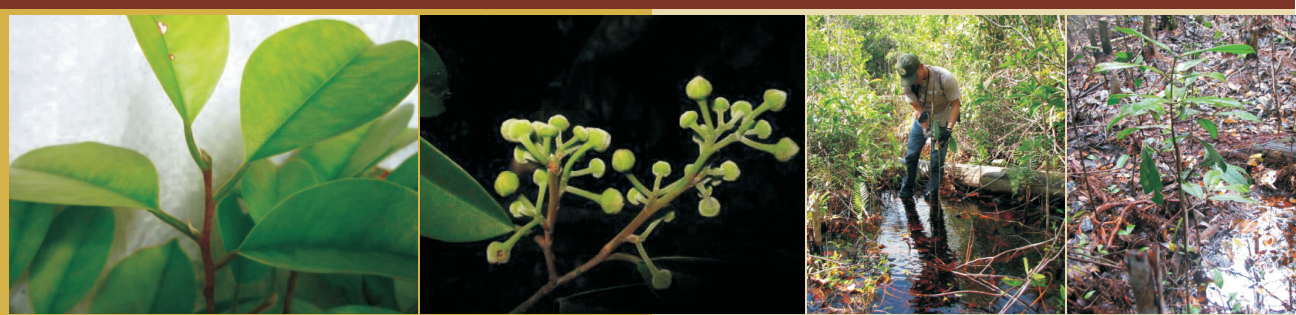


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GONYSTYLUS SPP.(RAMIN): POPULATION STATUS, GENETICS AND GENE CONSERVATION

An Executive Summary

ITTO-CITES Project on Exploratory Assessment on the Population
Distribution and Potential Uses of Non-*Gonystylus bancanus* Species
in Indonesia




Editors

**Marfuah Wardhani
Bugris Yafid
Tajudin Edy Komar
Siti Nurjanah
Dian Tita Rosita**

ITTO – CITES Project
in Cooperation with
Center for Forest and Nature Conservation
Research and Development
Ministry of Forestry

Bogor, 2010





Gonystylus keithii
Documented by Dr. Teguh Triono and team

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Bogor, 2010



***Gonystylus* spp. (Ramin): Population Status, Genetics and Gene Conservation**

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PREFACE

Ramin (*Gonystylus* spp.) has been listed in Appendix of Convention of International Trade of Endangered Species of wild flora and fauna (CITES) since 2001. This listing was driven by the findings that the population of species within this genus have been decrease significantly and some of them have been in serious threat. The threat has been associated with logging activities, human settlement and forest fires which have driven to habitat degradation and population depletion.

In order to obtain current status of each species in term of their population, regeneration and conservation effort, ITTO-CITES in cooperation with Forest and Nature Conservation Research and Development (FORDA) carried out an exploratory assessment of *Gonystylus* spp. in Sumatra, Java and Kalimantan, which are the major distribution in Indonesia. The field surveys of certain site location in those islands are made based on existing data and information collected earlier in literature review. The review was made from all existing information, printed and non-printed materials, herbarium specimen and technical workshops.

Results of the exploratory assessment, genetic relationship between species and the initiation of gene pool establishment are presented in this summary, whereas the technical details are available in the printed technical reports and guideline.

To all parties who have given their time and effort from field activities until the completion of this executive summary are highly appreciated and it is expected that this book could provide necessary information for relevant authorities, such as CITES Management Authority and CITES Scientific Authority.

Bogor, July 2010

Editors

ACKNOWLEDGEMENT

This summary is extracted from technical reports and guidelines developed under Activity Document 3 of ITTO CITES project on “Exploratory Assessment on the Population Distribution and Potential Uses of Non-*Gonystylus bancanus* Species in Indonesia”.

The authors would like to acknowledge the work of Ibrahim Yusuf to summarize the work of Dr. Teguh Triono *et al.* on “Evaluasi Kelimpahan Jenis, Populasi, Habitat dan Status Regenerasi Beberapa Jenis *Gonystylus* terpilih (Non - *Gonystylus bancanus*)”, Dr. AYPBC Widyatmoko on “Genetic relationship between species of *Gonystylus* spp.” and “Description of genepool establishment on Ramin”. To other who have given their contribution to this document are also appreciated.

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PART I. INTRODUCTION

Since 2001, all species of *Gonystylus* have been listed in Appendix III of CITES and in 2004, they were up-listed to Appendix II. According to their ecological distribution, some species of *Gonystylus* grow naturally in Indonesia. One of them - *G. bancanus* grows naturally in peat swamp forest and others grow in lowland and even in hill forest area. Since the inclusion of *Gonystylus* species to the CITES Appendix, there have not been any exploration and review on their current status of distribution, population and their potential uses for timber, except for *G. bancanus*. Herbarium specimen and ecological data of *Gonystylus* species indicate approximately 6 woody species of *Gonystylus* growing naturally in Indonesia. In trade, these species are speculated to be grouped into Mixed Light Hardwood (MLH) and therefore their trade figures and volume are not recorded and recognized. This project aims to explore the non-*G. bancanus* species in Indonesia other than *G. bancanus* which has been extensively studied.

The overall objective is to contribute to the sustainable management and conservation of ramin species. The specific objective is to explore the current status of *Gonystylus* species (non-*G. bancanus*) in Indonesia. The expected outputs are: (i) state-of-the-review on *Gonystylus* species other than *G. bancanus*, and (ii) information on the the current growing stock, population distribution and habitats of non-*G. bancanus* species.

