

DIVERSITY, DISTRIBUTION AND EVOLUTION OF *RAFFLESIA* *HASSELTII* AND ALLIED SPECIES

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INTRODUCTION

Since the first introduction of *Rafflesia arnoldii* by Robert Brown in 1821, more than 28 species of *Rafflesia* have been described by various botanists (Table 1). The first major revision was published by Meijer (1984) with a preliminary key to 12 species of *Rafflesia*, with four species were new to science then. Meijer (1997) later published a detailed account of his revision in the Flora Malesiana in which he recognised 13 species, including the new *Rafflesia tengku-adlinii* which was published a few years earlier by Mat-Salleh & Latiff (1989). Meijer (1997) recognises *Rafflesia patma* - *R. zollingeriana* and *R. tuan-mudae* - *R. arnoldii* as conspecifics, unpopular disposition that was not regarded as a good decision by later taxonomists (i.e. Zuhud et al. 1998, Nais 2001). Nais (2001) in the latest revision presented in his excellent "*Rafflesia of the World*" recognised 18 species and one variety, inclusive of 3 imperfectly known Bornean species (*R. borneensis*, *R. ciliata* and *R. witkampii*) due to the lack of well-preserved herbarium materials. Very recently, Wong and Gan (2002) reported a new species of *Rafflesia* from Peninsular Malaysia which was dubbed as *Rafflesia* "No. 19". However, the real 19th species of *Rafflesia* was published by Barcelona et Fernando (2002) from endemic populations in the Antique region in the Philippines's Panay Island. *Rafflesia* no. 19, was later published as *Rafflesia azlanii* by Latiff & Wong (2004).

Rafflesia species are patchily distributed from the Kra Isthmus in Thailand and south and westwards in Peninsular Malaysia, Sumatra, Borneo, Java and the Philippine Islands (Bänziger 1991, Mat-Salleh 1991, Meijer 1997) (Figure 1). Beside biological hiccups for *Rafflesia* has been known to have high mortality rate, bud-collection for traditional medicines has been of a great problem for some populations of *Rafflesia* (Mat-Salleh 1990). Thus, *Rafflesia* is exceedingly rare, and some species may be at the brink of extinction. Conservation of the *Rafflesias* has been given a high priority. In Indonesia, *Rafflesia* is protected by law and designated the National Rare Flower. In Malaysia, extensive efforts have been put into monitoring and protecting areas inhabiting *Rafflesia* species (Ismail et al. 1988, Nais & Wilcock 1998).



Rafflesia has been noted to feature an exceptional diversity in size, floral colour, pattern and distribution. The diameter of the flowers ranges from minute 15 cm (*R. manillana*, *R. rochussenii*) to gigantic one meter across. Some species are monotonous in colour and pattern of blotches and yet others with striking white blotches against the red background on the perigone lobes and diaphragm, either raised globose individual spots or shapeless joined continuum, as shown in diagrams and photographs in Meijer (1997) and Nais (2001).

For taxonomic purpose, the circumscription of *Rafflesia* species is based on floral morphology such as size of the flower, size and spot pattern of the diaphragm, the size of aperture opening, number of processes, pattern of inside “windows”, number of anthers, number of annuli, and structure, length and positioning of ramenta (Meijer 1997, Nais 2001) (Figure 2).

Table 1. Published species of *Rafflesia* compiled from *Index Kewensis*, with recognised species given in bold

1. *Rafflesia arnoldi* **R. Br.** in Trans. Linn. Soc. 13 (1821) 201
2. *Rafflesia arnoldii* var. *atjehensis* (Koord.) W. Meijer in Fl. Males., Ser. 1, 13 (1997) 23
3. *Rafflesia cumingii* R. Br. in Trans. Linn. Soc. 19 (1844) 243 (= *R. manillana*)
4. *Rafflesia hasseltii* **Suring.** Acta Soc. Reg. Sc. Neerl. (1879) 4-5
5. *Rafflesia horsfieldii* R. Br. in Trans. Linn. Soc. 19 (1844) 242 (=?)
6. *Rafflesia lagascae* Blanco, Fl. Filip. ed. 2. (1837) 595 (= *R. manillana*)
7. *Rafflesia manillana* **Teschem.** in Boston Journ. Nat. Hist. 4 (1844) 63-65, t. 6
8. *Rafflesia patma* **Blume**, Flora 8 (1825), 609
9. *Rafflesia philippensis* Blanco, Fl. Filip. ed. II. (1837) 565 (= *R. manillana*)
10. *Rafflesia rochussenii* **Teysm. & Binn.** in Nat. Tijdschr. Nederl. Ind. 1 (1850) 425
11. *Rafflesia schadenbergiana* **Goepp. ex Hieron.** in Gartenfl. 34 (1885) 3; t. 1177

