

Towards an account of Sapotaceae for Flora Malesiana

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ABSTRACT. An overview of the pan-tropical family Sapotaceae is provided with particular focus on the Malesian region. Past and current taxonomic and phylogenetic research is summarised and publications relating to the production of a Flora Malesiana Sapotaceae account highlighted. Challenges to delivering a Flora Malesiana account are identified and some potential solutions suggested.

Keywords. Flora Malesiana, Sapotaceae, systematics, taxonomy

Introduction

Sapotaceae is a pantropical family of trees and shrubs and is composed of about 50 genera and 1000 species. In Malesia there are an estimated 15 genera and 300 species. The family is ecologically important with representatives of the family common in the forests of Malesia. They occur from beach forests at sea level to mossy montane forests at over 4000 m altitude. The family is economically important and produces the important heavy hardwood timber, *Bitis* (mainly *Madhuca utilis* (Ridl.) H.J.Lam, *Palaquium ridleyi* King & Gamble and *Palaquium stellatum* King & Gamble) and the light to medium hardwood, *Nyatoh*, from many other species (Ng 1972). The family also produces edible fruit with *Manilkara zapota* (L.) P.Royen (sapodilla plum, *ciku*), and *Chrysophyllum cainito* L. (star apple), introduced from Central America, the most widely cultivated. The latex produced from *Palaquium gutta* (Hook.) Burck (Gutta Percha) has been used in the insulation of cables, golf balls and in root fillings in dentistry (Burkill 1966, Boer & Ella 2000).

It is a family which has historically been acknowledged as being taxonomically problematic (Pierre 1890; Baillon 1891; Dubard 1912, 1915; Lam 1939; Aubréville 1964; Baehni 1965; Pennington 1991). Although species tend to be relatively well defined, the genera are not. Estimates of number of genera range from 122 (Aubréville 1964) to 53 (Pennington 1991). There is a high level of homoplasy in the family and unique synapomorphies for genera are rare with most being distinguished on character-state combinations.

The family can be quite readily identified in the field by the white exudate (latex) produced from the cut bark and twigs, the spirally arranged leaves which are usually crowded at the tips of twigs and the often coppery underside of leaves. The flowers are in axillary fascicles usually behind the leaves and in fruit the calyx and style are persistent. The calyx provides a good taxonomic character at generic and

tribal levels and seed shape and the position and extent of the seed scar provide useful characters at the generic and species level (Pennington 1991).

Monographic studies

Most monographic work on the family in Malesia was undertaken by researchers based at the Rijksherbarium, Leiden from the 1930's to early 1960's. Over this period many papers were published in *Blumea* as part of the series "*Revision of the Sapotaceae of The Malaysian Area in a Wider Sense*". In these publications, the geographical area covered was much larger than what we today term Malesia and included areas such as the Solomon Islands, New Caledonia and Fiji.

The most important contributors include the director of the Rijksherbarium between 1933 and 1962, Herman Johannes Lam. He published important revisions of genera in the Sapotaceae including *Manilkara* (Lam 1941a) and *Burckella* (Lam & Royen 1952a). He also produced family accounts for *Sapotaceae of the Dutch East Indies* (Lam 1925, 1927), *New Guinea* (Lam 1932) and *the Pacific Islands* (Lam 1942), a paper on the *Phylogenetics of Sapotaceae* (Lam 1935) as well as several notes on a range of other genera (Lam 1938, 1939, 1943a, 1943b, 1957). He also published taxonomic accounts of the closely related family Sarcospermataceae including a *Revision of Sarcospermaceae* (Lam & Varossieau 1938, 1939; Lam 1941b) and an account of Sarcospermataceae for *Flora Malesiana* (Lam 1948).

