

## THE HAINAN-MINDORO CONNECTION, AN OBSCURE PATHWAY FOR PLANT MIGRATION IN SOUTHEAST ASIA

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### ABSTRACT

Recent geologic findings support the existence of an ancient micro-continent consisting of present day Reed Bank, northern Palawan, and southern Mindoro. This micro-continent is thought to have been located somewhere between the islands of Hainan and Taiwan during the Oligocene. Owing to the opening of the South China Sea, it drifted across and collided with proto-Philippine archipelago in mid-Miocene. Its southeastward displacement is suggested to offer an alternative pathway for direct plant migration from continental Asia (Tonkin-Hainan area) to the Philippines and elsewhere.

The island of Hainan (Guangdong Province, China), located west of the Philippines at about 18° N and 110° E, is known to have a subtropical to tropical flora (CHANG, 1962). Its floristic affinity has long been alleged to be with Indochina and Taiwan (CHANG, 1962; CHUN, 1964-77; MATTICK, 1964; WANG, 1982; TAKHTAJAN 1986). Only lately was its hepatic flora suggested to have an important relationship with tropical Malesia (WU & LIN, 1976).

Much to our surprise, a review of published records of Hainan mosses has yielded many more species of Philippine rather than of Indo-chinese affinity (IWATSUKI & TAN, 1979; TAN et al., 1988). There are even plant species confined to Hainan and the Philippines. These are: *Ahernia glandulosa* Merr., *Thalictrum philippinense* C. B. Rob., *Richeriella gracilis* (Merr.) Pax. & Hofm., *Trifidacanthus unifoliolatus* Merr., *Diplaziopsis hainanensis* Ching, *Syrrophodon semperi* C. Muell. and *Macromitrium goniostomum* Broth.

If one compares the flora of the Philippines with that of the broad Asiatic continent encompassing the Hainan-Yunnan-Indochina, the number of plant species and varieties that exhibit such a disjunctive distribution on both sides of the South China Sea becomes considerably more noticeable. Examples are: *Albizia corniculata* (Lour.) Pruce, *Brucea mollis* Wall., *Geodorum nutans* Ames, *Mnesithea laevis* (Retz.) Kunth var. *cochichinensis* (Lour.) Koning & Sosef, *Podocarpus pilgeri* Foxw., *Adiantum malesianum* Ghatak, *Ctenitis decurrentipinnata* (Ching) Ching (see

