

## PRELIMINARY STUDY ON THE PALM FLORA OF THE LORE LINDU NATIONAL PARK, CENTRAL SULAWESI, INDONESIA

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### ABSTRACT

The population size, structure, and composition of the palm flora in a 1350 m by 20 m rectangular plot in Gunung Potong and a 1500 m by 20 m rectangular plot in Tongoa were measured. The total palm species from both plots numbered 33 represented by 8 genera. Eight species, namely *Calamus omatus* var. *celebicus*, *Pinanga caesia*, *Arenga pinnata*, *Daemonorops* sp.3, *Calamus didymocarpus*, *Calamus* sp.4 (rapid spines), *Caryota mitis*, and *Areca vestiaria* have relatively high frequency values ranging from 5.46% to 10.66%. In addition, palm specimens previously collected from the park were examined at Herbarium Bogoriense to set up a preliminary checklist. So far, the national park is recorded as having 48 palm species represented by 11 genera which give figures of about 68% species and 58% genera of the total native Sulawesi palm flora. Though the number of endemic palms in Sulawesi is high (72%), namely 51 out of total native 71 species, only two species are locally endemic to Central Sulawesi namely *Gronophyllum sarasinorum* and *Pinanga* sp. nov. 1 (longirachilla). So far only the latter species is endemic to the national park.

**Key words:** palm diversity/Lore Lindu National Park/Sulawesi/Indonesia/endemic species

### INTRODUCTION

With emphasis on the sustainable use of biological diversity and its conservation, the Indonesian-German Research Program had initiated a comprehensive interdisciplinary research funded by the German Research Council (DFG) for a duration of 15 years beginning in 2000. The Program will be evaluated every three years. The research partners are two universities from Germany namely, Göttingen and Kassel, and two from Indonesia, Bogor Agricultural University (IPB, Bogor) and University of Tadulako (UNTAD, Palu). The overall goal is to identify factors which cause changes in forest margin areas. Therefore, the Program is known as "Stability of Rainforest Margins" abbreviated as STORMA. In addition to the research program, a development of related sciences, manpower and laboratory equipment are also provided. The field of research consists of social and economic dynamics, water and nutrient turnover, biological diversity, and land use systems. The location used for the research is in and around the Lore Lindu National Park, Central Sulawesi, Indonesia (Fig. 1).

Within this framework, an exploration of knowledge on palm diversity in and around the Lore Lindu National Park is being conducted. The present paper reports a preliminary study, based mainly on the field observations made during the two weeklong field trips to the national park in November 2000 and March 2001, as well as examination of earlier herbarium collections at Herbarium Bogoriense.

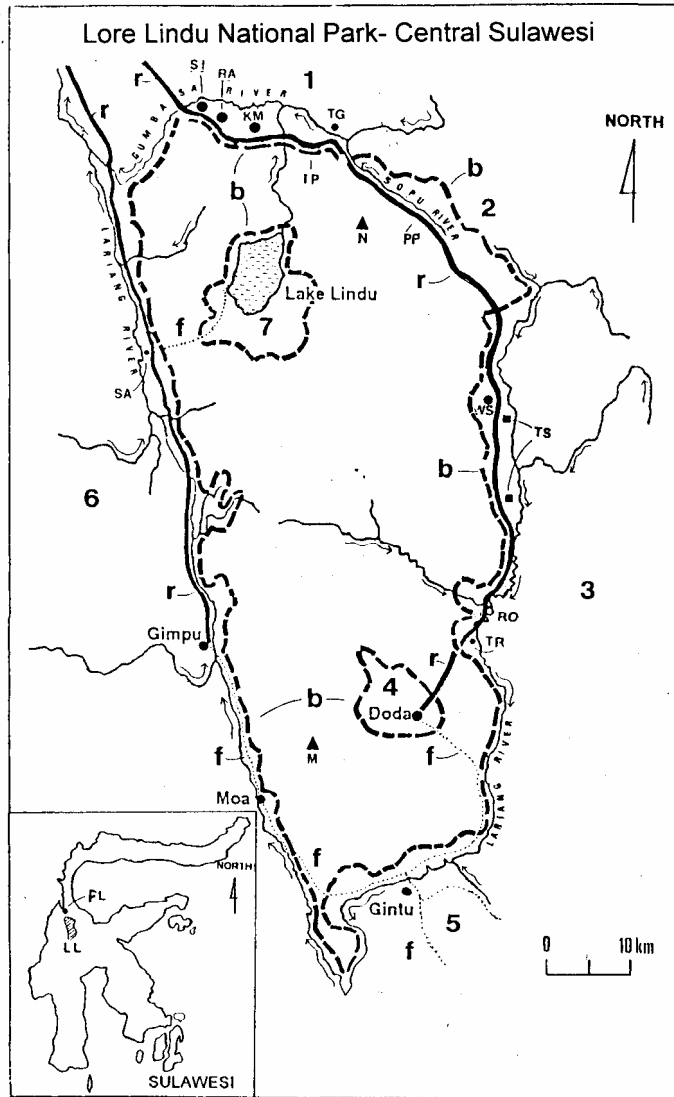


Figure 1. Valley study sites map in and around the Lore Lindu National Park, Central Sulawesi

1. Palolo, 2. Sopa, 3. Napu, 4. Besoa, 5. Bada, 6. Kulawi, and 7. Lindu. Mountains and others: N: Gunung Nokilalaki, M: Gunung Malemo, b: boundary of the national park, f: foot path, r: road. Location: KM: Kamarora, LL: Lore Lindu National Park, PL: Palu, PP: Gunung Potong plot, RA : Rahmat, RO : Rompo, SA : Sadaunta, SI : Sintuwu, TO : Tongoa, TP : Tongoa plot, TR: Torire, TS: Transmigration sites, WS: Wuasa.