12. *Rafflesia titan* Jack, Desc. Malay. Plants, 3 (1820) 1 (= *R. arnoldi*)
 13. *Rafflesia tuan-mudae* Becc. in Atti Soc. Ital. Sc. Nat. 11 (1868) 197
 14. *Rafflesia atjehensis* Koord. in Bull. Jard. Bot. Buitenz. 3 Ser. 1 (1918) 177 (= *Rafflesia arnoldii* var. *atjehensis*)
 15. *Rafflesia borneensis* Koorders, Bot. Overz. Rafflesiaceae. Ned.-Ind. (1918) 47
 16. *Rafflesia cantleyi* Solms-Laubach in Ann. Jard. Buitenz. 20, Suppl. 3 (1910) 2
 17. *Rafflesia ciliata* Koorders, Bot. Overz. Rafflesiaceae. Ned.-Ind. (1918) 64
 18. *Rafflesia gadutensis* W. Meijer in Blumea 30(1): 211 (1984)
 19. *Rafflesia keithii* W. Meijer in Blumea 30(1): 211 (1984)
 20. *Rafflesia kerrii* W. Meijer in Blumea 30(1): 212 (1984)
 21. *Rafflesia micropylora* W. Meijer in Blumea 30(1): 213 (1984)
 22. *Rafflesia patma* Blume in Flora 8 (1825) 609
 23. *Rafflesia pricei* W. Meijer in Blumea 30(1): 214 (1984)
 24. *Rafflesia tengku-adlinii* K. Mat-Salleh & A. Latiff in Blumea 34(1): 112 (1989)
 25. *Rafflesia witkampii* Koorders, Bot. Overz. Rafflesiaceae. Ned. Ind. (1918) 61
 26. *Rafflesia zollingeriana* Koorders, Bot. Overz. Rafflesiaceae. Ned. Ind. (1918) 67
 27. *Rafflesia speciosa* Barcelona et Fernando, Kew Bull 57 (2002) 648
 28. *Rafflesia azlanii* Latiff et M. Wong, Folia Malaysiana 4: 135-146 2004
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RAFFLESIA HASSELTII AND ITS DISTRIBUTION IN SOUTH EAST ASIA

Rafflesia hasseltii was described by Willem Frederik Reinier Suringar (1832 – 1898), in 1879 (Suringar 1880), based on the collection of Van Hasselt, Veth and Snelleman on 29 Dec 1877 from Liki and Lompatan Andjing in Sumatra and was said to be known as “Tjendawan Matahari”. More importantly, the species was said to resemble *R. arnoldii* R. Br. and *R. patma* Blume but with smaller flower than the two. The species was illustrated in detail showing the pattern of spots on the perigone lobes and diaphragm, as well as lateral sections of the flower. Early European botanists in Malaya, including Meijer (1983), had identified Malayan species currently known as *Rafflesia cantleyi* Solms-Laubach as *R. hasseltii* due to the similarity of the spots in Suringar’s illustration to this species. Meijer (1984, 1997) however, changed his mind and treated that common central Malaysian species as *Rafflesia cantleyi* and adopted another species from Sumatra as *R. hasseltii* (Figure 10), which was later adopted by Ervizal et al (1998) in their *Rafflesia* of Indonesia account. It was then become a norm to identify the one in Sumatra as *R. hasseltii* (Figure 1).

The existence of the species that seems to represent *R. hasseltii* in Peninsular Malaysia was discovered during MNS 1994 Belum Heritage and Scientific Expedition in Temenggor, Perak, and the photographs were published by Davison (1995). Two years later, another population was found from the southern part of Taman Negara by Latiff & Mat-Salleh (2001). Based on more recent discoveries, Latiff & Wong (2004) recently decided that this species can be distinguished from *R. cantleyi* – *R. hasseltii* and suggested a new name, *Rafflesia azlanii* to represent this taxon (Figure 2).

Meijer’s detail description and illustration of *Rafflesia hasseltii* in *Flora Malesiana* (1997) was based on original description of Suringar (1880) and fragmentary type in Leiden. Thus, the interpretation of this species is difficult. The species was also thought to be available in Samunsam, Sarawak, based on blurred picture taken by Cheksum Tawan from UNIMAS in 1999 (Nais 2001). This was later confirmed by Mat-Salleh & Ong (2004). *Rafflesia hasseltii* in Tanjung Datu has 2 – 3 rings of whitish pink warts surrounded with red circle. The upper zone of the flower tube near attachment of the diaphragm has two instead of four rings of toadstool-like compoundramenta, and has only 25 – 28 anthers as compared to only 20 anthers in Sumatra.

