Gardens' Bulletin Singapore **49** *(1997) 7–13.*

Root Hemi-parasitism In Malayan Olacaceae

STEPHEN P. TEO

Sarawak Herbarium
Sarawak Forestry Department
93600 Kuching
Sarawak

Abstract

Six species of Olacaceae found in the Malay Peninsula were investigated for parasitism. Root parasitism was observed only in *Olax psittacorum* and *Ximenia americana* var. *americana* but not in *Strombosia javanica, Scorodocarpus borneensis, Ochanostachys amentacea* and *Erythropalum scandens*. Haustoria of the two parasitic species were found attached to a number of hosts indicating that they are non-host specific. Anatomy of the haustoria revealed that the suckers of the haustoria form a cup-like structure around the stelar region of the host roots.

Introduction

Hemi-parasitism is known to occur among families of the Santalales. Nevertheless, the extent to which parasitism occurs within the Olacaceae has not been comprehensively investigated (Fineran, 1991). Cronquist (1981) stated that most genera of Olacaceae are parasitic, while Whitmore (1973) in his revision of Malayan Olacaceae, remarked that none is parasitic. Corner (1988) mentioned that the roots of *Ximenia americana* are parasitic including on roots of its own kind, while Backer and Bakhuizen (1965) stated that the Olacaceae of Java are sometimes parasitic. However, there is insufficient evidence to substantiate these claims. A review of literature shows that the only published work on parasitism in Olacaceae reported from Malesia is that on *Olax imbricata* from the Philippines (Herbert, 1922). Fineran (1991) cited geographical inaccessibility as the reason why the Olacaceae was poorly studied. Field work was therefore undertaken in Peninsular Malaysia to give a better understanding of the occurrence of hemi-parasitism in the Olacaceae.

Materials and Methods

Parasitism can only be demonstrated by the presence of haustoria and their penetration into the host roots. In the case of root parasites, the haustoria occur below the soil surface so are not easy to locate. Indeed, a

cangkul and shovel were used to unearth the roots. The root systems were then examined carefully for the presence of haustoria and host plants to which the haustoria were attached were identified as far as possible. Plants in their natural habitat as well as those cultivated at Rimba Ilmu (Botanic Garden), University of Malaya were used in the study. The following is the list of plants studied.

Erythropalum scandens Blume.
Bukit Lagong Forest Reserve, Selangor; Telok Cempedak, Kuantan, Pahang *(KLU 041342, KLU 041344, KLU 141349)*

Ochanostachys amentacea Masters
Rimba Ilmu, University of Malaya, Kuala Lumpur
(KLU 041331, KLU 041333, KLU 041345)

Olax psittacorum (Willd)Vahl.
Kampung Sungai Baging, Trengganu
(KLU 041337, KLU 041338)

Strombosia javanica Blume.
Bukit Lagong Forest Reserve, Selangor
(KLU 041341, KLU 041340, KLU 041339)

Scorodocarpus borneensis (Baill.) Becc.
Bukit Lagong Forest Reserve, Selangor
(KLU 041045, KLU 041382, KLU 041329)

Ximenia americana L. var. *americana* Defilipps
Blue Lagoon, Port Dickson, Negeri Sembilan
(KLU 041339, KLU 041340, KLU 041341)

Haustoria found during the study were preserved in 50% FAA (50% ethanol:formalin:acetic acid 18:1:1) for further morphological and anatomical investigations. They are also deposited in the University of Malaya Herbarium (KLU). Seedlings of species not already represented in Rimba Ilmu were brought back and grown there.

Results and Discussion

Only two of the six species of Olacaceae studied were found to be hemiparasitic, namely *Olax psittacorum* (Fig 1) and *Ximenia americana* var. *americana* (Fig 2).

