Conservation of *Aquilaria* (Thymelaeaceae) in Peninsular Malaysia

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INTRODUCTION

- **FAMILY**: Thymelaeaceae
- **SUBFAMILY**: Aquilariodeae
- **GENUS**: *Aquilaria* (CITES Appendix II)
- **DISTRIBUTION**: About 20 species distributed in tropical and subtropical Asia from Southern China throughout the Malesian region extending to the Pacific islands
- Lowland to lower montane forests to 1700 a.s.l.
- In Peninsular Malaysia, the five known species are:
  A. beccariana, A. hirta, A. malaccensis, A. microcarpa & A. rostrata

A. malaccensis

• Trees (*hirta*, *malaccensis*, *microcarpa*), treelets (*apiculata*, *citrinaecarpa*, *cumingiana*) or shrubs (*brachyantha*, *filaria*, *urdanetensis*).

• Bark smooth, pale whitish, stripping off in long, fibrous pieces.

• Leaves alternate, pinnately veined, petioled, fibrous.

• Inflorescences axillary, supra-axillary or terminal, sessile or short-peduncled.

• Flowers hermaphroditic, pedicelled; filaments short or filiform; stigma distinct, globose, capitate, pyramidal or oblong.

• Fruits 1-2 loculed, globose-obovoid or oblanceolate, rugose or smooth, puberulous to glabrous.


A. malaccensis


A. malaccensis

• **VERNACULAR**: Latin, *aquila* = an eagle. Malayan eaglewood, agarwood, aloeswood, gaharu, engkaras (Iban), karas (Malay).

• **USES**: gaharu, wood for incense; medicine for thyroid gland, abdominal complaints, asthma, colics, diarrhoea, aphrodisiac. carminative; prefumery; boxes, light indoor construction, veneer; ropes, clothes; gaharu tea.

http://www.21food.com/


http://thestar.com.my/

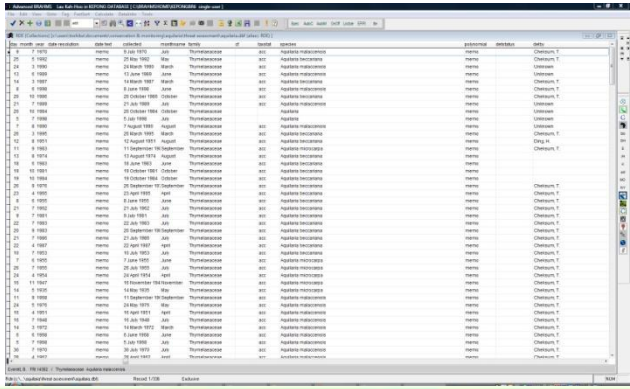

http://www.1agarwood.com/

APPROACH 1

Conservation assessment on all *Aquilaria* species from Peninsular Malaysia.

METHODS

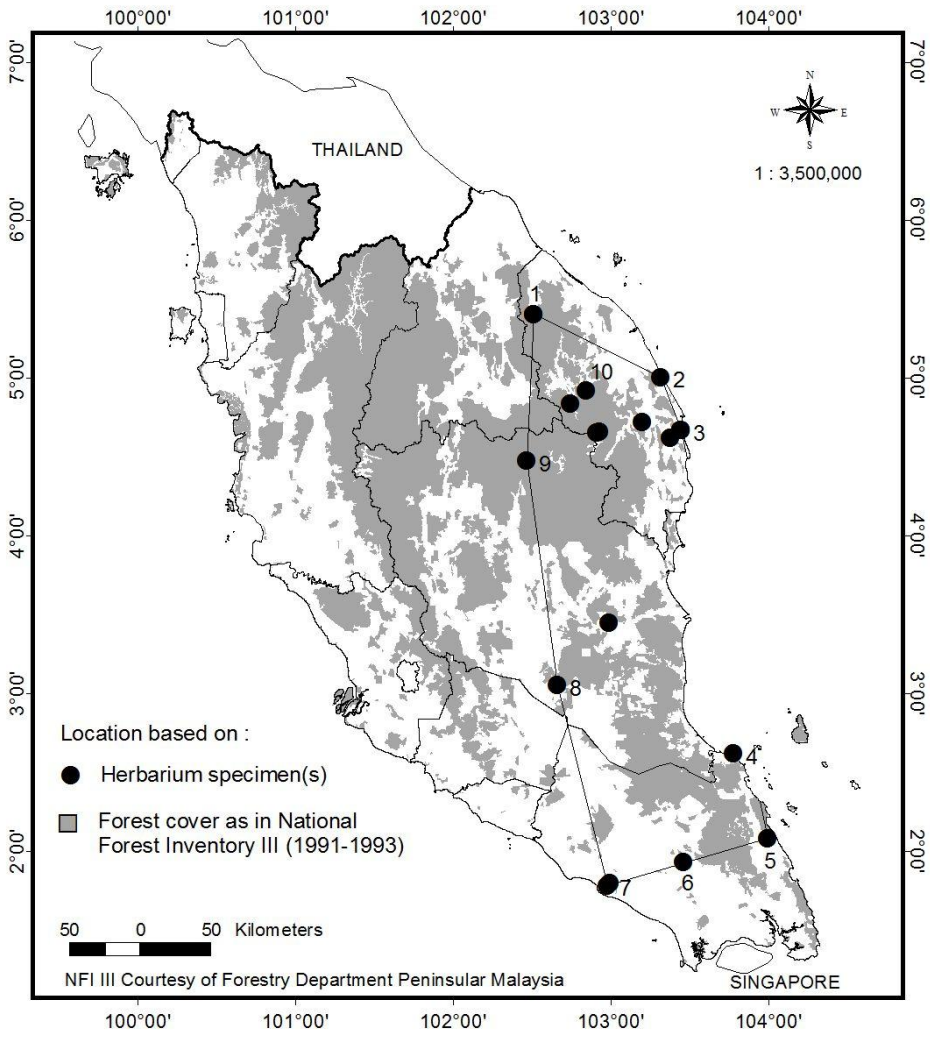
- based on the IUCN Red List Categories and Criteria version 3.1.
- herbarium specimens notes and if possible through ground truthing.
- manipulated in Botanical Research and Herbarium Management System (BRAHMS).
- maps were subsequently generated from ArcView GIS 3.2a.
- filling the Taxon Data Information Sheet (TDIS).