Intended Situation

Expected situation after project completion is the reversal of the current situation, indicated by the availability of information on population distribution, habitats and growing stocks, as well as the potential use. The information obtained from this project includes the bibliography of each species, biological description, ecology and habitat along its geographical, ecological range and brief genetic relationship between species. Previously, this information was not available or currently updated even though these species as a genus have been listed in the CITES Appendix since 2001.

By obtaining this important information, the current status of each species is updated and appropriate treatment and management plan for each species for conservation and utilization could be formulated. In addition, by having sufficient scientific information for each species, the decision to include all species in CITES Appendix will be having stronger justification from both scientific and technical aspects.

Taxonomic interpretation of *Gonystylus* spp. has been reviewed Airy Shaw (1972). Later, based on current information the review is updated by Sidiyasa (2005). There is no significant change in the latter, except further description based on existing information specific to species growing naturally in Indonesia. The list of the species is shown below. From the existing list of species, field assessment on current status of population and habitats was carried out to update the current distribution of the species, their genetic relationship and other aspects related to conservation.

Table 1. List of species within the genus *Gonystylus* (Airy Shaw 1972, Sidiyasa *et al.*, 2005)

No.	Species Name	Size of plants/height	Distribution	Potential value
1	<i>G. augescens</i>	Small tree	Borneo	Unknown
2	<i>G. ariolatus</i>	Shrub/small tree	Malaysia	Unknown
3	<i>G. calphytylus</i>	Shrub/small tree	Malaysia (Borneo)	Unknown
4	<i>G. reticulatus</i>	Shrub/small tree	Philippines (Mindanao)	Unknown
5	<i>G. macrophyllus</i>	Tree, up to 45 m	Nicobar Island (Kamorta), Malaysia	Wood for small boxes
6	<i>G. xylocarpus</i>	Tree, up to 36 m,	Borneo Malaysia and Indonesia	Timber for furniture
7	<i>G. stenosephalus</i>	Small tree	Borneo (Sarawak)	Unknown
8	<i>G. borneensis</i>	Shrub/small tree	Borneo	Unknown
9	<i>G. keithii</i>	Shrub/small tree	Borneo	Fish poison
10	<i>G. brunnescens</i>	Tree, 13-18 m	Peninsular Malaysia, Borneo	Used as ramin timber
11	<i>G. acuminiatus</i>	Tree, up to 25 m	Borneo, Peninsular Malaysia, Sumatra	Unknown
12	<i>G. confusus</i>	Tree, 15-30 m	Peninsular Malaysia, Sumatra	Used as ramin timber
13	<i>G. affinis</i> Syn: <i>G. beccarianus</i>	Tree, 9-24 m	Peninsular Malaysia, Borneo	House construction
14	<i>G. forbesii</i>	Tree, 20-40 m	Sumatra, Borneo	Wood
15	<i>G. velutinus</i>	Tree, 23-35 m	Sumatra, Bangka, Belitung, Borneo	Timber, furniture
16	<i>G. maingayi</i>	Tree, up to 27 m	Peninsular Malaysia, Sumatra	Wood
17	<i>G. pendulus</i>	Small tree	Borneo	Unknown
18	<i>G. micranthus</i>	Tree, up to 18 m	Borneo	Timber
19	<i>G. bancanus</i>	Tree, 18-42 m	Peninsular Malaysia, Sumatra, Borneo	Timber/wood/ general light construction

References

- Airy Shaw, H.K. 1972. Thymelaeaceae – Gonystyloideae. Flora Malesiana I, Vol 6(6).
- Sidiyasa, K. 2005. Potensi botani, ekonomi dan ekologi ramin (*Gonystylus* spp.). Prosiding Semiloka Nasional. Konservasi dan pembangunan hutan ramin di Indonesia. Bogor, 28 September 2005.

PART II. CONSERVATION OF *GONYSTYLUS* SPP.

In order to ensure the utilization of species within *Gonystylus* is not detrimental to the habitat and population, the government issued a logging moratorium policy in 2001 and listing ramin in the Appendix III of CITES in the same year.

Logging moratorium was primarily directed to ramin in general, however, only *G. bancanus*, has been commercially harvested and traded within the genus. Other species within the genus may have been logged but grouped into mixed light hardwood. Ramin and other tree species are currently conserved and protected in several types of conservation areas, such as national park, protected forest, nature reserves and plant genetic conservation areas as shown in Table 2.

Table 2. Conservation sites specific for *G. bancanus* in Indonesia

Names of conservation areas	Total Area (ha)	Location
Kerumutan Nature Reserves	120,000 ha	Riau, Sumatra
Berbak National Park	162,700 ha	Jambi, Sumatra
Kedaton, Research Sites (including genepool)	10 ha	District of OKI, South Sumatra
Sebangau National Park (including genepool ~ 5 ha)	568,700 ha	Central Kalimantan
Tumbang Nusa Research Station (including genepool ~ 2.5 ha)	5,000 ha	Central Kalimantan
Tanjung Puting National Park	300,040 ha	Central Kalimantan
Lahei Seed Production areas,	200 ha	Lahei, Central kalimantan

So far, there is no specific areas allocated for conservation of species other than *G. bancanus* and a few other species. *G. bancanus* which is dominantly growing in PSF are incorporated into several National Park as an integral part of conservation of species and unique biodiversity in the area. Until now several national Parks, Berbak NP, Sebangau, Tanjung Puting and Danau Sentarum are the areas where ramin from *G. bancanus* are naturally found and protected-conserved under the management of national park, and not specifically managed for ramin species.

Other conservation efforts which have been initiated later are in Research Forest (station), in the area of plant genetic conservation of the concessions and botanical gardens. Again they are not specifically protected and conserved. Illegal logging and forest fires are still the potential threat to the species.

PART III. STATE OF THE ART REVIEW FOR *GONYSTYLUS* SPP.

