A STUDY OF OLD WORLD AROIDS

Dr. Thomas B. Croat
Missouri Botanical Garden
2345 Tower Grove Ave.
St. Louis, Missouri 63110

The aroid family with 110 genera and between 2500 and 3000 species is world-wide in distribution, but with most species occuring in the tropical areas. The New World has only 46 genera while the Old World has 75 genera and only 10 genera occur in both areas. North America has 24 genera while South America has 38 and the West Indian region has only 9 genera. (It is poor in species as well.)

There are two major centers of distribution, the Americas, with 35 endemic genera and Asia with 34 endemic genera. Despite this almost equal distribution of genera between the two areas, there are great differences in species richness. For example, about 1350 described species or 55% of the total for the family are restricted to tropical America. My recently acquired experience with distribution of Araceae in the Old World tropics leads me to believe that real percentages will be even greater for the American tropics. A recently completed four month long field trip to Australia, southeast Asia and Africa allowed me to compare the aroids in these areas with those in the areas visited during the last 17 years in tropical America.

The areas visited included Australia, Papua New Guinea, the Philippines, Borneo (Sabah and Sarawak), Java, Singapore, Western Malaysia, Thailand, India, Pakistan, Egypt and Nigeria. The availability of aroids in the various Old World areas differs remarkably as to local collecting conditions but one general feature which was notable was the lower species diversity. This was to be expected, of course, in Australia which lies considerably south of the Equator. It is in general very dry except for a narrow border of rain forest beginning as far south as the State of New South Wales and extending all the way up into the Cape York Peninsula, which juts into the belly of New Guinea. There are only about a dozen species of Araceae known for Australia. These include the following genera (followed parenthetically by the number of species believed to occur there): *Alocasia* (1); *Amorphophallus* (2); *Gymnostachys* (1); *Pothos* (1); *Rhaphidora* (3) and *Typhonium* (4). Although large parts of the tropical areas of the country have been poorly collected it seems unlikely that more than 20 species will ever be found to occur there.

The first aroid I encountered in Australia was quite unexpected. This was *Amorphophallus galbra* F.M. Bailey (Fig. 1) flowering in an extrememly dry area in the Kakadu National Park, southeast of Darwin in the Northern Territory. The State of Queensland in the Cairns-Atherton-Port Douglas area was more like the wet tropics I am accustomed to and was richer in species with the moist ravines hosting *Alocasia macrorhiza* (L.) Schott, *Pothos loureirii* Hook-Arn., *Rhaphidophora australasica* F.M. Bailey and *Rhaphidophora pinnata* Schott. (Fig. 2). Elsewhere and less conspicuous was *Gymostachys anceps* R.Br., the only species in a genus endemic to Australia. This species looks more like a grass than an aroid (See illustration in *Exotica* 3, p. 236).

One of the highlights of my trip to Australia did not even involve native aroids but rather native aroid enthusiasts. During a marvelous trip planned largely by my good Australian friend, David Burnett in Sydney (along with the help of Ed Frazer in Brisbane, Peter McLain, Izabel Wheeler, Frank and Elva White in Townsville—Ayr, Keith Rogers in Ingham, Curt Butterfield and Debbie Almond in Port Douglas), I visited a long series of "bush-houses" filled with marvelous (mostly New World) aroids. I met a whole string of lovely people who must be the friendliest lot in the world. I lectured, consulted and advised, photographed, collected and studied plants and thoroughly enjoyed myself.

My real enlightenment concerning the low species diversity of aroid floras came when I traveled to New Guinea. At my first stop in Weewak on the north-western coast (and the site of the last hold-out of the Japanese invaders during World War II) I found ten species during my first one-half hour in the forest. This was not too bad, but the next two hours of searching yielded only an additional two species. A comparable length of time spent in almost any wet Neotropical forest between Costa Rica and Peru would yield twenty-five to thirty species of aroids.

Despite the relatively lower numbers of species, Old World aroids still frequently play a dominant role in such forests, climbing up and covering many trees and they are not less attractive for being present in fewer numbers. Indeed, Asia seems to have a disproportionate share of attractive genera including *Alocasia* (Fig. 3), *Aglaonema* (Fig. 4), *Amydrium*, and *Rhaphidophora* (Fig. 5). One of my favorite plants, *Amydrium magnificum* (Engler) Nicolson (Fig. 6) with its graceful thin pinnate leaves was common in New Guinea.