Aquilaria hirta Ridl.

- Conservation status: Vulnerable
- Widespread; from lowland up to 300 m a.s.l., hill slopes.
- Harvested for its *gaharu*, medicinal value; agriculture.
- Peninsular Malaysia, E. Sumatra, Riau, Lingga.

Geographical Distribution of *Aquilaria hirta* (Thymelaeaceae) in Peninsular Malaysia



Selected Localities

1. Bkt. Jebak Puyoh
2. Merchang
3. Bkt. Bauk F.R.
4. Penyabong
5. Tenggaroh F.R.
6. Rengam F.R.
7. Banang F.R.
8. Tasik Bera
9. Taman Negara, Kuala Keniyam
10. Hulu Terengganu F.R.

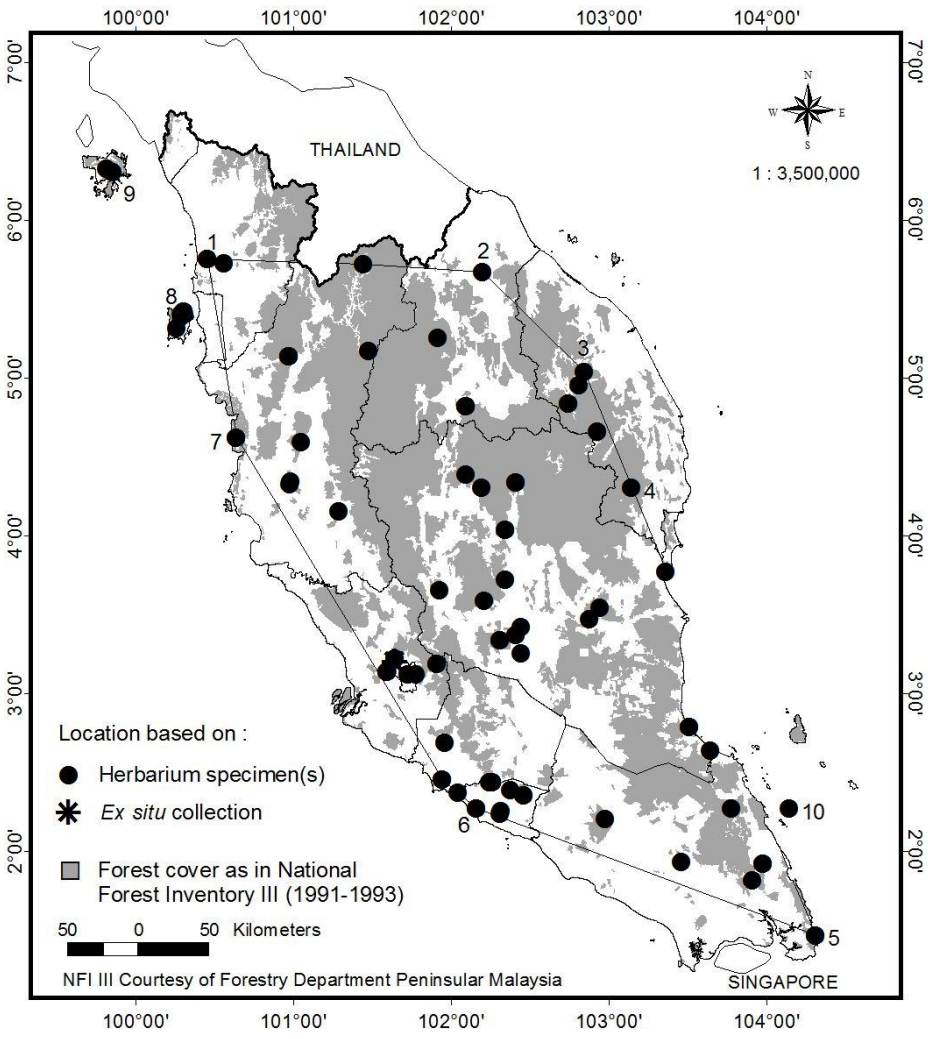
Extent of Occurrence (EOO) : 36, 739 sq km

Area of Occupancy (AOO) : 68 sq km

Forest cover within EOO : 58 %

Aquilaria malaccensis Lam.