The genus *Gonystylus*, consisting of 29 species and 1 variety that distributed throughout the Malesian area (including Indonesia) with the majority of species found in Borneo. Several species are commercially traded (CITES 2004). Fifteen species in the genus, including *G. bancanus*, are classified as vulnerable in the IUCN's Red List of Threatened Species due to observed, inferred or projected habitat loss and over-exploitation. Following this circumscription, a literature review on biology, ecology and potential uses of *Gonystylus* species other than *G. bancanus* has been conducted.

The results of the review shows that flowering season for *Gonystylus* species varies between February-March as well as May to October. The flowering and fruiting periods of ramin in Sumatra occur between August and October, although ramin trees sometimes produce flower and fruit in May. Meanwhile in Kalimantan, flowering and fruiting periods of ramin occur between January-May. However, the knowledge on flower biology and pollination syndrome of genus *Gonystylus* is still lacking. Thus, further studies are very crucial to be conducted.

Habitat preference of *Gonystylus* species ranged from primary non-inundated rainforest at low and medium elevations to 1500 m. It is associated with different tree species as reported by many authors. In most habitats, ramin is principally associated with *Shorea albida*, *Dactylocladus stenostachys*, *Dyera lowii*, *Cratoxylum arborescens*, *Palaquium* spp., and *Calophyllum* spp. The species are distributed throughout the Malesian with the vast majority of species found on Borneo. Distribution's exception occurs in Central and East Java and the Lesser Sunda Islands, although, a single specimen of *G. macrophyllum* from Flores was found during the review. *Gonystylus* distribution continues eastward towards the Solomon Islands, Nicobar and Fiji. The distribution trends show the decreasing number of species towards eastern part of Malesian region. Based on the specimen distribution data, a series of distribution map are provided of which West and East Kalimantan are recommended as the main targeted areas for further ground and stock survey following by other potential areas.

The slow natural regeneration capability has been recorded for *Gonystylus* from the literatures as well as from direct tree diameter measurement in the field. Tree diameter only increased 3 cm since 12 years ago. The current circumscription must be considered in the future development of conservation efforts and in the sustainable use and trade for *Gonystylus* species. Despite this slow growth, ramin whitish timber is highly prized and popular for various wood-work and wood craft. Several *Gonystylus*

species also produce non-timber forest products such as medicine, poison and incense that are valuable for the local people income. Based on the review's finding and the limited data during the study, several recommendations have been proposed.

Reference

CITES. 2004. Convention on International Trade in Endangered Species of Wild Fauna and Flora: Appendices I and II of CITES Thirteenth meeting of the conference of the Parties. 3-14 October 2004. Bangkok. Thailand.

PART IV. CURRENT STATUS OF GONYSTYLUS SPP. IN ITS ECOLOGICAL RANGE

Other than *Gonystylus bancanus*, there are 29 species of *Gonystylus* currently distributed in Malesian area, including Indonesia, Malaysia, Philippines, Papua New Guinea, Singapore and Brunei Darussalam. The major species are found in Kalimantan, Indonesia. Six species (*Gonystylus affinis*, *G. bancanus*, *G. forbesii*, *G. macrophyllus*, *G. maingayi* and *G. velutinus*) have been recognized commercially as wood producers; *G. bancanus* is the most often traded ramin (CITES 2004). Many of these species of *Gonystylus* are being exploited because the woods produced are very unique in texture for furniture, doors and windows. Other uses of this wood are sticks and boxes.

Field survey has been conducted to observe current status of *Gonystylus* other than *G. bancanus* in Sumatra, Kalimantan and Java. Data and information collection was conducted in 12 locations in Sumatra, Kalimantan and Java and the re-inventory of the potency was carried out in production forest and logged-over forest in conservation or other area. The primary data is collected using plots. The plots consist of permanent observation plots and semi-permanent observation plots. The data of growth rate of *Gonystylus* were collected by using existing permanent plots. In addition, several permanent plots also have been initiated. Each *Gonystylus* that grows in these plots has been re-identified, re-measured its diameter to get the growth rate. In addition, the field survey was also conducted with the establishment of 20 x 20 m sized semi-permanent plots.

The objectives of the evaluation are:

1. To obtain primary data on population, standing stock, distribution, conservation status, habitat (including its micro climate) and regeneration of *Gonystylus* spp. (other than *G. bancanus*) from Nangroe Aceh Darussalam Province, West Sumatera, Jambi, West and East Kalimantan, and West Java as have been identified in the literature studies, interviews and herbarium information as non-*G. bancanus* ramin potential distribution area.
2. To collect pictures of *Gonystylus* spp. (other than *G. bancanus*) with morphologic characteristics for field identifications, guidebook creation and other data collection related to the use of *Gonystylus* spp. by local people.

4.1. Complementary Data Collection

Other than primary data about the variety, population, regeneration potency, in this survey complementary data were also collected, such as:

Herbarium specimens and materials for studying DNA

Sample of leaves, fruits and flowers (if any) have been taken for herbarium collection as survey evidence and for further type identification purposes. These specimens are stored in Herbarium Bogoriense-LIPI, Cibinong. Some samples has been taken and preserved in silica gels. The samples could be used for phylogenetic study using DNA data, which was done in Yogyakarta.

Location and Habitat

Some parameters of observed location were recorded for every *Gonystylus* species found and written in GPS coordinates as well as pH of the soil, air temperature, velocity and light intensity. The micro climate was measured at 4 quadrants by distance approximately 1 meter from the observed tree.

Usage by Local People

In this survey, the information about the usage of each *Gonystylus* has been taken. The information collection has taken by interviews with local people those involved as field guide in survey activities, or by interviews with people who lived near field survey location.