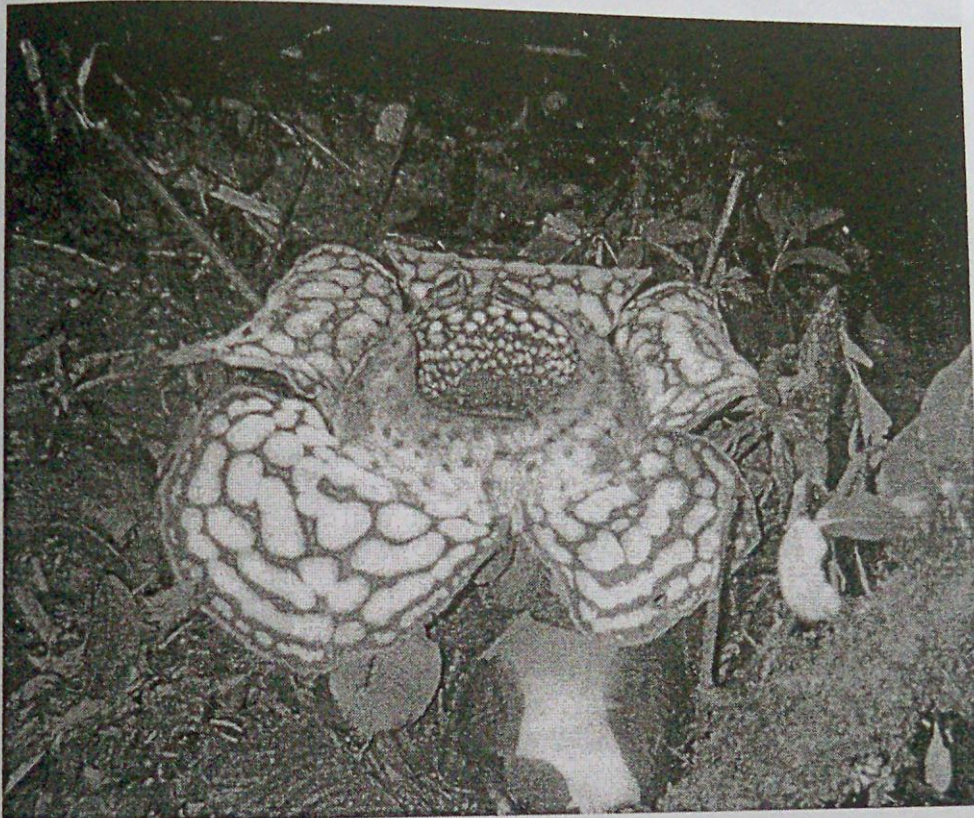




Figure 1. *Rafflesia hasseltii* from Kerinci Sebelat, Sumatra, (top) and
Tanjung Datu (bottom)

