COUNTRY REPORT

REPUBLIC OF THE MARSHALL ISLANDS

THIS DOCUMENT IS AN EDITED AND UPDATED VERSION OF THE ORIGINAL REPORT PRESENTED AT THE PACIFIC SUB-REGIONAL WORKSHOP ON FOREST AND TREE GENETIC RESOURCES

"STATE OF FOREST AND TREE GENETIC RESOURCES IN THE PACIFIC ISLANDS, AND SUB-REGIONAL ACTION PLAN FOR THEIR CONSERVATION AND SUSTAINABLE USE"

The Conference was organised by:

The South Pacific Regional Initiative On Forest Genetic Resources (SPRIG),
the Australian Agency For International Development (AusAID),
the Food And Agriculture Organization of the United Nations (FAO),
the Pacific Islands Forest and Tree Support Programme of the Secretariat of the Pacific Community (SPC),
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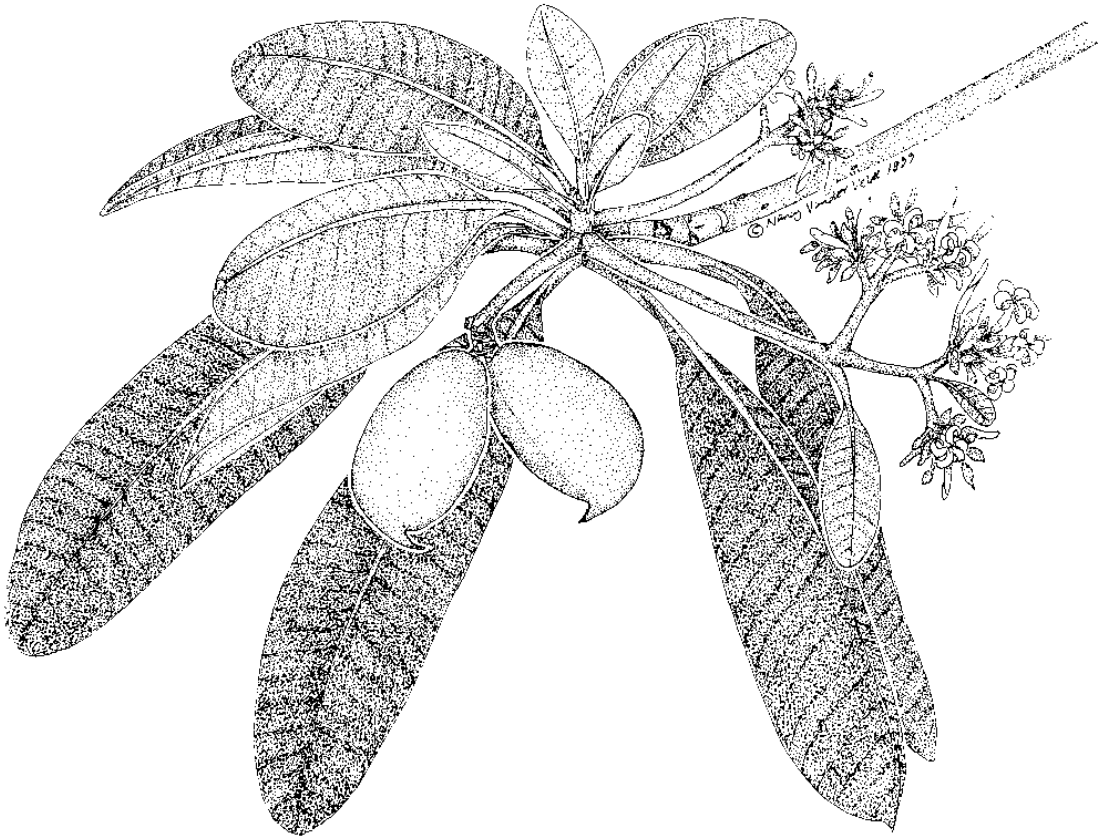
June 2002

Overview of the Marshall Islands' Forest Resources

Republic of the Marshall Islands
Ministry of Resources, Development and Works
Agriculture Division



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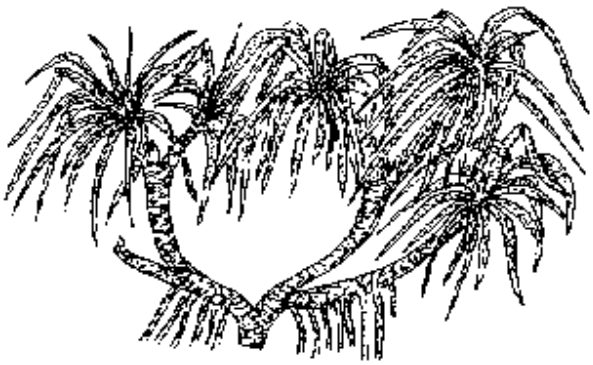
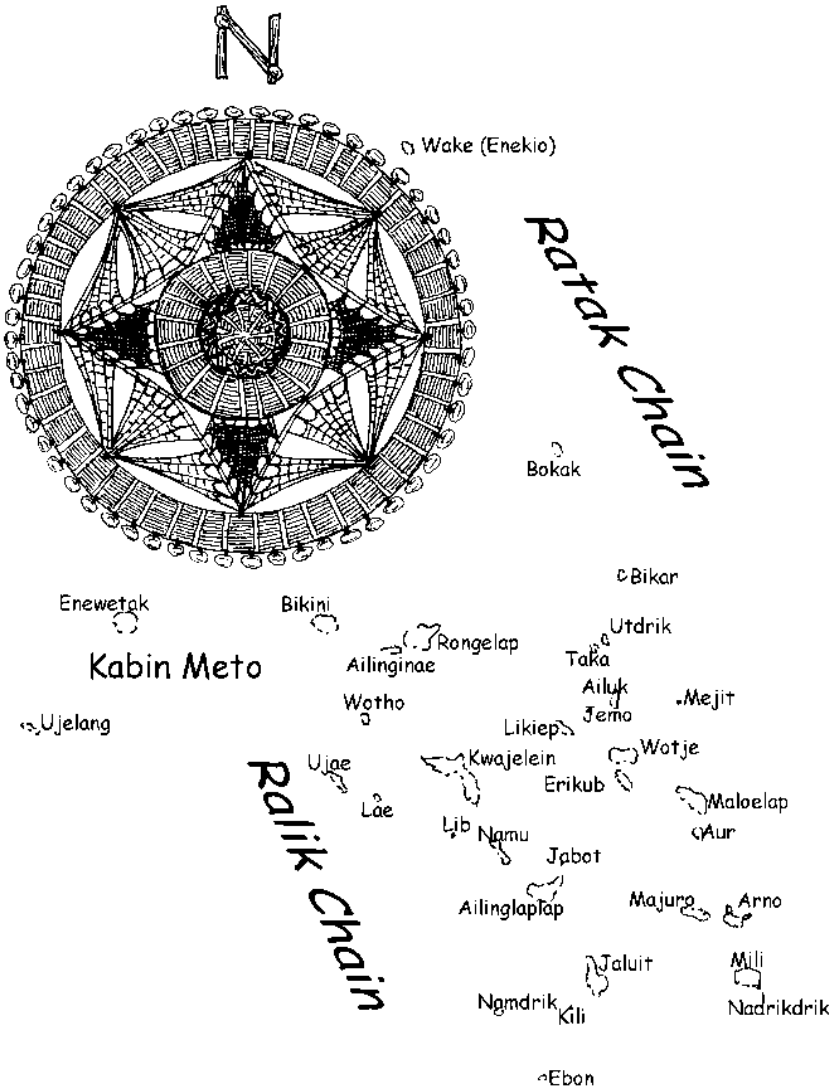


1. INTRODUCTION

GENERAL INFORMATION

On a map, the Marshall Islands may just look like tiny specks of land scattered over the vastness of the Central Pacific Ocean, but they are beautifully unique and covered by forest. The political entity of the Republic of the Marshall Islands encompasses 29 coral atolls and 5 solitary coral islands, and is comprised of approximately 1,225 individual islands and islets. These are situated from 160 degrees to 173 degrees longitude East, and between 4 degrees and 14 degrees latitude North. Total dry land area is only about 70 square miles. However, when the Exclusive Economic Zone (EEZ), is figured in, the Republic covers 750,000 square miles of ocean. 4,507 square miles of sea are found within the lagoons of the atolls.

The name "Marshall Islands" was given in honor of a 18th century British sea captain, John Marshall, who sailed through the area during a pan-Pacific crossing. The traditional names and demarcations between the chains of atolls are "Ratak" (easterly) and "Ralik" (westerly). Another traditional region is "Kabin Meto" ("far reaches of the sea " or "bottom of the sea") which includes the northwesterly atolls.



All of the Marshall Islands are low in elevation, the average height of land above sea level being 7 feet. The highest point is a sand hill, which varies in the range of 25 to 37 feet above sea level on Likiep Atoll. The air is warm and moist, with a humidity of about 80%, with considerable salt spray as well. The air temperature averages around 82 degrees, ranging between about 76 and 90 degrees.

The atolls vary in size from Kwajelein, the world's largest atoll (6.33 square miles with a lagoon of 839.30 square miles), to Bikar (with only .19 square miles of dry land, but 14.44 square miles of lagoon) and Namdrik (with more land, 1.07 square miles, but only 3.25 square miles of lagoon). The actual islands range from tiny sand spit islets which wash over during storms and extreme high tides to Kaben Islands, Maloelap Atoll and Wotho Islands, Wotho Atoll, which are almost a square mile each.

The lagoons within the atolls typically have at least one deep pass access; however, some such as Bokak and Namdrik have no natural passes at all.