New Guinea is much richer in species of Araceae than is Australia, yielding a total of twenty-one genera and one hundred thirty-nine species. Two of these genera, *Diandriella* with one species and *Holochlamys* (Fig. 7-8) with four species are endemic to New Guinea. The remaining genera are *Acorus* (1 sp.), *Aglaonema* (1), *Alocasia* (15), *Amorphophallus* (2), *Amydrium* (2), *Colocasia* (1 sp. introduced), *(Cryptocoryne* (4), *Cyrtosperma* (10), *Homalomena* (24), *Lasia* (1), *Pistia* (1), *Pothos* (14), *Rhaphidophora* (36), *Schizmatoglottis* (11), *Scindapsus* (6) *Spathiphyllum* (3), *Typhonium* (1-2), *Xanthosoma* (1 sp. introduced) and *Xenophia* (2). Of these, only *Homalomena* and *Spathiphyllum* are shared with the New World.

On the other hand, the terrestrial forms in the Asian tropics are often very abundant. This is especially true of *Schizmatoglottis* which have thin, often variegated leaves (Fig. 25). Both *Alocasia* and *Aglaonema* tend to be generally less abundant though may be profusely developed in a local situation. *Dieffenbachia* in the American tropics is most directly comparable to *Aglaonema* (Fig. 9) having roughly a comparable number of species and having the same general appearance, stature and distributional extent on a local basis.

Spathiphyllum occurs in both the New and Old World and *Holochlamys* (Fig. 7-8), which looks very much like *Spathiphyllum* and behaves the same way ecologically, occurs in New Guinea as well.

Dracontium in the American tropics is generally similar to the Old World *Amorphophallus* (Fig. 10) in appearance, ecology and extent of distribution (both are comparatively rare). In addition, *Montrichardia* and *Urospatha* of the New World with their simple sagittate blades and preference for wet habitats are roughly comparable to *Lasia* (Fig. 11) and *Cyrtosperma* (Fig. 12) of the Old World. However, there is a great contrast in the diversity of the terrestrial aroid flora with relatively fewer terrestrial forms in the New World.

For example, while *Homalomena* (Fig. 13, 25) is a diverse genus with one hundred, forty species, nearly all of them occur in Asia with perhaps fewer than twenty species in the New World tropics. There are relatively few American genera which are comparable. Perhaps the most readily comparable in most respects would be species of *Caladium* and *Xanthosoma*, neither of which is a particularly large genus (between the two only about sixty species). *Schizmatoglottis* is probably the most closely suited Asian partner to *Caladium* and *Xanthosoma* because all have relatively soft leaves and they are roughly comparable in size. *Schizmatoglottis*, *Homalomena* and *Alocasia* together have three hundred, ten species, greatly outnumbering their American counterparts of *Caladium*, *Homalomena* and *Xanthosoma*, with probably fewer than eighty species. Observations of a typical Asian forest understory clearly reflect these differences, exhibiting a generally greater understory aroid flora.

In addition to these comparisons, there is no direct counterpart to the widespread Asian genus *Cryptocoryne* or other riparian genera such as *Lagenandra*, *Aridarum*, *Heteroaridarum*, *Hottarum* and *Piptospatha*.

Other comparisons of the Old World and New World tropics can be made as well. one feature that became immediately apparent in Asia is the relatively greater proportion of habitat destruction that has taken place there. While New Guinea has huge remainig undisturbed tracts of forest, the Philippines, Java and the Malaysia Peninsula are much less well-forested (at least those parts I visited). Nowhere is this more evident than in the Philippines on Luzon Island where active logging operations go on in the few remaining reserves. The most conspicuous genus seen in the Philippines was *Rhaphidophora* and several conspicuous species, including *R. korthalsii* Schott (Fig. 14) was also common there. In the Bicol Park area of Camarines Norte Province, both *R. elmeri* and *R. monticola* (Fig. 27) were common and *Cyrtosperma merkusii* (Hassk.) Schott (Fig. 28) was commonly cultivated in the region also, being used as a root crop. This huge plant, growing to about three meters tall, forms large dense stands in usually low areas where it spreads by vegetative reproduction.