The Lore Lindu National Park covers 217 000 ha of lowland and montane rainforest. Approximately 70% of the Park lies between elevations of 1000 to 1500 m, and less than 10% is below 1000 m. The highest place located south of Tongoa is the summit of Gunung (Mount) Nokilalaki at elevation 2355 m, the other summit is located south of the Park namely Gunung Malemo at 2263 m (Mogea & Suhardjono 1981). Three big rivers drain the Park, namely Lariang, Gumbasa, and Sopo. The headwaters of Lariang drain at the eastern part of the Park, then flow to the south and round to the west then to the north of the Park. Near Gimpu, the river divides into two branches, one to the west ending in the west coast in South Sulawesi, the other branch to the north of the Park joins the Gumbasa river and ends at the coast near Palu. The upper Gumbasa river is the outlet of Lake Lindu. It flows to the north around Kamarora and Sintuwu then unified with Lariang. The lake is located at west of Gunung Nokilalaki. At the eastern north of the Park flows Sopo river, its lower reaches join at the Gumbasa river. Two enclaves in the Park are excluded from the national park, namely Lindu and Besoa valleys. Five other valleys are located around the Park, namely Palolo, Sopo, Napu, Bada, and Kulawi. There are two moderate roads available for large and public vehicles. The west is a route from Palu to Gimpu through Kulawi valley outside the Park. The east road is a route from Palu to Doda. The road segments near Tongoa to Wuasa, and Torire to Doda are through the eastern part of the Park. The road from Wuasa to Rompo in November 2000 was badly damaged, therefore it can only be transversed by a four-wheel drive vehicle (Fig. 1).

Further basic information of the Park is presented in the Indonesian Program Information Sheet of the Nature Conservancy (TNC 2000).

## MATERIALS AND METHODS

The sites selected for the study were at Tongoa, Gunung Potong, Rompo, Moa, Gimpu, and Sadaunta (Fig. 1). A national park topographical map, 12XL Garmin GPS, and altimeter were used to locate the site and to measure the elevation. Palm diversity was analyzed in each site using a modified Mueller-Dombois & Ellenberg (1974) rectangular plot transect. The transects were established from the lowest elevation on each site to the highest evaluation preferably following an existing foot path. For these two trips, palm diversity was studied in two sites. The first site was in a new cruising transect of Gunung Potong from 850 m to 1250 m altitude, on the plot of 1350 x 20 m; and the second site was in Tongoa on a foot path to the summit of Gunung Nokilalaki, at an average altitude of 750 m, on the plot of 1500 x 20 m. Each plot consisted of many rectangular subplots of 50 x 20 m for observation of either solitary or clustered young and mature palms. For the sapling's study, each subplot consisted of one sapling square plot of 5 x 5 m and one seedling square plot of 1 x 1 m for observation of seedling coverage. Through this study, species density, frequency, cover dominance, important value, structure, composition, and palm

population dynamics can be calculated. During the field observation, voucher specimens were made. Herbarium specimens, ripe fruits, and living seedlings were collected when necessary, particularly for proper identification and *ex. situ* conservation. Herbarium duplicates are deposited in Herbarium Celebense (CEB) at the University of Tadulako in Palu, Herbarium Bogoriense (BO), Netherlands National Herbarium Leiden Branch (L), and Herbarium of the Royal Botanic Gardens Kew (K). Palm collecting followed standard methods; for rattans a method introduced by Dransfield (1974) was followed. Palm classification is in accordance with the Genera Palmarum which was introduced by Uhl & Dransfield (1987). Temporary herbarium specimen preservation followed a modified Schweinfurth Technique (Steenis 1950). Identification was done in the field as well as at BO and CEB. To facilitate remembering unfamiliar or unidentified taxon in the field, a temporary nickname based on its significant morphological character was applied, hence in this paper a name like *Calamus* sp.8 (tuberosus) or *Calamus* sp.2 (ligule) is used. In addition, sketch drawings and digital photographs were made. Field observations were supported by examination of 61 herbarium specimens at BO. New taxa will be described and published in separate papers.

## RESULTS AND DISCUSSIONS

During identification of palms from the study sites, it was found that 15 taxa of *Calamus* and 4 taxa of *Daemonorops* (Table 2) need further identification particularly due to either incomplete herbarium specimens or lack of specimen types at BO, or a need for taxonomic revision. Hence, naming these palms required three ways. The first is the taxon's name based on its morphological similarity to a related species, hence the epithet "aff." is used, such as *Calamus* aff. *C. zollingeri*. The second is an expression of its significant character, such as when the taxon typically has long ligule, then the taxon is called *Calamus* sp.2 (ligule). Another example is where there is no spine on its knee (Fig. 7-9), the taxon is called *Calamus* sp. 1 (knee no spine). The third is when the epithet required long sentence to define the taxon, then it is called for example *Daemonorops* sp.3 (Table 2).

Some taxa are definitely new species, but their description is not published yet, hence the name is informal, such as *Calamus* sp. nov.1 (ahlidurii). The latter case is found as well as in *Caryota*, *Gronophyllum*, *Gulubia*, and *Pinanga* (Tables 2 and 3).

The number of species from both the Gunung Potong and Tongoa plots is 33 which belong to 8 genera (Table 1). *Calamus* is represented by 20 species, among them are the well-known commercial rattans namely 'batang' (*C. zollingeri*), 'lambang' (*C. ornatus* var. *celebicus*), 'tohiti' (*C. inops*), and 'ombol' (*C. symphy-sipus*); *Daemonorops* represented by five species, among them is an edible young sweetest cabbage 'uwe manis' (*D. macropterus*); *Pigafetta* represented by *P. elata*, an ornamental tree palm known as 'wanga' (Fig. 6). This palm, for about three decades, was misidentified as *P. filaris* (Dransfield 1998).

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Table 1. Absolute (FA) and relative frequency (FR) of palms from 27 subplots in Gunung Potong (P) and 30 subplots in Tongoa (T). Subplot size is rectangular 50 m by 20 m