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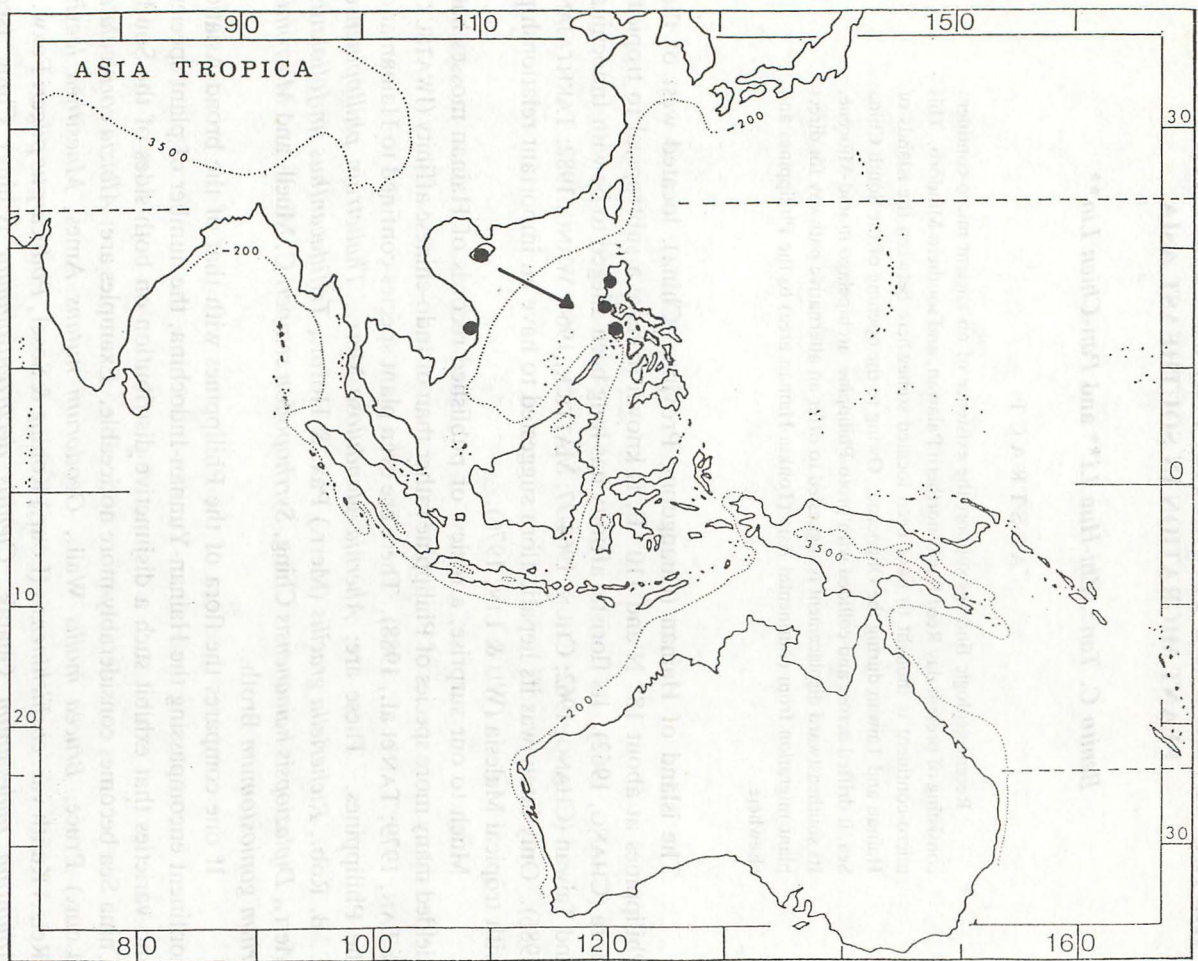


Figure 1. World distribution of *Ctenitis decurrentipinnata*.

Fig. 1), *Pseudocyclosorus tylodes* (Kunze) Ching, *Heterogonium sagenioides* (Mett.) Holtt., *Sphagnum luzonensis* Warnst., *S. robinsonii* Broth., *Leucoloma walkeri* Broth., *Calyptothecium caudatum* Bartr., *Duthiella declinata* (Mitt.) Zant., *Neckeropsis boniana* (Besch.) Touw & Ochyra, *Erpodium luzonensis* (Bartr.) Crum, *Syrrhopodon burmensis* (Hampe) Reese & Tan (See Fig. 2), *Bryum gemmigerum* (Broth.) Bartr. and *Bazzania sikkimensis* (Steph.) Herz.

Sister pairs or vicariad taxa are also known from these two regions. The following are examples: *Pinus ikedai* Yamamoto/*P. merkusii* Jung. & de Vr. ex de Vr. (see Fig. 3), *Daemonorops margaritae* (Hance) Becc. var. *margaritae*/*D. margaritae* var. *palawanicus* Becc., *Callicarpa longissima* Merr./*C. dolichophylla* Merr., *Embolanthera glabrescens* Li/*E. spicata* Merr., *Vaccinium viscifolium* K. & G./*V. nitens* Sleum. and *Meliosma lepidota* Bl. subsp. *longipes* (Merr.) Beus./*M. lepidota* subsp. *vulcanica* (Merr.) Beus.

Likewise, some taxa display a similar disjunction at the generic and subgeneric levels: the deer genus *Axis* (see Fig. 4), the phanerogamic genus *Caryodaphnopsis* and the moss subgenus *Heliconema* Mitt. of *Syrrhopodon* Schwaegr. The last mentioned taxon has a third disjunctive center of distribution in central South America (REESE & TAN, 1985).

