uses, *C. nucifera* is a 'cultural keystone species' (Garabaldi and Turner 2004) in many Pacific Island nations

Table 9. Most frequently mentioned trees with a specific use.

Species (Palauan name)	Total interviewed (n=43)	Oikull (n=27)	Ibobang (n=16)
<i>Cocos nucifera</i> L. (lius)	67	39	26
<i>Areca catechu</i> L. (buuch)	19	15	9
<i>Premna serratifolia</i> L. (chosm)	13	5	8
<i>Syzygium samarangense</i> (Blume) Merr. and Perry (rebotel)	11	11	0
<i>Macaranga carolinensis</i> Volk. (bedel)	11	7	4
<i>Rhizophora</i> spp. (tebechel and bngaol)	9	6	7
<i>Spondias pinnata</i> (titimel)	9	7	3
<i>Calophyllum inophyllum</i> L. (btaches)	8	6	5
<i>Averrhoa bilimbi</i> L. (imekurs)	8	8	1
<i>Melastoma malabathricum</i> L. var. <i>mariannum</i> (Naudin) Fosb. and Sach. (matakui)	8	6	3
<i>Terminalia catappa</i> L. (miich)	7	3	4
<i>Ixora casei</i> Hance (kerdeu)	7	2	6
Total	177	112	76

(e.g. Samoa, Whistler 1996) and in Central and South America (e.g. Belize, Arvigo and Balick 1998). Ridep Emesiochel calls the coconut tree the ‘mother of Belau’ because of its many uses. The recorded uses of coconut are similar in Oikull and Ibobang, with multiple interviewees providing similar uses. With 19 documented uses, *Areca catechu* is the second most identified plant in the study and is another cultural keystone species.

Clarence Kitalong listed 24 uses for the nut (n=7), trunk (n=8) and leaves (n=9) of the coconut palm. The coconut meat (endocarp) is a food and the fluid a drink. The hard outer nut (exocarp) is used for cups, bowls and utensils. Coconut oil is used singly or as one of several ingredients in food and medicine, to protect the skin after bathing from bites, infection or skin diseases, as a hair conditioner and as a mosquito repellent. The exocarp fibres start fires and keep them burning hot, and are fashioned into sieves and rope. The trunk of the coconut palm is used as firewood and to make trap doors, stirring utensils, taro-pounding implements, tool handles, walking canes, spears, benches and wall and flooring material. Coconut leaves are woven into baskets (Figure 3), folded as wraps for fish and ground tapioca, used as torches to provide light and made into ropes and toys such as balls, canoes and windmills. The midrib of the frond is used to make brooms and catch shrimp.

Fourteen uses for the coconut leaves (n=4), nut (n=9) and trunk (n=1) were provided by T. Watanabe, including its use as an ingredient in herbal hot baths, as food, and to make ropes, handbags, hats, brooms, water dippers, buttons, bras, belts, hair picks, baskets, hair oil and sieves. Dirratkelkang M. Ngirametuker provided 13 uses for the coconut leaves (baskets, brooms, firewood and toys), the branches (toys), the trunk (implements, canes and construction material), and the nut and its fibres (sieve, rope, oil, food and syrup).

Dirratesei E. Singeo described other uses of coconut, including the exocarp being used as a lime holder for the preparation of betel nut, and the nut’s oil being rubbed on the stomach to ease stomach aches. Because the healthy coconut juice cleanses the intestines, babies, young children and elders drink it to strengthen their immune systems. The young soft meat is sweet and good for desserts or snacking. After the nut is mature and the meat is hard, it is tasty when eaten with *Cyrtosperma merkusii*. Grated coconut meat is placed in a white cloth and wrung to



Figure 3. Dirrngerchemuul (Hinako Ngirmekur) weaving a *terkill* (a basket used to carry food for travelling) from *Cocos nucifera* (*lius*).

extract the milk used in food preparation and to revitalise hair by making it shiny, silky and strong. The grated meat can also be placed in a coconut sheath and heated and the warm oil used to heal a wound cleaned with *Morinda citrifolia* (*ngel*) (C. Kitalong). Coconut fronds are cut off the main midrib and stripped to leave the rachis, which is gathered and tied to make a broom. Individual pieces of the rachis are used to catch shrimp and small lizards. The young fronds can be woven to make small balls and animals to entertain children. Benches and flooring are constructed from the trunk.

After childbirth, the male or female placenta is wrapped in coconut fronds to symbolise manhood or womanhood and prosperity (W. Metes, C. Kitalong). The young frond is a symbol used during the passing of a chiefly title (E. Singeo, H. Takeo, N. Luiu, M. Kim, A. Bintorio). Dirrngerchemuul H. Takeo demonstrated how the young coconut leaf is prepared with the wild taro leaf to symbolise the transfer of clan titles. While the ritual to transfer traditional titles is practised or performed by men, it is the women who are the recipients of the title symbolised by the coconut and wild taro leaf.

The process of making rope from coconut husk fibres was described by Dirratasei E. Singeo. After the husks are buried under the sand in the ocean for about a month, they are pounded to remove excess fluid and stray fragments, rinsed with water and left to dry. Once dried, the fibres are placed in one's lap to be rolled in a circular motion and elongated by connecting one end to

another. It takes many coconut husks to make a single rope. One basket full of fibres from the coconut husk can make about 7 m of thick rope used for constructing a house or 12 m of thin rope to make tools (C. Kitalong). This rope can be used in tying together parts for traditional canoes, tools and structures such as a men's meeting house.

