

BOTANICAL SURVEY OF THE YELA RIVER VALLEY, KOSRAE, F.S.M.

FINAL REPORT

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U. S. D. A., Forest Service
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SUMMARY

A botanical survey of the Yela River valley in western Kosrae, F.S.M. was conducted to characterize the vegetation types (plant communities) in the area and determine their vascular plant species composition. The flora was documented by means of herbarium specimens, field identifications, and digital photos. Four vegetation types were recognized for the valley: (1) a well-developed fringing coastal mangrove forest occurs at sea level; (2) a majestic *Terminalia-Horsfieldia* swamp forest covers the valley bottom, extending to ca. 40-50 m elevation; (3) a lowland, non-swamp wet forest replaces it at elevations above ca. 20-30 m; (4) lower montane wet forest covers the rock outcrops, slopes, and ridges of the flanking mountains beginning at ca. 5 m. Ninety-nine vascular plant species and infra-species were recorded. Of these, 77 (77.8%) are indigenous, 13 (13.2%) are naturalized, 5 (5.2%) are endemic, and 4 (4.0%) are cultivated. The area supports a healthy, thriving forest with little disturbance, abundant seed production, numerous seedlings of all age groups, and very few naturalized plants, whose impact is minimal. This drainage area is a critical watershed for northwestern Kosrae. Its intact forest cover prevents erosion and damage to the coral reefs, while the mangroves buffer the coast and provide protection for juvenile marine organisms. The This truly unique ecosystem serves as a valuable watershed that help protect the reef from siltation, serves as a reservoir for biodiversity on the island,

KEY WORDS: Kosrae, Federated States of Micronesia, botanical survey, vascular plants, mangrove forest, swamp forest, lowland, lower montane, wet forest

INTRODUCTION.

A botanical survey of the Yela River Valley (Infal Yela), Kosrae, F.S.M. was conducted for the Institute of Pacific Islands Forestry, USDA Forest Service, Pacific Region, by David Lorence and Tim Flynn of the National Tropical Botanical Garden, Hawaii. Three site visits were made on 31 January and 1-2 February 2005. Lorence and Flynn were accompanied by Kosrae staff members of the Kosrae Island Resource Management Authority (Killion Isisaki, Blair Charley, and Moses Palik) and Kosrae Conservation and Safety Organization (Marston Luckymis). In addition, Peace Corps Volunteers Jason Kramer and Julie Cooper accompanied the group on separate days.

OBJECTIVES

The objectives of this project were to: (1) conduct three reconnaissance trips to distinguish and characterize the vegetation types and plant associations occurring in the area; (2) determine which vascular plant species (Pteridophytes and Angiosperms or flowering plants) occur in the area; (3) document the flora by collecting herbarium specimens for positive identification and taking digital photographs; and (4) produce a written report and checklist of the vascular flora accompanied by a CD with digital images of many of the species. Most of these photos were taken in Yela; the remainder were taken elsewhere on Kosrae and a few from cultivated plants. All photos were taken by D. Lorence

METHODS AND TRANSECTS

The study area was accessed by a speedboat taken from Okat Harbor to the mouth of the Yela River in the mangrove zone. Exploration was done by using a walk-through method which covered all the plant communities and conducting visual surveys of the vegetation. A topographic map was used to determine the location of the transects. GPS readings could not be taken due to the dense forest canopy in most areas. The amount of time spent exploring the area was limited by weather and constraints imposed by boat access to the area. On day 1 (31 Jan. 2005) the southern (right hand) branch of the river was explored to c. 60 m. elevation. On day 2 (1 Feb. 2005) the main (left hand) branch of the river was explored to c. 80 m elevation. On day 3 (2 Feb. 2005) the N-NE-facing slope of the ridge flanking the southern mouth of the river was explored to c. 50 m. Visual plant identifications were made when the species were known. When identification was uncertain or species were not yet documented, herbarium specimens were collected for identification and deposition in the herbarium of the National Tropical Botanical Garden on Kauai, Hawaii (Herbarium PTBG). A complete checklist of the vascular plant species encountered during the survey is submitted as Appendix 1. Scientific names and authors, botanical family names, and Kosraean names where known, are listed in the checklist. Consequently authorities for the scientific names of species are not given in the text. A CD with digital images of many of the species is included as Appendix II of this report.

Botanical nomenclature is based largely on "A Geographical Checklist of the Micronesian Dicotyledonae" by Fosberg, Sachet, and Oliver, published in *Micronesica* 15 (1-2): 41—295. 1979). The monocots are from "A Geographic Checklist of the Micronesian Monocotyledonae" by Fosberg, Sachet, and Oliver, published in *Micronesica* 20 (1-2): 18—129 (1987). The pteridophytes are from "A Geographical Checklist of the Micronesian Pteridophyta and Gymnospermae" by Fosberg, Sachet, and Oliver, published in *Micronesica* 18 (1): 1982). Families used in the checklist follow the Angiosperm Phylogeny Website: <http://www.mobot.org/MOBOT/research/APweb/>

SITE DESCRIPTION

Kosrae (Figure 1) is the easternmost of the Caroline Islands and politically is a member of the Federated States of Micronesia (FSM). It is a high island of volcanic origin with its highest point at Mt. Finkol (2069 ft. elevation). Its oldest lavas have been dated at c. 2.6 MY old (Duncan & Clague 1985). The Yela River (Infal Yela) valley is located in the Tafunsak District of NW Kosrae, at approximately 5° 19' N latitude and 162° 57' W longitude. It drains to the SW from the island's central mountain range which runs roughly N—S. The steep flanking mountains drain into the valley, and numerous smaller streams converge to form the two main branches of Yela River, which runs through a flat, broad valley bottom flanked at the coast by two rocky ridges rising to c. 200 m.