	P	T	FA	FR (%)
<i>Calamus ornatus</i> var. <i>celebicus</i>	17	24	41	10.66
<i>Pinanga caesia</i>	27	13	40	10.40
<i>Arenga pinnata</i>	08	25	33	08.58
<i>Daemonorops</i> sp.3	10	22	32	08.32
<i>Calamus</i> sp.1 (knee no spine)	14	15	29	07.54
<i>Calamus</i> sp.4 (rapid spines)	10	19	29	07.54
<i>Caryota mitis</i>	07	21	28	07.28
<i>Areca vestiaria</i>	01	20	21	05.46
<i>Calamus</i> sp.2 (ligule)	10	01	11	02.86
<i>Calamus zollingeri</i>	06	05	11	02.86
<i>Calamus</i> sp.8 (tuberosus)	06	02	08	02.08
<i>Caryota rumphiana</i>	05	01	06	01.56
<i>Daemonorops</i> sp.1	04	02	06	01.56
<i>Calamus</i> aff. <i>C. paspalanthus</i>	09	--	09	02.34
<i>Calamus</i> <i>ahlidurii</i>	04	--	04	01.04
<i>Calamus</i> sp.3 (longispinus)	03	--	03	00.78
<i>Calamus</i> sp.5 (regular)	03	--	03	00.78
<i>Calamus</i> sp.6 (soft white spine)	03	--	03	00.78
<i>Calamus</i> sp.7 (tattered ligule)	03	--	03	00.78
<i>Calamus inops</i>	03	--	03	00.78
<i>Calamus</i> aff. <i>C. ciliaris</i>	02	--	02	00.52
<i>Daemonorops macropterus</i>	02	--	02	00.52
<i>Pigafetta elata</i>	02	--	02	00.52
<i>Calamus</i> aff. <i>C. reinwardtii</i>	--	18	18	04.68
<i>Arenga undulatifolia</i>	--	14	14	03.64
<i>Daem. sp.1 (didymophylla)</i>	--	12	12	03.12
<i>Korthalsia celebica</i>	--	10	10	02.60
<i>Calamus symphysipus</i>	--	03	03	00.78
<i>Calamus</i> aff. <i>C. zollingeri</i>	--	02	02	00.52
<i>Calamus</i> aff. <i>C. inops</i>	--	01	01	00.26
<i>Calamus</i> aff. <i>C. javensis</i>	--	01	01	00.26
<i>Calamus</i> aff. <i>C. ornatus</i>	--	01	01	00.26
<i>Daemonorops</i> sp.4	--	01	01	00.26
Total number of subplot frequency			392	101.92

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Table 2. Checklist of palms in the Lore Lindu National Park

NO.	SPECIES NAME	NO. GENUS	NO.	SPECIES NAME	NO. GENUS
01.	<i>Areca catechu</i>	1	25.	<i>Calamus</i> sp.3 (longispinus)	
02.	<i>Areca vestiaria</i>		26.	<i>Calamus</i> sp.4 (rapid spines)	
03.	<i>Arenga pinnata</i>	2	27.	<i>Calamus</i> sp.5 (regular)	
04.	<i>Arenga undulatifolia</i>		28.	<i>Calamus</i> sp.6 (soft white spine)	
05.	<i>Calamus didymocarpus</i>	3	29.	<i>Calamus</i> sp.7 (tattered ligule)	
06.	<i>Calamus leicaulis</i>		30.	<i>Calamus</i> sp.8 (tuberosus)	
07.	<i>Calamus leptostachys</i>		31.	<i>Caryota mitis</i>	4
08.	<i>Calamus macrosphaerion</i>		32.	<i>Caryota rumphiana</i>	
09.	<i>Calamus minahassae</i>		33.	<i>Caryota</i> sp. nov.1 (angustifolia)	
10.	<i>Calamus inops</i>		34.	<i>Cocos nucifera</i>	5
11.	<i>Calamus ornatus</i> var. <i>celebicus</i>		35.	<i>Daemonorops macropterus</i>	6
12.	<i>Calamus othrostachyus</i>		36.	<i>Daemonorops robusta</i>	
13.	<i>Calamus symphysipus</i>		37.	<i>Daemonorops</i> sp.1 (didymophylla)	
14.	<i>Calamus zollingeri</i>		38.	<i>Daemonorops</i> sp.2	
15.	<i>Calamus</i> sp. nov.1 (ahli durii)		39.	<i>Daemonorops</i> sp.3	
16.	<i>Calamus</i> aff. <i>C. ciliaris</i>		40.	<i>Daemonorops</i> sp.4	
17.	<i>Calamus</i> aff. <i>C. inops</i>		41.	<i>Korthalsia celebica</i>	7
18.	<i>Calamus</i> aff. <i>C. javensis</i>		42.	<i>Licuala celebica</i>	8
19.	<i>Calamus</i> aff. <i>C. ornatus</i>		43.	<i>Livistona rotundifolia</i>	9
20.	<i>Calamus</i> aff. <i>C. paspalanthus</i>		44.	<i>Pigafetta elata</i>	10
21.	<i>Calamus</i> aff. <i>C. reinwardtii</i>		45.	<i>Pinanga caesia</i>	11
22.	<i>Calamus</i> aff. <i>C. zollingeri</i>		46.	<i>Pinanga</i> sp. nov.1 (longirachilla)	
23.	<i>Calamus</i> sp.1 (knee no spine)		47.	<i>Pinanga</i> sp. nov.2 (rubiginosa)	
24.	<i>Calamus</i> sp.2 (ligule)		48.	<i>Pinanga</i> sp. nov.3 (tenuirachis)	

Table 3. Checklist of native Sulawesi palms, local name, and geographical distribution 2000

No.	BOTANICAL NAME	NG	LOCAL NAME	GEOGRAPHICAL	DISTRIBUTION
01.	<i>Cocos nucifera</i> L.	01	kelapa	Tropical Asia	Group 1
02.	<i>Livistona rotundifolia</i> (Lam.) Mart.	02	woka	Tropical Asia	
03.	<i>Nypa fruticans</i> Wurm	03	nipah	Tropical Asia	
04.	<i>Oncosperma horridum</i> Scheff.	04	nibung	Tropical Asia	
05.	<i>Pholidocarpus maiadum</i> Becc.	05	matayangan	Tropical Asia	
06.	<i>Borassus flabellifer</i> L.	06	lontar	Tropical Asia	
07.	<i>Areca catechu</i> L.	07	pinang sirih	Malesia	Group 2
08.	<i>Arenga pinnata</i> (Wurm) Merr.	08	aren, saguer	Malesia	
09.	<i>Caryota mitis</i> Lour.	09	---	Malesia	
10.	<i>Corypha utan</i> Lam.	10	gebang	Malesia	
11.	<i>Licuala spinosa</i> Wurm	11	---	Malesia	