However, one of the most interesting species seen in the Philippines was a *Spathiphyllum*, a genus much more widespread in the American tropics. In this area, *Spathiphyllum commutatum* Schott was a long-stemmed erect plant quite unlike any American species (Figs. 16, 17) whose rhizomatous stems are scarecely visible about the surface of the ground. Borneo appeared to me to be more species-rich than either Papua New Guinea or the Philippines. In Sabah along the road from Kota Kinabalu to Tambunan, a single brief stop in a creek at four hundred, sixty meter elevation yielded eleven species including *Homalomena* sp. (Fig. 13), *Rhaphidophora* sp. (Fig. 5) and a genus believed to be *Schizmatoglottis* (Fig. 29). The same species of *Aridarum* was a common stream bed plant in Kota Kinabalu National Park at two thousand meters, elevation.

In Sarawak I visited the Bako National Park (not particularly rich in species) where I studied *Aridarum nicolsonii* Bogner (Fig. 30) and a couple of species of *Rhaphidophora*. Aroids there are restricted to the rocky cliffs at lower elevations and are usually closely associated with water courses. The higher elevations in the Park are given over to a short scrub forest growing over white sandstone.

The area of limestone hills along the road between Kuching and Padawan was richer in species. One of the most attractive species with a dark green there was *Alocasia porphyroneura* Hallier f. (Fig. 18), a small-leaved species with a dark green border and grayish center. Also seen in Malaysia was another species of *Amydrium, A. medium* (Zoll. & Mori) Nicholson (Fig. 19-20).

My trip to Java was principally for visiting the famous and expansive Botanical Gardens at Bogor (formerly called Buitenzorg) and to work in the Bogor Herbarium. My work there was at best slow and I had to postpone a trip to the field because I had contracted malaria in Borneo and suffered with it until I reached Singapore where I was able to take the cure (something even more terrible than the disease itself). Nevertheless, the Bogor trip was a limited success. I managed to spend several days photographing collections in the herbarium and also studied live plants in the Botanical Garden. Both the garden and the herbarium are the finest I have seen anywhere in the tropics. The Dutch botanists and horticulturists who started this noble undertaking in 1817 are to be commended.

Common among the plantings there is *Amorphophallus titanum* Beccari (See Josef Bogner's article in *Aroideana* 4 (2):44-35, 1981 for illustrations of this most interesting aroid). Quite a large area is devoted to aroids and the plants are mostly well-named and labeled.

The Singapore Botanical Gardens are mediocre in comparison to those at Bogor, but the herbarium, home of such active taxonomists as Ridley, Furtado, and E.J.H. Corner is a very important one. Relatively little unspoiled natural area exists on this heavily populated island, but with the help of J.F. Maxwell, I managed to see a couple of these areas.

I left Singapore (weakened and thirty pounds lighter) for Malaysia and traveled to Kuala Lumpur. Malaysia seemed to be about as rich in species as is Borneo and though much of the western side of the Malaysian peninsula is motly converted to agricultural pursuits (including rubber, pepper and oil palm plantations), there are still large tracts of virgin forest standing. One area near Ulu Gombak was particularly nice. Among the interesting plants seen in Malaysia were *Typhonium trilobatium* (L.) Schott (Fig. 31) with its three-parted leaf blades and interesting inflorescences (Fig 21) and a small peltate-leaved species of *Alocasia* (Fig. 22) possibly *A. beccarii* Engl. A trip to the Botanical Garden in Penang yielded relatively little of interest.

The remainder of the trip in Asia was spent primarily in the study of herbarium specimens at various important herbaria including the Kerr Herbarium and the Forestry Herbarium in Bangkok, the Botanical Survey of India in Calcutta and the University of Pakistan Herbarium in Karachi.

My return to the United States via tropical west Africa enabled me to collect in one of the few remaining tropical rain forest areas of Nigeria where I found several species of *Culcasia*, as well as *Rhektophyllum mirabile* N.E. Br. Fig. 23) and huge plants of *Anchomanes difformis* (Blume) Engler (Fig. 24 and 32). The leaves of *Rhektophyllum* though initially entire, soon are divided. The tubers of *Anchomanes* (Fig. 32) often grow laterally forming a distinctive structure.