In the valley bottom the soil is often saturated with fresh water seepage and supports mature swamp forest. The ground is covered in many areas by a dense mat of surface roots of the **Ka** (*Terminalia carolinensis*) and other species that rise for several cm above ground level. At relatively higher elevations, above 20-30 m, along the lower

flanks and toward the back of the valley the ground is better drained with no standing water.



Figure 1. Kosrae Island, showing survey area.

Above 40-50 m elevation the floristic composition changes somewhat with more palms, tree ferns, and **Elahk** (*Camptosperma brevipetiolata*) appearing. This vegetation is here termed lowland (non-swamp) wet forest. The rock outcrops and ridge flanking the southern side of the valley mouth above c. 20 elevation m support species characteristic of the lower montane wet forest. This drainage area is a critical watershed for northwestern Kosrae. Its intact forest cover prevents erosion and damage to the coral reefs, while the mangroves buffer the coast and provide protection for marine organisms that depend on such intact ecosystems for their survival.

VEGETATION TYPES (PLANT COMMUNITIES)

1. Mangrove forest (Insack) The mouth of the river and coastline is fringed by a mature mangrove forest zone 250—300 m wide inhabiting areas of brackish water. *Rhizophora apiculata* and *Rhizophora mucronata* predominate at the seaward margin and along the channel where the salinity is higher. Both species have prop roots. Inland of these the dominant species is *Bruguiera gymnorhiza*, characterized by its numerous

pneumatophore roots, which emerge from the mucky soil and water. Scattered large, emergent individuals of *Sonneratia alba* and occasional *Xylocarpus granatum* are

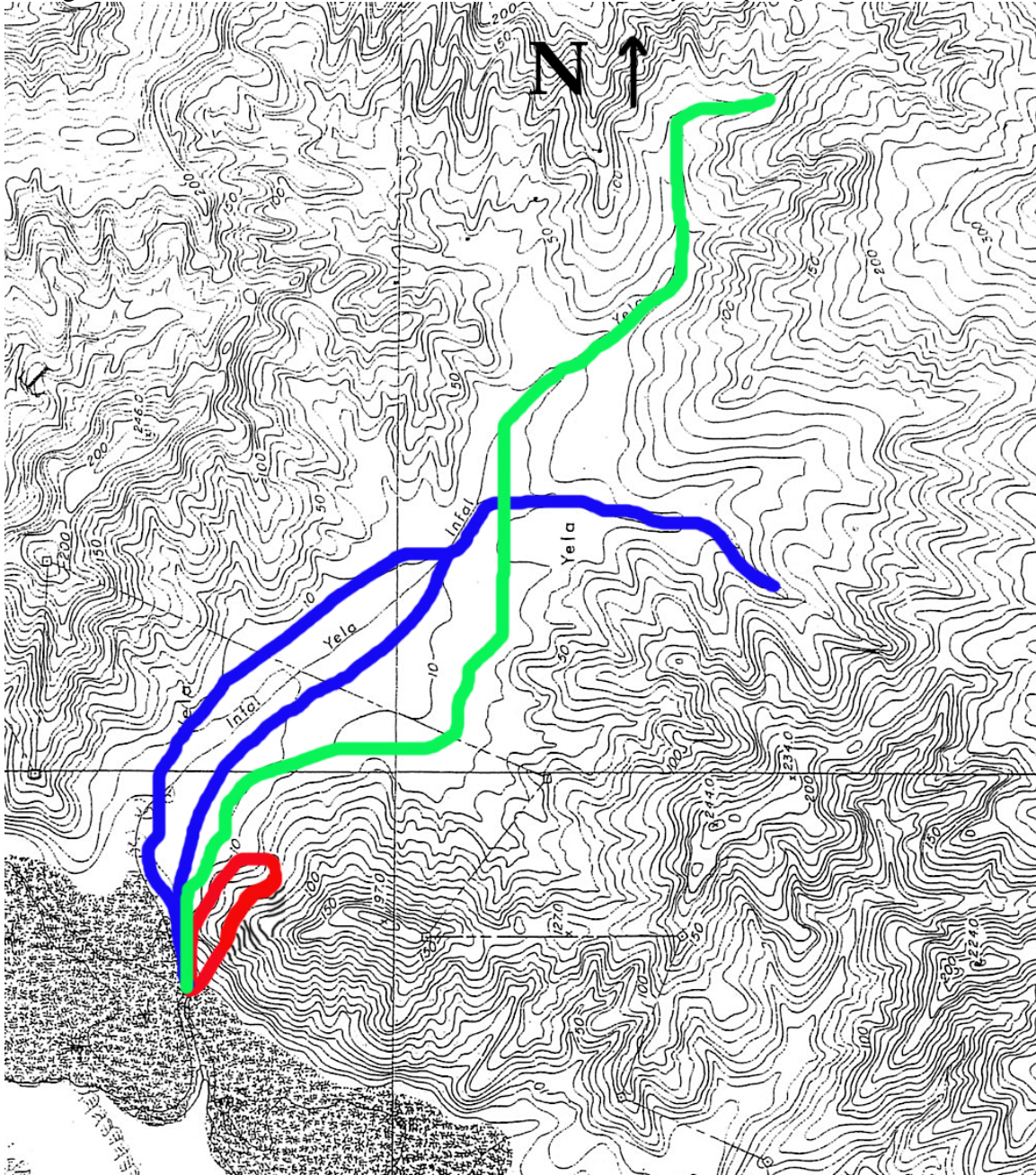


Figure 2. Topographic map of Yela River valley, showing transects taken during survey: blue, 31 Jan 2005; green, 1 Feb. 2005; red 2 Feb. 2005. Contours are in meters.

interspersed with the mangroves. Branches of the *Sonneratia* are festooned with epiphytic ferns (*Nephrolepis acutifolia*, *Microsorium scolopendria*, *Davallia solida*) and orchids, primarily *Dendrobium* spp. and *Phreatia micrantha*. Canopy lianas of both

Derris species are not uncommon. Patches of the sprawling or climbing shrub *Clerodendron inerme* var. *oceanicum* are occasional here. In some areas stands of *Hibiscus tiliaceus* occur along the river and among the mangroves.