4.2. Limiting Factors

This evaluation has been arranged to undertake field visit directly to the natural distribution location of *Gonystylus* spp. The largely wide area of distribution (non *Gonystylus*) has becoming a limitation to conduct field data collection; even though, the target area has been reduced in accordance with timeframe and resource allocation. Similarly, the access to the forest location was not possible, or very difficult, making the field data collection not able to be carried out perfectly. In addition, the time frame for field execution was not possible to visit a wide range of distribution as identified earlier based on existing references.

4.3. Existing Variety of Species

The survey results showed that 9 out of 12 locations visited where the target species of *Gonystylus* were found. From 9 targeted species, only 8 species were found. The found species were at sterile stage (no flowers and no fruits). Eventhough, Airy Shaw (1953, 1972 and 1973) has given the identification key on morphological

characteristics, it was difficult to use as quick reference to determine the species. The only one method that could be done fast in the field was by investigating vegetative characteristics such as leaf bones. For example, *G. velutinus* could be identified easily by identifying the yellow color of lower leaf bones. In dry condition, the color of leaf bones can be used to identify the species faster. In addition, the absence of liquid on stick often helped to differ it from *Dipterocarp* species.

These experiences have been becoming the important basis for making identification guideline of *Gonystylus* species. In the field, vegetative characters can be easily recognized. The difficulties of using taxonomic keys for *Gonystylus* identification has been often complained by some people. According to Sidiyasa, *et al.* (2010), the identification based on flower morphologic characteristic is very difficult while finding flowers on the field was difficult and many similar flower characteristics between each other.

4.4. Existing Condition

Observation results on all visited locations indicated that the population of *Gonystylus* distributes randomly. So it was not surprising if in some observation plots—either permanent or semi permanent—could only find 1 individual. For example, in a semi-permanent plots on Hutan Harapan, Jambi with the size of 0.5 ha only found one tree of *G. velutinus*. On the other hand, the inventory results between the two posts of 8 km distance, it was recorded 116 individuals from 2 species of ramin: *Gonystylus brunnescens* (114) and *Gonystylus velutinus* (2).

Table 3. Species richness based on field survey in Java, Sumatra and Kalimantan. As indicated that only *G. brunnescens* were found abundant in East Kalimantan, from 10 locations field visited. The choice of location to be field visited is based on earlier review on existing references (Triono et al., 2010.)

Jenis Gonystylus	Lokasi										Jumlah	
	Jawa Barat	Bodogol, Jawa Barat	Inhutani-2, Kalitim	HLS-Wain, Kalim	Bangkrai, Kalim	PT. ITCI, Kalim	G.Lumut, Kalim	CA. Mandor, Kalbar	G. Palung, Kalbar	Hutan Harapan, Jambi		
<i>Affinis</i>			2	-	-	-	-					2
<i>brunnescens</i>			-	264	146	144	-					524
<i>Confusus</i>									1			1
<i>consanguineus</i>			-	-	4	-	1					5
<i>Forbesii</i>			4	-	-	-	-	1				5
<i>Keithii</i>			1	-	-	-	-					1
<i>macrophyllus</i>	1	1										2
<i>Velutinus</i>			-	2	2	1	-			3		8
Jumlah	1	1	7	266	152	115	1	1	1	1	1	548

4.5. Natural Regeneration

From the eight species found, only *Gonystylus brunnescens* which recorded as having relatively larger population for its tree level, sapling or seeds with higher regeneration level. It was also recorded that August is the flowering season for *G. brunnescens* in Kalimantan. Meanwhile for the other species, only one individual seed found or even none of seed found nearby the main stem. This concluded that regeneration capacity of *Gonystylus* species is very low except for *G. brunnescens*.

4.6. Natural Habitat

According to habitation notes described in Airy Shaw's publication (1953, 1972 and 1973), generally the seven species of *Gonystylus* grow naturally on sandy clay, flat fields with gradient under 30 degrees. Only *G. forbesii* found in wet soil like in Cagar Alam Mandor, West Kalimantan. The average micro-climate around *G. brunnescens* on a plot as observed by Sidiyasa (Plot 7 in Kalimantan) indicated the Soil pH of 6.27, light intensity of 1633.85 Lux, air temperature 23.98°C, heat index of 34.21, and wind speed 0.095 m/sec. While the average micro climate around *G. brunnescens* on plot K (Plot Suzuki, 2001, Bangkirai, Kalimantan), was recorded that the soil pH of 6.5, light intensity of 888.2 lux, air temperature of 29.8°C, heat index of 32.3 and wind speed 0.15 m/sec.

4.7. Species Association

From the seven species of *Gonystylus*, generally the species are having association with Dipterocarpaceae, preferably with *Dipterocarpus* spp., *Shorea* spp., *Hopea* spp., and *Cotylelobium* spp., and some other plants. Species commonly associated with *Gonystylus affinis* and *G. brunnescens* are *Shorea laevis*, *Shorea ovalis*, *Dipterocarpus confertus*, *Knema cinerea*, *Garcinia nervosa*, *Diospyros buxifolia*, *Madhuca kingiana*, *Sarchotheca diversifolia*, *Blumeodendron tokbrai*, *Fordia splendidissima*, *Aglaiia simplicifolia*, *Macaranga lowii*, *Griffithianthus merillii*, *Lithocarpus elegans*, *Madhuca valida*, *Sindora leiocarpa*, *Melanochyllum fulvinervis*, *Cotylelobium lanceolatum*, and *Cleistanthus borneensis*.