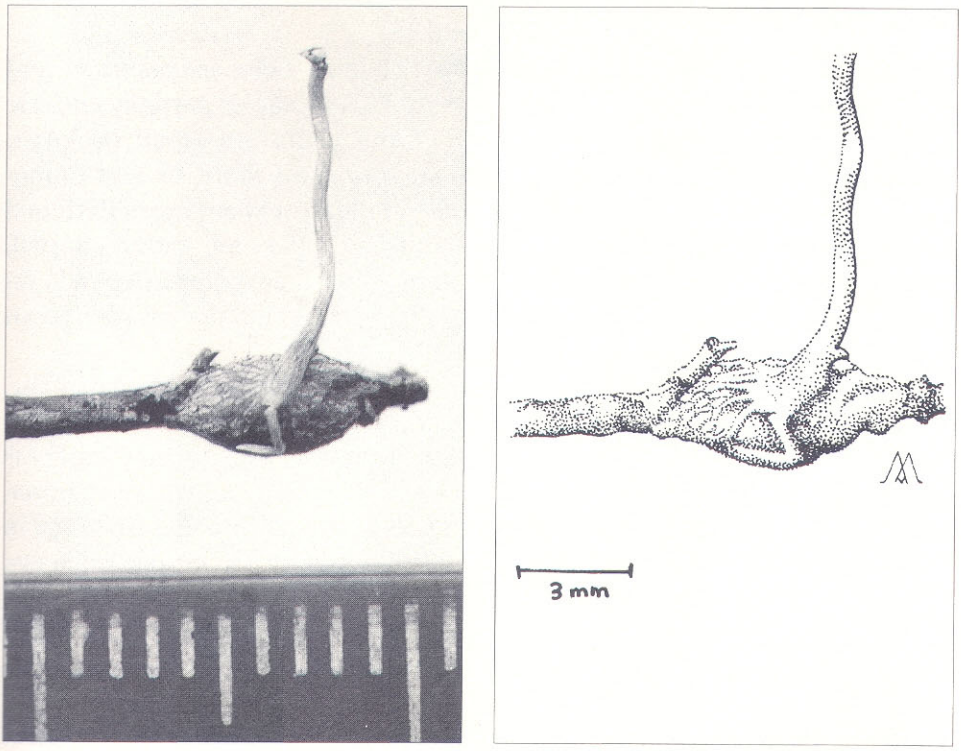

Figure 1. Haustorium of *Olax psittacorum* invading the root of its own species.

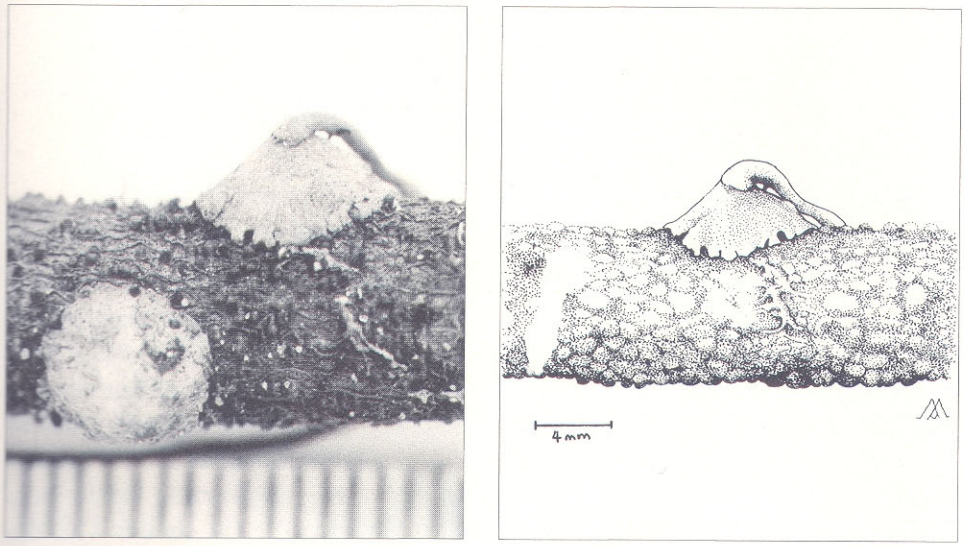

Figure 2. Haustorium of *Ximenia americana* var. *americana* invading the root of *Pongamia pinnata*.

Haustoria and host

Both primary and secondary haustoria occur in *Olax psittacorum* and *Ximenia americana* var. *americana*. The haustoria totally or partially encircle the host roots depending upon whether the roots are small or large, respectively. The haustoria of *Olax psittacorum* are more or less dome-shaped while those of *Ximenia americana* var. *americana* are more flattened and disc-like during the early stage but later become dome-shaped. Haustoria size ranged from about 1–20mm while their colour depends on age. In general, the haustoria darken with age. This may be due to an accumulation of phenolic compounds.

The haustoria of both *Olax psittacorum* and *Ximenia americana* var. *americana* invade the roots of other plants of their own species in the same way that Herbert (1922) reported in *Olax imbricata*. This further confirms the remark made by Corner (1988) for *Ximenia americana* var. *americana*. Self-parasitism probably arose out of the need to increase the efficency in the use of limited water resource, especially when the hemi-parasites are found in a hostile environment. In general, it appears that both species are non-host specific judging from the number of hosts they can attack (Table 1). However, only the roots of dicotyledons are attacked by the haustoria.

