A Review of *Biarum*: Small Aroids of the Mediterranean

Peter Boyce

Introduction

The genus *Biarum* Schott comprises 20 species of dwarf tuberous-stemmed herbs which occur in semi-arid and seasonally dry areas of southern Europe, North Africa, and the Near and Middle East. The genus's center of diversity is the Middle East, where 75 percent of the species occur as endemics.

Biarum species have a strongly seasonal growth regime; the plants begin growth in late summer or early autumn with the onset of winter rains and continue into late spring, when they become dormant with the onset of summer heat and drought. The majority of species blossom in autumn and early winter, and this, together with the often striking appearance of the inflorescence, has resulted in growing popularity of *Biarum* species among alpine garden enthusiasts.

All *Biarum* species have a tuberous stem (or in common growers' parlance, a tuber) with a relatively thin, somewhat papery skin. There are two types of roots, contractile and feeding. At the beginning of the growth season, the plant produces a small number of relatively thick, unbranched roots from the shoot base. These roots generally go down straight into the soil, anchoring the tuber, which has spent the previous four or five months rootless and thus insecure. Once the tuber is in a firm position, the much finer feeding roots start to develop. The feeding roots do not necessarily grow downward but instead form a dense mat, perhaps in response to the heavy but short-lived rains common in the areas where many species grow. The root mass is also doubtless very effective in taking up nutrients from the sparse soil in rock crevices and on stony hillsides, or when the *Biarum* is competing with other actively growing plants. Toward the end of the growth season, the feeding roots start to wither as the soil begins to dry out. At the same time, the tough central core of tissue inside the spongy contractile roots begins to contract. By this time, the root tip can be half a meter (20 inches) below the soil surface and is well secured, and so the new tuber that has formed during growth is pulled down more deeply, bringing it to approximately the same depth as the parent tuber was at the beginning of the growth period. This protects the tuber from undue heat and dryness during the dormant phase.

The main growth point (from which the above-ground parts emerge in fall) is central on the upper surface, either slightly raised or in a shallow depression. The growth is subtended (surrounded from below) by a single prophyll and a number of papery cataphylls—i.e., two layers of reduced leaf structures (similar structures are familiar at the base of *Crocus* leaves and flowers). On expansion the prophyll, the cataphylls, and the tuber apex are coated with a waxy, mealy substance. The leaves of the various species range from linear to spathulate and appear from late winter to early spring, their bases protected by a few cataphylls that are at first fleshy and later papery.

The inflorescence is typical of the Araceae, with the spathe divided into two regions: an upper, free, basically ligulate (strap-shaped) spathe limb, and a lower, cylindrical to globose spathe tube enclosing the true flowers. While the form of the spathe limb is important in species identification, it is the features of the spathe tube that are central to the classification of the genus—in particular, the degree of fusion of the spathe tube margins.

The spadix bears fertile flowers toward the base and a sterile appendix above. In all *Biarum* species, the fertile female flowers are borne in a hemispherical to weakly cylindrical cluster at the base of the spadix, while the fertile male flowers are carried in an oblong to cylindrical cluster approximately 1–2 cm above this. The fertile flowers are always separated by an interstice, which is usually provided with sterile flowers in the form of bristles or hooked structures, but is occasionally devoid of any floral traces. In some species, a further zone of fertile flowers is situated above the male flowers at the base of the sterile appendix. The form of the sterile appendix is useful in determining species. In many it is cylindrical or fusiform (spindle-shaped), but in a few taxa it is hairlike or stout-conical. All species but *Biarum ditschianum* have a naked appendix at the tip of the spadix; in that species, the base of the appendix is clothed with adpressed (lying flat against the appendix) to slightly prominent, transparent processes.

Biarum infructescences ("fruits" in common usage) are dense, globose to hemispherical heads of leathery berries carried at or partially below ground level. The berries ripen pale purple or grayish, and each contains a single leathery seed with a large oily caruncle at one end, which presumably attracts insects or other animals that distribute the seed away from the parent plant.

Classification

Biarum is divided into two subgenera: *Biarum* and *Ischarum*. Subgenus *Biarum* is defined by having anthers with thecae (pollen sacs) dehiscing by ventral, longitudinal slits; a beaklike connective structure that extends beyond the anther; and hooked, rarely peglike or filamentous staminodes (stamenlike structures without anthers) that are mostly present above and below the male flower zone and only rarely present below only the male flower zone. There are two species in this subgenus: *B. tenuifolium*, the most commonly cultivated *Biarum* species, and *B. rhopalospadix* (often cultivated under the synonym *B. spruneri*).