A co-worker of Lam's, Pieter van Royen, revised many large genera of Sapotaceae including *Planchonella* (Royen 1957a), *Palaquium* (Royen 1960a) and *Madhuca* (Royen 1960b). He also revised several other smaller genera such as *Burckella* (Lam & Royen 1952a, 1957b; Royen 1959), *Mimusops* (Royen 1952), *Manilkara* (Royen 1953, 1957c), *Xantolis* (Royen 1957d), *Diploknema* (Royen 1958a), *Aulandra* (Royen 1958b), *Eberhardtia* (Royen 1960d) and *Mastichodendron* (Royen 1960c) and compiled an account of Sapotaceae covering some 16 genera and 260 species for *Flora Malesiana* which was never published (Royen, Unpub.).

Willem "Wim" Vink started to revise van Royen's unpublished account but due to the large number of new forestry collections coming from the Malesian region, the many new species needing to be described and the many poorly known species needing new description, this could not be brought to fruition within the year allocated to the task. Several revisions of smaller genera such as *Leptostylis*, *Pycnandra* and *Magodendron* (Vink 1957) and *Chrysophyllum* (Vink 1958), however, were published and important contributions continue to be made by him (Vink 1995, 2001, 2002). Other Rijksherbarium researchers who published important works on Sapotaceae include van den Assem who revised *Ganua* (Assem 1953, Assem & Kostermans 1954), Jeuken who revised *Isonandra* (Jeuken 1952); Bruggen (1958a, 1958b) who revised *Payena* and *Aesandra*, and Herrmann-Erlee who revised *Krausella* and *Pouteria* (Herrmann-Erlee & Lam 1957, Herrmann-Erlee & Royen 1957).

One of the most important publications covering Sapotaceae throughout its distribution is *The Genera of Sapotaceae* (Pennington 1991). Based on morphology,

this reviewed the whole family and brought much clarity to the genera. It recognised 53 genera and 5 tribes and considered *Sarcosperma* to be part of Sapotaceae (not Sarcospermataceae). In Malesia, all 5 tribes are represented with Isonandreae containing most Malesian genera. Based on this work, the *World Checklist of Sapotaceae* was produced (Govaerts et al. 2001), as well as the related website (<http://apps.kew.org/wcsp/home.do>).

Molecular phylogenetic studies

The first large-scale molecular studies of Sapotaceae were produced by Anderberg & Swenson (2003) and Swenson & Ardenberg (2005). Based on molecular and morphological data, they proposed a new subfamily classification of Sapotaceae with three subfamilies being recognised, Sarcospermatoideae, Sapotoideae and Chrysophylloideae. Malesian genera are found in all three subfamilies. The sampling from Malesia, however, was poor with only 5 taxa represented. The two largest genera in Malesia, *Madhuca* and *Palaquium* had only a single species sampled and these were from outside the Malesian region. Swenson and co-workers have published several other important phylogenetic studies on the subfamily Chrysophylloideae especially from New Caledonia (Bartish & Swenson 2005, Swenson & Bartish 2007, Swenson & Munzinger 2007). Also researching the subfamily Chrysophylloideae, Triono et al. (2007) produced a molecular phylogeny of *Pouteria* from Malesia and Australasia to re-assesses the generic delimitation of *Pouteria* and its affinities with *Planchonella*. This did not support the broad circumscription of *Pouteria* by Pennington (1991).

Smedmark & Anderberg (2006, 2007) published work on the subfamily Sapotoideae and provided a useful backbone to research on the subfamily but again few samples were included from the Malesian region. This is being addressed by the author and co-workers at the Royal Botanic Garden Edinburgh (RBGE) who have substantially increased sampling of genera from the Malesian region, in particular from Pennington's tribe Isonandreae (Wilkie et al., in prep.). This will be used to help establish a robust generic and infrageneric framework to facilitate future monographic research on the family in Malesia. Researchers at RBGE are also using this data to investigate biogeographic patterns within Isonandreae (Richardson et al., in prep.).