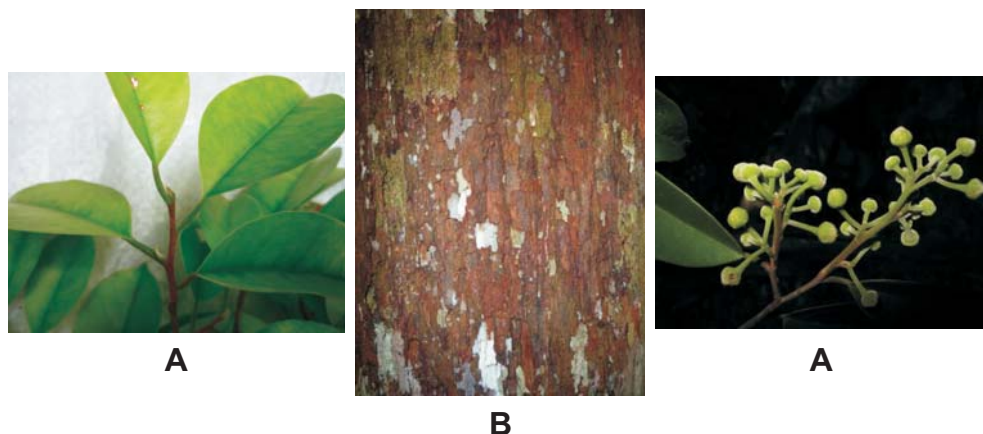


Figure 1. A. Leaf of *Gonystylus forbesii*; B. Bark of *G. Affinis*; and C. Flower of *G. brunnescens*.



Figure 2. Habitat of *G. forbesii* (left) dan habitat *G. affinis* (right) in Senturan Camp Malinau, East Kalimantan.

4.8. Conclusions and Recommendations

Conclusions

1. From 10 species of *Gonystylus* on recorded earlier of ITTO and CITES, only 8 species found other than *G. bancanus*, namely *G. affinis*, *G. brunnescens*, *G. confusus*, *G. consanguineus*, *G. forbesii*, *G. keithii*, *G. macrophyllus* and *G. velutinus*. Field observing of these 8 species were hardly carried out since the distribution is in a wide range areas, and 7 of the species could be categorized as rare except *G. brunnescens*.

2. From the 8 species found, only *G. brunnescens* is having good population distribution from tree level to seed with relatively high regeneration rate. As also recorded that August is flowering season for *G. brunnescens* in Kalimantan.
3. In general, the 8 species of *Gonystylus* grow in sandy clay at flat topography with gradient up to 30 degrees in a variety of micro climate conditions. Only *G. forbesii* found growing in wet soil like in Cagar Alam Mandor, West Kalimantan.
4. Local people are not familiar with the use of *Gonystylus* spp. other than ramin (*G. bancanus*), so the utilization of non-*G. bancanus* often used by mixed with other commercial timber.

Recommendations

1. Identification of species of *Gonystylus* categorized as traded timber is difficult to be carried out in the field, mainly if they on sterile condition and do not bear any flowers or fruits.
2. Since very limited distribution, slow and poor regeneration process, it is recommended that conservation actions for *G. affinis*, *G. confusus*, *G. consanguineus*, *G. forbesii*, *G. keithii*, *G. macrophyllus* and *G. velutinus* need to be taken. In addition, some of these species are potentially valuable for timber production.
3. The rarity of *G. affinis*, *G. brunnescens*, *G. confusus*, *G. consanguineus*, *G. forbesii*, *G. keithii*, *G. macrophyllus* and *G. velutinus*, part of *Gonystylus* species recorded on CITES which have been categorized as traded timber species, need to be further conserved.

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PART V. GUIDEBOOK FOR SPECIES IDENTIFICATION OF RAMIN

Tropical forest of Indonesia is rich with tree species and some of them are having appearance. This cause identification is becoming a crucial part in field forest inventory for various purposes. Based on recent survey (field assessment) conducted under this ITTO-CITES project: exploratory assessment of *Gonystylus* species, indicated the variety of tropical species and some of them are look alike. In order to assist a field staff or field surveyors in forest inventory for various purposes, a guide book for identification is becoming an important part.

The guidebook for ramin field identification is prepared based on the result of review report on the existing *Gonystylus* species in Indonesia and recent survey conducted in selected sites in Sumatra, Java and Kalimantan which are the major distribution of *Gonystylus* spp. Maluku and West Papua, the two large islands with possible *Gonystylus* species were not field survey due to some limiting factors.

This guidebook is containing the illustration and fresh photographs of *Gonystylus* recorded and collected during the field survey, and some species which were not found in the field but potentially growing in some island are also incorporated. The photograph of herbarium specimens are attached to the guidebook. Species key identification is also incorporated. As far possible, all vegetative and generative parts of each tree are recorded, collected and incorporated into this guidebook. The main stem, leave and bark are the components of the species which are always available to be used as key references.

It is recommended that this guidebook is distributed to the concerned stakeholders and used as reference or guide in the identification of *Gonystylus* species, especially during the field survey.

PART VI. GENETIC RELATIONSHIP BETWEEN SPECIES OF GONYSTYLUS SPP.