All the above floristic elements, whose origin and affinity seem to lie within continental Asia, are loosely attributed to the "Himalayan", "Indochina" or "Taiwan" influences in Philippine phytogeographical literature (MERRILL, 1928; LI & KENG, 1950; IWATSUKI 1957; TAN, 1984). Their distribution patterns share two noteworthy features: 1). These taxa are absent on the islands of Taiwan and Borneo proper (some may occur on Mt. Kinabalu; 2) the Philippine populations, which invariably range from Palawan, Mindoro and the adjacent islands of Luzon and Panay, represent outlier or marginal records.

VAN MEEUWEN et al. (1961) were probably the first to map out this peculiar distribution pattern and they attributed the cause to ecological barriers posed by the discontinuous formation of local wet rainforests. VAN STEENIS (1964) further elaborated the issue in detail and his paper should be read for more illustrative examples.

MERRILL (1938) proposed several possible pathways through which continental Asiatic plants could have migrated into the Philippine Islands. These routes, which were illustrated by VAN STEENIS (1936), are via the Taiwan-Philippine landbridge from the north and/or via the Borneo-Sulu/Borneo-Palawan landbridges in the south. Of these, the long and circuitous southern track, vis-a-vis Borneo proper, is unlikely for this group of plants because of their conspicuous absence on the main part of Borneo. On the other hand, the northern route via Taiwan lacks convincing geological evidence. Besides, the flora of Taiwan has been increasingly shown to have had little effect on the Philippine flora. In an early paper, LI & KENG (1950) demonstrated that the similarity of the two floras exists only in the small southern tip of Taiwan, the Hengchun Peninsula and its satellite islets. The same conclusion was arrived at by Chang in 1984. The failure of such families as the Nepenthaceae and Dipterocarpaceae to reach Taiwan is a strong