- Conservation status: Vulnerable
- Widespread; primary forests at low and medium altitudes up to 270m.
- Harvested for its *gaharu*, medicinal value; agriculture.
- India, Myanmar, Sumatra, Peninsular Malaysia, Singapore, Borneo (Sabah & Kalimantan), Philippines.



Selected Localities

1. Gn. Jerai F.R., Gn. Jerai
2. Sg. Pertok
3. Ulu Sg. Terengganu
4. Bkt. Kajang
5. Tanjung Penawar
6. Sg. Udang F.R.
7. Sg. Tinggi
8. Government Hill
9. Gn. Raya F.R.
10. P. Tinggi

Extent of Occurrence (EOO) : 97,034 sq km

Area of Occupancy (AOO) : 256 sq km

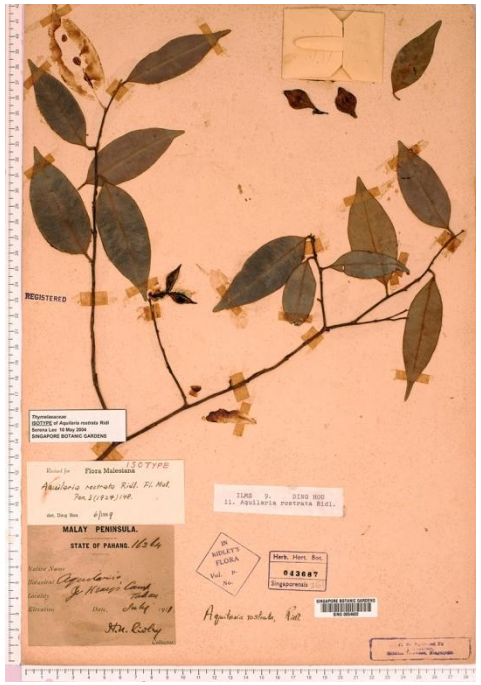
Forest cover within EOO : 53 %

Aquilaria rostrata Lam.

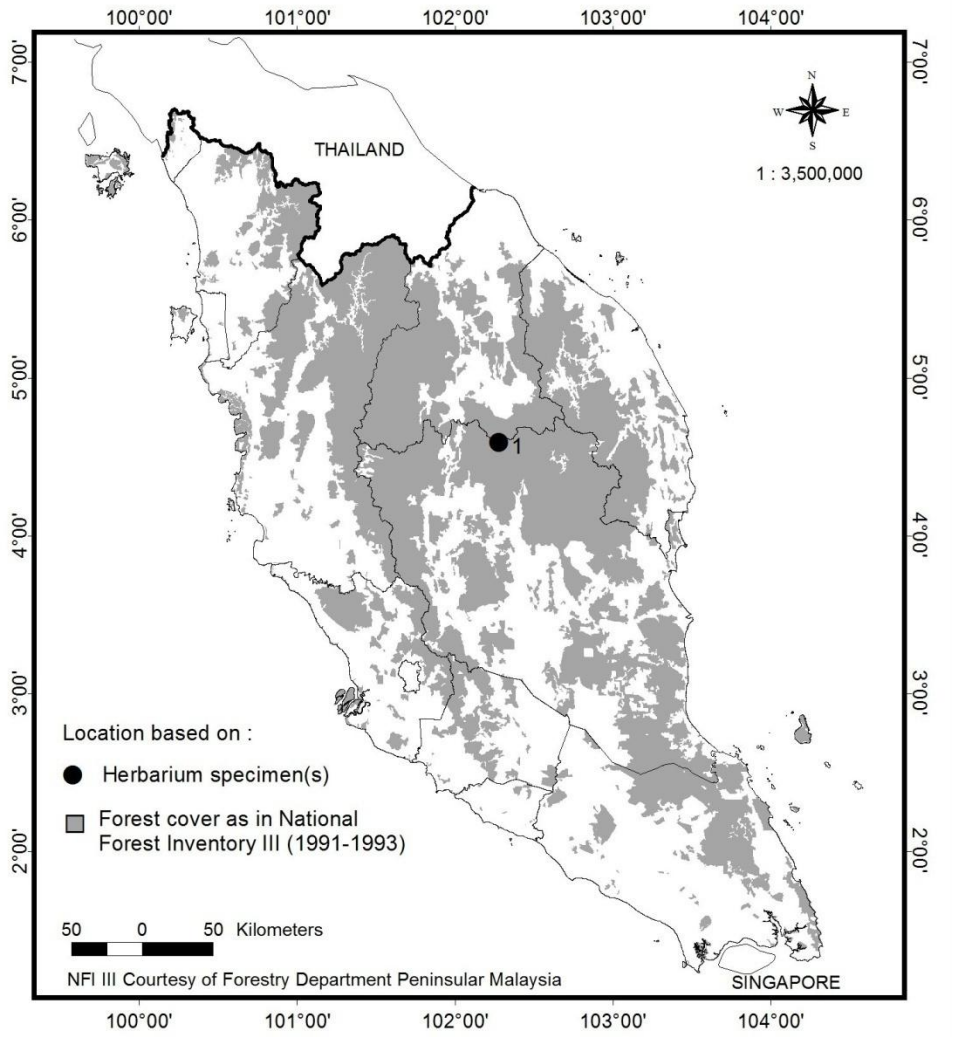
- Conservation status: Data Deficient

- Endemic to Peninsular Malaysia; upper hill Dipterocarp forest.

- Known from its type collection made in 1911.