Genetic relationship of ramin (*Gonystylus* spp.), as CITES-listed genus has been observed (as Widyatmoko. 2010, ITTO-CITES Project). DNA samples representing 9 different ramin species were extracted from leaf materials were achieved using modified CTAB method. ITS rDNA (ITS3) and 3 chloroplast non coding regions sequences were examined identifying genetic relationship among the species. No variation within species and sequence differentiation between species were recognized among the 9 species, included 3 unidentified *Gonystylus* spp. Based on ITS3 sequence, 9 species were divided into 3 clads. The first clade was *G. bancanus*. The second clade consisted of 5 species, *G. brunnescens*, *G. velutinus* and 3 *Gonystylus* sp. The third clade consisted of 3 species, *G. consanguineus*, *G. keithii* and *G. macrophyllus*. However, using combination of ITS3 and 3 chloroplast non coding regions, the 9 species were divided into 4 groups. The first group was *G. bancanus* and *G. macrophyllus*; the second group was *G. brunnescens*, *G. consanguineus*, *G. velutinus* (2 samples) and 1 *Gonystylus* spp. The third group consisted of *G. velutinus* (2 samples) and 2 *Gonystylus* sp. The other group was only consisted of *G. keithii*.

6.1. Genetic Relationship among Species

Genetic relationship of 24 samples of *Gonystylus* spp. was revealed by dendrogram (Figure 3 and Figure 4). Figure 3 revealed genetic relationship between 9 species of *Gonystylus* based on internal transcribed spacer sequence only. The dendrogram divided the 9 species into 3 different groups. *G. bancanus* was separated from the other 8 species. *G. brunnescens*, *G. velutinus* and 3 *Gonystylus* spp. were grouped together, and the third group consisted of. *G. consanguineus*, *G. keithii* and *G. macrophyllus*. Among the 9 species, 3 unidentified *Gonystylus* spp. have closed relationship, followed by *G. consanguineus* and *G. keithii*.

Based on sequence of the four regions, different dendrogram was produced (Figure 4). All 4 samples of *G. bancanus* were grouped together because no variation was found within this species. Different with Figure 3, in Figure 4 *G. keithii* was separated with another 8 species. *G. bancanus* was closed with *G. macrophyllus*, and *G. consanguineus* was closed *G. velutinus*. Similar relationship was revealed by 3 *Gonystylus* spp. Two of the species were closely related with *G. velutinus*, and the other *Gonystylus* spp. was closed with *G. brunnescens*. The dendrogram (Figure 4) divided the 9 species into 3 groups. The first group consisted of *G. bancanus* and

G. macrophyllus. The second group consisted of *G. keithii*, and the other 6 species placed into the third group. The third group can be separated into 3 small clades, those were *G. brunnescens* and *Gonystylus* spp. (Clade I); *G. consanguineus* and *G. velutinus* (Clade II); and *G. velutinus* and 2 *Gonystylus* spp. (Clade III).