2. Swamp forest. Inland of the mangrove zone, the relatively flat valley bottom (floodplain) is covered by a lowland swamp forest dominated by majestic stands of *Terminalia carolinensis* [**Ka**], a species endemic to Kosrae and Pohnpei, and *Horsfieldia nunu* [**Nunu**], endemic to Kosrae. According to local informants, the Ka forest was logged about 80 years ago during the Japanese occupation of Kosrae. The **Ka** and **Nunu** have re-grown to form a cathedral-like canopy of mature trees approximately 100 ft (30 m) tall. Subcanopy trees include juveniles of Ka and **Nunu**, abundant *Barringtonia racemosa*, *Neuburgia celebica*, and scattered *Dendrocnide latifolia*. Smaller trees and shrubs include *Polyscias subcapitata*, *Eugenia stelechanthoides*, *Ixora casei* and *Psychotria hombroniana* var. *hirtella*. Lianas and vines are frequent, including *Derris* spp., *Merremia peltata*, *Flagellaria indica*, and *Dioscorea bulbifera*. Areas of soil and gravel that are slightly raised along the river just above the mangrove zone support dense stands of the large sedge *Scirpodendron ghaeri*. Small colonies of the sedges *Kyllinga nemoralis* and *Cyperus* sp. occur in light gaps farther up the river along sand bars.

Dense stands of the fern *Thelypteris heterocarpa* 1-1.5 m tall comprise the dominant ground cover in many areas except in the densest shade, where other ferns notably *Bolbitis heteroclita* (with proliferous frond tips), *Nephrolepis saligna*, and *Tectaria grandifolia* are more common. The rhizomatous herbs *Curcuma australasica* and *Zingiber zerumbet* form dense stands in light gaps, but the plants become dormant for part of the year. Patches of the grasses *Centosteca lappacea* and *Oplismenus compositus* occur in openings. Several clumps of *Cyrtosperma chamissonis* were seen in swampy areas near the river, although these may be remnants from cultivation. The sprawling herbs *Aneilema vitiensis* and *Cyathula prostrata* occur in clearings.

Most of the trees support abundant epiphytes, notably the ferns *Antrophyum reticulatum* (with colonies often covering slender tree trunks) and the birds nest fern *Asplenium nidus*. At least two species of filmy ferns belonging to the genus *Trichomanes* form mats on tree trunks and rocks. Less common epiphytes include *Asplenium laserpitiifolium* and *A. pellucidum*, *Huperzia phlegmaria*, *Ophioglossum pendulum*, *Lindsaea repens* var. *lingulata*, *Psilotum complanatum*, and *Lepisorus accedens*. The herb *Procris peduncularis* is also frequent on trees.

The common hemiepiphytic fern *Asplenium scolopendropsis* has a juvenile form with finely divided leaves growing on mossy rocks, but the adult form climbs up trees and has undivided strap-like leaves. *Piper ponapensis* also has a terrestrial juvenile phase and an adult phase that scrambles up tree trunks. The hemiepiphyte *Freycinetia ponapensis* grows densely on many trees. The ferns *Davallia solida*, *Microsorium scolopendria*, and *Nephrolepis saligna* and several orchids are commonest on higher tree branches and in the canopy.

Canopy and subcanopy vines and lianas include *Derris elliptica* and *D. trifoliata*, *Merremia peltata*, *Dioscorea bulbifera*, and *Flagellaria indica*.

3. Lowland (non-swamp) wet forest.

The forest type changes to a non-swampy type above the zone of fresh water inundation of the soil, beginning roughly where the two river branches join (c. 15 m elev.) to c. 80 m elevation (the limit of our survey) and above. The vegetation is similar along the two river branches. The canopy here is dominated by *Horsfieldia nunu* and *Terminalia carolinensis*, with scattered individuals of *Neuburgia celebica*. The canopy tree *Camptosperma brevipetiolata* appears at c. 45 m and becomes more abundant with increasing elevation.

Mid stratum trees comprise mainly juveniles of canopy species, as well as the tree fern *Cyathea nigricans*, the palm *Ptychococcus ledermannianus*, and small trees or shrubs of *Eugenia stelechanthoides*. Less frequent species include *Ficus tinctoria* var. *neo-ebudicum*, *Hibiscus tiliaceus*, and *Morinda citrifolia*. One adult and scattered juveniles of the invasive introduced tree *Adenantha pavonina* were seen. Massive individuals of the fern *Angiopteris evecta* occur along stream banks.

The understory consists of the shrubs *Psychotria hombroniana* var. *hirtella*, *Ixora casei*, *Polyscias subcapitata*, *Antidesma kusaiense*, and *Astronidium kusaianum* (rare, seen twice). Several small trees of *Melochia villosissima* were seen in a clearing along the stream, as well as scattered individuals of the shrub *Boehmeria celebica*.