Rainfall tends to be seasonal, and can range from as much as 160 inches a year in the south to as little as 25 inches a year -- or less during the extremely dry years, there may be no precipitation whatsoever - in the north. Tropical storms (typhoons) are fortunately relatively rare, but when they do hit, can be devastating.

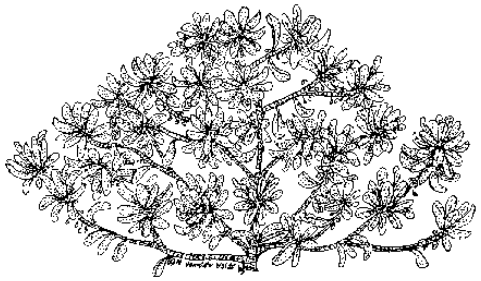
Between the rains, freshwater is naturally stored under the larger of the islands in what are called Ghyben-Herzberg lenses. An island needs to be at least 3 1/2 acres in size in order to maintain such a water lens.

Dry land only makes up less than 0.01 % of the area of the area of the Marshall Islands. This dry land is virtually 100% biologically derived material. The atolls and islands of the Marshalls are thought to have been formed according to Darwin's theory of atoll subsidence -- ancient volcanoes were slowly surrounded by fringing coral reefs, and after the volcanic peaks sank, the rings of coral atolls were left behind. The five solitary islands were formed by in much the same way, but from small enough peaks so that no interior lagoon developed. However "coral" atolls are composed of more than just the remains of stony corals. Coralline algae and foraminiferae have been found to form more "coral" land than true corals, and other remains of organisms such as mollusk shells and parts of echinoderms also playing a part.

On Enewetak and Bikini deep coring through around 4,000 feet of limestone yielded evidence of volcanic rock to substantiate the subsidence theory. The process of land formation within the Marshalls is calculated to have reached a stable enough point to be colonized by terrestrial life a mere 3,000 to 4.000 years ago -- an extremely brief time, geologically speaking.

The basic soil has been enriched by animals, plants and other living things of the land and sky. While some material from volcanoes or the continental areas may occasionally drift in, the Marshalls are so far from most areas where these materials originate, that their appearance is relatively rare.

Besides being so biologically derived, the Marshall Islands' environment is very nearly marine. The natural terrestrial ecosystems all contain species normally associated with the ocean -- be these shore and sea birds, land crabs, algae that grow on land, etc. In fact, in stark contrast to most terrestrial ecosystems, in the Marshall Islands, the most significant native land animals are crabs -- the land hermit crabs (*Coenobita* spp.), the coconut crab (*Birgus latro*) and other land crabs (Family Gecarcinidae).



Storms helped form the Marshall Islands, bringing in more material to some places and eroding away others. Even without storms, the regular winds constantly bring salt spray ashore. Native plants are able to deal with this constant barrage of salt (and hence are called halophytic or salt loving). Some species are more salt tolerant than others and the natural distribution observed with plants usually reflects this. For example, *Scaevola taccada* can handle quite a bit of salt and plants are found right on windward facing ocean beaches.

Major currents -- the North and South Equatorial Currents, and the Equatorial Countercurrent -- flow by the Marshall Islands at anywhere between 4 and 0.04 knots. These are known to bring with them many interesting things from all across the Pacific. Both natural and manmade objects have found on various atolls, even recent years, from as far away as Japan, Indonesia, Hawaii and California.

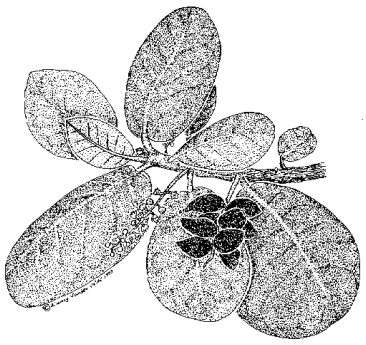
This is how it is thought that many plants have been able to colonize the Marshall Islands. Those with floating seeds likely came first -- *Argusia argentea* and *Scaevola taccada* are to this day considered to be pioneer species. *Guettarda speciosa, Premna serratifolia,* grasses and ground covers probably have followed. The succession of ecosystems seemed to have reached stable climax with tall stands of *Pisonia grandis* and *Neisosperma oppositifolium.* Although determining the actual native species at times comes down to educated guesses, a reconstruction shows only about 80 plants that seemed to have arrived on the Marshalls on their own. However, no single atoll likely had the entire array of the native species - for example, Arno is figured to have had 44, and the practically pristine northern atoll of Bokak has, even to the present, only 9. The only native land plants that are recognized as an endemic are two grasses and a false-spider lily, (all endemic to the Marshalls and other nearby islands).

Besides the plants, many types of terrestrial animal life probably arrived on the currents, still in quite a fortuitous manner. Insects, arachnids, as well as geckos and skinks could have rafted in on drift logs and debris, with some spiders "ballooning" or drifting in on their self-made webs. Birds and some insects could have flown in, other insects and arachnids could have "hitchhiked" on birds. Yet no one knows for sure what species are truly native nor exactly where most plants and animals came from.

On high islands, scientists figure that eventually this motley array of happenchance species were at least able to produce a stable environment and a form of natural equilibrium was achieved. After untold years, eventually humans arrived and, although they began to change things, there was enough land on these types of islands that their influence was limited.

This is one of the major differences between the Marshall Islands and other Pacific Islands areas. The soil was thought to be stabilized and beginning to be colonized on its own by plants, animals and other living things for a very short time before people became part of the scene. It is not even clear how stable the land environment was that the first humans found, but it was probably relatively simple. So when these first people set about importing their food crops and other useful species, they probably had more of an influence in shaping their own environment than almost anywhere else on earth! And since the land they found was so limited and accessible, these people were also able to influence a greater percentage of the natural environment than most other places. So humans can be said to be much more a part of the biodiversity of the Marshall Islands than in other areas.

Furthermore, what makes the Marshall Islands unique can also help to maintain them that way. The constant sea breezes and limited land area means no industrial air pollution. Soil that is so poor in nutrients, the continual salt spray and limited water supplies serve as built-in means of protecting the natural environment, even when humans are present. Many imported species of plants that have wrecked havoc on high islands, such as lantana (*Lantana camara*), have not been recorded as causing problems in the Marshalls, even though they are present. Typhoons will often harm imported species of plants but do not really bother the native ones very much.



Currently, it is estimated that there are over 63,000 people living in the Marshalls. Most of these live in the urban areas of Majuro and Ebeye. The densities within these communities is often cited as being some of the highest in the Pacific, but in practical terms, there are still open areas around Majuro, and many native plants. The Marshallese people maintain a tremendous knowledge of the native and traditional forests and plants.

MAJOR FOREST TYPES

From a general point of view, there is only one type of native forest in the Marshall Islands -- the mixed broadleaf forest. Of the approximately 80 species of vascular plants within this forest type, only 22 species are trees. (Some of the species may not be very big or tall trees, and may not be considered trees in other areas, but they do become woody and serve the niche of trees in this biota-limited environment.)

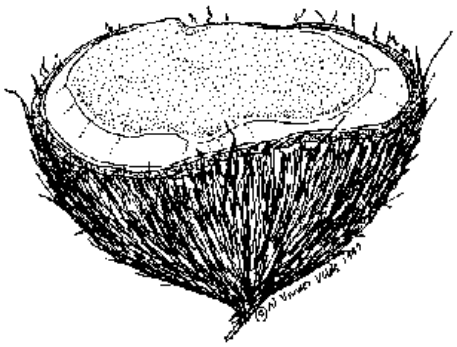
Within this all-inclusive designation, there are the monospecific stands. *Pisonia grandis* and *Neisosperma oppositifolium* are climax forests as well. Other monospecific stands are formed by *Cordia subcordata, Scaevola taccada, Barringtonia asiatica, Suriana maritima* and *Pemphis acidula*.

Because the atolls were initially formed from unstable sand and beach rock, soil stabilization by plants is vitally important. In general, any tree and plant that can make it in this environment is useful in that regard.

Another important function served by the native broadleaf forest is salt spray protection. Because of this, introduced food crops were able to survive and the islands with sufficient rainfall were able to be successfully colonized by people, beginning about 2000 years ago. The formerly towering *Pisonia* forests that nourished the sandy soil were thus cleared to make room for imported breadfruit planting (and other crops, such as taro). The settlers became involved in the horticultural perfection of *Pandanus tectorius* and eventually they produced numerous edible forms and clones.

Most of the mangrove species seem to have been prehistorically introduced. These are found primarily in inland embayments and depressions in the interior of islands. Hence, they are not the valuable soil expanders they are famous for around the high islands where they trap run-off from the rivers flowing down from mountains.

In the late 1800s, European traders introduced the concept of copra trade, and large tracts of land were converted into coconut plantations. Copra remains a major industry to this day in the country.



In a sense, it could be said that urban forests began as soon as people arrived. Today, they are the dominant forests around the population center of Majuro. *Delonix regia*, *Leucaena leucocephala*, *Tecoma stans*, *Plumeria* spp. and other exotic trees of recent origin can be found here, yet there is a good percentage of native and prehistorically introduced tree species around the houses as well. On the former German and Japanese headquarters of Jaluit, other exotic species were introduced experimentally. In the long run, however, most of these were not able to survive. On the larger islands that have relatively abundant land that is sufficiently protected from the salt spray, other exotic species, such as *Mangifera indica* and *Psidium guajava* are sometimes grown.

