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Studies on the Dipterocarpaceae of Borneo, II. Ant stipule-brood sites and extra floral nectary association in saplings of *Shorea macrophylla* [sect. *Pachycarpae*] in Sarawak, Malaysian Borneo

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Abstract. The presence of stipular and leaf blade extra floral nectaries and associated ant activity, including brood raising within stipules, is reported for saplings of *Shorea macrophylla* [sect. *Pachycarpae*] in Kuching Division, Sarawak.

Keywords: Dipterocarpaceae, *Shorea* Section *Pachycarpae*, *Rubroshorea*, Borneo, Sarawak, ants.

INTRODUCTION

The intricate and mutually beneficial associations existing between ants and tropical forest plants were first described for Asia by Beccari (1884–1886) and elaborated upon by Van Leeuwen (1913, 1923a,b,c). Subsequently an extensive body of literature has been generated for tropical Asia, notably for Euphorbiaceae (*Macaranga* – see for example Fiala et al. 1991), Rubiaceae (Huxley 1978; Razafimandimbison et al. 2005; Jebb & Huxley 2019), Melastomataceae (Clausing 1997), Apocynaceae (Kleijn and van Donkelaar 2001; Peeters & Wiwatwitaya 2014; Weissflog et al. 2017), and for the palm genus *Korthalsia* (Chan et al. 2012; Miler et al. 2016). Good general overviews for one lowland area of Peninsular Malaysia are provided of Fiala and Saw (2003) and Moog et al. 2003.

The Dipterocarpaceae, the dominant family of the canopy layer of lowland and hill forest in tropical Asia has no published reports of ant association on Borneo, despite the fact that the understory saplings of several species are routinely found with accompanying ants, especially at the active



Figure 1. *Shorea macrophylla* Active shoot tip of sapling. Note the long revolute stipules and the pale elliptical extrafloral nectaries on the newest stipules.

shoot tips. Here we report ant association and stipule nesting in *Shorea macrophylla* (de Vriese) P.S.Ashton [section *Pachycarpae* sensu Ashton 1963, 1982; *Rubro-shorea* gen. nov. ined. sensu Maury 1978, 1979; Maury-Lechon 1979a,b, Maury-Lechon and Curtet 1998; see also Heckenauer et al. 2017, 2018, 2019)]. To the best of our knowledge these are the first *in situ* observations for this species, although an image of extrafloral nectaries on the stipules of *S. macrophylla*, not native there but planted in the Forest Research Institute Malaysia, appears in Fiala and Saw (2003: Fig. 3).

Shorea macrophylla is a characteristic species of the forested flood plains a west Borneo, frequently developing almost pure stands and immediately recognizable by innovations with the long somewhat briefly persistent stipules (Figure 1 & 2). Saplings and young trees have disproportionately long wide-spreading plagiotropic branches typical of sect. *Pachycarpae*, with leaves of these branches distichously arranged and attached directly to the stem



Figure 2. *Shorea macrophylla* (A) active shoot tip of sapling. Note the long revolute stipules and the pale elliptical extrafloral nectaries on the newest stipules. (B) shoot tip of the red stipule expression. The extrafloral nectaries are clearly visible on the leaf blades. (C) detail of the amplexicaul bases of a stipule pair.

at the geniculum, in marked contrast to the spiralled leaves of the erect stem which have long slender petiole.

West Borneo has had four dipterocarp masting events over past five years with the result that it has been possible to study several large populations of saplings and young trees (up to 5m tall) of *Shorea macrophylla*. Observations revealed that almost every one of the several hundred plants we examined had *Crematogaster* ants associated with the active shoot tips, attracted to conspicuous extra floral nectaries on the exterior of the long stipules, and on the adaxial surface of the emerging and expanding leaf blades (Figure 3 & 4). Further examination of the typically revolute stipules revealed that they were often being used as brood chambers (Figure 5), with the loose edge of the tube packed with fragments of forest litter. On disturbance the ants hurriedly cleared the stipule of eggs (Figure 5). Although we did not see any active defence of the shoot tips by the ants