The ground flora primarily consists of the ferns *Thelypteris heterocarpa*, *Diplazium cyatheaefolium*, and *Nephrolepis saligna*, which form dense stands as well as patches of *Curcuma australasica*, *Microlepia speluncae*, *Tectaria grandifolia*, *Pteris quadriaurita*, and clumps of the sedge *Hypolytrum nemorum* ssp. *vitiense*.

Epiphytes include *Procris pedunculata*, various ferns also occurring in the swamp forest, and less commonly *Huperzia phlegmaria* and *Ophioglossum pendulum* (rare, on a fallen log). Several species of *Trichomanes* and *Selaginella* sp. are common, forming colonies on tree trunks and mossy rocks.

Hemiepiphytes on tree trunks are mainly *Piper ponapensis* and *Freycinetia ponapensis*, although *Epipremnum pinnatum* was seen climbing trees in one area along the stream. Higher level epiphytes are predominantly orchids (*Dendrobium* spp., *Phreatia micrantha*) and pteridophytes including the birds nest fern *Asplenium nidus* and *Nephrolepis acutifolia* with pendent fronds.

The ground cover consists of many of the same species as those in the swamp forest. Two clumps of an unidentified species of *Elatostemma* were seen in wet areas along the stream. This is a rather rare, possibly endemic species.

Canopy lianas and vines include *Derris elliptica* and *D. trifoliata*, *Merremia peltata*, *Flagellaria indica*, and *Dioscorea bulbifera*.

4. Lower montane wet forest.

This forest type occurs on the lower slopes of the mountains flanking the valley, above the fresh water inundation zone with well drained soil, extending up the rocky ridges from approximately 5 m elevation (the upper limit of our survey in this zone was 50 m).

No single canopy tree species is dominant here. The canopy consists of a mixture of *Horsfieldia nunu*, *Elaeocarpus carolinensis*, large *Ficus prolixa* var. *carolinensis* trees (to 30 m tall), and *Pouteria micronesica*. A single breadfruit (*Artocarpus altilis*) and a single *Inocarpus fagifer* (and a seedling) were seen on lower slopes, possibly representing remnants from cultivation; neither species appears invasive.

Mid-stratum trees include a great abundance of the stinging tree *Dendrocnide latifolia* from juveniles to 10 m tall, plus occasional *Ficus tinctoria*, *Eugenia stelechanthoides*, *Polyscias subcapitata*, *Antidesma kusaiense*, and scattered patches of *Hibiscus tiliaceus* which often forms dense thickets.

The understory consists of juvenile canopy trees and shrubs including saplings of a species of Sapotaceae (*Pouteria micronesica*), and *Psychotria hombroniana* var. *hirtella*. In the ground flora there is an abundance of ferns, primarily *Thelypteris heterocarpa* and *Nephrolepis saligna* in areas with less dense shade. In more densely shady areas the ferns *Tectaria grandifolia*, *Pteris quadriaurita*, *Bolbitis heteroclita*, and *Asplenium scolopendropsis* are the dominant ground cover. The trailing herb *Geophila repens* covers the ground in shady, well drained areas. The sprawling or scrambling shrubs *Embelia* sp. (sterile) and *Smythea lanceata* are uncommon in the understory. Vines and lianas include *Flagellaria indica*, *Derris trifoliata* and *D. elliptica*, *Merremia peltata*. *Piper ponapensis* is the commonest hemiepiphyte. Epiphytes include *Asplenium nidus*, *Antrophyum reticulatum*, *Trichomanes* spp. and *Selaginella* sp. on mossy rocks, and *Peperomia* sp. on *Ficus* roots and rocks.

SPECIES COMPOSITION.

Table 1. Numbers of species and infra-specific taxa recorded (percentages in parentheses)	
Cultivated	4 (4.0%)
Endemic	5 (5.2%)
Indigenous	77 (77.8%)
Naturalized	13 (13.2%)
TOTAL	99 (100%)

The Yela Valley ecosystem is highly intact and relatively free from naturalized invasive species. Ninety-nine vascular plants species were encountered during this survey. Only twelve (12.4%) of the total are non-native, and most of these are not serious invasives in the area. Several small, scattered clumps of *Costus speciosus* and one adult and several juveniles of *Adenantha pavonina* were seen. Two members of the Zingiberaceae family (*Curcuma australasica* and *Zingiber zerumbet*) form dense but localized populations in the lower valley bottom, but die back and become dormant in the cooler months and consequently are not considered as serious invasives.

A small plantation area along the river near the coast has a few cultivated plants including *Cocos nucifera* and *Musa x paradisiaca*. Several individuals (including rare juveniles) of *Inocarpus fagifer* and *Artocarpus altilis*, and several individuals of *Citrus aurantifolia* and *Annona muricata* were seen in the lower portion of valley. These are likely remnants from cultivation, or possibly sparingly naturalized.

The other non-native species encountered in this survey [*Cyperus* sp., *Kyllinga nemoralis*, *Dioscorea bulbifera*, *Oplismenus compositus* var. *compositus*, *Cyathula prostrata*] are either uncommon or have reached a state of balance within this ecosystem and are not considered invasive. For example, Basket grass, *Oplismenus compositus* var. *compositus*, is found mainly along the trail.

Two indigenous plants considered to be weeds in Kosrae occur in the area. The thorny scrambling shrub *Rubus moluccanus*, considered indigenous in Kosrae by Fosberg et al. (1979) was seen only once, in a light gap along the stream. *Merremia peltata*, also considered indigenous in Micronesia by Fosberg et al. (1979), occurs as a canopy liana and in light gaps, but does not seem to be invasive in mature forest with an intact canopy.