LAND USE

In 1952, William Hatheway did an extensive survey of the plants of Arno Atoll, located approximately 15 miles to the east of the capital atoll of Majuro. To the knowledge of the authors of this report, no subsequent survey of that caliber has been conducted. Table 1.1 therefore does give some insight into land use, but it may or may not be representative of the current status of Arno. Nor can it be said to be truly representative of the land use status of the entire country, in the 1950s or at present.

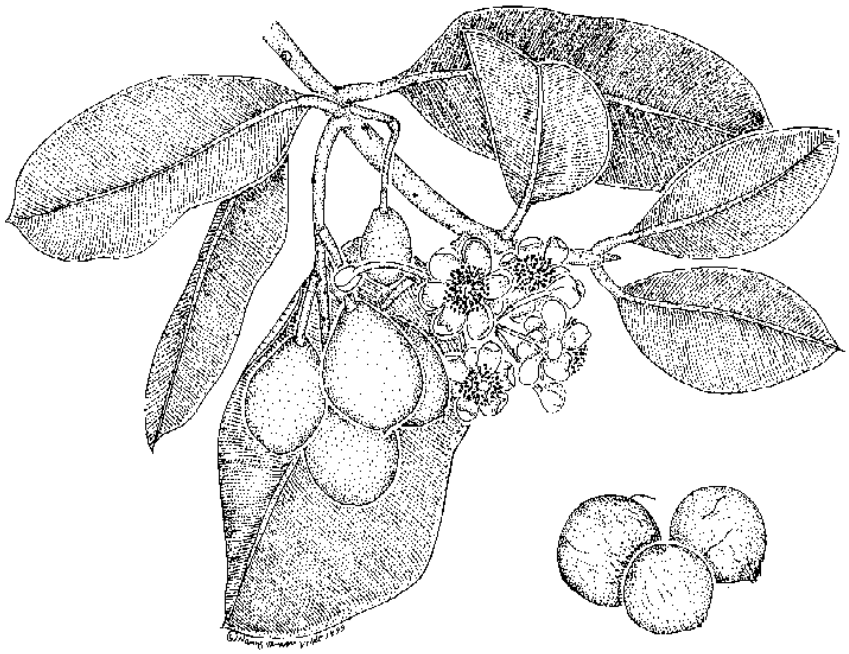
Table 1 -- Vegetation Cover of the Marshall Islands

Type	Number of stands	Area (acres)	Area (percent)
Coconut	147	2224.0	69.38
Breadfruit	53	227	8.64
scrub forest	143	566.3	17.67
saline flat	5	29.6	0.92
mangrove swamp	13	26.8	0.84
freshwater swamp	3	6.6	0.21
secondary forest	8	74.9	2.34
Totals	**372**	**3205.3**	**100.00**

William H. Hatheway 1953. The Land Vegetation of Arno Atoll, Marshall Islands. Atoll Research Bulletin 16, p.7

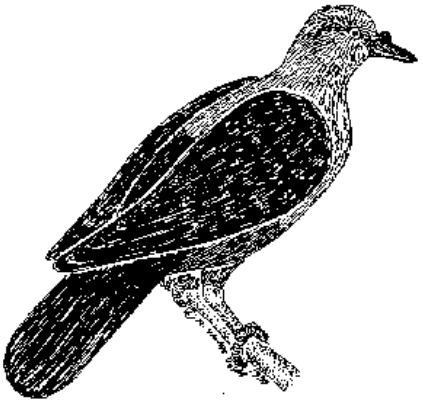
LAND TENURE SYSTEMS and LEGAL AND PLANNING

The land tenure system in RMI is feudal. There are three titles to holding a parcel of land and they are the Iroij (King), Alab (Chief), and Dri-Jerbal (Worker). The land title inheritance passes on to someone of the same clan usually adhering to the maternal system. All title-holders contribute to the development of the land with the worker being the most significant contributor to the management of the land. The Government acts as a facilitator to better practices both traditional and adapted, informed scientific information, and legal protection. (See Legislation, Regulations, Policies in the Marshall Islands Affecting Forestry and FRG).



CONTRIBUTIONS OF FORESTRY AND TREES TO THE ECONOMY AND ENVIRONMENT

Forest and trees are important to the Marshall Islands because they:

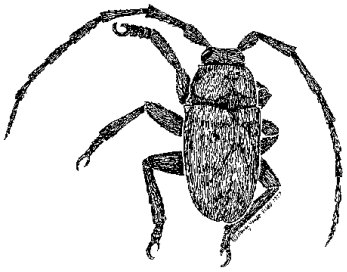


1.) provide **environmental services** --

a.) stabilize the otherwise sandy and rocky soil

b.) protect other trees and living things from the constant barrage of salt spray (as well as protecting non-living things, like houses, cars, electronic equipment)

c.) wave protection



d.) protect the habitat of endangered and endemic animals (the endangered and endemic Ratak Micronesian pigeon, the endemic pseudoscorpions, endemic insects, nesting areas for endangered sea turtles, etc.)

2) provide **food for the local people** --

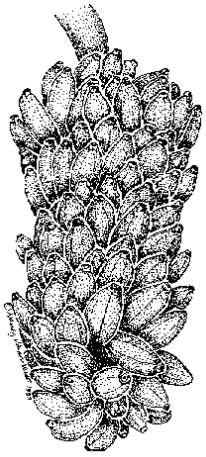
coconut plantations

breadfruit groves

pandanus

bananas

limes

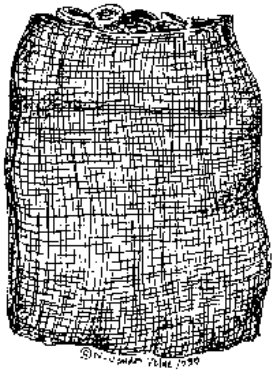


and protection for the survival non-tree food species, such as taro, pumpkin, etc.

3) and are a **major part of the economy** --

a.) copra production is the major source of income for those living in the outer islands

b.) handicraft material for the numerous women who make handicraft as their sole means of income



c.) fledgling tourist industry with its emphasis on ecotourism

Section 2 -- UTILIZATION AND DISTRIBUTION OF FOREST GENETIC RESOURCES

STUDIES RELATED TO THE USE AND KNOWLEDGE OF TREES BY THE LOCAL COMMUNITY

During the biodiversity workshops that were conducted from late 1997 to mid-1998 on six of the atolls, traditional use and knowledge of the natural resources were discussed. Thirty species of trees were named by the participants as being useful for everything from food, medicine, canoe and traditional house construction to providing playthings for children. A table presenting a compilation of those workshops is to be published as part of the National Biodiversity Report for the Marshall Islands, still pending publication.

Popular books which have dealt with plants and trees have been written and are available to the public. Mark Merlin, Alfred Capellle, Thomas Keene, James Juvik and James Maragos in their 1994 book, *Keinikkan Im Melan Aelon Kein*, discusses a variety of plants, native and introduced, both pre-historically and recently. Anthropologist Dirk H. R. Spennerman, in cooperation with the Historic Preservation Office, published in 1993 *Enaanin Etto*, which covers many aspects of the traditional and historic Marshall Islands. In the section under traditional land management, he discusses food plants, medicinal plants and species used in manufacture and construction. Some 23 trees species are included in his charts.

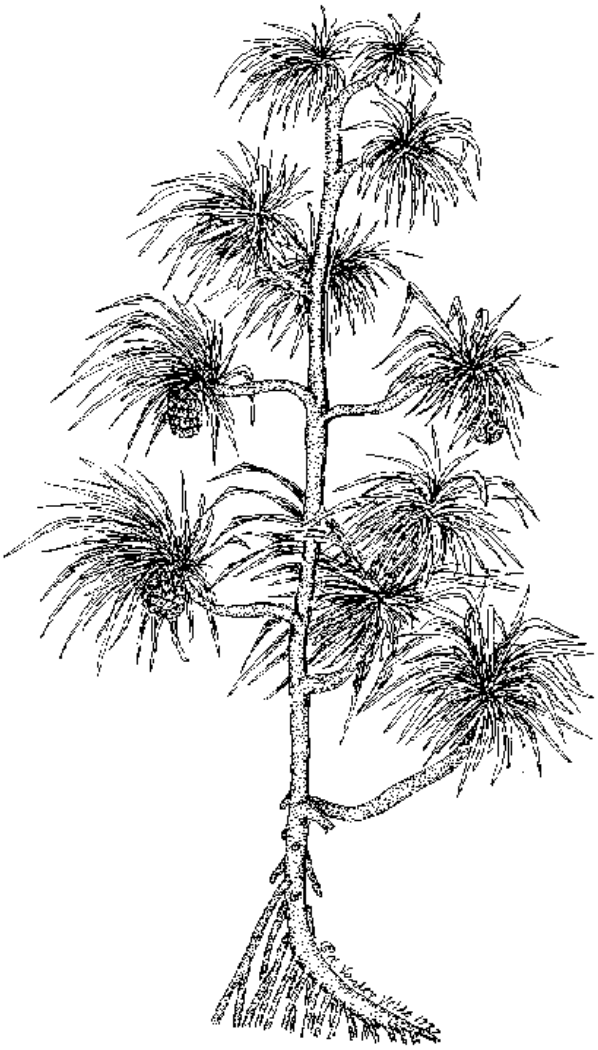


Table 2.1A : Important Indigenous and Prehistorically Introduced Tree Species of the Marshall Islands and Their Uses

**** = major use * = minor use ? = uncertain as to status (note: most of the information based on RMI biodiversity workshops**

