Studies on Schismatoglottideae (Araceae) of Borneo V: Preliminary Ecological Observations of *Schismatoglottis* (Araceae: Schismatoglottideae) on the Matang Massif

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ABSTRACT

The family Araceae in Sarawak comprises 31 genera, with more than 350 species, while on the Matang Massif alone 35 species in 14 genera are recorded to date. Of these *Schismatoglottis* Zoll. & Moritzi is the richest and most diverse genus with nine species (*Schismatoglottis asperata* Engl., *S. conoidea* Engl., *S. grabowskii* Engl., *S. mayoana* Bogner & M. Hotta, *S. motleyana* (Schott) Engl., *S. multiflora* Ridl., *S.* cf. *nervosa* Ridl., *S. tecturata* (Schott) Engl., *S. wallichii* Hook.*f.*) belonging to four of the informal species groups *sensu* Hay & Yuzammi (2000). Two of these nine, (*S. mayoana* and *S.* cf. *nervosa*) are endemic to Matang. Perhaps the most interesting aspect of these taxa is their ecological diversity. This paper will highlight these ecological aspects and speculate on the speciation processes involved in bringing about such diversity in a single genus.

KEY WORDS

Schismatoglottis, Matang Massif, ecology, Araceae.

INTRODUCTION

The Matang Massif, Kuching Division, has been shown to be a 'hot spot' for numerous plant families, notably Arecaceae, Araceae and Zingiberaceae, for each of which the species richness and diversity is among the highest for any equal sized area in prehumid South East Asia. The variations in topography and geology as outlined below are considered to have significantly contributed to the floral richness and high diversity at the Matang Massif, although other factors, including Matang's undoubted role as a refugium during drier periods in the last ice age. It is believed that Matang remained an island of mesophyllous evergreen forest during the period when, due to the lowering of the sea level and greatly reduced rainfall, much of the lowland forest retreated to leave tree-dotted savannah much like that found today in East Africa. This event would have caused extinctions and as well as the retreat of species into the evermoist isolated refugia with these species later undergoing localized speciation on the Matang Massif. Later, with the rise in sea level, and increase in rainfall the lowland forest would have re-

established and the Matang Massif together with its mesophytic herbaceous flora would have re-joined the surrounding landscapes.

HISTORY

The Matang Massif was among the first areas in Borneo that was the subject of biological exploration in the 19th century with the eminent Italian naturalist, Odoardo Beccari making enormously important historical collections between 1865 and 1868 from which he published on *Microcasia* (= *Bucephalandra*) in 1879 (Beccari, 1879). During his time on Matang, Beccari made numerous collections of aroids which were later worked up by Engler and published in Beccari's *Malesia* (Engler in Beccari, 1882). Engler described among several species from Matang, *Schismatoglottis asperata* Engl., *S. conoidea* Engl. and *S. beccariana* var. *cuspidata* which was later sunk into *S. mayoana* Bogner & M.Hotta. Coupled with works by Ridley (1905) who himself made a trip to Sarawak in 1903 and Merril (1921) these seminal studies laid the foundation for our Matang work, which aims to catalogue and describe the aroids of Matang (including Singgai and Berendang).

THE MATANG MASSIF

Location & Geology

The Matang Massif runs SW – NE some 30 km west of Kuching and comprises a series of peaks: Merkangau, Spugu, Serapi, Kagan, Bawang, Matang and Selang. There are two additional, isolated, peaks, Berendang and Senggi, to the SW of the main massif. The highest peak, Gunung (Malay for mountain) Serapi, is 911 m above sea level and flanked by steep slopes running to the narrow ridge top. Gunung Serapi comprises a thick succession of sandstone, conglomerate and interbedded shale while the ridge top forest is kerangas forest on deep podsols or peaty rather than sandy loam typical of lowland kerangas forest. The sandstone is fine- to medium-grained and consists of mainly angular grains of quartz with some feldspar. Conglomerate occurs as thin beds and lenses and consists of rounded pebbles in a sandy matrix. Most of the pebbles are of sedimentary rock, including chert and jasper, but volcanic and igneous rocks also occur. The shale is a fine grained rock, formed by consolidation of clay, silt and/or mud. These rocks belong to the Plateau Sandstone Formation which forms huge saucer-shaped basins deposited between 45 and 100 million years ago. The Matang Massif includes Kubah National Park at the northwest flank and ridge of the Gunung Serapi massif. The low-lying land north and east of Gunung Serapi consists mainly of shale, with some siltstone, of the Bau Formation. The shale is hard, dark grey or blue, and in places rich in plant remains (Hazebroek & Abang Kashim, 2000).

The Matang Massif serves as a water catchment area for Kuching Division where the forests allow much of the rainwater to be absorbed into the sandstone rocks. These porous rocks act as a huge sponge or reservoir water holding supply.