Endemic species

Five species endemic (or likely endemic) to Kosrae were recorded at Yela: *Antidesma kusaiensis*, *Astronidium kusaianum*, *Elatostema* sp., *Horsfieldia nunu*, and *Selaginella* cf. *kanehirae*. Although comprising only 5% of the total species, they are significant components of this ecosystem, especially *Horsfieldia*. A more extensive survey of the Yela region will undoubtedly yield additional endemic taxa.

It is important to note that a significant number of taxa endemic to Kosrae and Pohnpei also occur in the area, including *Elaeocarpus carolinensis*, *Maesa carolinensis* var. *carolinensis*, *Psychotria hombroniana* var. *hirtella*, *Ptychococcus ledermannianus*, *Terminalia carolinensis* to name several. Although not rare, these are important keystone species in this diverse ecosystem.

CONCLUSIONS AND RECOMMENDATIONS

The flat bottom of the Yela River valley can very generally be divided into two areas: (1) those of the salt water-inundated mangrove swamps; (2) and those of the adjoining fresh water lowland swamp forest whose water level rises and falls with the tides. Typical mangrove species (both *Rhizophora* species, *Sonneratia alba*, and *Bruguiera gymnorhiza*) give way to a multi-tiered forest dominated by the towering **Ka** and **Nunu** trees. The sub-canopy is populated by smaller *Barringtonia*, *Horsfieldia*, *Elaeocarpus*, *Neuburgia* and *Dendrocnide*.

Due to logistical constraints, two rather large components of the valley were not accessed to a significant degree. First, the epiphytic flora of the canopy is no doubt much richer than can be assessed from the floor of the valley. We were limited to visual observations and occasional fallen plants. It is almost certain that the orchid flora in particular is much more diverse than the two (epiphytic) species we found. It is also probable that additional fern species would be present in the upper canopy.

The second under-explored area is the very back of the valley, the upper valley walls, and ridge tops. These are steep, well-drained areas with rock outcrops and higher light levels covered by lower montane wet forest. Species composition is shared to a degree with the forests of the valley floor, but no single species dominates the canopy. Rather, a mixed canopy of *Ficus*, *Terminalia*, *Neuburgia*, *Horsfieldia*, *Eugenia* and *Dendrocnide* develops over the wet but well drained slopes. Seedlings and saplings of *Pouteria micronesica* were seen in one locality here, suggesting mature trees are present in the canopy. It is likely that other species not seen in the valley floor occur in these

topographically steep areas, given the greater variability of habitats on the slopes. Further survey work is desirable to more adequately assess these two habitats.

Yet despite the constraints of time and tide, a representative picture of the flora and vegetation of the Yela River valley was captured. What is abundantly clear is that the Yela valley is home to an extraordinary ecosystem. Recovering from what was surely a major disturbance during the years of the Japanese occupation, the valley supports an almost pristine forest type now exceedingly rare in Micronesia. The limited survey found ample evidence of a healthy, thriving forest with little disturbance, abundant seed production, numerous seedlings of all age groups, and very few invasive alien weeds whose impact is minimal. Clearly, this would change dramatically if a road were built through the Yela valley, as it would open this pristine area to logging, clearing for plantations, and subsequent invasion by alien weeds.

The stately **Ka** swamp forest community occurs only on Kosrae and Pohnpei. Without a doubt, the Yela River valley harbors the best preserved forest of this type on either of these two islands. The mangrove forest, non-swamp wet forest, and lower montane wet forest are also extremely well-preserved at Yela. The adjacent mangrove swamp buffers the coastline and provides a nursery for juvenile marine life. Together these plant communities comprise a truly unique ecosystem, one which serves as a valuable watershed, protects the reef from silting, and serves as a reservoir for biodiversity on the island. This biologically diverse, nearly pristine natural area is a unique part of the heritage of Kosrae and should be preserved for future generations.

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APPENDIX I.

**CHECKLIST OF THE PLANTS OF YELA RIVER VALLEY,
KOSRAE, F. S. M.**

by

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INTRODUCTION

This checklist of the vascular plants of the Yela River valley, Kosrae, FSM was compiled during a field survey of the vegetation conducted for the Institute of Pacific Islands Forestry, U. S. D. A. Forest Service. David Lorence and Tim Flynn made conducted a survey during three site visits made on 31 January and 1-2 February 2005. Herbarium specimens were collected by David Lorence (**DL**) and Tim Flynn (**TF**) for identification and deposited in the Herbarium PTBG at the National Tropical Botanical Garden, Kalaheo, Hawaii. Kosraean names, where known, are given in **boldface** type. Most of these were taken from Merlin, Taulung & Juvik (1993). Species status is indicated by the following abbreviations: C = cultivated; E = Endemic; I = Indigenous; N = Naturalized.

Botanical nomenclature for dicots is based largely on "A Geographical Checklist of the Micronesian Dicotyledonae" by Fosberg, Sachet, and Oliver, published in *Micronesica* 15 (1-2): 41—295. 1979). Monocots are based on "A Geographic Checklist of the Micronesian Monocotyledonae" by Fosberg, Sachet, and Oliver, published in.20 (1-2): 18—129 (1987). Pteridophytes are based on "A Geographical Checklist of the Micronesian Pteridophyta and Gymnospermae" by Fosberg, Sachet, and Oliver, also published in *Micronesica* 18 (1): 23—82. (1982). Families used in the checklist follow the Angiosperm Phylogeny Website: <http://www.mobot.org/MOBOT/research/APweb/>

This survey recorded the presence of 99 species and infra-specific taxa in the following categories.