Courtesy of SING



Locality

1. Taman Negara, Wray's Camp

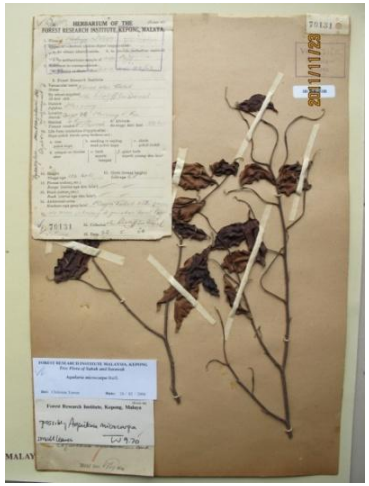
Extent of Occurrence (EOO) : n.a.

Area of Occupancy (AOO) : 4 sq km

Forest cover within EOO : n.a..

Aquilaria microcarpa Baill.

- Conservation status: Data Deficient
- Known from one locality; primary forests from lowland up to 200m a.s.l.
- Possible threat from land-use change.
- Sumatra, Singapore, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei).



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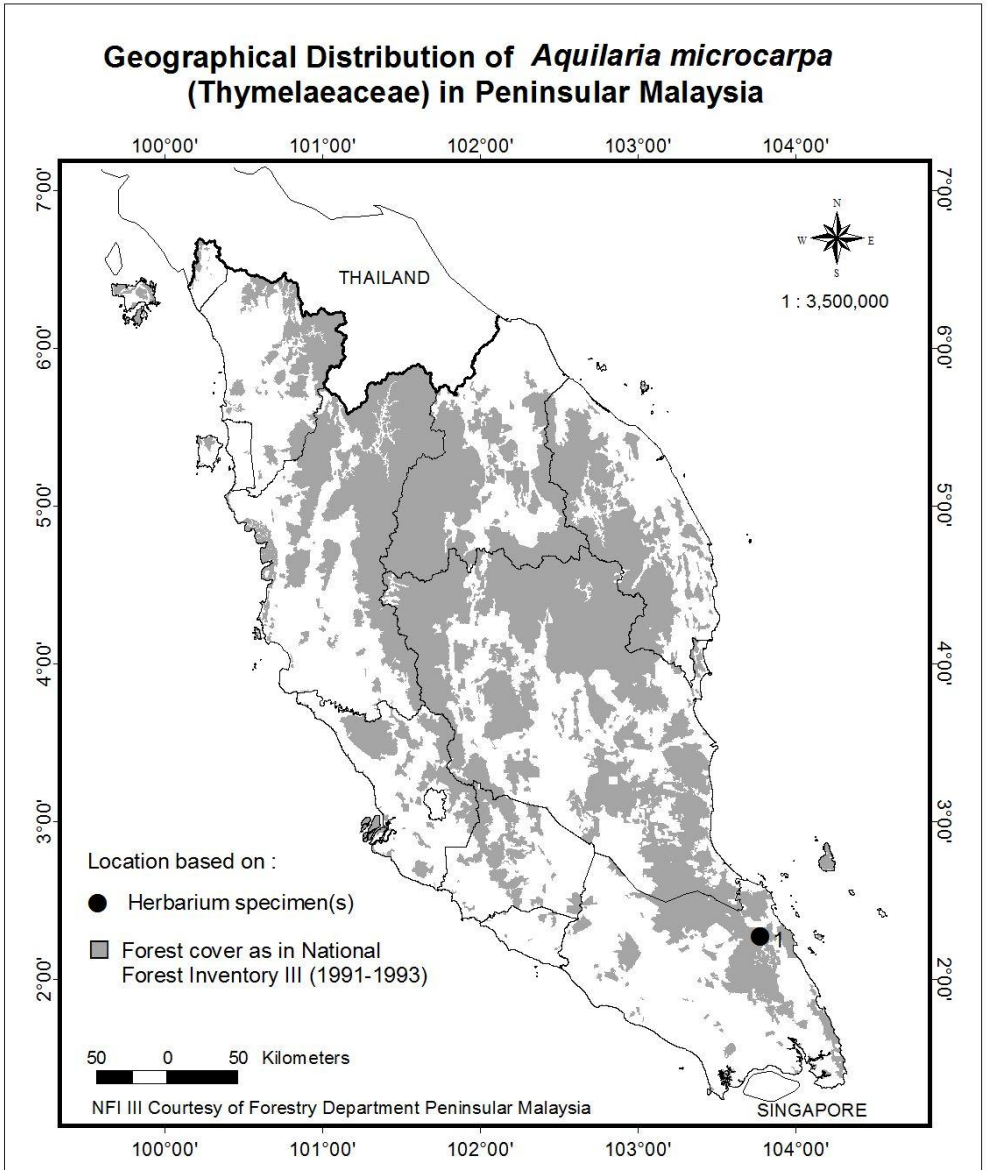


Locality

1. Mersing F.R.

Extent of Occurrence (EOO) : n.a.