	NAME OF SPECIES	WOOD				FOOD & FODDER				NON-WOOD PRODUCTS					SERVICES & ENVIRONMENTAL					OTHER			
No.	Scientific name	Po	Ro	Wd	Fu	Fr	Nu	Ve	Fd	Me	Gu	Oi	Cu	FL	Sh	Lf	WP	Cso	Sa	HD	BR	SE	TF
1.	***Pandanus tectorius***	*	*	*	*	**	*	*		**			**	*	*		**	**		**	*		
2.	***Artocarpus altilis***	*	*	**	*	**		*	*	*	*		*		**					*	*		*
3.	***Artocarpus marianensis***	*	*	**	*	**	*	*	*	*	*		*		*					*	*		*
4.	***Cocos nucifera***	*		*	*	**	**	*	**	*		**	*		*	*	**	*		**	*		*
5.	*Allophyllus timoriensis*	*			*				**	*			*										*
6.	*Argusia argentia*	*	*	*	*					**			**		*		**	**			*	*	
7.	*Barringtonia asiatica*	*	*		*					*			*		*		*	*			*		**
8.	*Bruguiera gymnorrhiza*	*	*	*	*					*			*					*		*		*	
9.	*Calophyllum inophyllum*	*	*	*	*					*				*	**		*	*		*	*		
10.	*Cordia subcordata*	*	*	*	*		*			*			*	*	*		*	*					
11.	*Dodonaea viscosa*	?	?	?	*	?						?	?	*									
12.	*Ficus tinctoria*	?	?	?	*	**				?					*								
13.	*Guettarda speciosa*	*	*		*					**			*	**	*		**	**					
14.	*Hernandia nymphaefolia*			*	*					*			*		*		*	*		**			
15.	*Hibiscus tiliaceus*	*	*	*	*								*	*	*		*	*		*			*
16.	*Intsia bijuga*	*	*	*	*					*			*				*	*					*
17.	*Ixora casei*	?	?	?	*					*				*	*								
18.	*Lumniitzera littorea*	*	*	*	*									**			**	**					
19.	*Morinda citrifolia*	*	*	*	*	*				**			*	*						*			
20.	*Neisosperma oppositifolium*	*	*	*	*		*			*			**	*			**	**					

KEY:

Wood
Po = posts, poles (ground contact)
Ro = Roundwood (above ground)
Wo = other wood (e.g. carving, canoe)
Fu = fuelwood, charcoal

Food & Fodder
Fr = fruit
Nu = nut
Ve = green vegetable
Fd = animal fodder

Non-wood Forest Products
Me = medicinal products
Gu = gums, resins, tannins
Oi = oils
Cu = cultural/custom
FL = cut flowers for garlands, leis, etc.

Services & Environmental
Sh = shade, shelter, amenity
Lf = living fence
WP = wave protection
Cso = coastal stabilization/soil conservation/wave protection
Sa =sacred

Other
HD = handicraft, dyes
BR = bird roost
SE = soil enrichment
TF = traditional fishing

Table 2.1A : Important Indigenous and Prehistorically Introduced Tree Species of the Marshall Islands and Their Uses
(Continued)

**** = major use * = minor use ? = uncertain as to status (note: most of the information based on RMI biodiversity workshops**

	NAME OF SPECIES	WOOD				FOOD & FODDER				NON-WOOD PRODUCTS					SERVICES & ENVIRONMENTAL					OTHER			
No.	Scientific name	Po	Ro	Wd	Fu	Fr	Nu	Ve	Fd	Me	Gu	Oi	Cu	FL	Sh	Lf	WP	Cso	Sa	HD	BR	SE	TF
21.	*Pemphis acidula*	*	*	*	**								*				**	**	*	*			
22.	*Pipturus argentus*	*	*	*	*				*	*			*					?		*			*
23.	*Pisonia grandis*	*	*	*	*					*			*						**		**	**	
24.	*Premna serratifolia*	*	*	*	*				*	*			*		*	*	*	*					
25.	*Rhizophora stylosa*	*	*	*	*													*					
26.	*Scaevola taccada*	*	*	*	*				**	*			*	*			**	**		*	**		*
27.	*Sonneratia alba*	*	*	*	*					*			*					*		*			
28	*Sophora tomentosa*	?	?	?	*					*			*										
29.	*Soulamea amara*	*	*	*	*					*			*										
30.	*Suriana maritima*	*	*	*	*					*			*										*
31.	*Terminalia catappa*				*		*			*			*		*								
32.	*Terminalia samoensis*	*	*	*	*		**			*					*								
33.	*Ximinea americana*	?	?	?	*	*				?			*										

KEY:

Wood
Po = posts, poles (ground contact)
Ro = Roundwood (above ground)
Wo = other wood (e.g. carving, canoe)
Fu = fuelwood, charcoal

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Nu = nut
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Non-wood Forest Products
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Oi = oils
Cu = cultural/custom
FL = cut flowers for garlands, leis, etc.

Services & Environmental
Sh = shade, shelter, amenity
Lf = living fence
WP = wave protection
Cso = coastal stabilization/soil conservation/wave protection
Sa =sacred

Other
HD = handicraft, dyes
BR = bird roost
SE = soil enrichment
TF = traditional fishing

Table 2.1B : Important Recently Introduced Tree Species of the Marshall Islands and Their Uses

**** = major use * = minor use ? = uncertain as to status** **(note: most of the information based on RMI biodiversity workshops**

	NAME OF SPECIES	WOOD				FOOD & FODDER				NON-WOOD PRODUCTS					SERVICES & ENVIRONMENTAL					OTHER			
No.	Scientific name	Po	Ro	Wd	Fu	Fr	Nu	Ve	Fd	Me	Gu	Oi	Cu	FL	Sh	Lf	WP	Cso	Sa	HD	BR	SE	TF
	WIDELY DISTRIBUTED																						
1.	*Abelmoschus manihot*							**															
2.	*Araucarua heterophylla*				*										*	*							
3.	*Carica papaya*					**		*		*													
4.	*Casuarina equisetifolia*				*										*	*		*			*		
5.	*Citrus auranifolia*	*	*	*	*	**				*					*								
6.	*Delonix regia*				*									*	**								
7.	*Inocarpus fagiferus*				*		**								*								
8.	*Leucaena leucocephala*	?	?	?	*			?	?						*							*	
9.	*Moringa oleifera*				*			**															
10.	*Musa spp.*					**		**	**	*				*									
11.	*Plumeria rubra*				*									**	*								
12.	*Plumeria obtusa*				*									**	*								
13	*Tecoma stans*				*									**									
14.	*Vitex trifolia*				*					*	**				*								
	LIMITED DISTRIBUTION																						
15.	*Erythrina variegata*				*										*								
16	*Gardenia taitensis*													**	*								
17	*Psidium guajava*				*	**				*					*								
18	*Mangifera indica*				*	**									*								
19	*Syzygium malaccense*				*					*													
20.	*Thespesia populnea*				*				*						*								

KEY:

Wood
Po = posts, poles (ground contact)
Ro = Roundwood (above ground)
Wo = other wood (e.g. carving, canoe)
Fu = fuelwood, charcoal

Food & Fodder
Fr = fruit
Nu = nut
Ve = green vegetable
Fd = animal fodder

Non-wood Forest Products
Me = medicinal products
Gu = gums, resins, tannins
Oi = oils
Cu = cultural/custom
FL = cut flowers for garlands, leis, etc.

Services & Environmental
Sh = shade, shelter, amenity
Lf = living fence
WP = wave protection
Cso = coastal stabilization/soil conservation/wave protection

Other
HD = handicraft, dyes
BR = bird roost
SE = soil enrichment
TF = traditional fishing
Sa =sacred

Table 2.2: Summary of the Distribution of some Tree Species in the Marshall islands

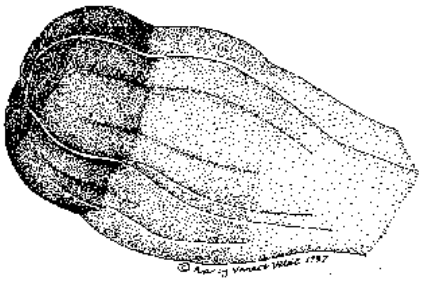
Species	Northern Isolated Atolls	North Ratak	South Ratak	Kabin Meto	Central Ralik	South Ralik
Aidia cochinensis			*			*
Allophylus timorensis		*	*	*	*	*
Artocarpus altilis		*	*	*	*	*
Artocarpus marianensis		*	*	*		*
Barringtonia asiatica		*	*	*	*	*
Brugueira gymnorrhiza		*	*	*	*	*
Calophyllum inophyllum		*	*	*	*	*
Cordia subcordata		*	*	*	*	
Dodonea viscosa		*	*	*		*
Guettarda speciosa		*	*	*	*	*
Hernandia aymphaefolia		*	*	*	*	*
Hibiscus tiliaceus			*	*	*	*
Intsia bijuga			*	*	*	*
Lumnitzera littorea			*			*
Mammea ordorata			*			
Morinda citrifolia		*	*	*	*	*
Neisosperma oppositifolia		*	*	*	*	*
Pandanus tectorius	*	*	*	*	*	*
Pemphis acidula		*	*	*	*	*
Piptutus argentus		*	*	*	*	*
Pisonia grandis	*	*	*	*	*	*

Table 3: Distribution of Important Indigenous and prehistorically Introduced Tree Species of the Marshall Islands