Numbers of species and infra-specific taxa recorded (percentages in parentheses)	
Cultivated	4 (4.0)
Endemic	5 (5.2)
Indigenous	77 (77.8)
Naturalized	13 (13.2)
TOTAL	99 (100)

PTERIDOPHYTES

(**Fa** is the Kosraean name for many ferns)

ASPLENIACEAE

Asplenium laserpitiifolium Lam. [Common epiphyte with pendant, tri-pinnate fronds] I

Asplenium nidus L. **Mihlihklihk** DL 9408 [Common epiphytic nesting fern, often providing niche for other ferns, i.e. *A. laserpitiifolium*, *A. pellucidum*, and *Vittaria elongata*] I

Asplenium pellucidum Lam. var. *pellucidum* DL 9421 [Common epiphyte with pinnate, more or less pendant fronds with a short creeping rhizome, often growing from nest of *A. nidus*.] I

Asplenium scolopendropsis F. Muell. DL 9424 [One of the most common ferns throughout the forest, epiphytic on almost all buttressing roots and mossy rocks (juvenile, pinnate form) as well as climbing many of the trees by means of long-creeping rhizomes (adult, entire, lanceolate-leaved form)] I

CYATHEACEAE

Cyathea nigricans Mett. **Po.** TF 7206 [Scattered tree ferns of up to 15 ft., stipe and lower rachis with thick layer of tan indument, old fronds not held as a skirt] I

DAVALLIACEAE

Davallia solida (G. Forst.) Sw. **Fa** DL 9425 [Common, epiphytic fern with long creeping rhizome] I

DENNSTAEDTIACEAE

Lindsaea repens (Bory) Thwaites var. *lingulata* Kramer TF 7207 [Scattered fern, epiphytic or terrestrial, usually climbing tree trunks with long-creeping rhizome] I

Microlepia speluncae (L.) T. Moore DL 9423 [Occasional ground fern in light gaps; from short-creeping rhizome, to 3.5 ft high] I

DRYOPTERIDACEAE

Bolbitis heteroclita (Presl) in C. Ch. DL 9417 [Probably the most common ground fern of shaded, wetter areas of swamp, reproducing both sexually and by means of vegetative buds on tips of terminal pinnae that root as frond touches ground] I

Diplazium cyatheaefolium (Rich.) Presl TF 7205 [Occasional ground fern from short-creeping rhizome] I

Nephrolepis acutifolia (Desv.) Christ [Very common terrestrial or sometimes epiphytic fern] I

Nephrolepis saligna Carr. **Fa** [Common epiphyte with pendant fronds] I

Tectaria grandifolia (Presl) Copel. TF 7196 [Very common ground fern] I

HYMENOPHYLLACEAE

Trichomanes humile G. Forst. [*Crepidomanes humilis* (G. Forst.) Bosch, DL 9401 I

Trichomanes grande Copel. DL 9401, 9416 I

Trichomanes sp. [Leaves clustered on erect rhizome, pinnae unlobed] I

LYCOPODIACEAE

Huperzia phlegmaria (L.) Rothm. [syn. *Lycopodium phlegmaria* L.; *Phlegmariurus phlegmaria* (L.) Sen & Sen] **Lum** TF7208, DL 9399 [Occasional pendant epiphyte growing out of mossy mats] I

MARATTIACEAE

Angiopteris evecta (G. Forst.) Hoffm. **Kalme** TF 7195 [Scattered but common large ground fern on erect rhizome, rhizome usually appearing stemless though occasionally 2-3 ft tall, fronds to 8-9 ft. long; cut fronds with strong spicy or cinnamon odor] I

OPHIOGLOSSACEAE

Ophioglossum pendulum L. DL 9415 [Occasional epiphyte, fronds pendant] I

POLYPODIACEAE

Lepisorus accedens (Bl.) Hosok. [syn. *Polypodium accedens* Bl.] [Small, epiphytic fern with long-creeping rhizome, fronds with a rounded base, narrowing above with a rounded apex] I

Microsorium scolopendria (Burm. f.) Copel. **Fa** [syn. *Phymatodes scolopendria* (Burm. f.) Pich. Serm.; *Phymatosorus scolopendria* (Burm. f.) Pic. Serm.] DL 9414 [Common epiphyte with long-creeping rhizome, doesn't seem to be terrestrial] I

PSILOTACEAE

Psilotum complanatum Sw. **Mahsrihsrihk** [Epiphytic, occasional] I

PTERIDACEAE

Pteris quadriaurita Retz. TF 7210 [Common, scattered ground fern often growing amidst *Thelypteris heterocarpa*, each of the lowest pinnae with ca. 4 "arms" on lower side] I

SELAGINELLACEAE

Selaginella cf. *kanehirae* Alston TF 7199, 7199A, DL 9404 [Epiphytic herb on rocks and boulders], E?