Area of Occupancy (AOO) : 4 sq km

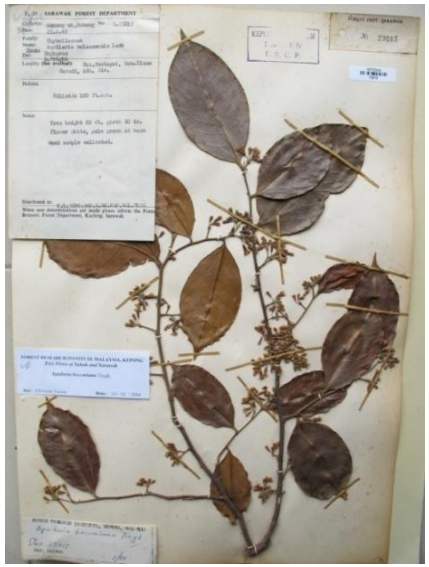
Forest cover within EOO : n.a.

Aquilaria beccariana Tiegh.

- Conservation status: Data Deficient

- Information on distribution via reference; primary forests, rarely in swampy area.

- Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan).



Courtesy of KEP

sterile specimen collected by MOSZKOWSKI (12, B) at Senamaninik, eastern Sumatra. I have not seen the type, but the locality and GILG's detailed description agree very well with the present species, especially the silky hairs occurring on the underside of the leaf which is peculiar to this species.

10. **Aquilaria rostrata** RIDL. Fl. Mal. Pen. 3 (1924) 148.

Tree. Branchlets pubescent, glabrescent. *Leaves* subcoriaceous, glabrous, rather shining on both surfaces, lanceolate, rarely ovate-oblong, 6½–10 by 2½–4½ cm; base obtuse, cuneate to attenuate; apex acuminate, the acumen up to 1½ cm; nerves 16–many pairs, simple or rarely branched, spreading or slightly curved and ascending, elevated beneath and visible above; veins visible beneath and obscure above; petiole 3½–7 mm. Pedicels *c.* 3 mm, brownish hairy. *Floral tube* cylindric, 6 mm long, splitting on one side, glabrous outside, sparsely puberulous inside. Calyx lobes slightly oblong, *c.* 1½ mm long, puberulous on both surfaces. *Petaloid appendages* unknown. *Stamens* sessile. *Fruits* (young) obovate-oblong or oblanceolate, including the stipe 3 by ¾–1½ cm, brownish hairy outside, long-narrowed towards the base, apex beaked. *Seeds* slightly ellipsoid-oblong, 10 by 4 mm (*excl.* the appendage), brownish, puberulous, acuminate, base attenuate and elongate into a slender appendage, glabrous.

Distr. *Malaysia:* Malay Peninsula (Pahang, Wray's Camp, Gunong Tahan, RIDLEY 16264, type, K, SING).

Note. As mentioned by RIDLEY the specimens are poor. No material has been collected since the type. I have seen two sheets of the type number and one other sterile unnumbered sheet. Only young fruits are available, with the persistent floral tube. Unfortunately, the petaloid appendages and stamens of them were eaten by insects except the basal parts of two sessile stamens in one flower. From the available material, it is impossible to verify the number and shape of the petaloid appendages and the number of stamens.

This species, as pointed out by RIDLEY, is characterized by the long-beaked fruits. In addition, the floral tube is longer than the lobes, and the stamens are sessile.

11. **Aquilaria beccariana** VAN TIEGH. Ann. Sc. Nat. Bot. VII, 17 (1893) 217; Bull. Soc. Bot. Fr. 40 (1893) 77; GILG, Bot. Jahrb. 28 (1900) 145; BOERL. Handl. 3 (1900) 112; BECC. Nelle Foreste (1902) 392; MERR. En. Born. (1921) 416.—*A. grandifolia* DOMKE, Notizbl. Berl.-Dahl. 11 (1932) 348.—*A. cumingiana var. parviflora* AIRY SHAW, Kew Bull. (1940) 261.—*Gyrinopsis grandifolia* QUIS. J. Arn. Arb. 27 (1946) 406.—**Fig. 1a–c.**

Tree up to 20 m tall and 36 cm diam. with grey and smooth bark. Young branchlets pubescent. *Leaves* papery to subcoriaceous, glabrous on both surfaces, sometimes scattered pubescent beneath, oblong, oblong-lanceolate, or elliptic-oblong, rarely elliptic, (7–)11–27 by (3–)6–8½ cm; base cuneate to attenuate; apex acute to acuminate; nerves (10–)15–25 pairs, curving and ascending towards the margin, elevated and prominent beneath, distinct above; veins loosely reticulate; petiole 5–7 mm. *Inflorescences* axillary or extra-axillary, branched and up to 1½ cm peduncled, short-paniculiform, pubescent; pedicels 3–7 mm, pubescent. *Flowers* 7–12 mm long, yellowish, greenish or yellowish-white. Floral tube cylindric, 10-costate, sparsely hairy outside. Calyx lobes slightly ovate, puberulous inside, 2–3 mm long, densely puberulous on both surfaces, sometimes glabrescent on the outside. *Petaloid appendages* oblong, *c.* 1 mm long, densely short-hairy. *Stamens* usually sessile, rarely with very short filaments, almost as long as the petaloid appendages. Disk ring-like to cupular, densely puberulous. Pistil *c.* 5 mm long, with a distinct stipe *c.* 2 mm long, the stipe accrescent and elongated. *Ovary* ellipsoid, attenuate to the base, gradually narrowed at the apex; stigma capitate. *Fruit* protruding from the top of the floral tube, ellipsoid or obovoid, 2–3½ by 1¾ cm, slightly puberulous and glabrescent, narrowed to the base into an elongate stipe up to 1½ cm, acuminate to the apex, usually slightly contracted in the middle; floral tube entire, very rarely splitting on one side (KADIR A 3601). *Seeds* black, ovoid, 10 by 5 mm, sparsely puberulous, acuminate to the apex, with an elongate tail *c.* 5 mm long, attached at the center of the appendage, the appendage slender, *c.* 1 cm long, densely reddish-brown pubescent.