The other subgenus is *Ischarum*, in which the anthers have thecae dehiscing by apical pores (openings on the tips) and a connective structure barely prominent or flush with the anther surface. Staminodes, where present, are filamentous and occur below the male flower zone.

The Species

1. *Biarum tenuifolium* (L.) Schott

Biarum tenuifolium is a widespread and variable species with discrete populations throughout the Mediterranean. For convenience, it can be divided into no fewer than six distinct subspecies.

The typical subspecies, subsp. *tenuifolium*, has a long-exserted, slender spadix appendix and densely arranged, well-developed, simple, curving staminodes. Early in the growing season, its leaf blades are elliptic-lanceolate; later-emerging leaves are linear-lanceolate. In immature plants, the leaf blade is always elliptic-lanceolate. The typical subspecies occurs from southern Italy to the southern Balkans and is the common *Biarum* in mainland Greece.

Two subspecies occur in the Iberian Peninsula: subsp. *arundanum* and subsp. *galianii*. Though clearly defined by their ecological requirements—subsp. *arundanum* a plant of terra rossa soils (reddish-brown residual soils over limestone bedrock), while subsp. *galianii* is restricted to loose sandy soils—they are difficult to separate morphologically in the absence of ecological data. Subsp. *arundanum* has the staminodes always strictly whorled, but they are irregularly scattered in subsp. *galianii*.

Subsp. *arundanum* is widespread in southwestern Spain, occurring in the regions of Cádiz, Córdoba, Granada, Málaga, and Seville, and is often extremely abundant, forming extensive colonies alongside cultivated land and beside paths; it is also found in southern Portugal, Gibraltar, and northern Morocco. The freshly opened spathe emits a particularly offensive odor similar to cattle dung. Subsp. *galianii* occurs in the Spanish regions of Badajoz and Huelva near the Portuguese border, where it is restricted to loose sandy soils.

The central Mediterranean is home to subsp. *abbreviatum*, which is distinguished by erect, short spathulate leaves, usually with undulate (wavy) to rarely somewhat crispulate (slightly curled) margins. The spathe limb averages 9 by 1.5 cm in size and is notable for its bicolored interior, deep purple-brown below with a striking green apical (upper) portion. The spadix appendix is generally only slightly longer than the spathe limb and rather broad compared with its length. The staminodes are rather poorly developed and peglike. Subspecies *abbreviatum* occurs in Italy (where it has been called *B. cupanianum* Guss. ex Paglia), Yugoslavia, the former Yugoslavian Republic of Macedonia, northern mainland Greece, and Corfu. It has yet to be recorded from Albania, where the typical subspecies occurs, but the presence of subsp. *abbreviatum* to the south of Lake Ochrid, close to the Albanian frontier, suggests that it does occur there.

Subsp. *idomenaeum*, from Crete, is notable for its strongly undulate-crispulate leaves that are closely adpressed to the ground. The spathes are generally similar in size to those of subsp. *abbreviatum*, but the staminodes are densely arranged and slender.

The easternmost subspecies, subsp. *zelebori*, is distinguished by large, bulky inflorescences, with the spathe limb averaging 20 by 3 cm, as well as by a robust, moderately exserted spadix appendix and rather sparse but substantial staminodes. The leaves do not display the marked heteromorphy (different shapes in early and late leaves) found in the typical variety, and the leaf blade is spathulate-lanceolate, often with gently undulate margins. Subspecies *zelebori* is restricted to southwestern Turkey, Rhodes, Cos, and a few scattered sites on Crete.

2. *Biarum rhopalospadix* C. Koch

The hitherto obscure, but prior name *Biarum rhopalospadix* must now be used for what had been known as *B. spruneri*. *Biarum rhopalospadix* is superficially similar to *B. tenuifolium*, especially to subsp. *abbreviatum*. It may be readily distinguished by its lack of staminodes, the stigma borne on a short style, the narrow, parallel-sided spathe limb, and the considerably stouter spadix appendix. The spring-flowering pattern is also useful in distinguishing *B. spruneri* from the majority of the Greek mainland populations of *B. tenuifolium*. To date, *B. rhopalospadix* has been found only in southern Greece (Attica, the Peloponnese), where it grows on terra rossa in grazed fields, open hill slopes, abandoned olive groves, and field margins at elevations up to 450 meters (1460 feet).

