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A New Ant-Tree from SE Asia: *Zanthoxylum myriacanthum* (Rutaceae), the Thorny Ivy-Rue

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Abstract: *Zanthoxylum myriacanthum*, a small Rutaceous tree growing mainly in secondary hill forests in SE Asia, is a true myrmecophyte. It possesses stem domatia in the form of hollow branches with slitlike openings. Branch hollows and entrance slits are produced by the plant itself through pith degeneration and growth processes. If the entrance is not kept open by ants it closes again by growth of the surrounding tissue after some time. The domatia are colonized opportunistically by different arboreous ants, e.g. *Crematogaster* and *Camponotus*. Additionally many small extrafloral nectaries are found on the leaflets of *Zanthoxylum myriacanthum*. Judging from herbarium studies and literature records at least four more true ant trees are found in the genus *Zanthoxylum* namely *Z. rhetsa* in SE Asia, *Z. conspersipunctatum*, *Z. pluviatile* and *Z. vinkii* in New Guinea. We could not confirm ant inhabitation in *Drypetes pendula* (Euphorbiaceae) on the Malay Peninsula, which has also been recorded to be an ant-tree.

INTRODUCTION

In his book "Wayside trees of Malaya" Corner (1988:35) lists for the Malay Peninsula trees which offer nesting space (called domatia) for ants. For ant-plants with stem domatia he mentioned species of the genera *Macaranga* and *Drypetes* (Euphorbiaceae). *Macaranga* is well known for its ant-inhabitants whose function has been investigated recently (Fiala *et al.*, 1989; 1990). As explained lated in this paper we could not confirm Corner's observations for *Drypetes* on the Malay Peninsula so far. Our search for myrmecophytes in the Malay Peninsula in the last few years, however, has revealed two new myrmecophytic associations whose trees possess stem domatia. One occurs between *Crypteronia griffithii* (Crypteroniaceae) and a highly specialized *Cladomyrma* species (Formicidae, Formicinae), and the other between *Saraca thaipingensis* (Fabaceae) and again *Cladomyrma* ants (Maschwitz *et al.*, 1991). (The ants were new to science and have now been described (Agosti, 1991).

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This paper describes another recently discovered ant-plant with stem-domatia, *Zanthoxylum myriacanthum.*

RESULTS

Zanthoxylum myriacanthum Wall. ex Hk. f. (Rutaceae)

Z. myriacanthum is a small tree which is reported to be rather common in secondary forest in the hills of the Malay Peninsula and Sabah. It also occurs in India, Sumatra and the Philippines. The bole and the twigs of this tree are armed with numerous sharp prickles. The leaves are pinnate with 5–23 elliptic leaflets (Fig. 1). They possess many tiny oil glands, which release a typical intensive terpene-like odour. The white or pale yellow flowers are arranged in terminal and axillary panicles. During a stay in Malaysia in 1991 we found a small recently fallen tree of this species (less than 10 m in height) at a steep slope in the Gombak Valley near Kuala Lumpur (about 500 m a.s.l.). It must have been lying there for one to several days since fresh shoots and leaves had begun to wilt. The tree was inhabited by ants which were already leaving it in great numbers. When we cut the branches we found them hollow not only at the young parts but also at branches with a diameter of up to 10.5 cm. These cavities were mostly without any nodal septa. The interior parts of the new shoots just behind the tips had become hollowed due to degeneration of the pith (Fig. 2). Independently from presence or absence of ants most of the young and still soft shoots showed slitlike openings distributed around the branch surface (Fig. 2, right). On the average 1.5 slits (0–4, n=34) could be found per young shoot (length 3.3 – 50 cm, n=30) at a distance of 1.5 – 11 cm from the tips. Each slit measured about 1.5 cm long on the average (0.8 – 3.32 cm; n=49) and was up to 2 mm wide. The diameter of the hollows in the young shoots was about 7 mm, and the wall thickness was about 1 mm (n=10). It was obvious that the slits of uninhabited shoots gradually closed due to growth of the wall tissue when the branches became older. Interestingly several treelets from 0.4 – 3 m in height, which were found later on did not yet possess openings, though their stems were hollow and in the elder specimens already slightly swollen. On the young trees we could discover many tiny round extrafloral nectaries, which were visited by workers of the large *Camponotus auriventris.* There sugar producing glands (tested with blood sugar testing sticks-dextrostix-) were situated on the underside of the leaflets, mostly near their bases and tips. On two larger leaflets we could count 60 and 87 nectaries, of which 32 and 15 respectively were on the blade bases, 4 and 5 respectively in the middle part, and 24 and 67 respectively at the leaflet tip. They could be distinguished from the numerous oil glands on the leaflets by their slightly larger diameter (0.5 – 1 mm) and their bright green colour. We could not check whether these nectaries also occur on the large domatia bearing tree. The domatia of two distantly positioned branches of the large tree