THELYPTERIDACEAE

Thelypteris heterocarpa (Bl.) Morton [syn. *Sphaerostephanos heterocarpus* (Bl.) Holtt.] TF 7197 [Probably the most common ground fern in more open, higher light areas of swamp forest] I

VITTARIACEAE

Antrophyum reticulatum (G. Forst.) Kaulf. TF 7193, DL 9405 [Very common clump-forming, epiphytic fern, fronds appearing drooping; on most trees of any size] I
Vittaria incurvata Cav. [epiphytic fern with clusters of thin, pendant fronds] I

ANGIOSPERMS: MONOCOTS

ARACEAE

Cyrtosperma chamissonis (Schott) Merr. **Pahsruhk** [Occasional to forming large stands, naturalized possibly semi-cultivated] N

Epipremnum pinnatum (L.) Engler DL 9413 [Single vine seen, with thick stem climbing to 10-15 m in tree in upper valley around 70 m, juvenile leaves entire, appressed, adult leaves pinnatifid] I

ARECACEAE

Cocos nucifera L. **Koacnu** [Coconut palm, a few plants cultivated at river mouth] C

Nypa fruticans Wurmb. **Fahsuc** [Mangrove palm, localized with mangroves] I

Ptychococcus ledermannianus (Beccari) Zona [syn. *Ptychosperma ledermannianum* (Becc.) Moore & Fosb., *Ponapea kusaiensis* Burret] **Pu** DL 9412 [Solitary palm to 12 m. scattered throughout the mid valley, abundant at higher elevations; seedlings not uncommon] I

COMMELINACEAE

Aneilema vitiensis Seem. (syn. *Rhopalephoravitiensis* (Seem.) Faden, see Flora Vitiensis Nova, vol 1, p. 279) TF 7198 [Sprawling herb with ascending branches with long, erect inflorescence, 10-60 cm; petals white to pale blue.] I

COSTACEAE

Costus speciosus Sm. (syn. *C. sericeus* Bl.) [Scattered, erect herb, not common] N

CYPERACEAE

Cyperus sp. TF 7200 [Herb growing on sand bar in light gap along river; uncommon; with DL 9406] N?

Hypolytrum nemorum (Vahl) Spreng. ssp. *vitiense* (C.B.Cl.) Koyama DL 9407 [Scattered clump-forming herb with erect inflorescences] I

Kyllinga nemoralis (J. R. Forst. & G. Forst.) Dandy ex Hutchinson & Dalziel (*Cyperus kyllinga* Endl.) DL 9406 [Herb growing on sand bar in light gap along river; uncommon; with TF 7200] N

Scirpodendron ghaeri (Gaertn.) Merr. **Srohoh** [Large sedge 3-4 m tall, along the fresh water rivers and marshes] I

DIOSCOREACEAE

Dioscorea bulbifera L. **Ellal** [Common high-climbing vine throughout valley, aerial tubers numerous about the ground] N

FLAGELLARIACEAE

Flagellaria indica L. **Tok** DL 9403 [Occasional, scattered liana with leaf tip tendrils] I

MUSACEAE

Musa x paradisiaca L. **Usr** [Banana, planted near stream mouth in clearing] C

ORCHIDACEAE

Dendrobium sp. **Mah** [Most common orchid, epiphytic with long pendant stems, often falling from canopy] I

?*Phajus amboinensis* Bl. TF7203 [Uncommon, a single plant seen along main stream, near 70 m, under ground layer canopy of *Thelypteris*] I

Phreatia micrantha (A. Rich.) Schlechter **Mah** DL 9400 [Two plants collected that had fallen from canopy] I

PANDANACEAE

Freycinetia ponapensis Mart. **Mweng orahk, Mweng srihsrihk** [Common high-climbing liana, juvenile plants crawling over ground] I

?*Pandanus tectorius* Park. ex Z. **Mweng** [One sterile clump seen in ridge forest; probably this species] I

POACEAE

Centosteca lappacea (L.) Desv. (*Centotheca* in flora of Guam) [Broad, fairly large leaf blade, with large diffuse inflorescence.] I

Oplismenus compositus (L.) Beauv. var *compositus* [Common along lower portions of trail along western side of valley] N

ZINGIBERACEAE

Curcuma australasica Hook. f. [Scattered individuals or large colonies, very common, becomes dormant] N

Zingiber zerumbet (L.) Sm. [Scattered herb throughout valley, becoming dormant] N

**ANGIOSPERMS:
DICOTS**

AMARANTHACEAE

Cyathula prostrata (L.) Bl. [Herb with long, terminal inflorescences, common along lower trail on south-western side of valley] N

ANACARDIACEAE

Camptosperma brevipetiolata Volk. **Elahk** [Scattered large mid to upper canopy tree in middle to upper portions of valley] I

ANNONACEAE

Annona muricata L. TF 7215B [Cultivated or possibly naturalized? A single sterile sapling seen along trail] C

ARALIACEAE

Polyscias subcapitata Kaneh. TF 7214 [Sparse shrub common throughout the valley] I

ASTERACEAE

Melanthera biflora (L.) Willd. [syn. *Wollastonia biflora* (L.) DC.] **Agaia** [Large, sprawling herb seen along main stream in light gaps] I

COMBRETACEAE

Terminalia carolinensis Kaneh. **Ka** [Dominant canopy tree in lower freshwater swamp, few seedlings seen although ground littered with fruit] I

CONVOLVULACEAE

Merremia peltata (L.) Merrill **Puhlah** [Common vine, scattered to forming dense stands, fallen flowers yellow] I

ELAEOCARPACEAE

Elaeocarpus carolinensis Koidz. **Nahnek** [Mid-to upper canopy tree, fruiting now, numerous fallen fruit seen, blue] I

FABACEAE

Adenanthera pavonina L. **Mwetkwem** [only a single adult and a few seedlings seen] N
Derris elliptica (Roxb.) Benth. **Op** DL 9418 [Vine, leaflets 5-7 (rarely 9), 10 cm long or more, pale glaucous beneath, midrib puberulent above.] I

Derris trifoliata Lour. **Ohsrah** [Probably one of the two most common vines in the valley; leaflets 3-5 (rarely 7), usually less than 10 cm long; flowers white or faintly pink.] I

Inocarpus fagifer (Park.) Fosb. **Kihrak** [Occasional large trees and a few scattered seedlings seen] N