	NAME OF SPECIES	KABIN METO (NW RALIK)									RALIK CHAIN (SOUTHERN)									RATAK (NORTHERN)									RATAK (SOUTHERN)							
• = recorded or observed on well documented atolls; or expected to occur on less documented atolls																																		
x = extirpated																																		
No	**atoll/island (some names appreviated or shortened)**	**Ujela**	**Enew**	**Bikini**	**Rnglp**	**Rngri**	**Alingi**	**Woth**	**Ujae**	**Lae**	**Kwaj**	**Lib**	**Namu**	**Jabot**	**Alngl**	**Jaluit**	**Kili**	**Namd**	**Ebon**	**Boka**	**Bikar**	**Utdri**	**Taka**	**Mejit**	**Ailuk**	**Jemo**	**Likie**	**Wotje**	**Eriku**	**Maloe**	**Aur**	**Majur**	**Arno**	**Mili**	**Nadri**
1.	***Pandanus tectorius***	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
2.	***Artocarpus altilis***	•	•	•	x			•	•	•	•	•	•	•	•	•	•	•	•			•		•	x	•	•	•		•	•	•	•	
3.	***Artocarpus marianensis***		•		x				•		•					•						•			•		•					•	•		
4.	***Cocos nucifera***	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
5.	*Allophyllus timoriensis*	•		•	•		•	•	•	•	•		•		•	•						•							•			•	•	•	
6.	*Argusia argentia*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
7.	*Barringtonia asiatica*									•	•		•		•	•																•	•	•	
8.	*Bruguiera gymnorrhiza*				•	•				•		•	•		•	•		•	•			•		•	•		•	•				•	•	•	
9.	*Calophyllum inophyllum*	•		•	•	•		•	•	•	•		•		•	•	•	•	•			•		•	•		•	•	•	•	•	•	•	•	
10.	*Cordia subcordata*	•	•	•	•	•		•	•	•	•	•	•	•	•	•		•	•			•		•	•	•	•	•	•	•	•	•	•	•	•
11.	*Dodonaea viscosa*			•				•																			•								
12.	*Ficus tinctoria*										•		•		•	•																•	•		
13.	*Guettarda speciosa*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
14.	*Hernandia nymphaefolia*	•		•						•	•					•	•		•								•					•	•		
15.	*Hibiscus tiliaceus*	•		•				•	•	•	•	•	•	•	•	•	•	•	•					•	•		•	•		•	•	•	•	•	
16.	*Intsia bijuga*						•	•	•	•	•				•	•													•		•	•			
17.	*Ixora casei*										•				•	•											•					•	•		
18.	*Lumniitzera littorea*														•	•																	•		
19.	*Morinda citrifolia*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	
20.	*Neisosperma oppositifolium*	•	•	•	•			•	•	•	•		•		•	•									•		•		•	•	•	•	•	•	
21.	*Pemphis acidula*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•	•		•	•		•	•	•	•	•	
22.	*Pipturus argentus*	•							•	•	•				•	•												•				•	•	•	
23.	*Pisonia grandis*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
24.	*Premna serratifolia*	•						•	•	•	•		•		•	•		•	•			•		•	•		•	•	•	•	•	•	•	•	
25.	*Rhizophora stylosa*														•	x																			
26.	*Scaevola taccada*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
27.	*Sonneratia alba*											•			•	•		•														•	•		
28	*Sophora tomentosa*	•		•		•			•						•	•																•	•		
29.	*Soulamea amara*			•				•	•	•	•				•										•								•		
30.	*Suriana maritima*	•	•	•	•	•	•	•	•	•	•				•	•						•	•		•		•		•					
31.	*Terminalia catappa*										•					•																•	•		
32.	*Terminalia samoensis*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•		•	•	•	•	•	•	•	•	•	•	•	•
33.	*Ximenia americana*		•	•					•	•																						•			

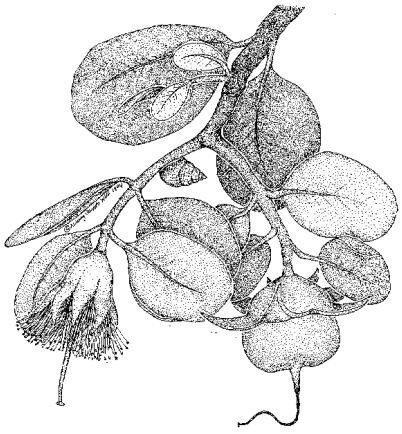
Section 3 -- CONSERVATION OF FOREST GENETIC RESOURCES

TREES AT RISK



Urbanization and the problems so often associated with it are threats to all the forest types in the Marshall Islands. However, since there are no endemic species of trees, there is not likely threat of any species going extinct. Nevertheless, some of the **cultivated forms** and **clones of *Pandanus tectorius*** are reported by the local people to have disappeared and continue to be threatened with extirpation. For the most part, being clones, they do not reproduce by seed and must be skillfully propagated with shoots. The advent of modern civilization and easy access to more convenient foodstuffs is said to be why fewer and fewer people continue in this traditional horticultural practice.

Pemphis acidula, as a species, is not threatened. But there are stands of this tree with individuals that reach remarkable sizes. One of the authors of this report investigated a monospecific stand of this species and found some trees 5 and 6 feet in circumference and up to 30 feet tall -- much larger than recorded in the literature for anywhere in this species' range. Additionally, these may be very old, but since this slow growing tree is a valuable source of firewood by the local people, these remarkable stands are at risk of being lost.



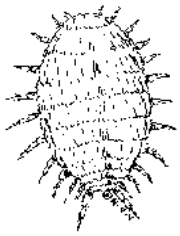
The **mangrove depressions**, especially those of ***Sonneratia alba***, are only on a few atolls (and one solitary island) and only one island, or just few islands, of those atolls. Currently, they appear to be in good shape, but because of their small size, they could easily be threatened by human pressure, development or pollution.

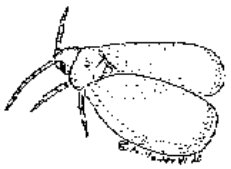
The **shrub forests of Bikar and Bokak** in the far north contain only 9 species of vascular plants each. The only trees found on these arid atolls are *Pisonia grandis*, *Argusia argentea*, and *Scaevola taccada* on them both, with *Pandanus tectorius* on Bokak. (The endemic grass *Lepturus gasparricensis* is on Bokak.) These atolls are considered to be ecologically pristine and have been recommended as national preserves with no visitation by humans. Any introduction of exotic species or development could easily and quickly destroy their environments.

THREATS

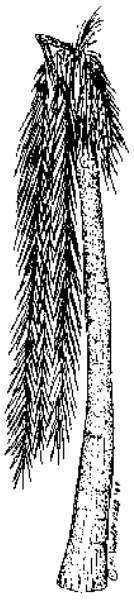
Invasive plants and animals are becoming more and more acknowledged as one of the most serious threats to all of the biodiversity of the Marshall Islands. The worldwide weed, *Bidens pilosa,* recently became almost omnipresent on Majuro and is spreading to the outer islands. *Wedelia trilobata,* with its attractive flowers and ground cover properties, is being purposely introduced into gardens on many atolls, and from there is invading nearby areas.

Breadfruit groves are being threatened by invasive insect pests. Valuable coconut plantations are vulnerable to this same threat. Biological control is being used to stave off this attack, and so far seems to be having some success. But so far the spiraling whitefly, which is causing damage to numerous native trees and valuable food crops, is spreading unchecked. Bananas are being hard hit by this pest, and it has been observed infesting native trees on some of the uninhabited islets of Majuro Atoll.





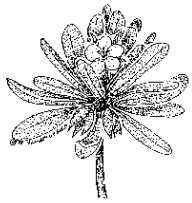
The long-legged ant is also posing a threat to many native trees and ecosystems. Unlike most other invasive species, it will invade undisturbed forests. It is now found on several atolls of the Marshalls, where it is killing the land crabs and stripping the bark off *Pisonia grandis.*



Climate change is also of major concern to the Marshall Islands. Being low-lying atolls, any increase in the sea level could have serious consequences. Besides the obvious problems that would come from inundation, there are also the more subtle ones. It is figured that if the sea temperature around the Marshalls should rise just one more degree Celsius, there could be massive coral die-off, similar to that already seen in the Western Pacific and Indian Ocean. Without the protection of living coral, the land would be more vulnerable to waves. Sea level rise carries the potential of causing salt water to seep into the valuable freshwater lenses, which would mean that trees that tap those water sources would not be able to survive. The scenario of climate change also carries the prospect of more severe storms as well as droughts. The recent drought that hit the Marshalls after Typhoon Paka left in its wake many dead and dying coconut palms and breadfruit trees.

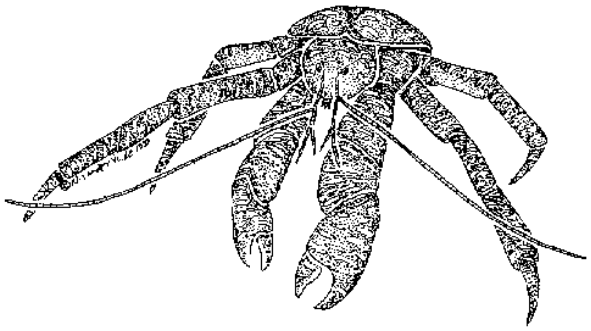
NUCLEAR TESTING

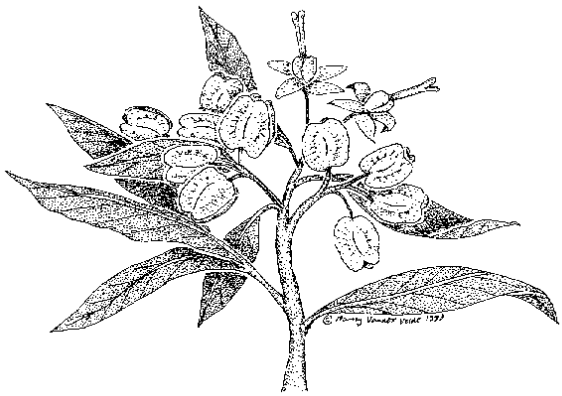
A negative impact on the forests and environment that is somewhat unique to the Marshalls Islands is the nuclear testing done on the atolls of Kabin Meto. These certainly had immediate and negative impacts on the plants and animals. Between 1946 and 1958, 67 bombs were tested on what was known as the Pacific Proving Ground -- 44 at Enewetak Atoll and 23 at Bikini.