Figure 1. Branch of the ant tree *Zanthoxylum myriacanthum*

were inhabited by two different ant colonies, namely *Crematogaster* sp. (Myrmicinae) and *Camponotus* sp. (Formicinae). Both ant colonies did not keep any trophobiontic insects in the domatia. We found only two scale insects in the hollows of the tree near an open entrance slit. The colony of a small blackish *Crematogaster* species was very large and contained several thousands of workers. They had been living in the hollow stem but at that time were beginning to emigrate. When we opened the nest branches we were attacked by the aggressive workers. We did not find any carton nest material within the stem hollows. Only the entrance slits were narrowed with carton mass (Fig. 2, middle). Along the stem a series of entrances had been kept open by the ants. In the nest interior and broods could be found. Workers were removing pith from some fresh slits in the young shoots.

A second large branch was inhabited by *Camponotus (Colobopsis)* cf. *saundersi* (for details of this ants' biology see Maschwitz and Maschwitz, 1974). Here the workers had subdivided the interior of the stem hollows into many chambers by means of carton septa. This ant species also kept old domatia entrances open, even at a branch with a diameter of up to 5 cm.

In the herbarium of the Forest Research Institute Malaysia (FRIM) we have checked six other specimens of *Z. myriacanthum* which were collected in Peninsular Malaysia. Five of them were hollow, and in one of the two young shoots a typical slit was present. The only shoot which seemed to be solid was a small flowering shoot. Two specimens from Sabah were also hollow, and one of them displayed the typical slits.

In Peninsular Malaysia only four species of *Zanthoxylum* are found. According to Hartley (1966) and Whitmore (1972, Vol. 1:387) the branches of *Z. rhetsa* (= *Z. limonella*) are also hollow and can be inhabited by ants. The only two specimens of this species in the FRIM herbarium were not hollow, however, these were again both flowering shoots. From the herbarium collection we could check specimens of further species for presence of stem cavities. Without hollows were: *Z. avicennae* (a climber from Sabah), *Z. acanthopodium* and *Z. nitidum* (both shrubs from the Malay Peninsula), *Z. ovalifolium* and *Z. retroflexum* (Sumatra), *Z. brachyacanthum* and *Z. veneficum* (Queensland). Only one more species from the FRIM collection was discovered to possess stem cavities and entrance slits: *Z. vinkii* (from Irian Jaya, New Guinea) which differs from other species of the genus *Zanthoxylum* in having no prickles.

Drypetes pendula Ridley (Euphorbiaceae)

This tree from lowland forest was recorded by Corner (1988, Vol. 1:285) as having hollow twigs which are excavated by ants. In Lambir National Parks, Sarawak, two at present still unidentified species of *Drypetes* were found with ants in the twigs (J. LaFrankie, pers. comm.). During a