Table 1 : Plants invaded by the haustoria of *Olax psittacorum* and *Ximenia americana*.

Olax psittacorum	*Ximenia americana*
Aglaia sp. (Meliaceae)	*Pongamia pinnata* (Leguminosae)
Tetracera sp. (Dilleniaceae)	*Terminalia catappa* (Combretaceae)
Psychotria sp. (Rubiaceae)	
Anacardium occidentale (Anacardiaceae)	

Anatomical sections of the haustoria of *Olax psittacorum* and *Ximenia americana* var. *americana* reveal that the sucker at the distal end of the vascular core forms a structure that is appressed to the stele of the host roots (Fig. 3 & 4). The suckers are only connected to the xylem but not the phloem. The location and arrangement of the conducting vascular cells in both *Olax psittacorum* and *Ximenia americana* var. *americana* are essentially similar. In *Olax psittacorum*, only one strand of the conducting tissue links the host to the parasite and occupies a central position in the sucker whereas for *Ximenia americana* var. *americana*, there exist two strands of conducting tissue and both strands are at the periphery.

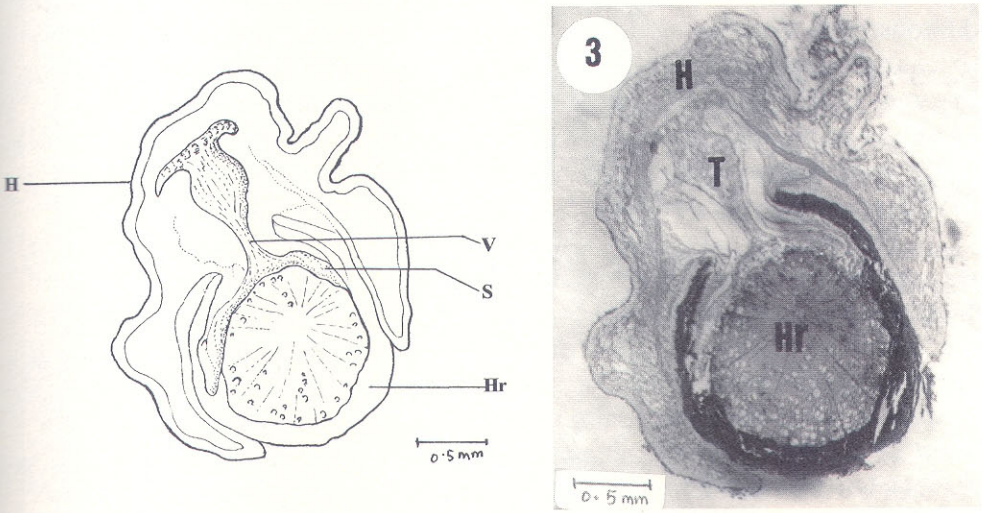

Figure 3. Cross-sectizon of the haustorium of *Olax psittacorum.*
H-haustorium; Hr - host root; V-vascular core; S-Sucker; T-vascular core

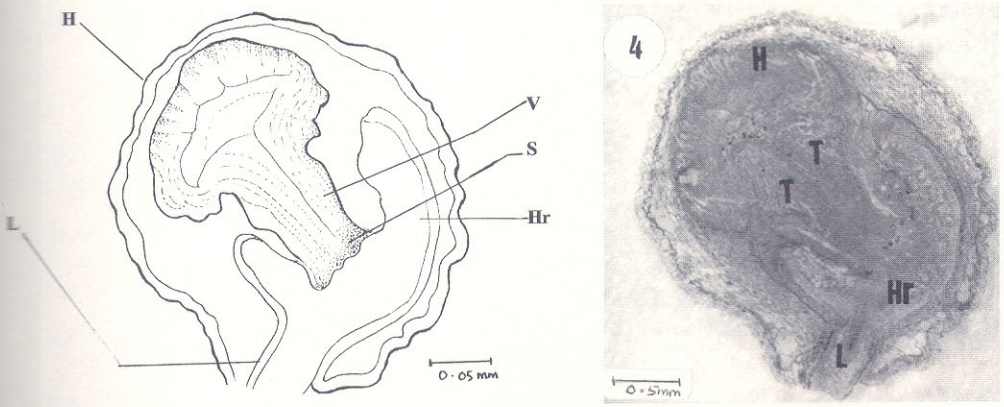

Figure 4. Cross-section of the haustorium of *Ximenia americana* var. *americana*. H-haustorium; Hr - host root; L-lateral root; V-vascular core; S-Sucker; T-vascular core

Correlation between parasitism and habitat in Olacaceae

The occurrence of parasitism among different families and orders demonstrates that this mode of nutrition has evolved independently many times during the evolution of angiosperms (Nickrent and Franchina, 1990; Fineran, 1991). Parasitism might have developed among different taxa due to similar habitat conditions. This might occur where certain nutrients and water were scarce, and especially under circumstances favourable for the development of organic connections between plants (Fineran, 1991).