The Nigerian stop completed this long aroid collecting trip. The trip gave me a first-hand introduction to many of the Old World genera and gave direction to genera still in need ot taxonomic studies. The approximately three hundred live collections will hopefully form the basis for further studies with the Old World genera.

In Africa, aroids tend to be even less well-represented than in Asia. The whole of tropical West Africa (as treated by John hutchinson in his "Flora of Tropical West Africa") includes only fifty-two native species and this is a wet tropical area many times larger than Papua New Guinea (compared earlier with Panama) but with many fewer known species. It has, moreover, been much more well collected, so these numbers are less likely to change. Considering the size of the tropical West African region it is also generically poor, as well, with only thirteen native genera. This yields an average of only four species per genus compared with over twenty-one species per genus in Asia and over thirty per genus for tropical America. In terms of habit, sixty-five percent of the species are either terrestrial or aquatic (*Pistia* with one species being the only true aquatic). Of the remaining species, many are frequently more common as ground creepers than they are a epiphytes. This is often true of *Culcasia* and *Rhektophyllum*. Thus, the African aroid flora compares more closely with that of Asia than America in terms of habit. Papua New Guinea (as a representative of Asia) had thirty-one percent of its species epiphytic whereas Panama (an American representative) has ninety-three percent of its species epiphytic.

This, no doubt conservative, estimate of one hundred, thirty-nine species of the Papua New Guinea Araceae prepared by Lord Alistair Hay at the Forestry College in Bulolo is unquestionably low; considering the extent to which the country has been collected. Nevertheless, the fact remains that even if the current count were to be doubled to two hundred, seventy-eight species it would represent a flora notably less rich in aroid species than comparable areas of the Neotropics. For example, Panama has an estimated three hundred, eight species of Araceae in 28,576 square miles. By contrast, Papua New Guinea (the eastern half of the island of New Guinea only) has an area 5.6 times larger with roughly the same number of species (already having allowed for a doubling of the number of species to reflect the fact that New Guinea remains poorly collected). That this is true despite a larger number of genera (twenty-one for Papua New Guinea versus sixteen for Panama) reflects an important characteristic of Asian aroids, namely high generic diversity and low species diversity. While Panamanian genera have an average of over nineteen species per genus, the New Guinea aroids (based on current estimates of numbers of species have fewer than seven species per genus on the average. This is borne out by studies of all areas in Asia. While the average number of species per genus for the entire family is 22.3, the average number of species per genus in Asia is 21.2 while in the American tropics the average number of species per genus is 30.2

Other comparisons can readily be made between New World and Old World aroids. For example, while roughly one half (seven of sixteen genera) of Panamanian genera are epiphytic (or principally so) only three of the twenty-one Papua New Guinean aroids are epiphytic. These three epiphytic genera, *Amydrium*, *Rhaphidophora* and *Scindapsus* account for thirty-one percent of all species. Panamanian epiphytic groups are proportionately even more important with ninety-three percent of all the species epiphytic or principally so. These differences are immediately apparent and are exhibited by the fact that fewer trees in Asia are covered with epiphytes.

Fig. 1. *Amorphophallus galbra* F.M. Bailey; Kakadu National Park, Northern Territory; Australia; *Croat 52418a.*

Fig. 2. *Rhaphidophora pinnata* Schott; Australia: Queensland, Lake Eachum *Croat 52651.*

Fig. 3. *Alocasia* sp. Borneo: Malaysia: Sarawak; Kuching.

Fig. 4. *Aglaonema crispum* Papua New Guinea: Morobe: Lae Botanical Garden; *Croat 52874*

Fig. 5. Rhaphidophora sp. Borneo: Malaysia: Sabah; Kota-Kinabalu-Tambunan; *Croat 53118*

Fig. 6. *Amydrium magnificum* (Engler) Nicolson: Papua, New Guinea: Morobe: Road from Lae to Sankewep, *Croat 52817*

Fig. 7-8. *Holochlamys beccarii* Engler. Papua New Guinea; Morobe: Lae Botanical Garden.