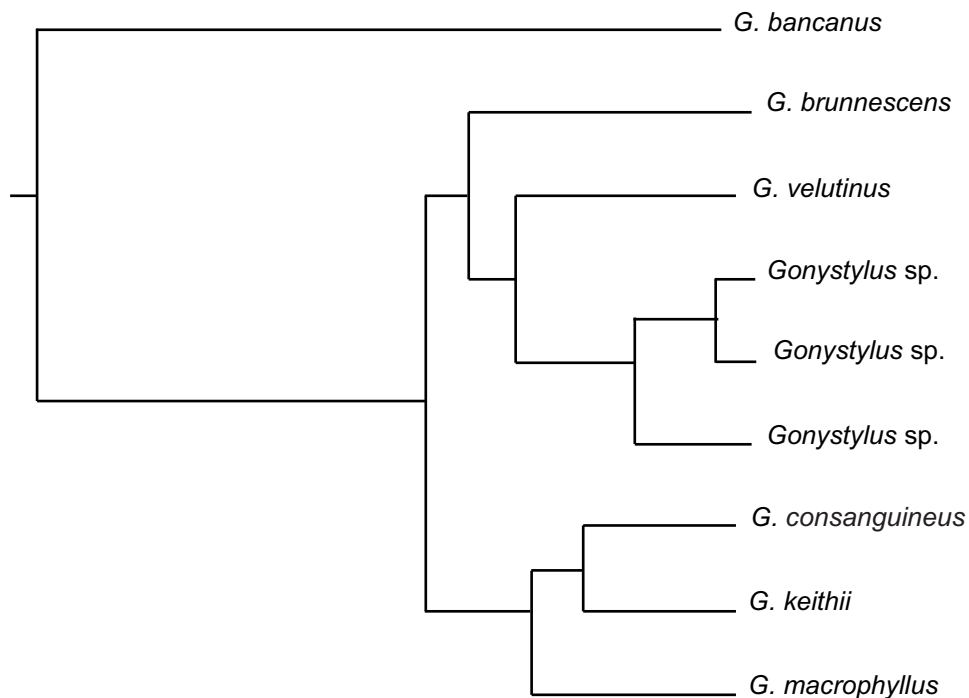


Figure 3. Dendrogram of *Gonystylus* sp. based on sequence of ITS-3

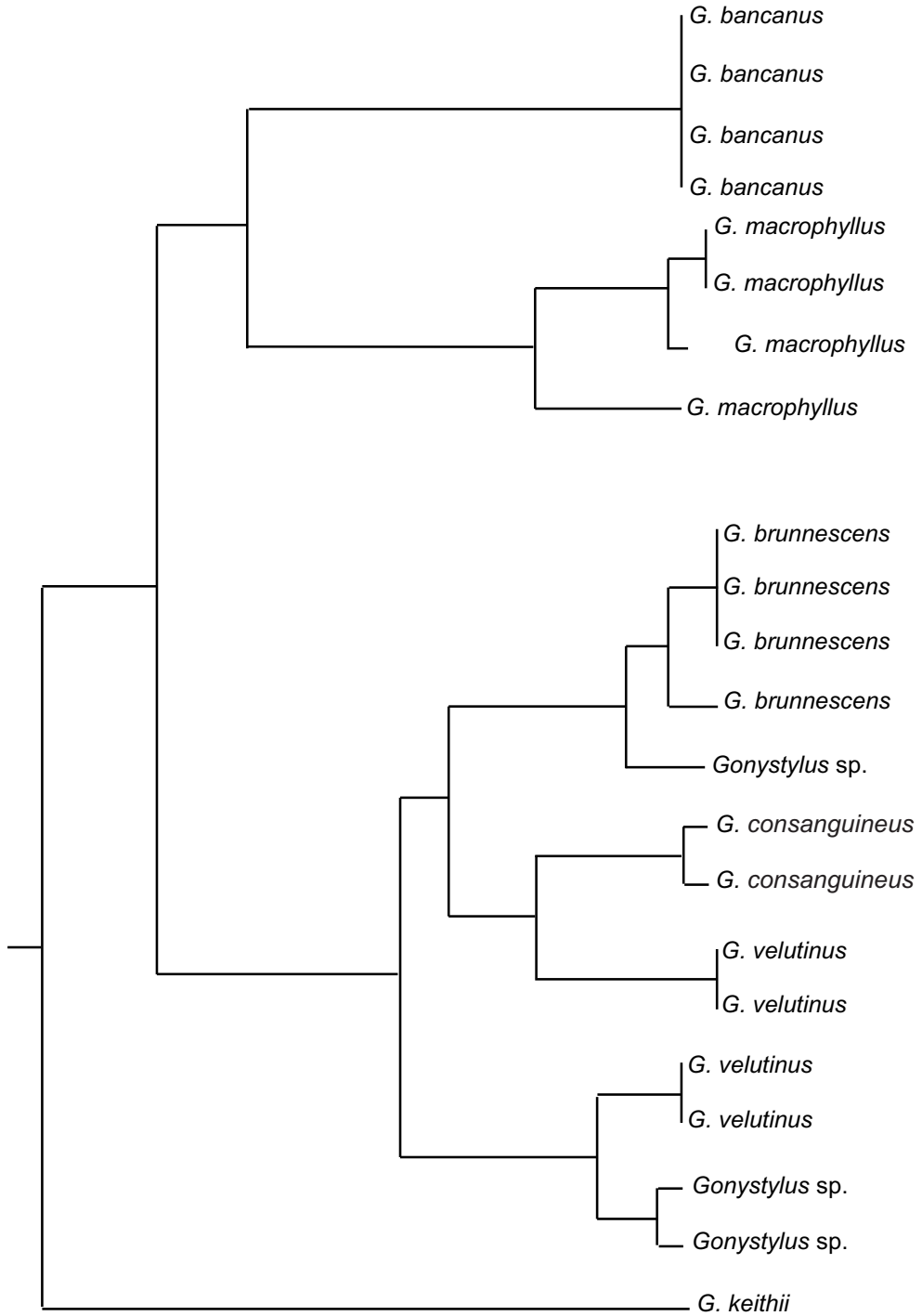


Figure 4. Dendrogram of *Gonystylus* sp. based on sequence of ITS-3 and cpDNA non-coding regi.

Further detail on the observation of genetic relationship between species for *Gonystylus* spp. could refer to the report by Antonius YPBC Widiyatmoko, 2010 - "Genetic relationship between species of *Gonystylus* spp".

6.2. Conclusions

1. Leaves of nine *Gonystylus* spp, include 3 unidentified species, can be used to elucidate genetic relationship between species.
2. No sequence variation was found within species for internal transcribe spacer (ITS3), however, each species could be differentiated using this region.
3. Sequence variation within species was found for three chloroplast non coding regions, except for *G. bancanus*.
4. Based on ITS3 sequence, 9 species were divided into 3 clades. The first clade was *G. bancanus*; the second clade consisted of 5 species, *G. brunnescens*, *G. velutinus* and 3 *Gonystylus* spp; and the third clade consisted of 3 species, *G. consanguineus*, *G. keithii* and *G. macrophyllus*.
5. Nine species were separated into 4 groups based on sequence combination of ITS3 and 3 chloroplast non coding regions as (1) the first group was *G. bancanus* and *G. macrophyllus*; (2) the second group was *G brunnescens*, *G. consanguineus*, *G. velutinus* (2 samples) and 1 *Gonystylus* spp; (3) the third group was *G. velutinus* (2 samples) and 2 *Gonystylus* spp., and (4) the fourth group which is different from the other three groups was *G. keithii*
6. A technical report on "Genetic relationship between species of *Gonystylus* spp." was prepared for internal distribution to all interested parties.

Reference

AYPBC Widyatmoko. 2010. Genetic Relationship between Species of *Gonystylus* spp. ITTO CITES Project bekerjasama dengan Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam. Bogor. Technical Report. Published for Internal Distribution.

PART VII. GENE POOL ESTABLISHMENT FOR *G. BANCANUS*

7.1. Gene Pool Establishment in Sumatra

In order to enhance conservation of ramin genetic resource and to rescue the natural seedlings (wildlings), it is important to collect and pool the genetic materials in several secure location sites, ideally in nearly similar PSF. These genetic materials could be further used as sources of shoots for vegetative propagation and sources of genetic materials for selection in tree improvement program. The genetic materials are randomly collected from the natural sources.

Until today, three locations have been identified and initial establishment have been started. Kedaton, Ogan Komering Ilir (OKI) of South Sumatra has been selected for this purpose to replace poor accessible Merang Kepahyang as originally planned. Ten ha of PSF in Kedaton (OKI) has been chosen for ramin gene pool establishment and other related activities for ramin. Administrative work (legal process) to free the area from other activities other than ramin work has been executed under ITTO-CITES project in Kedaton, South Sumatra. Two ha out of ten ha have been cleared and planted with ramin genetic materials collected earlier and the remaining 8 ha will be used for plantation trial using seedling raised from seed and vegetative shoot propagation.