In 1956, F. Raymond Fosberg went to several of the irradiated islands and realized that "the vegetation on some of the islets visited was not normal". Yet previous to this, he said that "no serious attention was paid to these abnormal phenomena" and he felt that it was already "too late to make any systemic study". What he did observe, however, was again, that radiation affects different plants differently. *Suriana maritima* suffered badly, being found in a dead or dying state. *Pisonia grandis* was abnormally defoliated. Even hardy grasses seem to have suffered. And although *Argusia argentea* and *Scaevola taccada* seemed unaffected at that time, later studies indicated that even these had measurable levels of radioactivity.

The long-term effects of radiation are still not fully understood. The different components of radioactive materials have a wide range of characteristics. Different plant species absorb these elements at different rates. Lichens, for example, are very tolerant of radioactivity. But people do not depend on lichens for food. A major part of the research has centered on food crops and animals. Coconuts have been found to retain a significant amount of Cesium-137, and hence when coconut crabs eat coconuts, Cesium-137 builds up in their bodies. (And in a similar fashion, when people eat coconuts -- or coconut crabs -- the risks of radiation buildup and related sicknesses increases.) Other plants tested show certain levels of radioactivity but are used as local medicine and not food and so at the conclusion of their extensive studies, Drs. Steven Simon and James Graham said these would be safe to use.





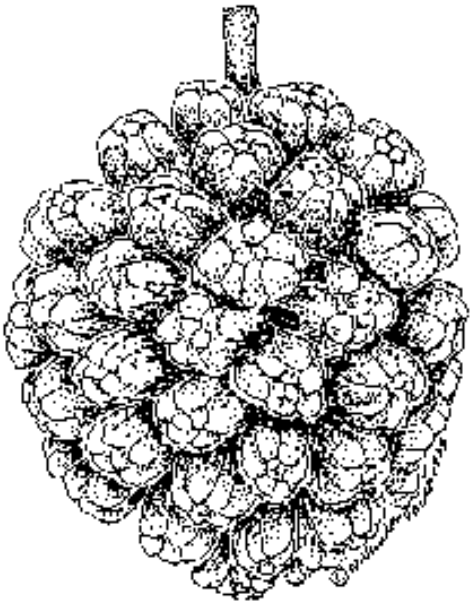
By declaring the irradiated atolls uninhabitable by humans after the testing, much of the land was left to recolonize itself. Slight variations were found, such as large stands of *Dodonea viscosa* on Bikini, which Fosberg had not documented elsewhere, but William Taylor had recorded these before the testings. On Enewetak, some species disappeared, but others were introduced. But most of the recolonization of plants followed a pattern fairly similar to what has been theorized originally occurred throughout all of the Marshall Islands.

Birds returned in abundance, nesting safely away from human pressure. The reappearance of the large nesting colonies is figured to play an important part not only in accelerating the entire recolonization process on the affected islands, but also in understanding the recovery of atoll communities. Nevertheless, richer soils retain radioactive material more than poor sandy or gravely soils do, so much of the soil has retained radioactivity.

The resettlement of the plants and animals on the land has, in general, been considered to be so complete that some scientists voiced concern when it was proposed to scrape the land to remove residual radiation before human reoccupation, although this option was favored by the islanders. The scientists prefer the use of potassium fertilizer, which they say would be absorbed by plants in preference to Cesium-137. The concern is that scraping would destroy the plants and the bird nesting habitats.

Section 4 -- PRIORITY ACTIONS FOR FOREST GENETIC RESOURCES

Presently, the only tree species in the Marshalls that deserves priority action to preserve is ***Pandanus tectorius***, particularly its **cultivated forms and clones**. Benjamin Stone studied this subject decades ago and found 123 Marshallese names for the clones (and perhaps different manifestations of those clones, or regional names for the same clones). The common consensus of the Marshallese people is that these clones (often referred to as "varieties") are disappearing. They were developed through the horticultural efforts of the original inhabitants of the islands and this skill is being lost along with the clones.

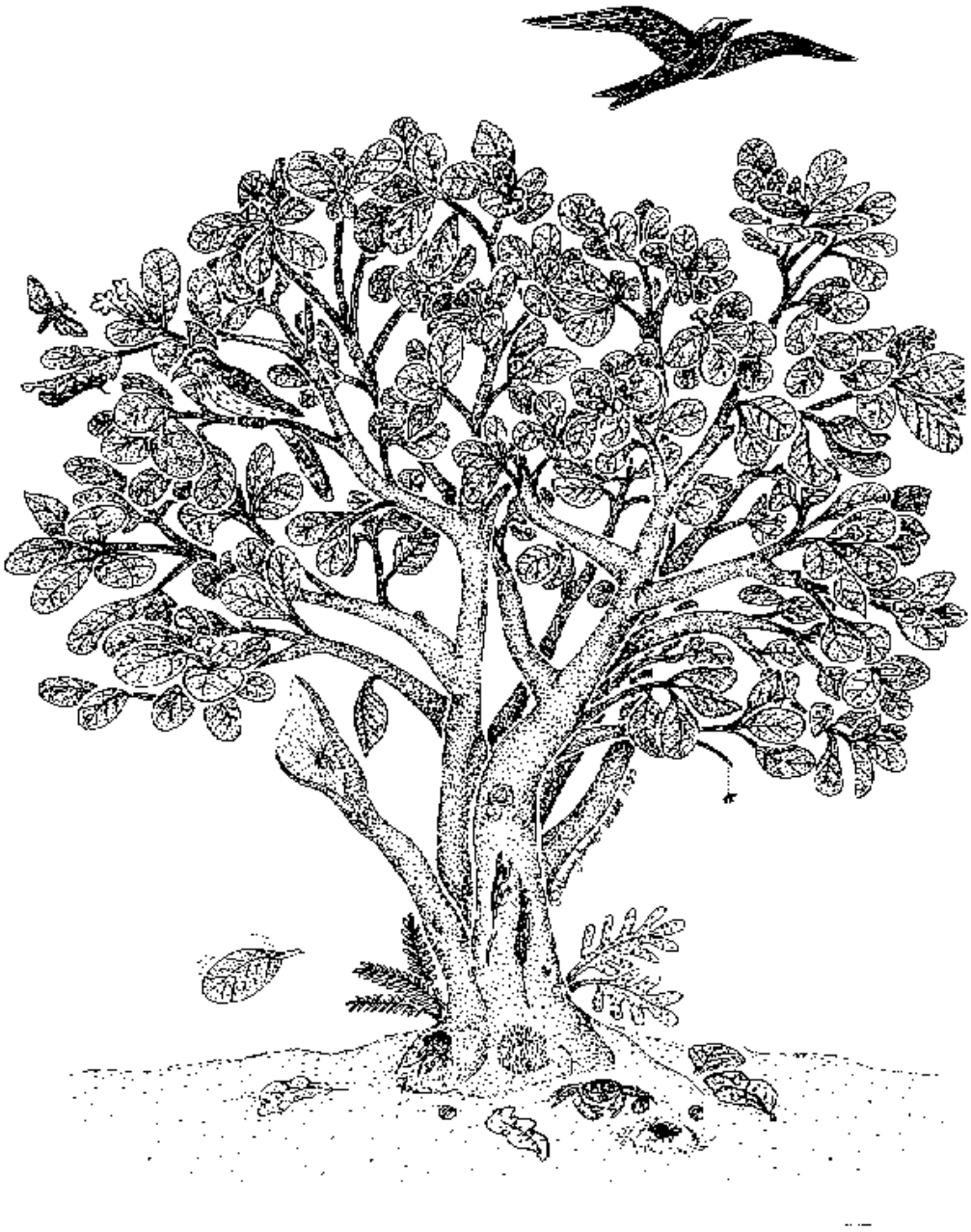


Section 5. INSTITUTIONS AND RESOURCES FOR FGR

The Ministry of Resources, Development and Works – Agriculture Division has the mandate to promote sustainable agriculture (agroforestry) development for the Republic. This strategy has led to the creation of the agroforestry section in the Agriculture Division with specific attention to the multiple uses of trees. The Division also collaborates with the Environmental Protection Agency (EPA), which executes projects like the Biodiversity Project for the Marshall Islands, and with individual resident experts like Nancy Vander Velde.

Section 6 -- CONCLUSIONS AND RECOMMENDATIONS

In many ways, it can be said that the status of the forests in the Marshall Islands is a paradox. They are in general not particularly threatened and still to be found in abundance. On the other hand, they have likely suffered from more impact by humans than almost any other place in the Pacific. Besides having entire islands vaporized during the nuclear bomb testing program, there is really no land in the entire country that people have not been utilizing for thousands of years. Farming the land, living on it and periodically visiting remote areas for the purpose of harvesting the forest resources is a tradition that continues on in the Marshall Islands.