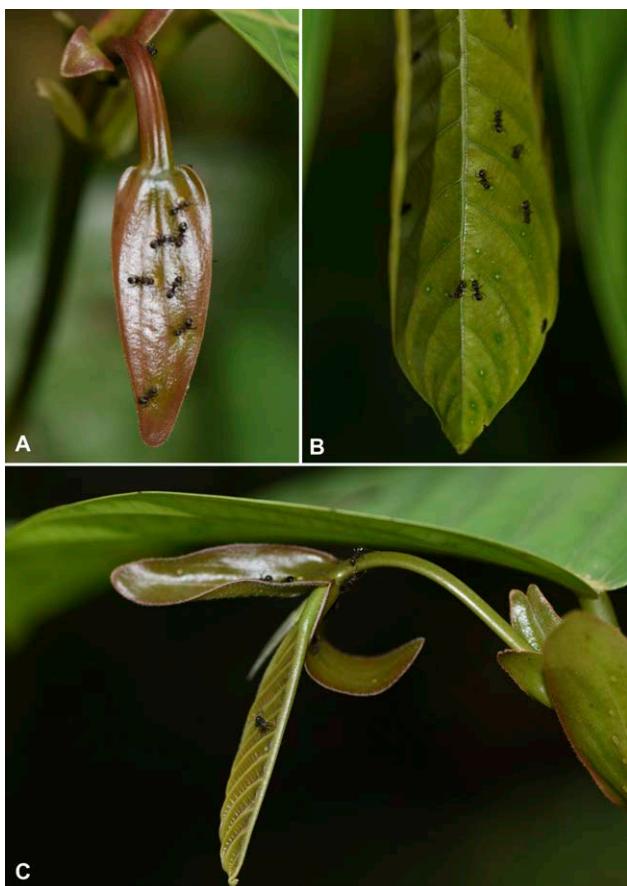


Figure 3. *Shorea macrophylla* (A) *Crematogaster* ants feeding on stipular extrafloral nectaries. (B) *Crematogaster* ants feeding on leaf blade extrafloral nectaries. (C) shoot tip with associated *Crematogaster* ants.

against herbivorous pests, it was notable that none of the plants with ant association showed any sign of caterpillar and chrysomelid beetle damage to the leaf blades, whereas the few plants encountered without ants had extensive damage (Figure 6).

Although the observations presented here are solely associated with saplings and for a single species, and in no way a statistically proven set of data, they are compelling evidence that ant associations exist in Dipterocarpaceae and that both parties appear to gain advantage – food and brood sites for the ants and rather clear evidence that leaf blade damage is negligible in plants with associated ants. Much more detailed studies are required for *S. macrophylla* in particular to determine if ant associations continue into the mature tree canopy, and if they do whether the same of ants are involved, or if a different species is recruited, or if the exposure of the saplings results in different ant species associations. It is also important that the study is extended to more



Figure 4. *Shorea macrophylla* (A) leaf blade showing extrafloral nectaries. (B) detail of leaf blade extrafloral nectaries. (C) shoot tip with associated *Crematogaster* ants.

species of *Shorea* on Borneo. As it stands, we have evidence that two further species of sect. *Pachycarpae* (*Shorea splendida* (de Vriese) P.S.Ashton and a species we are yet to be able to name) have ant associations, although seemingly no nesting.

STIPULE CHARACTERS AND TAXONOMY

Given the ecological importance of the species, the local community level economic significance of the fruits ('nuts') as a source of a high grade fat (see for example Blacher-Mathiesen 1994), and by no means least that *Shorea macrophylla* is one of the most readily recognizable species of dipterocarp on Borneo, there is an remarkable level of taxonomic and morphological muddle and misinformation in the primary literature (Ashton 1982, 2004). In particular there is confusion concerning diagnostic characteristics, notably the erroneous report of flattened stipules (Ashton 2004: 204), and the supposed presence