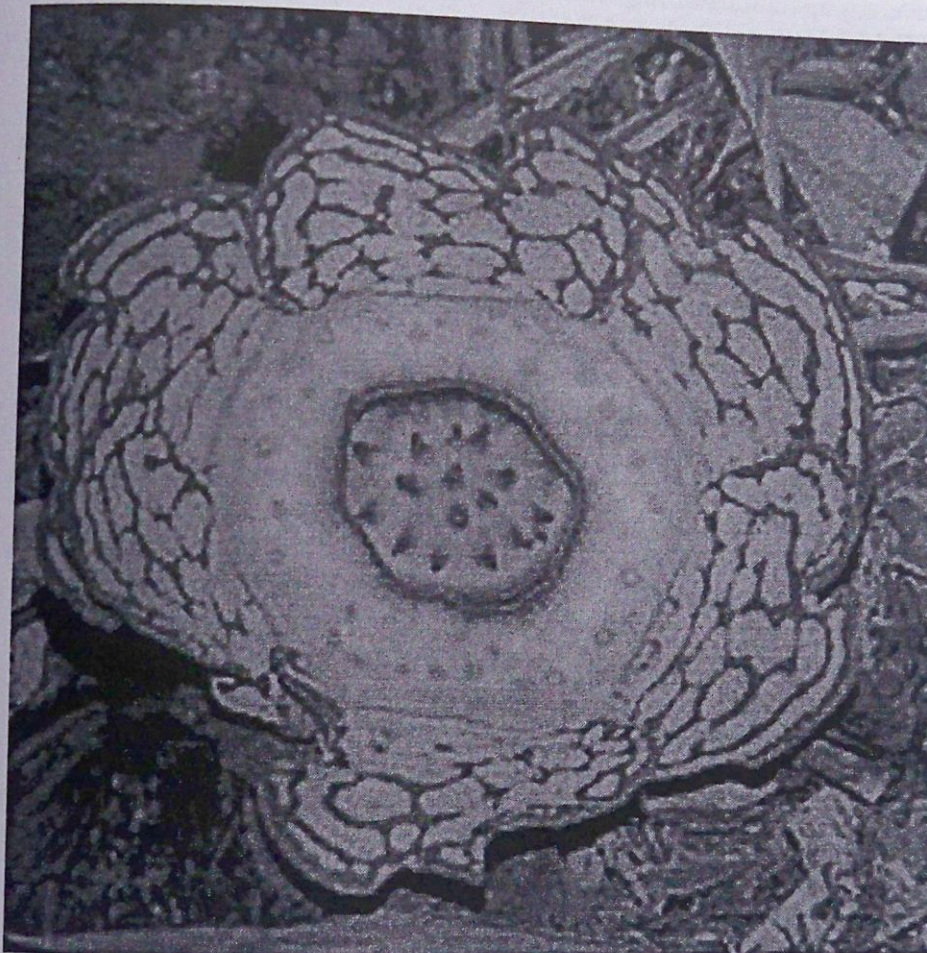


Figure 2. *Rafflesia azlanii* from Belum, Perak, Malaysia

SYSTEMATIC REVISION OF *RAFFLESIA HASSELTII*

In Sumatera, populations of *Rafflesia hasseltii* occur in Bukit Tiga Puluh NP, Kerinci Seblat National Park and Bukit Dua Belas in Jambi. Photographs of this species show the differentiation in flower size, number of circular ring and blot pattern (Table 2). Morphological variations of *Rafflesia hasseltii* in Sumatra and Borneo, as well as distinguishing characters between this species and *R. azlanii* - *R. cantleyi* need to be studied and redocumented. It is also interesting to find out their divergence, and evolution. This can be achieved with detail taxonomic revision, and systematic analysis using not only external morphological characters, but also molecular approach and micromorphology. Phenology, sexual dimorphism, climatic variations and distribution would also help to settle outstanding issues in their status. Close cooperation between Malaysia-Indonesia in scientific collaborations, especially UKM-UNRI joint research program helps to realise this objective.

The main objective of this study, a PhD project of UNRI academic staff in UKM, is to answer these following questions :

1. What are the distinguishing morphological characters within species of *R. hasseltii* complex?
2. Is there morphological plasticity in the each of the species ?
3. What is the effect of rain and weather patterns on the morphology of *Rafflesia hasseltii* members?
4. How far is the genetic variability of *R. hasseltii* complex? Recent advances in molecular biology have provided a variety of new tools applicable in systematic research.
5. What is the genetic relationship of buds in the *Rafflesia* population? Are they the same individual? Can we use genetic finger-printing to tell their origin?
6. What about sexual dimorphism in *Rafflesia*? Are they diecous or monoecious? Are there external morphological variations among sexes, population pattern?

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Table 2. The Morphological Comparisons among *Rafflesia hasseltii* complex

Characters	<i>R. hasseltii</i>					
	Riau BTNP (Widyatmoko 1998)	W. Sumatera (Nais 2001 : Meijer 1997)	Jambi (Zuhud et al. 1998)	Bengkulu (Oryx 1999)	TN. Pahang (Latiff &Mat Salleh 2001) (= <i>R</i> <i>azlanii</i>)	Tanjung Datu. Sarawak (Ong 2004)
Mature Bud	15-17 cm	18-19 cm	18-19 cm	Na	Na	14.5
Open flower dimension	20-25 cm	35-50 / 38- 55 cm	35-50 cm	Na	42-46 cm	φ42-53, O42-46 cm
Perigone lobes	Na	10-13 cm long, 14-17 cm wide	Na	Na	7-10 cm long, 14-18 cm wide, hairy on the outside,	10-14.5 cm long, 12.6-20 cm wide, semi orbicular
Color and pattern	5 pinky-white blot, red; Blots large	5 whitish- pinkish blots across, Blots large, 5x3 to 10 x 1 cm	White large blot, back ground red	5 pinky- white blot, red; Blots large	orangeish when young, chocolate- brown when old	Red background, whitish-pinkish blots (different in dry n wet season)
Circular ring	1, spots	1, with 25 dots	1,2,3, irregular rounded or oblong spots	3, spots	Na	2-3, rounded or oblong size 3-6 mm
Diaphragm opening	Na	½ as wide as thw apex of te flower tube	Na	Na	Na	5.5-7.2 cm, diamt 14.5-24 cm, pentagonal, 4-8.5 cm wide
Window	Na	Whitish or pale yellowish with dark brown zone near the rim	Na	Na	Na	3 white warts rings, 10-20 mm wide
Processes	Na	15-24, not flattened	18-21	Na	20	φ22, O15-16
Ramenta (Upper)	Na	Toadstool- like compound ramenta, 4- 11 mm	Na	Na	Linear with swollen apices	8-10 mm, thicker than mid and lower ramenta, linear, swollen apices
Ramenta (midle)	Na	Generally linear, swollen apices	Na	Na		8-11 mm
Ramenta (lower)	Na	Generally linear, swollen apices	Na	Na		5-8 mm
Anther	Na	20	Na	Na	Na	25-28