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Table 3. Continued

No.	BOTANICAL NAME	NG	LOCAL NAME	GEOGRAPHICAL	DISTRIBUTION
12.	<i>Arenga undulatifolia</i> Becc.	08	---	Borneo, N, C, S, S, E. Sulawesi, Philippines	Group 3
13.	<i>Eugeissona utilis</i> Becc.	12	---	Borneo, S. Sulawesi	Group 4
14.	<i>Areca oxycarpa</i> Miq.	07	---	N. Sulawesi	Group 5
15.	<i>Calamus pseudomollis</i> Becc.	13	---	N. Sulawesi	
16.	<i>Caryota</i> sp. nov. 2 (pumiila)	09	---	N. Sulawesi	
17.	<i>Daemonorops riedeliana</i> (Miq.) Becc.	14	---	N. Sulawesi	
18.	<i>Pinanga</i> sp. nov.4 (biloba)	15	---	N. Sulawesi	
19.	<i>Pinanga inequalis</i> Blume	15	---	N. Sulawesi	
20.	<i>Pinanga minor</i> Blume	15	---	N. Sulawesi	
21.	<i>Calamus</i> sp. nov.1 (ahlidurii)	13	---	N, C. Sulawesi	Group 6
22.	<i>Caryota</i> sp. nov. 1 (angustifolia)	09	pola	N, C. Sulawesi	
23.	<i>Daemonorops macropterus</i> (Miq.) Becc	14	uwe manis	N, C. Sulawesi	
24.	<i>Gronophyllum sarasinorum</i> Burr.	16	---	C. Sulawesi	Group 7
25.	<i>Pinanga</i> sp. nov.1 (longirachilla)	15	---	C. Sulawesi	
26.	<i>Calamus paucijugus</i> Becc. ex Heyne	13	---	N, S. Sulawesi	Group 8
27.	<i>Pinanga</i> sp. nov.4 (longipes)	15	---	N, S. Sulawesi	
28.	<i>Calamus leiocaulis</i> Barlett	13	ronti	C, S. Sulawesi	Group 9
29.	<i>Calamus orthostachyus</i> Furt.	13	---	C, S. Sulawesi	
30.	<i>Calamus scleiacanthus</i> Becc. ex Heyne	13	---	C, S. Sulawesi	
31.	<i>Calamus tolitoliensis</i> Becc. ex Heyne	13	---	C, S. Sulawesi	
32.	<i>Daemonorops lamprolepis</i> Becc.	14	---	C, S. Sulawesi	
33.	<i>Calamus amphybolus</i> Becc. ex Heyne	13	---	S. Sulawesi	
34.	<i>Calamus bonienseis</i> Becc. ex Heyne	13	---	S. Sulawesi	
35.	<i>Calamus pachystachys</i> Warb. Ex Becc.	13	---	S. Sulawesi	
36.	<i>Calamus pedicellatus</i> Becc. ex Heyne	13	samole	S. Sulawesi	
37.	<i>Pinanga</i> sp. nov.5 (soroakoensis)	15	---	S. Sulawesi	
38.	<i>Gronophyllum microspadix</i> Burr.	16	opisi	S. Sulawesi	
39.	<i>Gronophyllum kjellbergii</i> Burr.	16	---	S, SE. Sulawesi	Group 11
40.	<i>Gulubia</i> sp. nov. 1 (longistamina)	17	---	S, SE. Sulawesi	
41.	<i>Calamus kandarienseis</i> Becc.	13	---	SE. Sulawesi	Group 12
42.	<i>Gronophyllum</i> sp. nov.1 (macrospadix )	16	---	SE. Sulawesi	
43.	<i>Gronophyllum selebicum</i> (Becc.) Becc.	16	---	SE. Sulawesi	
44.	<i>Calamus didymocarpus</i> Warb. ex Becc.	13	---	N, C, S. Sulawesi	Group 13
45.	<i>Calamus leptostachys</i> Becc. ex Heyne	13	togisi	N, C, S. Sulawesi	
46.	<i>C. macrospheiron</i> Becc.	13	---	N, C, S. Sulawesi	
47.	<i>Calamus symphysipus</i> Mart.	13	ombol	N, C, S. Sulawesi	
48.	<i>Pinanga</i> sp. nov.2 (rubiginosa)	15	---	N, C, S. Sulawesi	

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Table 3. Continued

No.	BOTANICAL NAME	NG	LOCAL NAME	GEOGRAPHICAL	DISTRIBUTION
49.	<b>Calamus ornatus</b> var. <b>celebicus</b> Becc.	13	lambang	N, C, S, SE. Sulawesi	Group 14
50.	<b>Daemonorops robusta</b> Warb. ex Becc.	14	noko	N, C, S, SE. Sulawesi	
51.	<b>Pigafetta elata</b> (Mart.) H. Wendl.	18	wanga	N, C, S, SE. Sulawesi	
52.	<b>Licuala celebica</b> Miq.	11	---	N, C, S, SE. Sulawesi	
53.	<b>Calamus koordersianus</b> Becc.	13	---	N, S, SE. Sulawesi	Group 15
54.	<b>Pinanga</b> sp. nov.3 ( <b>tenuirachis</b> )	13	---	N, C, SE. Sulawesi	Group 16
55.	<b>Calamus kjellbergii</b> Furt.	13	---	Sulawesi 1)	Group 17
56.	<b>Calamus scleracanthus</b> Becc. ex Heyne	13	---	Sulawesi 1)	
57.	<b>Daemonorops schlechterii</b> Burr.	14	---	Sulawesi 1)	
58.	<b>Licuala bisula</b> (Mart.) Miq.	11	---	Sulawesi 1)	
59.	<b>Licuala flabellata</b> Mart.	11	---	Sulawesi 1)	
60.	<b>Pinanga furfuracea</b> Blume	15	---	Unknown locality in Sulawesi	Group 18
61.	<b>Pinanga</b> sp. nov. 5 ( <b>aurantiaca</b> )	15	---	Unknown locality in Sulawesi	
62.	<b>Pinanga</b> sp. nov. 6 ( <b>dentata</b> )	15	---	Unknown locality in Sulawesi	
63.	<b>Pinanga</b> sp. nov. 7 ( <b>mogea</b> )	15	---	Unknown locality in Sulawesi	
64.	<b>Areca vestiaria</b> Giseke	07	pinang yaki	N, C, S, SE. Sulawesi, Moluccas	Group 19
65.	<b>Pinanga caesia</b> Blume	15	---	N, C, S, SE. Sulawesi, Moluccas	
66.	<b>Calamus inops</b> Becc. ex Heyne	13	tohiti	N, C, S, SE. Sulawesi, Moluccas	
67.	<b>Calamus zollingeri</b> Becc.	13	batang	N, C, S, SE. Sulawesi, Moluccas	
68.	<b>Korthalsia celebica</b> Becc.	19	---	N, C, S, SE. Sulawesi, Moluccas	
69.	<b>Calamus minahassae</b> Warb. Ex Becc.	13	dato	N, C, S. Sulawesi, Moluccas	Group 20
70.	<b>Daemonorops sarasinorum</b> Warb. ex Becc.	13	---	N, C. Sulawesi, Moluccas	Group 21
71.	<b>Pinanga macrorachis</b> (Burr.) Mogea (not published yet)	15	---	N, S. Sulawesi, Moluccas	Group 22