Legislation, Regulations, Policies in the Marshall Islands Affecting Forestry and FRG

International --

- Compact of Free Association between the United States of America and the Republic of the Marshall Islands (1986), Title One, Article VI --

pledge between the two countries to "promote efforts to prevent or eliminate damage to the environment and biosphere and to enrich understanding of the natural resources of the Marshall Islands."

section 161 (a) (1) -- the United States to continue to apply environmental controls which were in effect previous to the Compact

section 161 (a) (2) -- the United States to continue to apply *U. S. National Environmental Protection Act* in the RMI

section 161 (a) (3) -- the United States to apply environmental standards similar to those of the U.S. environmental studies when conducting activities requiring a U.S. Environmental Impact Statement

section 161 (a) (4) -- the United States to provide technical support from appropriate U.S. environmental agencies in the development of environmental studies, with the RMI being able to comment during the development

section 161 (b) -- the Marshall Islands has an obligation to develop and enforce comparable environmental standards and procedures.

- Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (SPREP Convention); related protocols (ratified 1987) -- "to prevent, reduce and control pollution resulting from vessels, land-based sources, sea-bed activities, discharges into the air, disposal of toxic and non-toxic wastes, testing of nuclear devises and mining", with further protections for fragile ecosystems and endangered species contemplated.

(Possible Future Ratifications) --

- Convention on International Trade in Endangered Species (CITES Convention)
- London Dumping Convention
- Migratory Bird Treaty
- Convention on Conservation of Nature in the South Pacific (Apia Convention)

Republic of the Marshall Islands --

- Republic of the Marshall Island Constitution (1979), Article X - preservation of traditional land tenure and titles system;

no person with customary land rights may alienate or dispose of land without approval of traditional land owners

- Real and Personal Property Act, (section 13) -- only RMI citizens, citizens' wholly-owned corporations and RMI government can hold title to land.

Non-citizens can lease land

- Public Lands and Resources Act (1988 Title 9, Chapter 1, section 3) -- all lands below mean high water mark belong to the government, with exceptions but no right to abuse, destroy or damage mangroves or land

- Land Acquisition Act 1986 -- provision for government acquisition of lands for public use and the payment of just compensation

Biodiversity Conservation

Endangered Species Act (Trust Territory Act, 1995, adopted as it by Nitijela) -- protection of endangered and threatened species and subspecies

Ratak Micronesian Pigeon, *Ducula oceanica ratakensis*

authority to set up conservation and research programs for conserving endangered and threatened species.

authority to acquire land or aquatic habitats for the conservation of resident endangered or threatened species

- Tourism Act 1991 -- establishes a Marshall Islands Visitors Authority (MIVA) with power to identify and recommend likely conservation areas with tourism potential

MIVA is empowered to work with any body responsible for land protected areas

Environmental Planning and Assessment --

- National Environmental Protection Act 1984 --

(1) overview, part II -- study impact of human activity on natural resources;
prevent degradation or impairment of environment;

regulate human activity to ensure safe, healthful, protective, aesthetically and culturally pleasing surroundings

preservation of important natural aspects of the nation's culture and heritage, while supporting variety of individual choice

regulations regarding drinking water, pollutant, pesticides and other harmful chemicals, hazardous waste, preservation of natural aspects of heritage, other aspects that may be required

(2) enforcement

(3) environmental impact assessments, section 33 -- all government agencies include a report on the environmental impact in all matters where there is or may be an environmental impact

section 34 -- when there is a proposed action, there will be submitted a detailed statement on environmental and cultural impact any adverse unavoidable environmental effects alternatives

relationships between local short-term uses and long-term productivity irreversible and irretrievable impact on resources

must obtain comments of interested public and government department involved, with the public given reasonable time given to inspect the statement

- Coast Conservation Act 1988 -- protection and preservation of the coast from sea erosion or encroachment of sea in connection with the development activities of:

buildings, depositing of wastes or other material from outfalls, vessels, etc. removal of sand, coral, shells, vegetation, sea grass, etc., dredging, filling, land reclamation, mining or drilling for mineral does not include fishing) within 25 feet landward of mean high water line and 200 feet seaward of mean low water line

permits for proposed development activity

- Planning and Zoning Act 1987 -- every local government to establish a Planning Commission and Planning Office.

zoning according to land use
preservation of natural landscape and environment
identification of appropriate locations for recreational areas and parks
building permits

- Draft RMIEPA Clean Air Regulations

Agriculture and Agro-forestry

- Tobolar Copra Processing Authority Act 1992 -- to plan, establish, manage, operate, and maintain all aspects of copra processing for RMI

- Animal and Plant Inspection Act -- all animals and plants entering or transported within RMI are subject to inspection;

plant and animal quarantines and regulations;

cargo manifests;
emergency quarantine measures

- Plant and Animal Quarantines and Regulations

- Export Meat Inspection Act -- regulation of export meat and meat products.

methods of slaughtering,
postmortem examination
labeling,
sanitation inspection
control and storage

- Draft RMIEPA Pesticides Regulations -- importation, distribution, sale and use of pesticides

RMIEPA may ban pesticides producing substantial adverse effects on human health and the environment

permits required for sale and distribution and importing of restricted use pesticides by those other than certified applicator

experimental use permits for conducting small scale laboratory or field tests of unregistered pesticide

system to certify private commercial pesticide applicators

- RMIEPA Earthmoving Regulations -- control of all earthmoving activities, or any construction or other activity which disturbs or alters the surface of the land, a coral reef or bottom of a lagoon

includes all excavations, dredging, embankments, land reclamation, land development, mineral extraction, ocean disposal, depositing or storing of soil, rock, coral or earth

purpose to prevent accelerated erosion, accelerated sedimentation, disturbance of potential cultural resources

those engaged in earthmoving must design, implement and maintain effective erosion control plans, sedimentation control plans, cultural preservation measures

permits, plowing or tilling for agricultural and building or adding to one or two family residences exempted

Water Quality

- RMIEPA Marine Water Quality Regulations -- uses for which marine waters of RMI shall be maintained and protected, specify water quality standards, prescribe standards necessary for implementing, achieving, maintaining specified marine water quality

assure that no pollutants are discharged into RMI waters without treatment or control to prevent pollution, except when there is permit
parts VII and VIII -- strict marine pollution control requirements and oil pollution prevention measures

prohibition against discharge of sewage from vessels

- Trust Territory Marine and Fresh Water Quality Standard Regulations -- environmental oversight of fresh waters

- Trust Territory Public Water Supply Systems Regulations -- sets forth minimum standards and requirements to insure that water supply systems are protected against contamination and pollution and do not constitute a health hazard

a public water system is one that serves pipe-borne water for human consumption with at least 15 service connections or regularly serves at least 25 individuals

Waste Management

- Littering Act 1982 -- prohibits the unauthorized dumping, throwing away, playing or leaving of refuse of any kind, or anything which tends to pollute, mar or deface

- RMIEPA Solid Waste Regulations -- establish minimum standards governing design, construction, installation, operation and maintenance of solid waste storage, collection and disposal systems.

includes garbage, refuse or other discarded solid material; waste oil, pesticides, paints, solvents, hazardous waste

permits required to operate solid waste disposal systems.
smaller private disposal systems require written approval of RMIEPA

- Public Health, Safety and Welfare Act -- sanitation section includes inspection and control of latrines and toilets, limiting accumulations of rubbish.

sanitation standards may be established for the halt of introduction of disease by insects entering on aircraft

- Trust Territory Pollution Control Regulations

- RMIEPA Toilet Facilities and Sewage Disposal Regulations -- establish minimum standards for toilet facilities and sewage disposal to reduce environmental pollution, health hazards and public nuisance

generally required that all public buildings and homes have toilet and sewage facilities, according to stated standards.

No building construction without first obtaining a permit

Fire Control Act (1988 Title 7, Chapter 7, section 2)
no fires for clearing land without authorization permit and proper control

Bill of Rights -- no taking of land except by Government and them only for public use

local regulations --

Bikini --
regulations of Local Government Council July 28, 1997
5) all wildlife protected on and around Bikini, Aoemen and Eneu islands,
including birds, nesting turtles and their eggs
7) all other natural resources preserved so they are not exploited

Kwajelein --
USAKA (United States Army Kwajelein Atoll) hence under United States laws and regulations)

(rest of atoll) --
Ordinance #5 -- (pig control)
Ordinance No. 83-05 (garbage collection fee)
Ordinance No. 86-20 (animal control)
Ordinance No. 89-42 (littering)
Ordinance No. 94-69 (waste disposal, sanitation)

Ujae --
Ordinance No. 83-9 (pig ordinance)
section 5. reserve areas and species
right to designate specified areas and specified species as off-limits to commercial exploitation in order to protect the subsistence food sources of residents
Ordinance No. 1986-2 (waste disposal, sanitation)

Lae --
Ordinance No. 1993-3 (littering, dumping)

Jabot --
Ordinance No. 01-1994 (pig control)

Jaluit --
Ordinance No. 1991-8 (pig control)
Ordinance No. 91-9 (dog license)

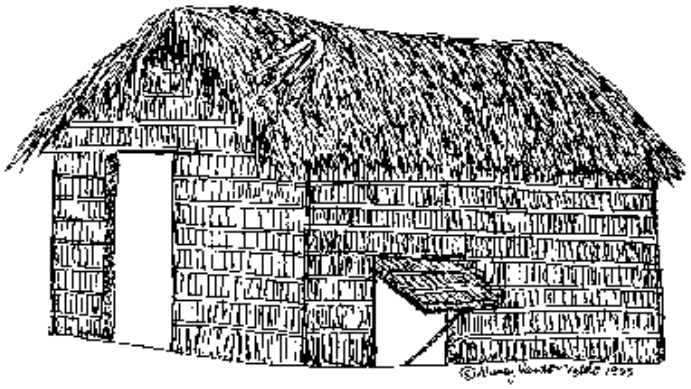
Utdrik --
Ordinance No. 87-8 (piggery ordinance)

Mejit --
Ordinance No. 94-21 (sanitary regulations)