3. *Biarum carduchorum* (Schott) Engler

Biarum carduchorum is fairly widespread, occurring from southern and southeastern Turkey to southern Iran on bare terra rossa hill slopes, in open situations, field margins, and long-fallow fields up to 2750 meters elevation (9020 feet). It is most readily separated from *B. angustatum* by the upward-directed staminodes and the considerably wider leaves; in addition, *B. carduchorum* is found farther inland than B. *angustatum*.

4. *Biarum angustatum* (Hook.f.) N.E.Br.

This large-flowered species, although fairly common in the wild, is decidedly rare in cultivation. *Biarum angustatum* is outwardly very similar to *B. carduchorum* when in flower but is easily distinguished by the downward-directed staminodes and narrower leaves. Another point of separation concerns the distribution of the two species. *Biarum angustatum* is essentially a "coastal" species, restricted to Syria and Israel on terra rossa in open, grazed, sometimes almost completely bare fields up to 350 meters elevation (1148 feet), while *B. carduchorum* is an inland and not infrequently upland species, distributed from southeastern Turkey and northwestern Syria through Iraq and into Iran.

5. *Biarum aleppicum* Thiébaut

Biarum aleppicum is related to *B. carduchorum* and *B. angustatum* but is readily dis-

tinguished by having the spathe tube margins free almost to the base and by the sessile stigmas. Plants of *B. aleppicum* individually carry many more leaves than either *B. angustatum* or *B. carduchorum*, although the leaf shape approaches that of *B. angustatum*. In the wild it is restricted to northeastern Syria, where it is a rare plant. It has nonetheless proven comparatively easy to grow, although to my knowledge it is currently grown only in a few botanic gardens.

6. *Biarum eximium* (Schott & Kotschy) Engler
Biarum eximium differs from all other species of subgenus *Ischarum* in that the staminodes are evenly distributed over the entire length of the interstice between the male and female flower zones. The spathe is very broad, almost oblong. For a long time *B. eximium* was considered to be restricted to southern Turkey, but recently populations have been discovered in Jordan.

7. *Biarum crispulum* (Schott) Engl.
Biarum crispulum has been almost universally treated as a synonym of *B. bovei* despite being readily separable by its narrow, incurved, and heavily crispulate spathe margins, and a spadix appendix smelling of sour milk (as compared with the dung odor in *B. bovei*). This is the commonest *Biarum* in northwestern Syria, forming extensive colonies in bare red soil to the north of Aleppo, and it is widespread in the provinces of Adana and Hatay in southern Turkey and in northern Syria. There is also a western extension to Cappadocia.

8. *Biarum bovei* Blume
Biarum bovei has been confused with *B. kotschyi* and *B. pyrami*. Part of the trouble appears to stem from the scarcity of true *B. bovei* in cultivation: most plants being grown under this name are *B. dispar* (some are *B. crispulum*), and confusion with the Afro-Iberian *B. dispar* has led to the belief that *B. bovei* is consistently variable throughout its range when, in fact, the variation has a clear geographical basis. For distinctions, see the next entry. The true *B. bovei* is very little cultivated.

9. *Biarum dispar* (Schott) Talavera
This interesting species (photo, p. 273) has been much confused with the closely allied *B. bovei* from the eastern Mediterranean. It can be distinguished readily by the interstice, which is approximately twice as long as the staminate flower zone, by the presence of fewer and more scattered staminodes, and by the narrower mature leaf blade. The overall size of the inflorescences has been used previously as a diagnostic feature, *B. dispar* having a smaller inflorescence than *B. bovei*. While this appears to be true for the North African populations of *B. dispar*, it does not necessarily hold true for Spanish populations, which are often as large as, if not larger than, typical *B. bovei*. However, part of the apparent size overlap between the species appears to be due to confusion with a previously overlooked species, *B. mendax*, which displays dimensions in excess of both *B. dispar* and *B. bovei* and is readily separable from either.