Fig. 9. *Aglaonema marantifolium* Blume. Papua New Guinea: Morobe: Busu River Valley, *Croat 52844.*

Fig. 10. *Amorphophallus* sp. Borneo: Malaysia: Sarawek; Road from Kuching to Padawan, *Croat 53170.*

Fig. 11. *Lasia spinosa* (L.) Twaites. Papua New Guinea: Morobe: Lae Botanical Garden, *Croat 52905.*

Fig. 12. *Cyrtosperma johnstonii* (Bull.) N.E. Br. Papua New Guinea: Morobe: Lae Botanical Gardens.

Fig. 13. *Homalomena* sp. Borneo: Malaysia: Sabah; Road from Kota Kinabalu to Tambunan, 460 meters elev., *Croat 53104.*

Fig. 14. *Rhaphidophora korthalsii* Schott. Philippines: Luzon: Quezon: Quezon National Park, *Croat 52993.*

Fig. 15. *Pothoidium lobbianum* Schott. Philippines: Luzon: Quezon: Quezon National Park, *Croat 53043.*

Fig. 16. *Spathiphyllum communtatum* Schott. Philippines: Luzon: Camarines Norte: Bicol National Park, *Croat 53048.*

Fig. 17. *Spathiphyllum commutatum* Schott. Philippines: Luzon: Camarines Norte: Bicol National Park, *Croat 53048.*

Fig. 18. *Alocasia* sp. Borneo: Sarawak: Road from Kuching to Padawan, *Croat 53183.*

Fig. 19-20. *Amydrium medium* (Zoll. & Mori) Nicolson. Borneo: Sarawak: Kuching Botanical Research Center.

Fig. 21. *Typhonium trilobatum* (L.) Schott. W. Malaysia: Kuala Lumpur.

Fig. 22. *Alocasia* sp. W. Malaysia: Selangor: Genting Highlands. *Croat 53338.*

Fig. 23. *Rhektophyllum mirabile* N.E. Br. Nigeria: Ogun: Omo Forest Reserve. *Croat 53495.*

Fig. 24. *Anchomanes difformis* (Bl.) Engler. Nigeria: Ogun: Omo Forest Reserve. *Croat 53493.*

Fig. 25. *Homalomena* sp. Borneo: Sarawak: Road from Kuching to Padawan, *Croat 53174.*

Fig. 26. *Homalomena* sp. Borneo: Sarawak: Road from Kuching to Padawan, *Croat 53174.*

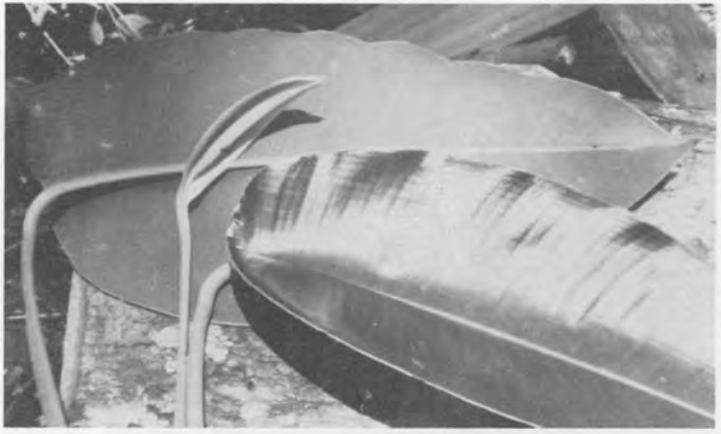

Fig. 27. *Rhaphidophora monticola.* Philippines: Luzon: Camarines Norte: Bicol National Park, *Croat 58033.*

Fig. 28. *Cyrtosperma merkusii* (Hassk.) Schott. Philippines: Luzon: Camarines Norte: Bicol National Park, *Croat 53048*

Fig. 29. *Schizmatoglottis* sp. Borneo: Malaysia: Sabah: Road from Kota Kinabalu to Tambunan, *Croat 53110.*

Fig. 30. *Aridarum nicolsonii* Bogner. Borneo: Malaysia: Sabah: Bako National Park, *Croat 53211.*

Fig. 31. *Typhonium trilobatum* (L.) Schott. W. Malaysia: Kuala

Fig. 32. *Anchomanes difformis* (Bl.) Engler. Nigeria: Ogun: Omo Forest