Wotje --
Ordinance No. 1987-6 (protection against cutting of vegetation by non-land owners)
Ordinance No. 1987-8 (pig ordinance)

Aur --
Ordinance No. 1993-05 (pig control)

Majuro --
Ordinance No. 1986-2 (dog license)
Ordinance No. 1986-16 (littering)
Ordinance No. 1986-17 (garbage regulations)
Ordinance No. 1986-24 ((protection against cutting of vegetation by non-land owners)
Ordinance No. 1990-11 (pig-fence ordinance)



REFERENCES:

Anderson, Donald 1950. The Plants of Arno Atoll, Marshall Islands. Atoll Research Bulletin, No. pp. 1 - 4

anon. 1951. The Agriculture of Arno Atoll, Marshall Islands. Atoll Research Bulletin No. 6, pp. 1 - 46

Blumenstock, David I. (ed) 1961. A report on typhoon effects upon Jaluit Atoll. Atoll Research Bulletin. Vol. 75, pp. 1 - 105

Doran, Edwin Jr. 1961. Marshall Islands Landscapes. Atoll Research Bulletin, No. 85, pp. 11 - 15

Falanruw, Marjorie C., Jean E. Maka, Thomas G. Cole, and Craig D. Whitesell 1990. Common and Scientific Names of Trees and Shrubs of Mariana, Caroline,and Marshall Islands. Pacific Southwest Research Station, Berkeley, California

Fosberg, F. R(aymond) 1953. Vegetation of Central Pacific Atolls, A Brief Summary. Atoll Research Bulletin, No. 23, pp. 1 - 26

_____ 1955a. Northern Marshall Islands Expedition, 1951-1952. Narrative. Atoll Research Bulletin, No. 38, pp. 1 - 37

_____ 1955b. Northern Marshall Islands Expedition, 1951-1952. Land biota: Vascular plants. Atoll Research Bulletin, No. 39, pp. 1-22

_____ 1959a. Long-term Effects of Radioactive Fallout on Plants? Atoll Research Bulletin. Vol. 61, pp. 1 - 11

_____ 1988. Vegetation of Bikini Atoll, 1985. Atoll Research Bulletin, No. 315, pp. 1 - 28

Fosberg, F. R. and M.-H. Sachet 1962. Vascular plants recorded from Jaluit Atoll. Atoll Research Bulletin No. 92, pp. 1 - 39
_____ 1982. Micronesian Poaceae: Critical and Distributional Notes. Micronesica Vol. 18 (2), pp. 45 - 102

Fosberg, F. R., Marie-Helene Sachet and Royce Oliver 1979. A Geographical Checklist of the Micronesian Dicotyledonae. Micronesica 15 (1-2), pp 41-295

_____ 1982. Geographical Checklist of Micronesian Pteridophyta and Gymnospermae. Micronesica 18 (1), pp 23 - 82

_____ 1987. A Geographical Checklist of the Micronesian Monocotyledonae. Micronesica Vol. 20 (1-2) pp 19 - 129

_____ 1982. Micronesian Poaceae: Critical and Distributional Notes. Micronesica Vol. 18 (2), pp. 45 - 102

Fosberg, F. R., Marie-Helene Sachet and Royce Oliver 1979. A Geographical Checklist of the Micronesian Dicotyledonae. Micronesica 15 (1-2), pp 41-295

_____ 1982. Geographical Checklist of Micronesian Pteridophyta and Gymnospermae. Micronesica 18 (1), pp 23 - 82

_____ 1987. A Geographical Checklist of the Micronesian Monocotyledonae. Micronesica Vol. 20 (1-2) pp 19 - 129

Gessel, S. P., and Walker, R. B. 1992. Studies of Soils and Plants in the Northern Marshall Islands. Atoll Research Bulletin No. 359, pp. 1 - 70

Hatheway, William H. The Land Vegetation of Arno Atoll, Marshall Islands. Atoll Research Bulletin, No. 16, pp. 1 - 67

Lamberson, Janet O. 1982. A Guide to Terrestrial Plants of Enewetak Atoll. Bishop P. Bishop Museum, Honolulu, Hawaii

_____ 1987a. Natural History of Terrestrial Vascular Plants of Enewetak Atoll. pp. 17 - 35 in Devaney, Dennis M., Ernst S. Reese, Beatrice L. Burch, and Philip Helfrich (eds.). The Natural History of Enewetak Atoll, Volume II, Biogeography and Systematics. United States Department of Energy, Washington, D.C.

Miller, Carey D., Mary Murai, and Florence Pen 1956. The Use of Pandanus Fruit as Food in Micronesia. Pacific Science, Vol. X, pp. 3 - 16

Morrison, R. J. 1992. Soil and Physical and Chemical Limitations to Increased Agricultural Production on Atoll Soils. in Chase, Robert G. (ed) A Review of Agricultural Development in the Atolls. University of the South Pacific, Apia, Western Samoa

Reese, Ernst S. 1987. Terrestrial Environments and Ecology of Enewetak Atoll.
in Devaney, Dennis M., Ernst S. Reese, Beatrice L. Burch, and Philip Helfrich (eds.). The Natural History of Enewetak Atoll, Volume I, The Ecosystem: Environments, Biotas, and Processes. United States Department of Energy, Washington, D.C.

RMI Biodiversity Team (pending) The Marshall Islands -- Living Atolls Amidst the Living Sea

Sabath, Michael D. 1977. Vegetation and Urbanization on Majuro Atoll, Marshall Islands. Pacific Science, Vol. 31, no. 4, pp 321 - 332

Simon, Steven L. and James C. Graham 1994. Findings of the Nationwide Radiological Study, Republic of the Marshall Islands. Summary Report.

_____ 1995a. RMI Radiological Survey of Bikini Atoll. RMI Nationwide Radiological Study, Republic of the Marshall Islands

_____ 1995b. RMI Radiological Survey of Enewetak and Ujelang Atolls. RMI Nationwide Radiological Study, Republic of the Marshall Islands

_____ 1995c. RMI Radiological Survey of Northern Rongelap Atoll. RMI Nationwide Radiological Study, Republic of the Marshall Islands

_____ 1995d. RMI Radiological Survey of Rongerik and Ailinginae Atolls. RMI Nationwide Radiological Study, Republic of the Marshall Islands

_____ 1995e. RMI Radiological Survey of Utrik, Taka, Bikar and Bokak Atolls. RMI Nationwide Radiological Study, Republic of the Marshall Islands

Stone, Benjamin C. 1963. The Role of Pandanus in the Culture of the Marshall Islands. in Barrau, Jacques, Plants and Migration of Pacific Peoples. Bishop Museum Press, Honolulu, Hawaii

Taylor, William Randolph 1950. Plants of Bikini and other Northern Marshall Islands. University of Michigan Press, Ann Arbor, Michigan

Thaman, Randolph R. 1974. Lantana camara: Its Introduction, Dispersal and Impact on Islands of the Tropical Pacific Ocean. Micronesica Vol. 10 (1), pp. 17 - 39

Thomas, P. E. J, (ed.) 1989. Report of the Northern Marshall Islands Natural Diversity and Protected Areas Survey, 7-24 September 1988. South Pacific Regional Environmental Programme, Noumea, New Caledonia; East West Center, Honolulu, Hawaii

Whistler, W. Arthur 1980. Coastal Flowers of the Tropical Pacific. Pacific Tropical Botanical Gardens. Lawai, Kauai, Hawaii

-- "The Land Vegetation of Arno Atoll, Marshall Islands", William Hatheway 1953

"Before the arrival of the Marshallese voyagers, the vegetation of Arno atoll was composed chiefly of dicotyledonous trees and shrubs. Along the boulder ramparts and extending perhaps 100 feet inland on windward islands was a scrub vegetation composed principally of *Scaevola frutenscens* [=*taccada*], *Pandanus tectorius*, *Terminalia samoensis*, and *Guettarda speciosa*. This scrub merged inland on stony soils with a forest of trees 20 to 60 feet tall. Prominent among these were *Barringtonia asiatica*, *Hernandia sonora* [=*nymphhaeifolia*], *Ochrosia oppositifolia* [=*Neisosperma oppositifolium*], *Intsia bijuga*, *Pandanus tectorius*, *Guettarda speciosa*, *Pisonia grandis*, and *Cordia subcordata*. Ground cover was sparse, being featured chiefly of tree seedlings and suckers, clumps of *Asplenium nidus* among the rocks, and patches of *Peperomia* sp. On sandier soils nearer the lagoon, groves of tall *Pisonia* trees served as rookeries for numerous fish-eating seabirds. Hardpans of prosphatic limestones developed under the *Pisonia*s. *Allophylus timorensis*, *Guettarda speciosa*, *Intsia bijuga*, *Pipturus argenteus*, *Cordia subcordata*, and *Premna obtusifolia* were also present on sandy interiors, although they probably did not form mixed stands with the *Pisonia*s. Along the dunes of lagoon shores a scrub of *Scaevela* with occasional *Suriana maritima* and *Sophora tomentosa* formed a narrow belt at the edge of the forest. Along eroding lagoon shorelines in which beachrock was exposed, *Pemphis acidula* formed the bulk of vegetation.

"Saline flats were covered with nearly pure stands of *Pemphis* . . . Fresh-water swamps were covered by forests of *Pandanus tectorius* . . .

Along the lagoon shores of island damaged by typhoons herbaceous palnts such as *Triumfetta procumbens*, *Lepturus repens*, *Wedelia biflora* [=*Wollastonia biflora*, *Vigna marina*, *Fleurya ruderalis*, and *Fimbristylis atollensis* [=*F. cymosa*], maintained precarious footholds in the face of the advancing woody vegetation."