Distr. *Malaysia:* Sumatra (Palembang), Malay Peninsula (Johore), and common in Borneo.

Ecol. Primary forests, rarely in swampy forest (Johore: S.F. 29008, K), from the lowland up to 825 m.

Vern. *Mĕrkaras puti*, Sum., *gaharu*, *gumbil*, *njabak*, M, *tanduk* = *garu*, Born.

Notes. This species is characterized by the cylindric floral tube, the oblong and puberulous petaloid appendages which are almost as long as the sessile or subsessile stamens, and the stiped pistil with a short, puberulous, ring-like disk at its base.

The type specimen of the present species was collected by BECCARI (PB 2339, FI) from Sarawak. It has rather small leaves (8½–13½ by ½–4 cm) and young flowers. The type of *A. grandifolia* (GRASHOFF 693, BO) collected in the swamp forest, Palembang, S. Sumatra, has larger leaves (17–27 by 6–8½ cm) and young flowers. Many specimens collected in the Malay Peninsula (*e.g.* S.F. 29008, 29195, 29381, 29470) and Borneo (*e.g.* bb 34916, ENDERT 3319, 4035, C.F. 34453, PURSEGLOVE P 4752, RUTTEN 68, PATRICK PING San A 1726, and WOOD San 15218) have flowers and fruits in different stages of development and their leaves show a variable size. From this additional material we can clearly infer that only one species is represented.

Aquilaria cumingiana var. parviflora was based on HAVILAND 3092 (type) and several other collections from western Borneo. All the specimens cited in the original description agree with the present species and are quite different from *A. cumingiana*.

Comparison between Peninsular Malaysia's and the global conservation status of five *Aquilaria* species

Species	**Peninsular Malaysia status**	**Global status (ARW, 1998; WCMC, 1998)***
Aquilaria beccariana	DD	VU (A1d)
Aquilaria hirta	VU (A4cd)	VU (A1d)
Aquilaria malaccensis	VU (A4cd)	VU (A1cd)
Aquilaria microcarpa	DD	VU (A1d)
Aquilaria rostrata	DD	DD

Source from:

Asian Regional Workshop (Conservation & Sustainable Management of Trees, Vietnam) 1998. *Aquilaria malaccensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 22 February 2011.

World Conservation Monitoring Centre, 1998. *Aquilaria beccariana*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 24 October 2011.

World Conservation Monitoring Centre, 1998. *Aquilaria hirta*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 24 October 2011.

World Conservation Monitoring Centre, 1998. *Aquilaria microcarpa*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 24 October 2011.

World Conservation Monitoring Centre, 1998. *Aquilaria rostrata*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 24 October 2011.

A. hirta

APPROACH 2

To study the reproductive ecology of the most sought-after species, i.e., *A. malaccensis*

METHODS

- Field surveys to identify study sites.

- Individuals 5 cm diameter at breast height (DBH) and above were tagged with aluminium tags.

- Coordinate reading for each tree was obtained using Garmin GPSMAP 60CSx.

- Trips were made periodically to monitor flowering and fruiting activities as well as to locate more *Aquilaria malaccensis* tree.

SITE 1


MAP OF PENINSULAR MALAYSIA
PERLIS
Kangar
Raya
Langkawi
Pedu
Alor Setar
KEDAH
Jerai
Georgetown
PENANG
THAILAND
Kota Bharu
Bakar
Temengor
Lawit
Kuala Terengganu
Stong
KELANTAN
Kenyir
South China Sea
Larut
Chenderoh
Rabong
Bubu
Korbu
Tahan
TERENGGANU
Ipoh
Brinchang
PERAK
Batu Putih
Tapis
Benom
Kuantan
PAHANG
Semangkok
SELANGOR
Ulu Kali
Chini
Straits of Malacca
Shah Alam
Bera
Tioman
NEGERI SEMBILAN
Seremban
Besar
KUALA LUMPUR
Ledang
MELAKA
Melaka
Belumut
JOHOR
Johor Bahru
INDONESIA
SINGAPORE
0 25 50 100
Kilometers
Legend
Mountain / Hill
City
River
National boundary
State boundary
Lake
Altitude (m)
< 500
500 - 1000
1000 - 1500
> 1500
6°15'N
5°0'N
3°45'N
2°30'N
1°15'N
100°0'E
101°15'E
102°30'E
103°45'E

SITE 1- Results

• Fragmented forest in the district of Perak Tengah, Perak.

• 15 trees were discovered and tagged.

• During the study period in Mac, a tree was observed barely fruiting.

• Seedlings were seen measuring between 20 cm and 2 m of height.