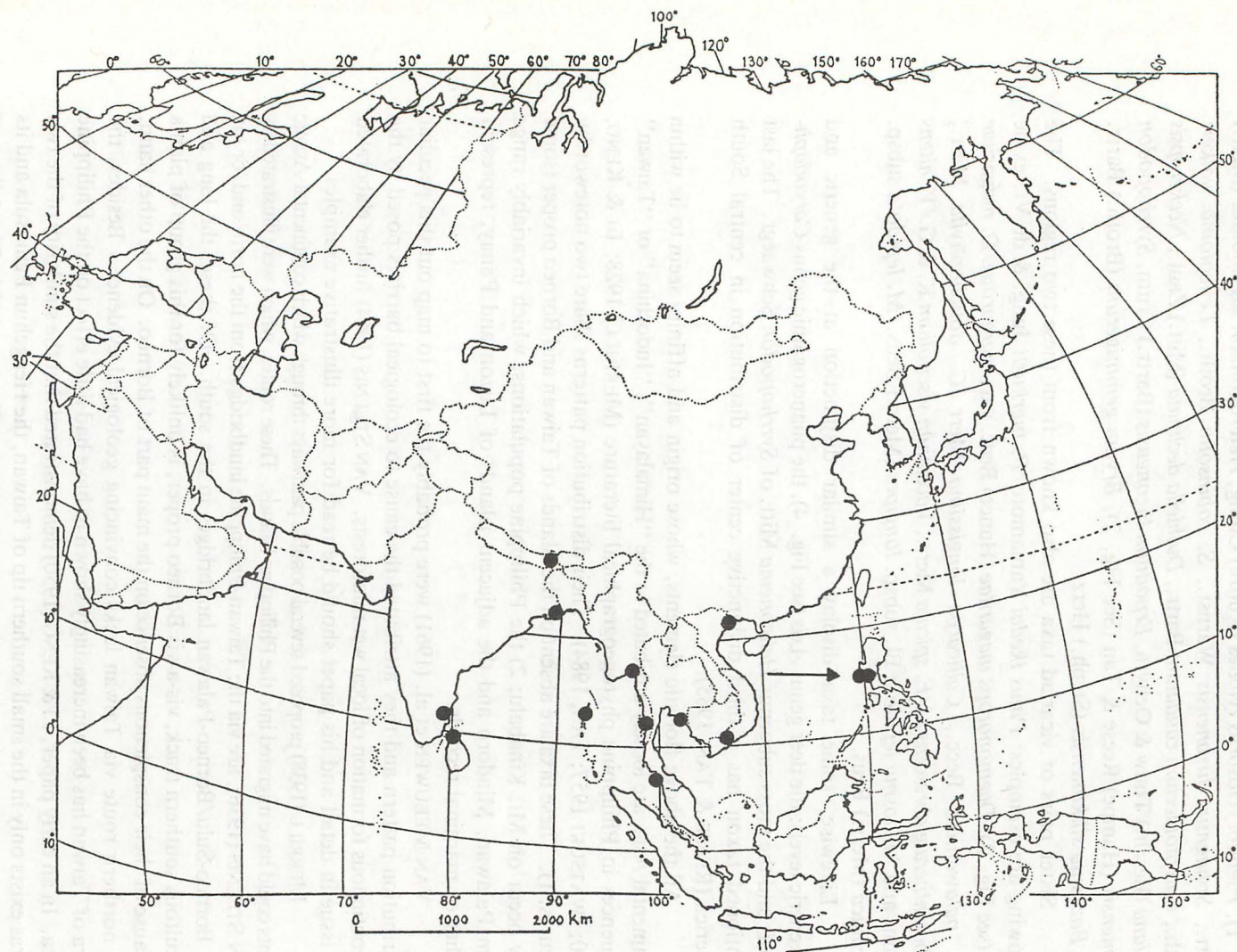


Figure 2. Distribution of *Syrrhopodon burmensis*.