Forest Types & Ecology

Kerangas forest is developed on slopes formed by sandstone bedding surfaces, mainly on the western flanks of Gunung Serapi and its northwest ridge. Riverine forest in Matang massif is found in the broad valley of the Rayu River. Alluvium in the flat bottom of the Rayu River consists of sand and mud deposited when the river floods its banks. Transition between forest types is gradual. Shrub and secondary forest of Mixed Dipterocarp Forest (MDF) is gradually growing up where the natural forest had been removed from past logging activities (Hazebroek & Abang Kashim, 2000).

Red-yellow podzolic soils cover most of the rocks where the natural vegetation on these soils is mainly MDF, and its deep shaded forest floor provide excellent habitat for forest herbs. Steep gallery also provides moist and shady environment which is most suitable for terrestrial aroids. Riverine forest is moderately rich with

aroids due to its tendency to occasional floods which disperse the seeds or seedlings, and with its high humidity providing suitable growing conditions.

The remarkably rich floral diversity of the Matang Massif is almost certainly due to the combination of heterogeologies of intercalated sandstones and shales, and further at the east, limestones coupled with a wide range of soils and exposures that, along with features such as the valley bottoms, hill slopes, ridge tops and stream banks created by the dissected landscape, provides numerous ecologies and micro habitats. The Matang Massif is a centre of endemic and narrowly distributed taxa which occur from riverine forest via transitional lowland and upper hill MDF to kerangas.

Ecology of *Schismatoglottis* on Matang Massif

Schismatoglottis Zoll. & Moritzi is by far the largest aroid genus in Borneo (in excess of 100 species) and together with four smaller satellite taxa, *Aridarum* Ridl., *Bucephalandra* Schott, *Phymatarum* M.Hotta and *Piptospatha* N.E.Br., comprises Tribe Schismatoglottideae. *Schismatoglottis* extends from Myanmar throughout the non-monsoonal parts of Thailand and Indochina into SW tropical China (Yunnan) southwards through Malesia to the tropical Western Pacific. There are also a few species in the Neotropics. The richest and most diverse concentration is in Borneo, where an estimated 95% of *Schismatoglottis* are endemic.

Most *Schismatoglottis* are terrestrial and are often abundantly common in the forest herb layer; the genus also comprises a significant number of rheophytes or lithophytes, sometimes restricted to particular substrates. *Schismatoglottis* frequently display a high degree of micro-endemism.

Seven of the nine species of *Schismatoglottis* present on Matang occur in MDF. The exceptions are *S. multiflora* Ridl. and *S. mayoana* Bogner & M.Hotta which are obligate rheophytes and lithophytic respectively.

Schismatoglottis motleyana (Schott) Engl., (Fig. 1), *S.* cf. *viridissima* A.Hay (Fig. 2) and *S. wallichii* Hook. *f.* (Fig. 3) belong to the calyptrata Group (see Hay & Yuzammi, 2000) delimited by fully adnate petiolar sheaths and hapaxanthic-shoots, and while widespread on a variety of substrates elsewhere in Sarawak on Matang are notably restricted to sandstone-derived soils in open but evermoist forest. *Schismatoglottis* cf. *viridissima* often include a few individuals which vegetatively look similar to *S. motleyana* but without yellow stains on the scar tissues of the base of petioles. *Schismatoglottis wallichii* occurs in riverine forest into MDF and also in the transition between MDF to kerangas whereas *S. motleyana* sometimes occur in kerangas (tropical heath forest) when it is not too dry. All ultimately form large clonal colonies that seldom flower but rather spread by vigorous stolons. These species on Matang display high abundance in big populations but low morphological diversity.

Schismatoglottis asperata Engl., *S. conoidea* Engl. and *S.* cf. *nervosa* Ridl., pleionanthic-shooted species grouped under *S. asperata* group (Hay & Yuzammi, 2000), are found on both shales and sandstones in deep shade in MDF and riverine forest. These species are notable for profuse flowering and considerable seedling regeneration.

Schismatoglottis asperata (Fig. 4 & 5) and *S. conoidea* (Fig. 6), both originally described from Matang, display marked variation between different populations, especially in leaf markings, from blotched yellow to plain green. *Schismatoglottis asperata* is readily identified by its asperate crisped alate petioles with an open petiolar sheath and occurs in wide variety of variegated forms occurring in presumably interbreeding populations with non-variegated forms.

Schismatoglottis conoidea is highly distinctive with its elongated internodes and slender stems which are white, at first erect, later becoming decumbent, with plants forming loose, creeping colonies with

Fig. 1. *Schismatoglottis motleyana* (Schott) Engl. with cordate leaf bases and spotted leaf laminae.

Fig. 2. *Schismatoglottis* cf. *viridissima* A. Hay showing cordate leaf bases and two emerging inflorescences.