The two parasitic species, *Olax psittacorum* and *Ximenia americana* var. *americana*, thrive well in dry, sandy coastal areas while the non-parasitic members are found in humid evergreen forest. Most hemiparasitic taxa of the Santalales prefer somewhat open habitats with extreme conditions, e.g. dry or harsh (Fineran, 1991). Parasitism may have arisen out of the need to adapt in a water-deficient habitat. In fact, the dry, sandy habitat along the coast of the Malay Peninsula supports a high number of other parasitic plants from different famillies, namely, *Champereia manillana* (Opiliaceae), *Dendrotrophe* spp. (Santalaceae) and *Cassytha filiformis* (Lauraceae).

The fact that there is only connection between the haustorium and the xylem in both *Olax psittacorum* and *Ximenia americana* var. *americana* coupled with their occurrence in only dry habitats demonstrates that hemi-parasitism is one of the adaptive features that may increase the efficiency in the use of water. This is also found to be true in other hemi-parasites (Pate *et al.*, 1990a, 1900b; Fineran, 1991). However, there is no co-relationship between type of root system and life-form with hemi-parasitism as suggested by other workers such as Pate *et al.* (1990a, 1990b) and Fineran (1991). For example, *Olax psittacorum* has a shallow and extensive root system and is a scrambling shrub, while *Ximenia americana* var. *americana* has a root system quite deeply rooted and it is a tree up to 5 m high.

Within the haustoria of root parasites, there are unusual xylem conducting cells known as graniferous (granule-containing) tracheary elements (Fineran, 1985). Fineran (1985) noted that the nature of the granules in Olacaceae is not consistent and varies from protein in one genus to starch in another. On the other hand, the nature of granules in other families of the Santalales is very consistent. Fineran suggested that this showed that the Olacaceae is an unnatural family and with different treachery elements, root parasitism has arisen at least twice in the family.

Conclusion

This study shows that only some species of the Olacaceae are hemi-parasitic, namely *Olax psittacorum* and *Ximenia americana* var. *americana,* and that they are non-host specific and that self-parasitism occurs.

Acknowledgements

I am indebted to Dr. N. Prakash, University of New England, Australia, Dr. Noorma Wati Haron and Prof. Haji Mohamed Abdul Majid, Head of Botany Department, University of Malaya for their comments. Thanks are also due to Mr. Mohamed Akip and Mr. Joseph Pao for the illustrations provided. This paper reports part of an MSc thesis submitted to the University of Malaya, Kuala Lumpur, which was supervised by Dr. Noorma Wati Haron. Financial grants from Vote F 150/94 (University of Malaya) and R & D 1-07-04-049-04 (Malaysian government) are gratefully acknowledged.

References

Backer, C. A. and R. C. Bakhuizen van den Brink. 1965. *Flora of Java.* **2**: 63–64.

Corner, E.J.H. 1988. *Wayside Trees of Malaya.* The Malayan Nature Society Kuala Lumpur, Malaysia. 3rd edition.

Cronquist, A. 1981. *An Integrated System of Classification of Flowering Plants.* Columbia University Press, New York.

Fineran, B. A. 1985. Graniferous treachery elements in haustoria of root parasitic angiosperms. *Bot. Rev.* **51**: 389–441.

Fineran, B. A. 1991. Root hemi-parasitism in the Santalales. *Bot. Jahrb. Syst.* **113**: 277–308.

Herbert, D. A. 1922. Parasitism of *Olax imbricata. Philipp. Agric.* **11**(1): 17–18.

Nickrent, D. L. and C. R. Franchina. 1990. Phylogenetic relationships of the Santalales and relatives. *J. Mol. Evol.* **31**: 294–301.

Pate, J. S., J. Kuo and N. J. Davidson. 1990a. Morphology and anatomy of the haustorium of the root hemiparasite *Olax phyllanthi* (Olacaceae), with special reference to the haustorial interface. *Ann. Bot.* **65**: 425–436.

Pate, J. S., S. R. Pate, J. Kuo and N. J. Davidson. 1990b. Growth, resource allocation and the haustorial biology of the root hemiparasite *Olax phyllanthi* (Olacaceae). *Ann. Bot.* **65**: 437–449.

Whitmore, T. C. 1973. Olacaceae. *Tree Flora of Malaya.* **2**: 299–307.