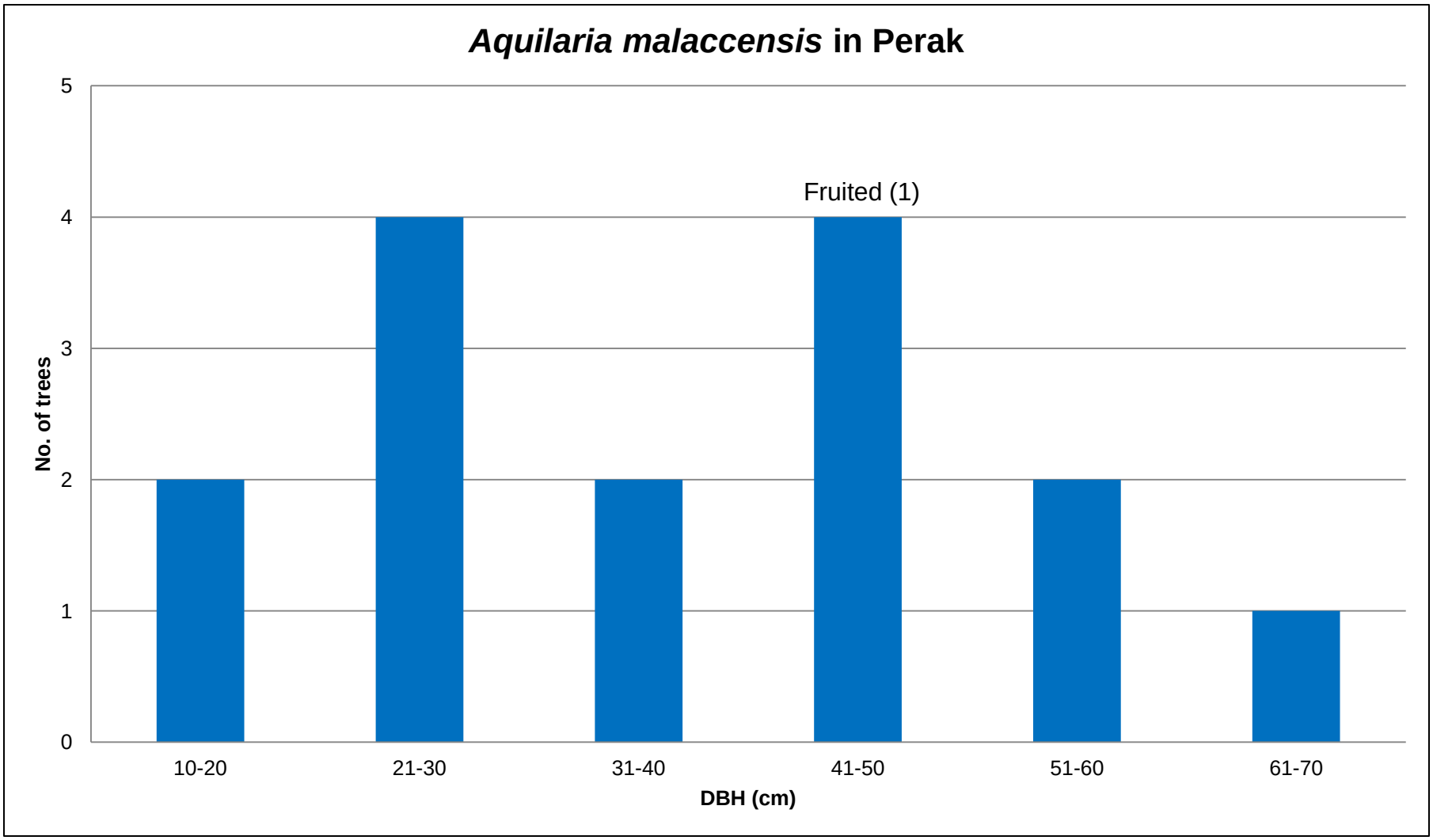
• Potential predators are giant black squirrels.

• Since then, no more activities were recorded.

17.3.2011

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Fruiting												
Germination												