7.2. Gene Pool Establishment in Kalimantan

Two other sites for genepool establishment are located in Sebangau National Park and Tumbang Nusa (Research Station) Central Kalimantan. Five ha in Sebangau National Park have been identified and selected for gene pool establishment. Initial collection and plantation of the genetic materials have been carried out. In this area, at least 4,000 genetic materials collected from the surrounding areas have been planted (pooled).

Two ha of gene pool with at least 1,500 genetic materials (wildlings) have also been planted in Tumbang Nusa Research Station. In addition, approximately 6,000 genetic materials (wildlings) have also been pooled in this station with special treatment and management as Hedge Orchard or sources of shoot for vegetative propagation. The genetic materials are arranged in six lanes of 4 m wide and 50 m long, and planted with spacing of 0.5 m x 0,5 m. The total area occupied is 1200 m².

By the establishment of these gene pools, there are at least 8000 vegetative shoots (80% harvestable shoot cuttings) could be cut a year and 6000 vegetative seedling could be produced a year. Using 3 m x 3 m spacing, at least 6 ha of PSF could be rehabilitated and planted per year without the frustration of waiting for seed.

The gene pool establishment in OKI (South Sumatra) is coordinated and further managed in cooperation with the Regional Research Center (FORDA) South Sumatra, based in Palembang, South Sumatra. The gene pool establishment in the Sebangau National Park is executed and further managed by the Office of Sebangau National Park under coordination and cooperation with the Regional Research Center-FORDA South Kalimantan. Other gene pool and Seedling collection (Hedge Orchard) in Tumbang Nusa Research Station are executed and further managed under coordination and cooperation with the Regional Research Center-South Kalimantan, based in Banjarbaru (South Kalimantan).



Figure 5. Establishment of ramin gene pool which could function as stock plant in KHDTK Tumbang Nusa.



Figure 6. Establishment of ramin gene pool in Sebangau Nasional Park.



Figure 7. Establishment of ramin gene pool in KHDTK Tumbang Nusa.

7.3. Conclusions and Recommendations

1. It is recommended that in order to cover a wide range of genetic materials of ramin, further collection of genetic materials from different sources be carried out.
2. Genetic analyses of ramin pooled in gene conservation sites (genepool) need to be carried out.

PART VIII. OVERALL CONSLUSIONS AND RECOMMENDATIONS

8.1. Conclusions

1. The utilization of timber other than *G. bancanus* are very limited and even not familiar by most local people, except ramin (*G. bancanus*). The utilization of non-*G. bancanus* may have been used as mixed with other commercial timber.
2. Observation using molecular marker indicated the presence of grouping between species. There are four groups identified from 9 specimen studied. The first group was *G. bancanus* and *G. macrophyllus*; the second group was *G. brunnescens*, *G. consanguineus*, *G. velutinus* (2 samples) and 1 *Gonystylus* spp; and the third group was *G. velutinus* (2 samples) and 2 *Gonystylus* spp. *G. keithii* was placed into a different group.
3. Most species, other than *G. bancanus* are having relatively small population and widely distributed in a wide range of areas. After *G. bancanus*, only *G. brunnescens* is having potential for further plantation trial. These species are currently not specifically protected except those growing naturally in conservation/protected areas.

8.2. Recommendations

1. In order to ensure the conservation of existing species of ramin, other than *G. bacanus*, especially those rarely found, extremely slow growing and poor regeneration, it is recommended that *ex situ* and *in situ* conservation be immediately established. Those species include *G. affinis*, *G. confusus*, *G. consanguineus*, *G. forbesii*, *G. keithii*, *G. macrophyllus* and *G. velutinus*.
2. Some species which have been recorded as traded timber species, but rare in nature, *G. affinis*, *G. brunnescens*, *G. confusus*, *G. consanguineus*, *G. forbesii*, *G. keithii*, *G. macrophyllus* and *G. velutinus*, need to be immediately conserved.
3. Observation for genetic relationship between species need to be further carried out for other species which have been predicted as over 30 species.
4. The initial genepool establishment for *G. bancanus*, as additional effort to conserve the gene resources, is recommended to be expanded to other species. The representativeness needs to be widened in accordance with their natural range of distribution.

5. The genetic variation of the species in the genepool sites needs to be further analyses to ensure the conservation of the existing genetic variation.
6. Relevant stakeholders are recommended to use the guidebook for field identification of ramin and provide training to the field staff especially during the pre–harvest inventory.

LIST OF PUBLICATIONS

1. Literature review on *Gonystylus* spp. other than *Gonystylus bancanus*: Botany, Ecology and Potency – **Published for general distribution.**
2. Evaluation on Species Diversity, Population, Habitat, and Regeneration Status of Selected *Gonystylus* Species (Non – *Gonystylus bancanus*). (Evaluasi Kelimpahan Jenis, Populasi, Habitat dan Status Regenerasi Beberapa Jenis *Gonystylus* terpilih (Non - *Gonystylus bancanus*)) – **Technical Report, published for internal distribution.**
3. Genetic relationship between species of *Gonystylus* spp.– **Technical Report, published for internal distribution.**
4. Embriogenic Callus Induction Effort from Ramin Shoot (Upaya Induksi Kalus Embriogenik dari Potongan Daun Ramin) – **Technical Report, published for internal distribution and scientific publication.**
5. Guidebook for field identification of ramin species (*Gonystylus* spp.) in Indonesia (Panduan Identifikasi Jenis-jenis Ramin (*Gonystylus* spp.) di Indonesia) – **Published for general distribution.**



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