10. *Biarum olivieri* Blume

Biarum olivieri is a curious species that, although allied to *B. bovei*, *B. dispar*, and *B. crispulum*, is separable by its linear to linear-lanceolate leaves, its much thinner, almost papery spathe texture, its fully connate (united) spathe tube margins, and its filamentous spadix appendix. The floral odor produced by *B. olivieri* is also distinctive: both *B. dispar* and *B. bovei* produce a dunglike odor which, although unpleasant, is not nauseating; *Biarum olivieri* produces a disgusting smell of sour milk when in blossom, similar to but considerably stronger than that produced by *B. crispulum*. The habitat favored by *B. olivieri*, consolidated sand, is quite different from the heavy red terra rossa favored by *B. bovei*, *B. dispar*, and *B. crispulum*.

To date *B. olivieri* is known from only three wild locations. The original locality is an area of sub-coastal sands on the Egyptian coast, where it forms extensive colonies in association with *Arisarum vulgare* Targ.-Tozz. and *Eminium spiculatum* (Blume) Schott. A second, more recently discovered site is in the Negev Desert in southern Israel; and in 1995 Chris Lovell collected *B. olivieri* in Jordan on the road from Ibria to Rauble.

11. *Biarum straussii* Engler

The distinctive appearance of *Biarum straussii* in flower—the inflorescence emerging from the middle of a mature leaf rosette—leaves little chance of confusing it with any other species, except perhaps *B. syriacum*, from which it differs by the much broader leaf blade. Confusion might occur with species of *Eminium*, especially with the entire-leaved forms of *E. intortum*, but the entirely free spathe margins and different arrangement of the staminodes in *Eminium* should readily separate them. In the sterile state, however, *B. straussii* is quite similar to *B. bovei*, and they are often confused in herbaria.

12. *Biarum syriacum* (Spreng.) H.Riedl

If its unusual spring flowering period is ignored, *Biarum syriacum* would appear, on the basis of floral morphology, to be related to *B. bovei* and *B. kotschyi*. The rather oblong spathe tube and the arrangement of the staminodes are similar to those of *B. bovei*. However, the foliage of *B. syriacum* is quite different and, in fact, no other species of subgenus *Ischarum* has similar clumps of grassy leaves. *Biarum syriacum* is restricted to the seasonally dry clay plains in northern Syria, where it is rare.

13. *Biarum carratracense* (Haenseler) Font Quer

Biarum carratracense (photo, p. 273) has been associated with *B. bovei* and *B. tenuifolium* but is quite clearly distinguishable from either. The oblong, slightly inflated spathe tube with the margins connate for over half their length and the fusiform spadix appendix suggest an affinity to *B. kotschyi* and *B. fraasianum*, although *B. carratracense* is geographically isolated from either species. Vegetatively, *B. carratracense* would appear to be closest to *B. kotschyi*, which has a similar lanceolate-elliptic leafblade; however, *B. kotschyi* has the petioles free to the

ground whereas in *B. carratracense* the petiole bases are often imbricated to form a weak pseudostem. Further, the staminodes are far fewer in *B. carratracense* than in *B. kotschyi*; some material of the Spanish species almost lacks pistillodes except for a couple of vestigial bristles on the upper part of the interstice. To date, *B. carratracense* has been found only in southwestern Spain, where it is common in dry mountain pastures, field margins, and tracksides in terra rossa soils.

14. *Biarum kotschyi* (Schott) B.Mathew ex H.Riedl

Biarum kotschyi can be regarded as intermediate between *B. bovei* and *B. pyrami* on the basis of the shape of the spathe tube, spadix appendix, staminodes, and foliage. *Biarum kotschyi* and *B. carratracense* are also similar in their rather slender spathe limbs, fusiform spadix appendices, and arrangements of the staminodes, but they can be readily distinguished by the degree of connation of the spathe tube margins (three-quarters free in *B. kotschyi*, half free in *B. carratracense*) and by their distinct geographical distributions.

Biarum kotschyi is a common species in parts of southeastern Turkey, and a search of a dry hillside will usually reveal this species. Schott's citation of the type locality (as in some other cases) must be regarded as suspect. *Biarum kotschyi* has never been found in Lebanon or Syria, and it appears to be restricted to a few provinces in Turkey. It is most likely that the type of *B. kotschyi* originated in the southeastern Turkish provinces of Bitlis, Diyarbakir, Urfa, Gaziantep, and Maras.

15. *Biarum fraasianum* (Schott) Nyman

Biarum fraasianum is most similar to *B. bovei*, *B. kotschyi*, and *B. carratracense*, particularly in the degree of spathe tube inflation and the fusiform spadix appendix. The arrangement of the staminodes in *B. fraasianum* is closer to that found in *B. dispar* than to that of *B. carratracense* and *B. kotschyi*, but its geographical distribution and the greater overall similarity to *B. kotschyi* leads me to suspect that the closest relationship lies with the latter species.