LAMIACEAE

Clerodendron inerme (L.) Gaertn. var. *oceanicum* A. Gray **Kwacwak** [Scrambling or vining shrub along channel in mangrove forest; with terminal white flowers] I

Vitex negundo L. var. *bicolor* (Willd.) Lam [Small shrub along channel in mangrove forest] I

LECYTHIDACEAE

Barringtonia racemosa (L.) Spreng. **Kwenguhl** [Probably the most common seedling in the swamp forest and one of the more common mid-canopy species] I

LOGANICAEAE

Neuburgia celebica (Koord.) Leenhouts **Tohoh** DL 9409 [Common mid level canopy tree, ground littered with orange fruit] I

LYTHRACEAE

Sonneratia alba J. E. Sm. **Fuliohfohl** [Common large tree of the mangrove forest] I

MALVACEAE

Heritiera littoralis Dry. **Lum** [Occasional in lower swamp forest] I

Hibiscus tiliaceus L. **Lo** [Scattered sprawling trees forming thickets in light gaps] I
Melochia villosissima (Presl) Merr. [occasional small tree w discolourous cordate, dentate leaves, long pubescent stems; found in light gaps] I

MELASTOMATACEAE

Astronidium kusaianum Hosok. **For fino** TF 7204, 7207A [Occasional shrub or small tree to 18 ft. Sterile.] E

MELIACEAE

Xylocarpus granatum Koenig **Tuhi** [Scattered large tree in mangrove swamp with beautiful, sinuous buttressing roots] I

MORACEAE

Artocarpus altilis (Parkinson) Fosb. **Mos** [Occasional, only two small saplings noted] N
Ficus tinctoria G. Forst. var. *neo-ebudicum* (Summerh.) Fosb. **Shrah** TF 7215 [shrub or small tree with large, asymmetrical leaves, scattered, especially on the lower valley walls] I
Ficus prolixa G. Forst. var. *carolinensis* (Warb.) Fosb. **Kohnyah** [Huge banyan-like canopy tree with aerial roots.] I

MYRISTICACEAE

Horsfieldia nunu Kaneh. **Nunu** [Second most common canopy tree. Nunu along with *Barringtonia racemosa* are the most common seedling trees in the swamp forest] E

MYSINACEAE

Embelia sp. DL 9419 [Shrub of 1 m with decumbent stems, sterile] I
Maesa carolinensis Mez var. *carolinensis* [Understory shrub] I

MYRTACEAE

Eugenia [*Syzygium*] *stelechanthoides* Kaneh. **Nes** DL 9420 [Relatively common SHRUB OR small tree, large leaves with cordate leaf bases, cauliflorous flowers white, fruits red or pink; scattered or forming small groves.] E

PHYLLANTHACEAE

Antidesma kusaiense Kaneh. [Lianescent shrub or sm. tree 8 m.] E

PIPERACEAE

Peperomia sp. **Pwepuh** TF 7213 [More or less succulent herb epiphytic on large roots or rock faces in moist shade of valley walls] I
Piper ponapense C. DC. **Kai-fuhl** [Along with *Derris trifoliata*, one of the most common vines in the forest; hemiepiphytic] I

RHAMNACEAE

Smythea lanceata (Tul.) Summerh. TF 7215C [Liana or sprawling shrub; only sterile plants seen; leaves alternate] I

RHIZOPHORACEAE

Bruguiera gymnorhiza (L.) Lam. **Sroal** [Common component of the coastal mangrove forest. Producing the dominant seed crop this time of year.] I

Rhizophora apiculata Bl. **Suhkasrihk** [Cymes always 2 flowered, shorter than petiole.] I

Rhizophora mucronata Lam. **Kahrahk** [Cymes several flowered (always more than 2), longer than petiole.] I

ROSACEAE

Rubus moluccanus L. **Kohkihl** [occasional] I

RUBIACEAE

Geophila repens (L.) I.M. Johnston var *asiatica* (Cham. & Schlectend.) Fosberg DL 9422 [Common to abundant but scattered creeping herb, fl. white, fruit red.] I

Ixora casei Hance **Kalsruh** DL 9411 [Common sprawling shrub to small tree, often forming small groves] I

Morinda citrifolia L. **I** [Scattered small tree in understory] I

Psychotria hombroniana (Baillon) Fosb. var. *hirtella* (Val.) Fosb. DL 9410 [Small shrubs of up to 6 ft, locally common in some areas] I

RUTACEAE

Citrus aurantifolia (Christm.) Swingle **Laim** [A few lime trees seen in lower portion of valley, possibly formerly cultivated] C

SAPINDACEAE

Allophylus ternatus (Forst.) Radlk. TF 7204A [Sterile, sprawling shrubs of ca. 8 ft. seen along main river around the 70 m mark] I

SAPOTACEAE

Pouteria micronesica (Kaneh.) Fosb. TF 7215A [Sterile saplings or small treelets seen on western side of valley, no adults found] I

URTICACEAE

Boehmeria celebica Bl. TF 7212 [occasional shrub of up to 8 ft.] I

Dendrocnide latifolia (Gaud.) **Elat** TF 7211 [Probably the most common shrub to mid-canopy tree in the valley. Bears tiny stinging hairs, especially on inflorescence.] I

Elatostema sp. TF 7209 [Rare succulent herb in rocky soil near upper part of valley, in shade. Not identified to species; indigenous or possibly endemic.] I?

Pipturus argenteus (G. Forst.) Wedd. var. *argenteus* [Occasional shrub] I

Procris pendunculata (Forst.) Wedd. [Relatively common epiphytic herb; lvs anisophyllous, axillary pedunculate inflor.] I