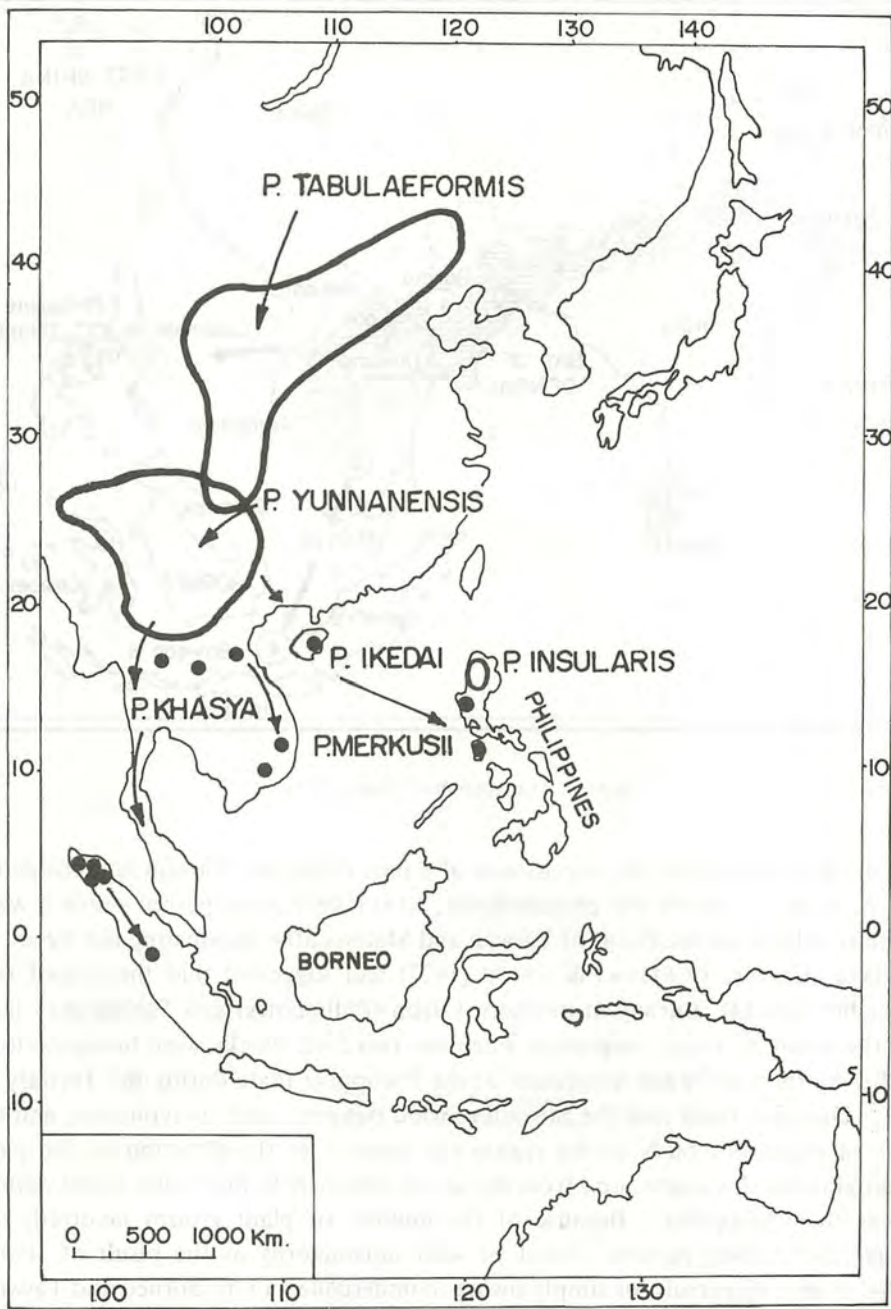


Figure 3. Distribution of some *Pinus* species in Southeast Asia.

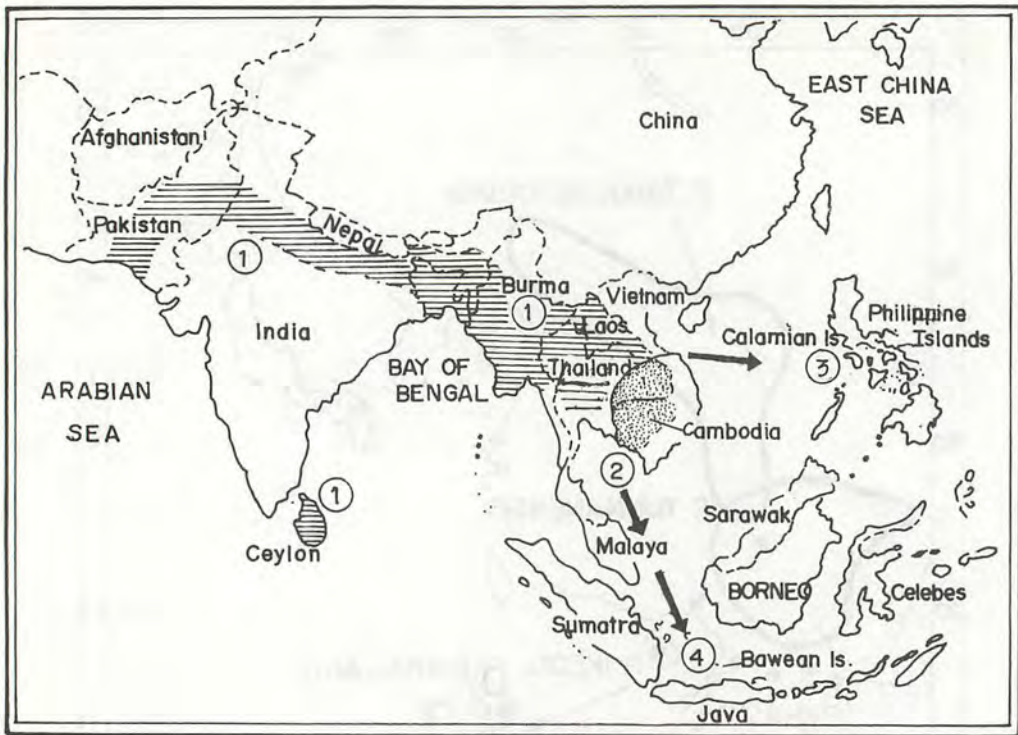


Figure 4. Distribution of *Axis* in Asia.

piece of evidence against the importance of a past Philippine-Taiwan landbridge for plant exchanges. As for the pteridophytes, KUO (1985) could perceive only a weak relationship between the floras of Taiwan and Malesia after eliminating the weedy or waif taxa. Earlier, IWATSUKI & PRICE (1977) had suggested that the shared fern species between Mt. Burnay in northern Luzon (Philippines) and Taiwan may have been the result of recent migration when the two land blocks were brought closer together by the northward movement of the Philippine Plate during the Tertiary.