17.3.2011



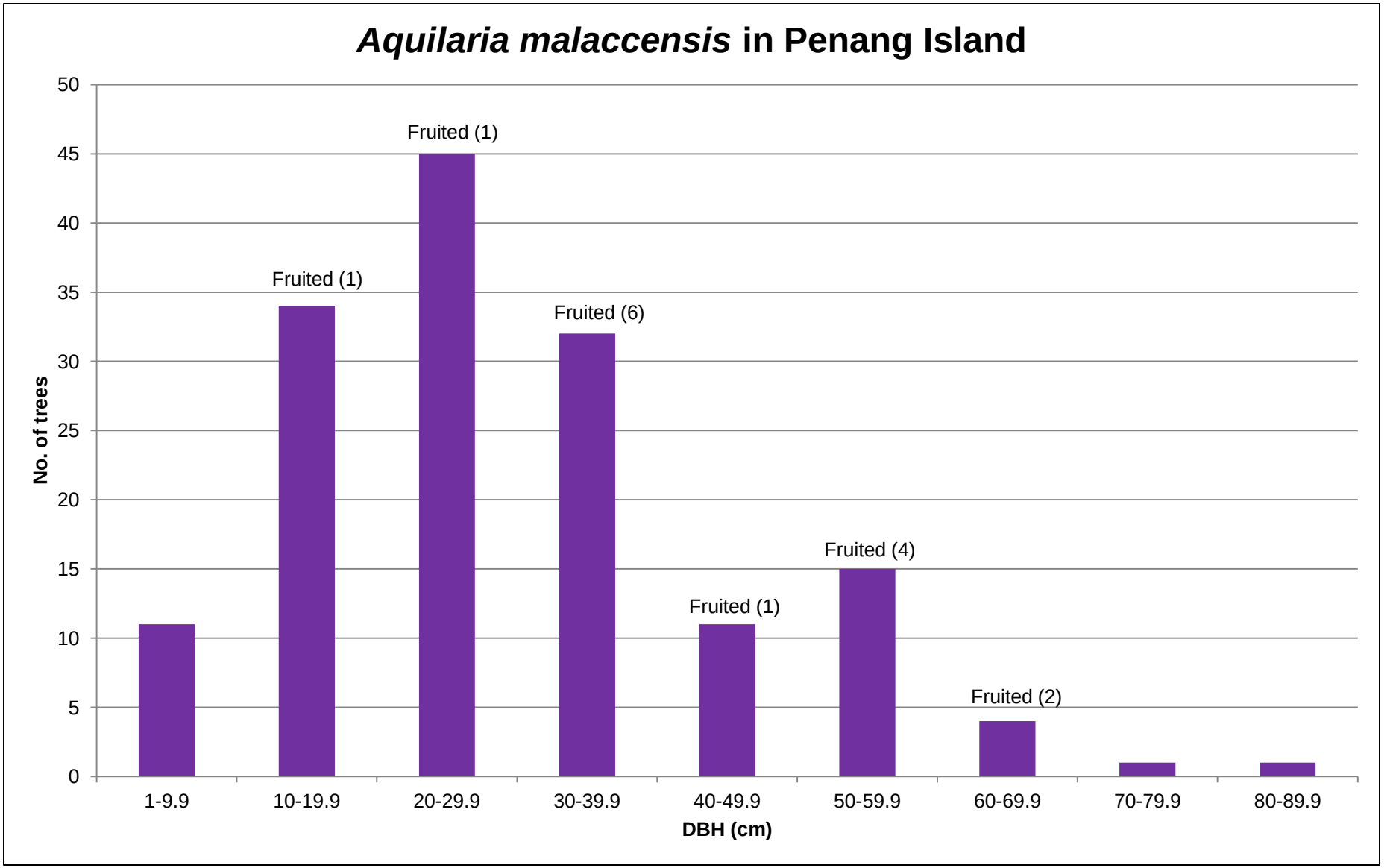
Trees range between 10 and 70 cm DBH.

SITE 2


MAP OF PENINSULAR MALAYSIA
PERLIS
Kangar
Raya
Langkawi
Pedu
Alor Setar
KEDAH
Jerai
Georgetown
PENANG
THAILAND
Kota Bharu
Bakar
Temenggor
Lawit
Kuala Terengganu
Stong
KELANTAN
Kenyir
South China Sea
Larut
Chenderoh
Rabong
Bubu
Korbu
Ipoh
Tahan
TERENGGANU
Brinchang
PERAK
Batu Putih
Tapis
Benom
Kuantan
PAHANG
Semangkok
SELANGOR
Ulu Kali
Chini
Straits of Malacca
Shah Alam
Bera
Tioman
NEGERI SEMBILAN
Seremban
Besar
KUALA LUMPUR
Ledang
MELAKA
Melaka
Belumut
JOHOR
Johor Bahru
SINGAPORE
INDONESIA
0 25 50 100
Kilometers
Legend
Mountain / Hill
City
River
National boundary
State boundary
Lake
Altitude (m)
< 500
500 - 1000
1000 - 1500
> 1500
6°15'N
5°0'N
3°45'N
2°30'N
1°15'N
100°0'E
101°15'E
102°30'E
103°45'E

SITE 2- Results

- Northern region of PM in Penang Island.
- 154 trees were discovered and tagged.
- Fifteen trees from the populations had flowered and fruited between Mac-July.
- Seedlings were tagged and measured for regeneration study.
- Potential predators are squirrels and macaques.



Trees range between 5 and 90 cm DBH.

5.4.2011

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Fruiting												
Germination												

14.4.2011

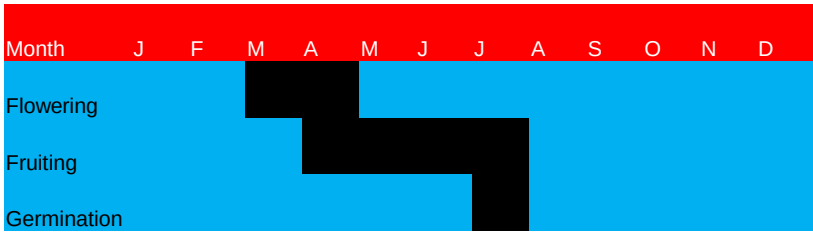
13.5.2011

Month	J	F	M	A	M	J	J	A	S	O	N	D
Flowering			■	■								
Fruiting				■	■	■	■	■				
Germination												

16.6.2011


AM 18 13/5/2011

19.7.2011



19.7.2011

- Mixture of sand and soil, placed in nursery.

- 16 days to germinate, up to 80%.

The future of *Aquilaria* in Malaysia

- More aspects to be studied, i.e. pollination, germination and population viability studies.

- Molecular studies.

- Law enforcement on forest reserves and protected areas.

ACKNOWLEDGEMENTS

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- Department of Wildlife and National Parks Peninsular Malaysia
- Universiti Teknologi Petronas
- Public Works Department of Penang
- Penang Botanic Gardens
- IUFRO - APAFRI

THANK YOU