Source: Mogea, 2000

Names in bold are the palms found in the LLNP, 1) = specimens not available in BO, G = Genus number



While the number of species in Gunung Potong and Tongoa is the same (23 in 7 genera), the species composition and population sizes are different (Table 1). *Pigafetta* is only found in Gunung Potong and *Korthalsia* only in Tongoa. Thirteen species were found in both Gunung Potong and Tongoa, among them 8 species have high absolute and relative frequency values (Table 1), meaning that those species occur in most of the 57 subplots (namely 27 subplots in Gunung Potong and 30 subplots in Tongoa). *Calamus ornatus* var. *celebicus* occurred in 41 subplots (10.66%), *Pinanga caesia* in 40 subplots (10.40%, Fig. 3 - 5), *Arenga pinnata* in 33 subplots (8.58%), *Daemonorops* sp.3 in 32 subplots (8.32%), *Calamus didymocar-pus* in 29 subplots (7.54%), *Calamus* sp.4 (rapid spines) in 29 subplots (7.54%), *Caryota mitis* in 28 subplots (7.28%), and *Areca vestiaria* in 21 subplots (5.46%). Of the 10 species found only in Gunung Potong, *Calamus* aff. *C. paspalanthus* is the most significant occurring in 9 subplots (2.34%). Likewise 10 species were only found in Tongoa, 4 species had much higher absolute and relative frequency values namely *Calamus* aff. *C. reinwardtii* occurred in 18 subplots (4.68%), *Arenga undu-latifolia* in 14 subplots (3.64%), *Daemonorops* sp.1 (didymophylla) in 12 subplots (3.12%), and *Korthalsia celebica* in 10 subplots (2.60%). These figures on palm diversity may change as a result of further identification and further study as more plots are established.

Outside the Gunung Potong and Tongoa plots, other species of palms were found such as *Calamus macrosphaerion* var. *macrosphaerion* and *C. orthostachyus* in Gunung Malemo and Moa (Kramadibrata & Dransfield 1992); 'ronti' (*Calamus leiocaulis*) and 'togisi' (*C. leptostachys*) in Moa (Siebert 1997).

A study on the role of rattan resources in the Moa and Au in the southern part of the Park has been done by Siebert (1997). It revealed that 'togisi' (*Calamus leptostachys*), 'ronti' (*C. leiocaulis*), 'lambang' (*C. ornatus* var. *celebicus*), 'batang' (*C. zollingeri*), and 'noko' (*Daemonorops robusta*) are the important rattans which produced a quite good rural cash income.

Other palms outside the two above mentioned plots are *Caryota* sp. nov.1 (angustifolia) in Gunung Malemo (Zumaidar 2001), this species is solitary as *C. rumphiana* (Fig. 2); *Licuala celebica* and *Livistona rotundifolia* were common and widespread throughout the Park (personal observation); *Pinanga* sp. nov.1 (longirachilla), *Pinanga* sp. nov.2 (rubiginosa), and *Pinanga* sp. nov.3 (tenuirachis) were found in and around Gimpu (Sinaga 2000). The rachillae of *P. caesia* and *Pinanga* sp. nov.2 (rubiginosa) are set up in many planes, the leaf sheath is dull green to bluish deep green in *P. caesia* (Fig. 2 - 4), while it is reddish orange in *Pinanga* sp. nov.2 (rubiginosa). The rachillae of *Pinanga* sp. nov.1 (longirachilla) and *Pinanga* sp. nov.3 (tenuirachis) are set up in one plane, the leaf sheath is yellowish green in *Pinanga* sp. nov.1 (longirachilla) and it is yellow in *Pinanga* sp. nov.3 (tenuirachis).

*Pinanga celebica* was not listed in the current Sulawesi palms (Table 3) due to uncertainty of its existence. The story of this taxon started in 1871, when Scheffer described *Pinanga patula* var. *celebica* based on the specimen of Riedel s.n. The label was annotated with the plant coming from Gorontalo - North Celebes, but in



2. Solitary *Caryota rumphiana*, stem 6 m long
3. Solitary *Pinanga caesia*, stem 7 m long, 12 cm in diameter
4. Solitary *Pinanga caesia* (living collection of *Mogea* 7467), stem 10m long, 16 cm in diameter
5. Top portion of *Pinanga caesia* (living collection of *Mogea* 7467) shows top portion of the stem, inflorescences, and leaf sheath 80 cm long,



6. At the center are three tree palms of *Pigafetta data*, the tallest is about 25 m
7. *Calamus* sp.1 (knee no spine; living collection of *Mogea* 7466), leaf rachis 140 cm long, cirrus 100 cm long, white triangle indicates the rachillae bearing reddish brown fruit
8. Top portion of infructescence of *Calamus* sp. 1 (knee no spine, *Mogea* 7466) bearing one ellipsoid reddish brown almost ripe fruit of 15 mm long and 7 mm in diameter
9. Base portion of infructescence of *Calamus* sp. 1 (knee no spine, *Mogea* 7466) bearing many very young fruits, leaf sheath 15 mm in diameter

1876 he changed its status to *Pinanga celebica*. He wrote that the plant clusters, had whitish leaves, a long inflorescence rachis with numerous rachillae, and obovoid fruits. This character diagnosis, however, is inadequate for identification to the species level as they are too general. Moreover the clustered habit is not found in any of the East Malesian *Pinanga* (Sinaga 2000).