Fig. 3. *Schismatoglottis wallichii* Hook. *f.* with lanceolate plain dark green leaf lamina and solitary inflorescence.

Fig. 4. *Schismatoglottis asperata* Engl. in its plain leaf form.

uniform morphology within the same population.

By comparison, *S.* cf. *nervosa* (Fig. 7) is highly uniform in appearance. Readily identified by the petioles with longitudinal ridges and the strong terpenoid smell released when its vegetative tissues are crushed, this is one of several yet to be described vicariant species related to *S. nervosa* Ridl. (Wong, in prep). The ecology of this new species differs from its nearest sister species, *S. nervosa*, in that *S.* cf. *nervosa* grows terrestrially in deep litter over exposed black soil, sometimes between sandstone rocks while *S. nervosa* is restricted exclusively to humus pockets at the base of the Bau limestones. Species of the "nervosa complex" are each highly micro-endemic to particular geologies and ecologies and are also seemingly sensitive to disturbance. When gross disturbance occurred in an area in Matang, as observed by the two authors at the Indian Temple

Fig. 5. *Schismatoglottis asperata* Engl. with white-blotched leaf laminae.

trail, the species went extinct from the locality.

Schismatoglottis tecturata (Schott) Engl. (Fig. 8 & 9) is a lithophyte or grows on deeply shady and consolidated earth banks. This species displays unusual shoot organisation with the petiolar sheath greatly reduced so as to become no longer functional as a protective structure and with the leaf-protective role of the sheath taken over by prophylls and cataphylls; similar morphology occurs in many *Philodendron* Schott. *Schismatoglottis tecturata* flowers profusely at Matang and as a result most populations comprise individuals from seed and thus display wide variations in size and leaf lamina colouration although inflorescences show little or no correlated variation.

Schismatoglottis mayoana and *S. multiflora* are members of the Multiflora Group sensu Hay & Yuzammi (2000) defined by, among other characters, pleionanthic shoots and the adnate portion of the petiolar sheath short but the remainder extended into long ligular portion. *Schismatoglottis multiflora* is widespread in but endemic to West Sarawak and West Kalimantan while *S. mayoana* is as far as is known endemic to the Matang area. *Schismatoglottis mayoana* and *S. multiflora* differ by the presence of a spadix appendix in *S. mayoana*, but none in *S. multiflora* and in the leaves which are glossy dark green in *S. multiflora* and matte olive-green in *S. mayoana*. Other diagnostic characters involve the mechanics of the inflorescence, particularly the spathe, during anthesis. On-going field work has shown that the pollination strategy is markedly different in the two species and that these inflorescence mechanics and

Fig. 6. *Schismatoglottis conoidea* Engl. with plain dark green leaf laminae, at female anthesis.

pollination differences are coupled with different fruit and seed dispersal strategies. A detailed account of these findings and their taxonomic and ecological implications will be published by Lee *et al.* (in prep).

Aside from the above morphological differences, the species differ significantly in their ecology. *Schismatoglottis mayoana* (Fig. 10 & 11) usually occurs as a lithophyte on sandstones under light to heavy shade, whereas *S. multiflora* is an obligate rheophyte (Fig. 12). *Schismatoglottis mayoana* sometimes occurs on steep gallery forest on sandstone in wet or rarely dry shady shade MDF. Sometimes, both species occur sympatrically on shales and sandstones on the main watercourses in Matang but always with *S. multiflora* in the path of the water flow and *S. mayoana* on the cliff sides of the waterfalls away from all but the heaviest spate flow.

Fig. 7. *Schismatoglottis* cf. *nervosa* Ridl. at male anthesis.

Fig. 8. *Schismatoglottis tecturata* (Schott) Engl. with plain leaf laminae, growing on consolidated earth banks.

Fig. 9. *Schismatoglottis tecturata* (Schott) Engl. with grey mid-band to the leaf laminae.

Fig. 10. *Schismatoglottis mayoana* Bogner & M. Hotta on the side of a small waterfall on sandstone.

Fig. 11. *Schismatoglottis mayoana* Bogner & M. Hotta on the steep and dry soil gallery forest; note the pendant inflorescence.

Fig. 12. *Schismatoglottis multiflora* Ridl. as a rheophyte on sandstones; note the glossy leaf laminae.

CONCLUSIONS

The richness of *Schismatoglottis* in Matang massif is certainly in part related to the variation in rock types and topography, which leads to a variety of soil types. It also depends on the diversity of micro habitats such as valley bottoms, hill slopes, ridge tops and stream banks. While some *Schismatoglottis* are restricted to particular habitats, others are tolerant of a range of habitats. *Schismatoglottis* in Matang are less abundant (both as individuals and species) in Kerangas (tropical heath) forest. The forest transition into mixed dipterocarp forest (MDF) is where the *Schismatoglottis* starts to flourish. At altitudes higher than 800 m *Schismatoglottis* are more-or-less absent.

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