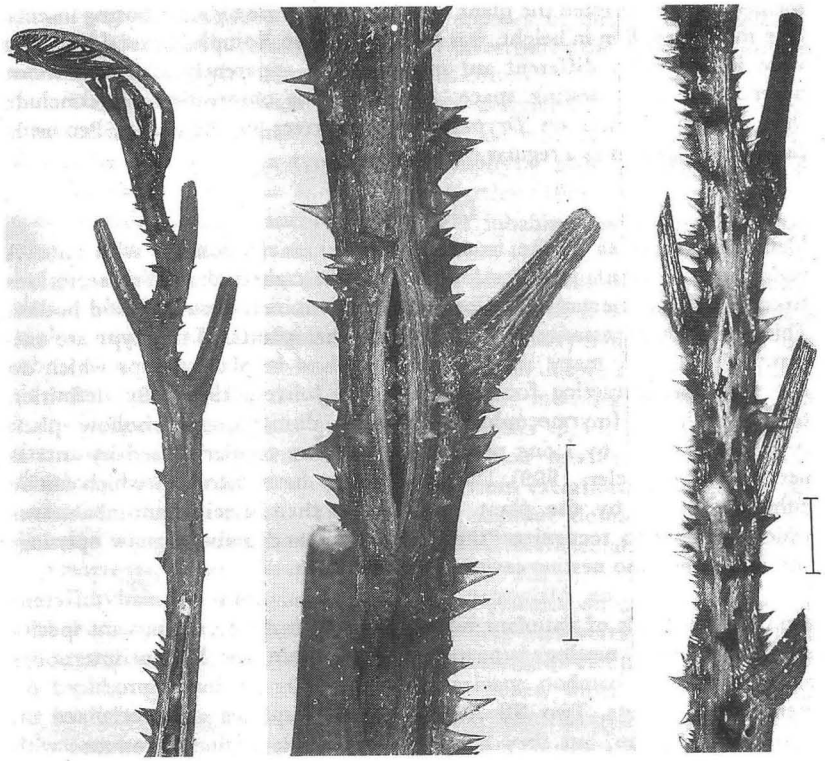

Figure 2. left. Pith degeneration in the interior of a young shoot of *Zanthoxylum myriacanthum*. The degenerated remains of the pith can be seen in the hollow of the lower part of the shoot.

middle. Opening slit of a stem domatium in a young shoot. The entrance has been narrowed with carton material by the ants.

right. Two openings of a young shoot. In the lower slit *Crematogaster* workers can be seen. (bar length 1 cm)

stay in Pasoh Field Station, Negeri Sembilan (about 140 km southeast of Kuala Lumpur) we censused trees of *D. pendula* for possible ant-association. Although the species is rather abundant at Pasoh forest, trees do not occur gregariously and are therefore difficult to find. We came across 13 small-sized trees which were accessible for investigation and dissected their branches to look for cavities and ant-colonization. Ants were detected only in two cases: one *Crematogaster* queen and one small colony of unidentified myrmicine ants with only a few workers. In both cases they

seemed to have entered the plant through holes made by stem-boring insects. One more tree, 8 m in height, was found in Endau Rompin. Several branches were inhabited by different ant species which apparently also used shoot borer hollows as nesting space. Based on this observation we conclude that ant-inhabitation on *Drypetes pendula* trees in the Malay Peninsula cannot be regarded as a regular relationship.

DISCUSSION

Many plant species in the tropics live in close relationship with ants. A wide range of plants provides food for ants as carbohydrate rich secretions from extrafloral nectaries and/or from nutrient rich tissue as food bodies. This does not necessarily mean, however, that plants of this type are ant-plants. In general, many ant-plant have evolved in plant groups which do not offer ant-attracting food (examples in Jolivet, 1986). By definition true ant-plants (myrmecophytes) possess domatia, i.e., hollow plant structures formed by living plant tissue that are regularly used by ants as nesting space (Keeler, 1989). Domatia need to have entrances which can be either produced by the plant itself or by their specific ant-inhabitants which are able to recognize "their" hostplant and actively gnaw openings and sometimes also nesting cavities into their host.

Our studies on Malaysian ant-plant associations revealed different evolutionary levels of ant-plant interactions: for instance, various ant species are often found nesting opportunistically within the hollow internodes and branches of bamboo species, using openings originally produced by stem-boring insects. Two SE Asian *Polyrachis* species are specialized on nesting in bamboo, but they live on leaves in silk pavilions produced with larval silk (Dorow & Maschwitz, 1990). Therefore these bamboos do not qualify as myrmecophytes.