Betel nut palm or 'pinang sirih' *Areca catechu* and coconut palm or 'kelapa' *Cocos nucifera* is often planted in a village garden, the former usually used for a living fence to mark boundaries. Sugar palm or 'aren' or 'saguer' *Arenga pinnata* is often grown in gardens around the Park, and are often found on the forest border or in disturbed primary lowland and montane forest. Hence, including these last mentioned palms, the number of species or taxa so far known to occur in and around the park is 48 represented by 11 genera (Table 2) namely *Areca* 2 species, *Arenga* 2 species, *Calamus* 26 species, *Caryota* 3 species, *Cocos* 1 species, *Daemonorops* 5 species, *Korthalsia* 1 species, *Licuala* 1 species, *Livistona* 1 species, *Pigafetta* 1 species, and *Pinanga* 4 species. Including here are some other of unidentified genera (Table 2 and Appendix 1). As shown in Appendix 1, many of the herbarium specimens are sterile, though it is still important to figure out the diversity but to describe or to identify up to the genus level is often inadequate. *Calamus* are often difficult to separate from *Daemonorops* when they are all still in the vegetative stage. On the other hand, the morphology of seedling, sapling, juvenile, and mature in the palm species is often distinct. Therefore, adequate observation in the field, fertile and correct collection for the herbarium specimens is very necessary. If this field study is successfully done, it is believed that there might be some new taxa particularly of *Calamus* and *Daemonorops*, but also of *Pinanga*, *Licuala* and *Caryota*.

Most Calami in and around the Park are clustering rattans but few of them are solitary such as in *Calamus inops*, *C. leptostachys*, and *C. symphysipus*. Stem diameter varies from 6-40 mm, with the leaf sheath diameter varying from 8 - 45 mm. The smallest cane is *C. leiocaulis* and the largest is *C. zollingeri*. Petioles are mostly green, but are reddish brown in *Calamus* sp.14 (*Mogea* 7465, Fig. 13). The leaf sheath and the petiole are covered by scarcely small spines such as in *C. ornatus* var. *celebicus*; but *Calamus* sp.4 (rapid spines; *Mogea* 7461) are covered by slender, rapid, greenish, large spines (Fig. 10); in *C. macrosphaerion* var. *macrosphaerion*, by rapid, flat, triangular, blackish brown spines (Fig. 12); and in *Calamus* sp.14 (*Mogea* 7465) by scarcely brown, flat, triangular comblike spines (Fig. 13). The specimens of *Mogea* 746.5 might be *Calamus* sp. nov.1 (*ahlidurii*) or *Daemonorops macropterus*. When already matured, the identity of the specimen will be much easier to determine as the difference between *Calamus* and *Daemonorops* can only be seen after the flowering stage, namely the peduncular bract in *Calamus* is tubular and attached to the rachis of the inflorescence while it is leafy-like and deciduous in *Daemonorops*. *Calamus* sp.2 (ligule; *Mogea* 7456) has the only conspicuous ocrea or ligule (Fig. 11). *Calamus* in Sulawesi are mostly cerriate, hence from this point the vegetative characters of *Calamus* are not different from *Daemonorops*. However, sometimes the species identity can be found based on the number of the leaflets on either side of the rachis, mostly *Daemonorops* has regular (rarely in groups) and very narrow leaflets compared to *Calamus*. The number of leaflets in *Daemonorops* is mostly on the average between 40 to 80 leaflets, while in a small diameter cane of

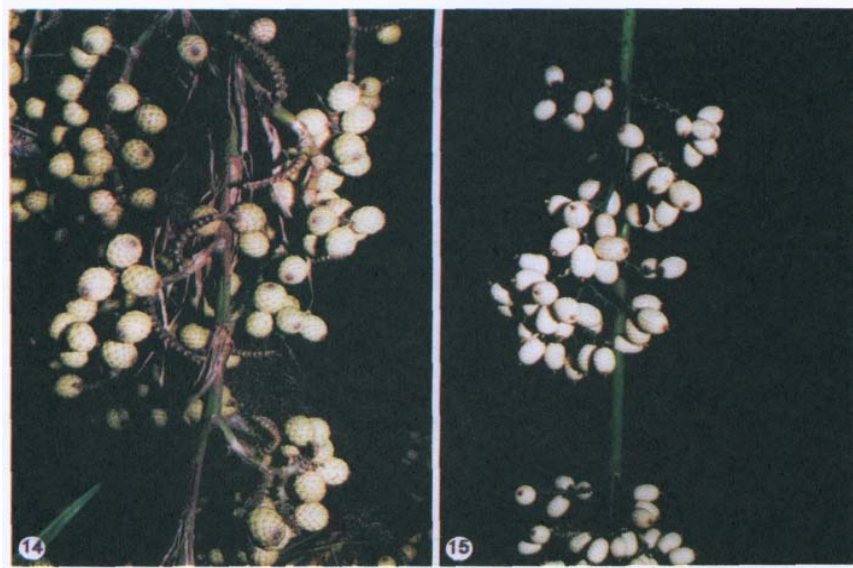
*Calamus*, the leaflets are very much less in number, usually 6 to 16 such as in *Calamus minahassae* which has only 12 leaflets set up in 6 groups, each group consisting of one or two leaflets. When ripe, the fruit colour is pale greenish-white such as in *Calamus macrosphaerion* (Fig. 14) or glossy white (Fig. 15) as in *Calamus* sp. 1 (knee no spine) or black as in *Calamus zollingeri*.

Native palms in Sulawesi are represented by 71 species in 19 genera (Table 3) based on observations from about 20 sites all over Sulawesi (Moge 2000) updated by recent current examination of the specimens and recent field work. Pending further identification, the number of genera and palm species in and around the Park represents about 58% and 68% of genera and species of Sulawesi's palm flora, respectively.

*Metroxylon sagu* was probably planted long ago for their edible carbohydrate and is considered here as an introduced species. Its original distribution is in Moluccas and New Guinea. Sagu baruk (*Arenga microcarpa*) has apparently been cultivated in District Sangir Talaud for 80 years already. Its original distribution is the same as for the sago palm. Sihombing *et al.* (1980) incorrectly identified it as *A. obtusifolia*. The sagu baruk covers about 19 890 ha or about 30% of the total agricultural area in the district (Sihombing *et al.* 1980). 'Salak Pangu', *Salacca zalacca* var. *amboinense*, was cultivated for some decades in Pangu Village, District Minahasa, North Sulawesi. The salak pangu now is popular as an edible fresh fruit in North Sulawesi. It was said that the cultivation started in 1961. Now salak pangu plantations cover about 654 ha with about 2 million individual plants (Dannie 1999). Other introduced palms are mostly indoor or outdoor ornamental plants. So far known, the number of the introduced palms in Sulawesi is 20 (Table 4), including the palm for plantation namely 'sawit' or oil palm *Elaeis guineensis*. Based on their origin, the introduced palms consist of 12 groups. These introduced palms were found in Palu and on the way to the Park.