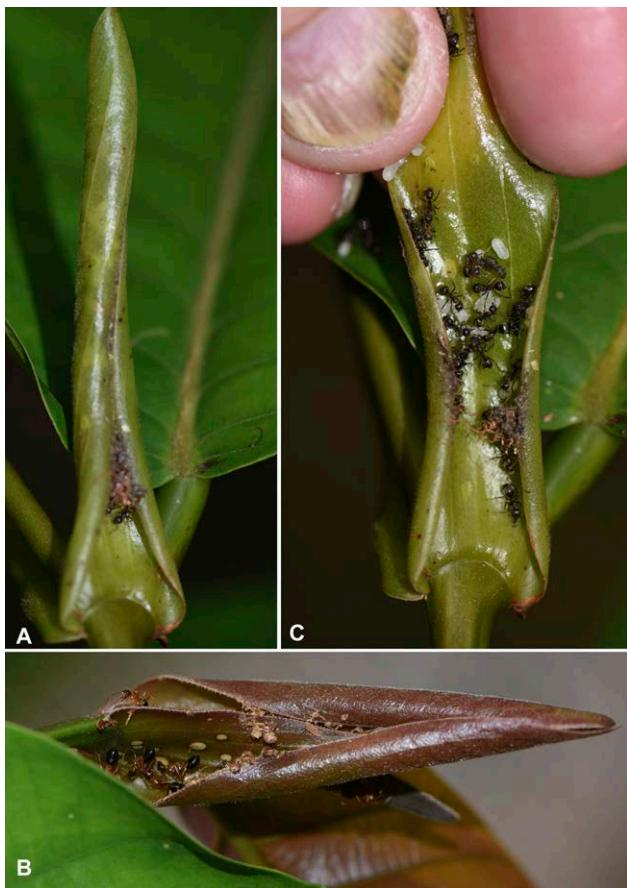


Figure 5. *Shorea macrophylla* (A) revolute stipule containing a *Crematogaster* ant brood chamber. Note the debris used to seal the open edges of the stipule. (B) the same stipule artificially opened with ants removing eggs. (C) another stipule brood chamber opened to show the (formerly external) extrafloral nectaries which are enclosed as the stipule margins recurves to fashion the tube.

of “persistently densely evenly pale brown pubescent” or “stipule..., petiole, leaf blade below, and midrib above”. In reality the stipules of *S. macrophylla* are consistently revolute (Figure 1, 2 & 5), while with the exception of the stipules, which are externally sub-microscopically glandular-stellate-pubescent, all the above-mentioned parts are entirely glabrous (Figure 5).

Remarkably, the conspicuous extra floral nectaries on the stipules and leaf blades (Figure 1 & 4) are not mentioned at all in the primary taxonomic literature, although Maury-Lechon & Curtet (1998: 11) state that “Extra-floral nectaries were recently found in many genera (Ashton, personal communication)”, the presence of such structures in African *Monotes* A.DC. was reported by Verdcourt (1989), and Balgooy et al. (2015), Fiala and Saw (2003), and Moog et al. (2003) all make note of their presence.



Figure 6. *Shorea macrophylla* (A) leaf blade showing typical chrysomelid beetle damage associated with saplings that have no ant association. (B) leaf blade showing typical caterpillar damage associated with saplings that have no ant association.

Given the above points, and that the sapling stages of most *Shorea* have never been adequately documented, and with that the descriptions of the often highly diagnostic stipules are often at best inadequate, it seems useful to provide a proper description here.

Shorea macrophylla (de Vriese) P.S.Ashton, Gard. Bull. Singapore 20(3): 278. 1963.

Stipules paired, tightly appressed in bud, soon divergent with the margins strongly revolute to fashion a tube, rather briefly persistent with the pair falling to leave a conspicuous scar by the time the associated shoot has increased in length by about five additional nodes; stipules equal, up to 5 cm long by 1.5 cm wide, rather narrowly lingulate, bases amplexicaul, briefly and narrowly auriculate, externally sub-microscopically glandular-pubescent, either dull rich red with scattered elliptical green extrafloral nectaries, or bright green with pale yellow nectaries, interior glabrous, somewhat waxy, concolorous with exterior, lacking extrafloral nectaries.

SCOPE FOR FURTHER WORK

Our observations are based on seedlings and saplings of a single species in detail, and two further species for which we have partial observations. Comprehensive

studies of more species are highly desirable, especially in situations of high species diversity.

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