Species of the genera *Myrmeconauclea* Merr. and *Neonauclea* L. (Rubiaceae) provide stem domatia but no food. In *Myrmeconauclea strigosa* many different ant species were found using this nesting space in an opportunistic manner (Maschwitz *et al.*, 1989). On the other hand there also exist highly specific systems on an obligate mutualistic basis as in the association with *Macaranga* trees, where nesting space and food are provided by the plant (e.g. Fiala & Maschwitz, 1991, 1992; Fiala *et al.*, 1991).

Between myrmecophytic and nonmyrmecophytic associations transient stages can be found. In Malaysia such a borderline case was discovered by the late Y.P Tho (pers. comm.) in the dipterocarp tree *Shorea acuminata* which produces many pairs of large semi-persistent stipules at the tips of young shoots. These concave shell-like stipules are used as nesting space by a *Technomyrmex* species, which glues them together with carton material. In this way specific "artificial" domatia are produced by the ants. This *Technomyrmex* sp., however, is not specialized on *Shorea acuminata* but nests in foliage of a variety of trees by attaching leaves with carton in the

same way as described above for the stipules of *Shorea acuminata*. F. Rickson (Oregon University) has recently investigated the defensive function of the ants for the plant they inhabit (pers. comm.).

The tree *Zanthoxylum myriacanthum* described in this paper possesses stem cavities with natural openings which are regularly inhabited by ants. It can be regarded as a typical myrmecophytic plant. In addition to *Z. myriacanthum*, *Z. rhetsa*, and *Z. vinkii*, Hartley (1966) recorded two more species with hollow branchlets sometimes inhabited by ants: *Z. conspersipunctatum* and *Z. pluviatile*, both from New Guinea. Worldwide, however, the genus comprises about 200 spp., most of them tropical and subtropical about whose ant-association no information exists. *Z. myriacanthum* is a typical example of an ant-plant which is facultatively inhabited by different arboreal ant species which use nesting space in an unspecific and opportunistic manner. While the *Crematogaster* sp. only modifies the entrance and keeps it open during plant growth, *Camponotus* sp. cf. *saundersi* modifies the interior of the stem domatia by carton production. Additionally *Zanthoxylum myriacanthum* offers nectar from extrafloral nectaries on the underside of the leaflets. Three species without domatia from Central America are also recorded to possess extrafloral nectaries: *Z. belizense*, *Z. panamense*, *Z. setulosum* (Schupp & Feener, 1991).

Very conspicuous are the numerous prickles on the plant. This is probably a protection against larger climbing herbivores. Being inhabited by aggressive ants, the tree may gain additional protection against flying phytophagous insects. Additionally the terpenes, which are produced in the numerous oil glands of the leaflets may contribute a further repellent effect against phytophagous insects. They were, however, ineffective against papilionid caterpillars that we found on young treelets.

The discovery of *Z. myriacanthum* as a true myrmecophytic plant is the fifth hitherto undescribed ant-plant system found by us in Malaysia within a few years (Maschwitz *et al.*, 1989, 1991; Maschwitz & Fiala, unpubl.). This indicates that more ant-plant associations are still waiting to be discovered in that region in the future.

Typical for many ant-plants like *Z. myriacanthum* is their occurrence in secondary growth habitats where herbivore pressure is high (Beattie, 1985; Huxley, 1986). *Drypetes pendula*, however, also occurs in primary forest. The specimens investigated at Pasoh and Endau Rompin forest were neither naturally hollow nor excavated by a specific ant. This indicates that this *Drypetes* species is not a true myrmecophytic plant. Whitmore (1972, Vol. 2: 87–91) also does not mention any ant-inhabitation in this species. It cannot be excluded, however, that in other regions of the Malay Peninsula *Drypetes pendula* or related species might be occupied by a specific ant, which recognizes this tree as its host and excavates the stem interior. We have observed a similar case in *Saraca thaipingensis* which in many areas of Peninsular Malaysia is not inhabited by its specific *Cladomyrma* ants

(Maschwitz *et al.*, 1991). Another possibility might be that the ants observed by Corner entered the *Drypetes* branches through holes formed by stem boring insects. Such generalist colonizers, however, cannot establish their colonies without preformed holes.

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