10. Base portion of young *Calamus* sp.4(rapid spines, living collection of *Mogea* 7461) shows 50 cm long petioles and leaf sheaths covered by rapid slender long greenish white spines
11. Top portion of young 1.5 m tall *Calamus* sp.2 (ligule, living collection of *Mogea* 7456) shows top of leaf sheaths bearing conspicuous young entire and old tattered ocrea
12. Middle portion of *Calamus macrosphaerion* var *macrosphaerion* (living collection of *Mogea* 7470) shows leaf sheaths of 4 cm in diameter and petioles covered by rapid flat triangular blackish brown spines
13. Base portion of young *Calamus* sp. (living collection of *Mogea* 7465) shows reddish brown petioles covered by scarcely black flat triangular combed-like spines



14. Nearly top portion of infructescence of *Calamus macrosphaerion* (living collection of Moge 7470) bearing pale greenish white almost ripe ellipsoid fruits of 10 mm in diameter  
 15. Middle portion of infructescence of *Calamus* sp. 1 (knee no spine, living collection of Moge 7487) bearing white ellipsoid ripe fruits 8 mm in diameter

Table 4. Checklist of introduced palms in Sulawesi and their origin

NO.	BOTANICAL NAME	LOCAL NAME	ORIGIN	GROUP
01.	<i>Elaeis guineensis</i> Steud.	sawit	Tropical Africa	1
02.	<i>Phoenix reclinata</i> Jacq.	korma hias	Tropical Africa	
03.	<i>Chrysalidocarpus lutescens</i> H. Wendl.	palem kuning	Madagascar	2
04.	<i>Neodypsis decaryi</i> Jumelle	palem segitiga	Madagascar	
05.	<i>Hyophorbe lagenicaulis</i> (L.H. Bailey) H.E. Moore	palem botol	Madagascar	
06.	<i>Rhapis excelsa</i> Henry ex Rehder	waregu	South Asia	3
07.	<i>Cyrtostachys renda</i> Blume	pinang merah	West Malesia	4
08.	<i>Salacca zalacca</i> (Gaertn.) Voss var. <i>zalacca</i>	salak	West Malesia	
09.	<i>S. zalacca</i> var. <i>amboinensis</i> Becc.	salak pangu	West Malesia	

Table 4. Continued

NO.	BOTANICAL NAME	LOCAL NAME	ORIGIN	GROUP
10.	<i>Arenga microcarpa</i> Becc.	sagu baruk	Moluccas, N. Guinea	5
11.	<i>Metroxylon sagu</i> Rottb.	sagu	Moluccas, N. Guinea	
12.	<i>Actinorhysis calapparia</i> (Blume) H. Wendl. 1)	jambe sinagar	New Guinea	6
13.	<i>Ptychosperma macarthurii</i> H. Wendl.	palem papua	New Guinea	7
14.	<i>Veithcia merrillii</i> (Becc.) H.E. Moore	palem putri	Philippines Isl.	8
15.	<i>Archontophoenix alexandrae</i> H. Wendl. & Drude	palem aleksander	Queensland, Australia	9
16.	<i>Wodyetia bifurcata</i> A. Irvine	palem ekor bajing	Queensland, Australia	
17.	<i>Licuala grandis</i> H. Wendl.	palem kol	New Britain	10
18.	<i>Pritchardia pacifica</i> Seem. & H. Wendl.	palem pasifik	Fiji Isl.	11
19.	<i>Roystonea regia</i> O.F. Cook	palem raja	Tropical America	12
20.	<i>Thrinax radiata</i> Lodd ex Deef.	palem bintang	Tropical America	

1) *Actinorhysis calapparia* (Blume) H. Wendl. & Drude ex Scheti.

It is listed that native palms of Sulawesi consist of 71 species and can be divided into 22 groups based on local and regional plant geographical distribution, namely Tropical Asia, Malesia, Borneo; North, Central, South, and Southeast Sulawesi; unknown locality in Sulawesi, and Moluccas (Table 3). The number of palm species endemic to Sulawesi is moderately high (70.83%) namely 51 out of total native 71 species. However, only two species namely, *Gronophyllum sarasi-norum* and *Pinanga* sp. nov.1 (longirachilla), are endemic to Central Sulawesi (Table 3, Group 7). The latter species is so far known only from Gimpu (Fig. 1) the south portion of the Park (Table 3 and Appendix 1).

## CONCLUSION

This preliminary study on palms in and around the Lore Lindu National Park, including observations on 1350 m by 20 m rectangular plot sites in Gunung Potong, a 1500 m by 20 m rectangular plot in Tongoa, herbarium specimens collected from Gunung Nokilalaki, Sopa Valley, Moa, and Gunung Malemo revealed that there are 48 species belonging to 11 genera. *Calamus* and *Daemonorops* are very dominant as shrubs and climbers. The largest genus in the Park-is *Calamus* with 25 species, followed by *Daemonorops* (6 species) and *Pinanga* (4 species). However, more



fertile collections of these genera are still required. It is therefore expected that some undescribed and locally endemic palms may still be found as *Calamus*, *Daemonorops*, *Licuala*, *Caryota* and *Pinanga*.

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### Appendix 1. Specimens examined:

Note: Plant name: Locality, elevation, phenological state (st: sterile, ffl: female flower, mfl: male flower, fl: hermaphrodite flower, fr: fruit), date, collection number, deposited Herbarium, with the exclamation point means that the author has seen the specimens)

*Areca vestiaria*: Tongoa, foot path to the summit of Mt. Nokilalaki, alt. 750 in, fr.02-03-01, *Mogea* 7473 (BO!, CEB!)

*Arenga undulatifolia*: Tongoa, foot path to the summit of Mt. Nokilalaki, alt. 750 in, st.02-03-01, *Mogea* 7474 (BO!, CEB!)

*Calamus didymocarpus*: Mt. Nokilalaki, Toro, fr.23-04-75, *Meijer* 9465 (BO!).