Until recently *Biarum fraasianum* was a species about which very little was known. Carl Nicolaus Fraas's original collection occurred more than 150 years ago, and the plant had not been refound. However, in the mid-1990s *B. fraasianum* was rediscovered in several different localities in Greece, and as result it revealed numerous hitherto unknown characteristics, including spring flowering and a sweet smell at anthesis (onset of flowering). The latter feature is particularly uncommon in *Biarum*, shared only with *B. davisii*.

16. Biarum pyrami (Schott) Engler

This large, showy species (photo, p. 273) is perhaps the most readily distinguishable of the autumn-flowering *Biarum* species owing to the globose, strongly inflated spathe tube, large spathe, and greatly attenuated spadix appendix. The usually bullate (heavily veined and "blistered") leaves are also unusual in the genus and provide a ready means of identifying *B. pyrami* in Turkey, where no

other species shares this character. In Turkey, *B. pyrami*, *B. bovei,* and *B. kotschyi* form an apparently closely related group of species, but they are readily distinguishable from one another.

Israeli material of *B. pyrami* is rather distinct from that of Turkish and Syrian origin, and some authorities recognize it as a separate variety, var. *serotinum*, on the basis of its much later, winter flowering period and smooth (not blistered) leaves.

17. *Biarum mendax* P.C. Boyce

Biarum mendax is endemic to southeastern Spain and has been variously assigned to *B. bovei* Blume, or *B. dispar* (Schott) Talavera, on the basis of its overall similarity to them. However, *B. mendax* is readily separable by its greater size, exceeding that attained by *B. pyrami*. Indeed, *B. mendax* bears the largest inflorescence yet recorded in *Biarum*. It can be distinguished from all three of the abovementioned species by its completely fused spathe tube. *Biarum mendax* belongs to a group of species defined by spadices bearing sterile flowers only between the male and female flower zones, and by the inflated lower spathe. The specific epithet is from the Latin *mendax* "deceitful," in allusion to the similarity between the dried herbarium specimens of this species, *B. bovei,* and of *B. dispar,* which has resulted in its being hitherto overlooked.

18. *Biarum auraniticum* Mouterde

Biarum auraniticum is unique in its genus in possessing a white spathe limb. There is no doubt that this is a most singular species, not only for its coloration but also because of its remarkably wide, bottle-shaped ovaries. These two characteristics make it difficult to envisage a close relationship for this species. The lack of pistillodes, the ovate-elliptic, long-petiolate leaves and slightly inflated spathe tube support a link to *B. bovei* or *B. kotschyi*. *Biarum auraniticum* is endemic to southwestern Syria, where is known only from the area around the town of Sanamein.

19. *Biarum ditschianum* Bogner & Boyce

Biarum ditschianum has an extraordinary appearance in flower compared with most other *Biarum* species. The spathe limb is reduced to a narrow rim on the spathe tuber, and the most notable feature is the relatively massive, dark yellow spadix appendix. Two other *Biarum* species have unusual inflorescences: *B. davisii* has pinkish-white spathes, a purple spadix appendix, and a sweet odor at anthesis; and *B. auraniticum* has a greenish-white spathe and a yellow spadix, but its odor is unknown. Both species lack a zone of sterile flowers (staminodes) on the interstice separating the male and female flower zones, a feature also seen in *B. ditschianum*.

Perhaps the most unusual feature of *B. ditschianum* is the presence of hairlike processes on the base of the spadix appendix. Such structures are otherwise unknown in the genus and are uncommon in the Araceae. Their function is not clear, although it is possible that they play a role in pollination. The inflores-

cence of *B. ditschianum* is also notable for being exceptionally foul-smelling, with a powerful odor of carrion and excrement which attracts carrion flies.

20. *Biarum davisii* Turrill

Biarum davisii (photo, p. 273) is an attractive species which, until the discovery of *B. ditschianum*, ranked as the most unusual in the genus. Apart from its remarkably small size, characteristics such as the basically ovate foliage, deeply urceolate (urn-shaped) spathe tube, pinkish-brown spathe, and sweet lilac-like smell when in blossom are all unique in the genus. It is well established in cultivation.