Floristic studies

Several floristic accounts of the family have been produced in the Malesian region. *The Tree Flora of Malaya* (Ng 1972) covered 11 genera and 76 species and kept *Sarcosperma* in the Sarcospermaceae, the *Manual of the Larger and More Important non Dipterocarp Trees of Central Kalimantan* (Argent et al. 1997) covered 5 genera and 36 species, and the *Tree Flora of Sabah and Sarawak* (Chai & Yii 2002) covered 11 genera and 120 species, including *Sarcosperma*. Two further flora accounts are in preparation. The Sapotaceae account for the *Flora of Peninsular Malaysia* will

cover an estimated 11 genera and more than 80 species and will have contributions from a wide range of Malaysian taxonomists (Wilkie et al., in prep.) and the *Flora of Thailand* Sapotaceae account covering 9 genera and 45 species (Chantaranothai 1999) is due to be published by 2011 (Chantaranothai, in prep.).

Challenges to delivering a Flora Malesiana account

An account of Sapotaceae for Flora Malesiana with an estimated 15 genera and 300 species is clearly deliverable; however, there are several issues that need to be addressed if a modern account is to be produced. The first is the development of a robust generic framework within Sapotaceae. It has been recognised that generic limits are problematic and that the circumscription of several genera are still not clarified fully. Recent molecular phylogenetic studies are helping address this but much still needs to be done, in particular increased sampling of taxa found in the Malesian region. A second challenge is that previous sectional classifications of genera by authors such as Dubard (1909), Lam (1925), van Royen (1960a) are not congruent with recent molecular phylogenies (Wilkie et al., in prep). This makes producing taxonomic accounts of large genera such as *Madhuca* and *Palaquium* difficult. It is therefore important that new sectional classifications are developed for these genera so that taxonomists can work with groups of manageable size. Finally, there is still a lack of good fertile material for many Malesian taxa. If full taxonomic descriptions are desired, a detailed collecting programme for the family is needed, in particular from the under-collected areas of East Malesia.

Facilitating the production of a Flora Malesiana account

For taxonomists to contribute to the Flora Malesiana Sapotaceae account, they need access to specimen information, access to the actual specimens and access to the literature. Over the past two years, RBGE has been trying to address these issues largely through the establishment of the Sapotaceae Resource Centre (www.sapotaceae.info). This brings together Sapotaceae specimen data held by various institutes in Malesia and Europe (E, K, KEP, L, SAN, SAR, SING) as well as from individuals who have worked on Sapotaceae. To date, access to over 45,000 Sapotaceae specimen records is available via the website. The data is constantly being updated and cleaned as it is used for projects such as the Flora of Peninsular Malaysia.

A large collection of Sapotaceae herbarium specimen images has also been gathered. In order that they are as accessible to as many people as possible, these are being linked to specimen information on the website. However, with over 16,000 Sapotaceae herbarium specimen images from Malesia, this will take some time. The most effective and efficient way to make these images available on the web is constantly being reviewed.

A library of some 500 Sapotaceae reprints built up over 30 years by T.D. Pennington and V. Wink has been converted to PDF format and the best way to share this information (taking into account copyright issues and other international projects such as the Biodiversity Heritage Library) is currently being investigated.

The delivery of a Flora Malesiana Sapotaceae account will require the enthusiasm and commitment of taxonomists from the Malesian region, particularly those at an early stage in their career. The Sapotaceae Resource Centre is designed to stimulate interest in the family as well as link Sapotaceae researchers together.

Conservation assessments

Taxonomists should not just be in the business of documenting plants before they are gone—they need to be doing more to make sure they don't go in the first place. Integral to the Flora Malesiana Sapotaceae account has to be the production of Conservation Assessments (IUCN 2001) as these can lead to long-term monitoring of species and their active conservation (e.g., Chan 2007; Chua et al. 2009, 2010).

Conclusion

Delivering an account of Sapotaceae is achievable in the medium term. However, this will require the commitment of a substantial amount of time by researchers. To help this happen, the objectives of Flora Malesiana need to be embedded and championed by many more institutes. Taxonomists from Malesia also need to be much more involved in producing accounts than has traditionally been the case. This will require financial support. Flora Malesiana as the *collective voice* of Malesian taxonomy is ideally placed to address these concerns and to help leverage funding from global initiatives to achieve these aims.

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