*Calamus inops*: Kulawi, Moa, Mt. Malemo, mfl.24-10-77, *Mogea* 1474 (BO!); *ditto.*, *Mogea* 1475 (BO!); *ditto.*, *Mogea* 1476 (BO!); *ditto.*, *Mogea* 1477 (BO!, K). Tongoa, foot path to the summit of Mt. Nokilalaki, alt. 750 m, ffl.05-03-01, *Mogea* 7490 (BO!, CEB!).

*Calamus macrosphaerion* var. *macrosphaerion*: Kulawi, Mt. Malemo, fr.20-10-77, *Mogea* 1347 (BO!).

*Calamus minahassae*: Sopu Valley, fr.05-05-79, *de Vogel* 5212 (BO!, L).

*Calamus omatus* var. *celebicus*: Sopu Valley, fr.26-04-79, *de Vogel* 5054 (BO!, L); *ditto.*, 02-05-79, *de Vogel* 5172 (BO!); Kulawi, Moa, fr.22-10-77, *Mogea* 1411 (BO!).

*Calamus orthostachyus*: Kulawi, Moa, Mt. Malemo, fr.18-10-77, *Mogea* 1329 (BO!, K, L), *ditto.*, *Mogea* 1330, mfl. (BO!).

*Calamus symphysipus*: Tongoa, foot path to the summit of Mt. Nokilalaki, alt. 750 m, st.02-03-01, *Mogea* 7472 (BO!, CEB!).

Undeterminate *Calamus* from Tongoa, foot path to the summit of Mt. Nokilalaki, alt. 750 m: *Calamus* aff. *C. omatus*, st.03-03-01, *Mogea* 7478 (BO!, CEB!), *ditto.*, mfl.03-03-01, *Mogea* 7479 (BO!, CEB!). *Calamus* aff. *C. reinwardtii*: path to the st.02-03-01, *Mogea* 7476 (BO!, CEB!); *Calamus* sp.4 (rapid spines), st.18-11-00, *Mogea* 7442 (BO!, CEB!) = *Mogea* 7461 (see at Gunung Potong alt. 950 m); *Calamus* sp.7 (tattered ligule), st.03-03-01, *Mogea* 7477 (BO!, CEB!); *Calamus* sp.8 (tuberosus), fr.03-03-01, *Mogea* 7486 (BO!, CEB!); *Calamus* sp.9 mfl.05-03-01, *Mogea* 7488 (BO!, CEB!).

Undeterminate *Calamus* from Gunung Potong, alt. 850 m: *Calamus* sp.8 (tuberosus), st.26-02-01, *Mogea* 7455 (BO!, CEB!). *Calamus* sp.2 (ligule), st.27-02-01, *Mogea* 7456 (BO!, CEB!). *Calamus* sp.6 (soft white spine), mfl.01-03-01, *Mogea* 7471 (BO!, CEB!).

Undeterminate *Calamus* from Gunung Potong, alt. 950 m: *Calamus* sp.4 (rapid spines), st.27-02-01, *Mogea* 7461 (BO!, CEB!) = *Mogea* 7442 (see at Tongoa); *ditto.*, alt. 1200 m, mfl.01-03-01, *Mogea* 7468 (BO!, CEB!).

Undeterminate *Calamus* from Mt. Roroka, Timbu: *Calamus* sp.10, st.20-05-79, *de Vogel* 5482 (BO!); *ditto.*, fr. 13-05-79, *de Vogel* 5334 (BO!).

Undeterminate *Calamus* from Sopu Valley: *Calamus* sp.11, st.05-05-79, *de Vogel* 5209 (BO!); st.05-05-79, *de Vogel* 5218 (BO!).

Undeterminate *Calamus* from Mt. Nokilalaki: *Calamus* sp.12, st.22-04-75, *Meijer* 9438 (BO!); *ditto.*, st. 04-05-75, *Meijer* 10021 (BO!).

Undeterminate *Calamus* from Kulawi, Moa: *Calamus* sp.13, st.14-10-77, *Mogea* 1290 (BO!); *ditto.*, st. 18-10-77, *Mogea* 1324 (BO!), *ditto.*, *Mogea* 1325 (BO!); *ditto.*, *Mogea* 1326 (BO!); *ditto.*, *Mogea* 1328 (BO!); *ditto.*, st.22-10-77, *Mogea* 1433 (BO!).

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*Caryota* sp. nov.1 (*angustifolia*): Kulawi, Moa, Mt. Malemo, alt. 1200 m, fr.23-10-77, *Mogea* 1441 (BO!); *ditto.*, fl.+fr.24-10-77, *Mogea* 1473 (BO!)

*Daemonoropx macropterus*: Sopu Valley, fr.22-05-79, *de Vogel* 5326 (BO!); Tongoa, foot path to the summit of Mt. Nokilalaki, alt. 750 m, st.05-03-01, *Mogea* 7491 (BO!; CEB!)

*Korthalsia celebica*: Kulawi, Moa, Mt. Malemo, st.,23-10-77, *Mogea* 1462 (BO!); *ditto.*, *Mogea* 1463 (BO!)

*Pinanga caesia* Blume: Palu: Sopu Valley, alt. 1000 m, fr. 12-04-79, *de Vogel* 5064 (BO!); Gunung Potong, alt. 950 m, fr.28-02-01, *Mogea* 7467 (BO!, CEB!);

Parigi, alt. 800 m, fr.17-04-75, *Meijer* 9378 (BO!); Kulawi, Gimpu, Moa, alt. 1200 m, st.19-10-77, *Mogea* 1343 (BO!); *ditto.*, fr.1 1-10-77, *Mogea* 1271 (BO!); *ditto.*, fr.1 1-10-77, *Mogea* 1274 (BO!); *ditto.*, *Mogea* 1275 (BO!); Mt. Malemo, fr.23-10-77, *Mogea* 1443 (BO!).

*Pinanga* sp. nov.1 (*longirachilla*): Kulawi, Gimpu, alt. 600 m, fr.1 1-10-77, *Mogea* 1275 (BO!); Mt. Malemo, alt. 1000 m, fr.17-04-79, *Mogea* 1443 (BO!).

*Pinanga* sp nov.2 (*rubiginosa*): East of Tongoa, alt. 720 m, fr.02-03-81, *Johannxxal*, *Nybm* & *Riehe* 126 (BO!).

*Pinanga* sp. nov.3 (*tenuirachis*): Kulawi, alt. 600 m, fr. 11-10-77, *Mogea* 1271 BO!).