The coconut endocarp is used as food and drink, the fibres from the husk are used to make rope and to embellish fish hooks, the husk is firewood, the meat is ground for milk and oil that is used to remove skin boils and water from the ear, and the leaves are used to wrap food. Coconut fibre is used to make small hand nets (*derau*) and land traps for crabs and chickens (S. Ubedei) and to wrap food and cleanse the body (I. Ngiraibai). The leaves are woven into toys (*btul* or *eberdord*), the nut's oil is used for ear aches and the husk is used to make smoke (F. Wasisang). The leaves can be made into brooms, baskets and food wrapping; the nut is a source of food and drink; the trunk is used for firewood and to make small bridges and benches; the meat from young coconuts (*kleu*) is mixed with salt and eaten to prevent dehydration, the young sprout (*meolt*) is used to wrap tapioca and make grass skirts (G. Emesiochel, S. Chiokai). The husk (*ulengchidel*) is used to clean pots and make rope or cords, and the trunk is used for compost and flooring (S. Chiokai).

Nineteen uses for *Areca catechu* were given by women from Oikull (E. Singeo, M. Kim, N. Luiu, H. Takeo). The nut is chewed with lime and *Piper betle* (*kebui*) leaf as a stimulant. The *Areca catechu* nut and *Piper betle* leaves are an integral part of customary exchanges between clans during important rituals such as first-birth, marriage and funerals. The *Areca catechu* palm has numerous medicinal purposes. The root is used with *Leea guineensis* (*sngall*) to ease menstrual cramps, and in Ibobang, is one of the plants in the ritual cleansing after the first menstruation (F. Wasisang). Juice from the pounded roots relieves toothaches. Five to seven days after the umbilical cord has fallen off, betel-nut juice is applied to a newborn's navel as a natural antiseptic. Heating the ripe nut softens it so that juices can be extracted and applied mornings and evenings after the newborn's bath. To prevent bed wetting, the nut is cut in half and given to babies to chew and suck on.

The betel-nut trunk is cut into flooring and benches (G. Emesiochel). The lower portion of the trunk is used to make spears, dancing paddles and sticks. *Areca catechu* leaves are used for fertiliser. Its smooth inner sheath is good for long-term food storage (up to a week, depending on the type of food), to wrap a baby and as a raincoat. Sheaths are fashioned into dancing skirts and, when sewn together with *Hibiscus tiliaceus* fibre, used to make coats and handbags. The outer sheath is stripped and pounded to make a loincloth. Infants bite down on the young fronds when teething. Children play by sitting inside the fronds and sliding down hills (F. Wasisang).

Conclusion

During 2006 to 2010, an ethnobotanical study was conducted in Oikull, Airai State, and Ibobang, Ngatpang State, on Babeldaob, Palau's largest island. The objective of this pilot study was to document in as much detail as possible the use of plants in all aspects of Palauan culture, using the theme 'the cycle of life', or from birth to death. During interviews, we recorded uses for 200 plant species; 171 species in Oikull and 127 in Ibobang. Plants were mainly used for medicine (70 species), construction (41 species), food (27 species) and toys (22 species). Knowledge differed depending on traditional gender roles and practices. Men described plants used for construction, tool making, firewood, fishing and canoe making. Women described plants used for medicinal uses for the first-birth ceremony (Figure 4). Men and women described how



Figure 4. Uodelchad ra Esel (Terue Daniel) and her daughter Uwai Skebong sorting the inner bark fibres of *Hibiscus tiliceaus* (*chermall*) in preparation for making a grass skirt for a first-birth ceremony.

plants were used for food, recreation, art and medicine for primary care. Two palm species, *Cocos nucifera* and *Areca catechu*, had the most uses and were considered cultural keystone species.

This preliminary study shows that Ibobang and Oikull use many plant species for similar purposes. The communities continue to maintain strong ties between their plants and culture. We found that there are certain families or individuals who are renowned for their knowledge and have very specific skills that are part of their own family knowledge and a source of prestige and wealth. There is much more knowledge that needs to be documented in Palau. This is only the beginning. We were heartened by a summer youth program in Ibobang where we observed and documented the elders teaching their youth how to build crab traps, weave baskets, fish and fix Palauan food. Oikull's traditional leaders have also begun youth programs.

Conservation of plant diversity, integration of traditional knowledge and practices in educational programs, and promotion of culture through local, regional and international fairs will ensure that the Palauan culture and its plant diversity survives through the next millennium.

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Note

1. Sharks were hunted from sail boats with special hooks. Mlamitoi from Peleliu who grew up in Oikull's Ngesileong clan was known for trapping a shark by himself. He could both manoeuvre the sail of his canoe and catch the shark by throwing a coconut to it to bite on (A. Rufino). There is a legend in Oikull of how an Airai god, Medechii, claimed Ngerduais Island. Medechii challenged the other gods that whomever could throw the betel nut fiber (*ulemachel*) the furthest would own Ngerduais Island. While the gods were fixing their betel nut, chewing it and preparing to throw, Medechii put the red honeyeater bird (*chesisebangiau*) into his mouth pretending it was his betel nut as it was red like a chewed betel nut. The gods threw their betel nut and Medechii grabbed the bird out of his mouth quickly without being detected. The bird flew all the way to Ngerduais and Medechii claimed the island as his own.

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Appendix 1. Use categories with the total number of plant species for each village.

Use	Oikull	Ibobang
Medicine	48	39
Food	23	7
Construction	14	43
Toys	12	10
Fishing	7	9
Cleaning	6	2
Rope	6	3
Canoe	4	10
Farming	4	5
Accessories	3	0
Baskets	2	1
Canoe paddle	2	0
Clothing	2	0
Custom	2	1
Firewood	2	10
Tools	2	7
Chicken trap	1	3
Decoration	1	3
Dye	1	3
Fibre	1	0
Food wrap	1	1
Magic	1	0
Pillow	1	1
Storyboard	1	1
Bridge	0	1
Chewing	0	3
Sail	0	2
Taboo food	0	1
Total	147	166