One also finds that the prevailing wind patterns, such as typhoons, and the routes of migratory birds in the region run counter to the direction of the plant migration under discussion, i.e., from the source continent to the outlier island stations such as the Philippines. Because of the number of plant groups involved, this peculiar distribution pattern cannot be seen satisfactorily as the result of several parallel chance dispersals, or simply owing to undercollection in Borneo and Taiwan.

What then could be the cause(s) of this type of disjunction between the Indochina floristic region (TAKHTAJAN, 1986) and the Philippines? Early in 1964, van Steenis suggested that a high mountain range might have existed as an extension of the Indochinese Peninsula or Hainan into what is now the South China Sea, opposite

North Borneo. He offered this hypothesis to explain the possible migration of Indochinese and Chinese plants to Borneo, bypassing Taiwan, the Philippines and Malay Peninsula. MEIJER (1974) accepted the same hypothesis of having a past land mass in much of the present day South China Sea in his discussion on the evolution and migration of several taxa of Dipterocarpaceae in the Malesian region.

Recently, SUN et al. (1981) reviewed the Tertiary palynofloras of the northern rim of the South China Sea, which includes Hainan, the Leizhou Peninsula, the coastal basins of Guangdong Province of China, and the Tonkin Gulf of Vietnam. They concluded that the Oligocene palynofloras between their study areas and the Kalimantan of Borneo bear strong similarity in having representatives of many temperate genera, such as *Picea*, *Tsuga* and *Ephedra*, which are not found in Borneo today. This observed similarity, according to the authors, is best explained by a much closer geographical distance between Borneo and the Tonkin region during the Oligocene, or alternatively, by the presence of a high land mass in the intervening area (see also MUELLER, 1972). Thus far, however, the suggestion of a land mass in the South China Sea has been dismissed for lack of geological evidence.

In recent years, efforts to study the origin of South China Sea and the spreading of its sea floor have produced a vast amount of paleomagnetic data as well as detailed information on the regional stratigraphy (TAYLOR & HAYES, 1980; HOLLOWAY, 1982; MCCABE et al., 1982). One important outcome has been the growing body of geologic evidence supporting the presence of an ancient micro-continent in the northern rim of South China Sea during the mid-Oligocene. HOLLOWAY (1982) surmised that the micro-continent at least included the southern portion of Mindoro Island and the northern (Calamian) portion of the Palawan Island group. The original position of this micro-continent was placed off the coast of South China between Hainan and Taiwan. This ancient continent, called the "Reed Bank-Mindoro-Calamian" land block, broke off from the continental shelf of mainland China and drifted across the old China Sea during the Miocene to join the proto-Philippine island chain (TAYLOR & HAYES, 1980; HOLLOWAY, 1982). Collision of this micro-continental block with the Philippine archipelago probably took place about the middle or late Miocene (McCABE et al., 1982). Although the land size of this extinct micro-continent is debatable (Dr. L. HEANEY, pers. comm., 1987), there is good evidence of middle to late Oligocene unconformities or breaks in the geologic stratigraphy of northern Mindoro and the Calamian blocks to indicate a terrestrial environment (TAYLOR & HAYES, 1980; FERNANDEZ et al., 1982).

Accepting these arguments, the southeastward drifting of the ancient "Reed Bank-Mindoro-Calamian" land block may have served as an ark, carrying with it the indigenous biota to the Philippines (AUDLEY-CHARLES, 1981). Upon their arrivals, some of these exotic biota may have become established locally and spread out to neighboring islands. During the last glaciation, a few may have reached the northeastern corner (Mt. Kinabalu area) of Borneo through the emerging Palawan-Borneo landbridges. Over the millenia of evolution and owing to large scale forest

destruction caused by man, traces of this migration track can only be seen today in a limited number of plant taxa exhibiting such an enigmatic Indochina (Hainan)-Philippine disjunction. Although supported by geologic evidence, the above land drift hypothesis should not be taken to account for *all* the disjunctive plant distributions around the South China Sea.

Future collections in the region, especially from Mindoro and Palawan Islands (Philippines), Hainan (China) and Indochina, will undoubtedly shed more light on the validity and value of this obscure pathway of migration of plants from the Asiatic continent directly into the island groups bordering the western margin of the Pacific Ocean.

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