Biarum davisii is a plant of limestone screes and terra rossa pockets on calcareous hillsides and is widespread but rather local on Crete and in southwestern Turkey. Where it occurs it is often abundant, forming extensive colonies; however, its small size together with the fleeting appearance of the inflorescences means that *B. davisii* is much overlooked, and this has led to the belief that it is rare. More recent observations, together with data on herbarium sheets, suggest that this is not the case and that it occurs in most parts of Crete. The Cretan populations of *B. davisii* are remarkably uniform, plants from opposite ends of the island being virtually indistinguishable morphologically.

Cultivation

Biarum species fall into three groups for the purpose of cultivation. Some species, notably *B. tenuifolium* and *B. rhopalospadix*, are easy to grow and are hardy outdoors in the milder gardening regions if planted in sheltered positions. However, the majority of species require some winter protection, ideally frost-free, and are best grown in pots in a cool greenhouse or alpine house, or planted directly into a sheltered coldframe. Last, there are a few species that tax the grower's skills and require cosseting in a cool greenhouse; *B. olivieri* is typical of this third group.

Outdoor cultivation

The tubers require quite deep planting (8–10 cm/4-5 inches from the soil surface to the top of the tuber) and rich, well-drained soil. If the soil tends toward clay, then the addition of sharp sand and grit, particularly as a cushion beneath the tuber, is beneficial. In warm areas the tubers can be planted in open places, in a rockery for example, but in less ideal situations a planting site at the base of a west- or south-facing wall will provide the best chance of success. When happy, *B. tenuifolium* will spread freely both by offsetting and from seed. Not all subspecies of *B. tenuifolium* are equally successful outdoors; subsp. *tenuifolium* and subsp. *abbreviatum* are the easiest. *Biarum rhopalospadix* grows well in conditions similar to those for *B. tenuifolium*. In particularly sheltered places with a Mediterranean-like climate, other species that are worth experimenting with outdoors include *B. crispulum*, *B. davisii*, *B. dispar*, and *B. kotschyi*.

Cultivation under glass

Cultivation in a frost-free greenhouse gives perhaps the best success. A narrow but deep clay pot with a compost of equal parts sterilized loam, humus, and sharp grit should be used, with annual repotting into fresh compost. When growth begins in autumn, water should be given sparingly until the plant is growing well. Too much water early on can result in root loss. Under glass the plants should be given as much light as possible during the winter to prevent leaf etiolation. Ventilation must be given on all but the coldest days, and water applied regularly but carefully, since moisture remaining lodged in the leaf sheaths can result in rotting. The plants should continue growing throughout the winter, with a balanced soluble fertilizer given weekly given to maintain vigor. Toward early spring growth will slow down, and by mid-June the leaves will turn yellow and wither. At this time direct watering should be stopped; the soil should be kept just moist by plunging the clay pot to the rim in sand and keeping the sand damp. The inflorescence will emerge soon after the foliage dies. Once flowering is over, the soil should be allowed to dry out and the plant rested. Care should be taken not to allow the pot to become too hot, as this can cause desiccation of the tuber. Repotting should be carried out annually in July or early August.

Propagation is best effected by sowing freshly collected seed on the surface of a mixture of equal parts sterilized loam, humus, and sharp grit, then covering the seed with 1 cm (1/2 inch) of sharp grit. Germination occurs in late fall and winter; stored seed may germinate erratically after two or three years. The seedlings should be kept growing until the leaves wither in summer, and then the little tubers can be transplanted into larger pots; care must be taken not to desiccate these tiny tubers, for instance by keeping their pots in a shaded site in the greenhouse or frame.

After 14 years in the Herbarium, Royal Botanic Gardens, Kew, working on the taxonomy and phylogeny of Araceae with particular interest in the wet Southeast Asian tropics and the European Mediterranean, and two years as freelance biological consultant based in southwestern France, Peter Boyce is presently based in Kuching, Sarawak, Malaysia, managing a federal government-funded project for a biotechnology company studying aroids and gingers with a view to evaluating their suitability for commercial horticulture, and also to evaluate the level to which they are threatened in the wild by illegal exploitation. Current horticultural and research interests include *Homalomena*, *Alocasia,* and *Schismatoglottis,* along with numerous non-aroids including Zingiberaceae, *Hoya*, *Begonia* (collaborating with Ruth Kiew, Singapore B.G.) and *Hanguana*.