A TAXONOMIC REVISION OF *BIARUM*

Araceae

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Summary. This paper contains a revision of the genus *Biarum* Schott. 21 species and 6 subspecies are recognised. All the taxa (except *B. mendax* Boyce) are illustrated by line drawings, and most of them are shown as paintings or as photographs in habitat or in cultivation. Distribution maps of all the species are given and a key to all taxa is provided.

Introduction

Biarum comprises 21 species of dwarf tuberous-stemmed herbs occurring in semi-arid and seasonally dry areas of southern Europe, North Africa, the Near and Middle East. The centre of diversity is the Middle East, where 75% 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, continuing into late spring when they become dormant at the start 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 the growing popularity of *Biarum* species amongst alpine garden enthusiasts. In most species the inflorescence emerges from the bare ground before the leaves (hysteranthous), but in some species the leaves are regularly synanthous, emerging at the same time as the inflorescence, and a few, such as *Biarum syriacum*, are proteranthous, with the inflorescence emerging after the leaves have developed. A taxonomic summary of the genus was given in *Aroideana* (Boyce 2006). Further aspects of the horticultural popularity of the genus have been covered by Mayo (1983) and Mathew (1987).

History of the Genus

Until the publication of Schott's articles in the *Wiener Zeitschrift f ür Kunst, Literatur, Theater und Mode* (1829a, 1829b, 1829c, 1829d, 1829e, 1829f, 1829g; 1830a, 1830b, 1830c, 1830d, 1830e) and his aroid account in *Meletemata Botanica* (1832), the genus *Arum* was ill-defined, containing numerous species bearing only superficial similarity to the type of the genus, *A. maculatum* L. Schott attempted to bring a degree of homogeneity to *Arum* by segregating the anomalous taxa in new genera. Schott (1832) proposed the genus *Biarum* to account

for two species of *Arum* (*sensu* Linnaeus) with uniovulate ovaries and a basal placenta, loosely arranged staminate flowers with anthers dehiscing by ventral longitudinal slits, scattered staminodes and pistillodes and connate spathe tube margins. The two species included were *Biarum gramineum* (Lam.) Schott and *B. tenuifolium* (L.) Schott.

Blume (1836) retained Schott's two species and described an additional three, *Biarum bovei*, *B. homaïd* and *B. olivieri*. Blume divided *Biarum* into two sections, placing Schott's species in "Sectio 1" (i.e. sect. *Biarum*) and creating sect. *Ischarum* for the three new ones. Blume distinguished sect. *Ischarum* by the lack of staminodes, anther thecae dehiscing by apical pores and more-or-less elongated style. By contrast, in sect. *Biarum sensu* Blume, both staminodes and pistillodes are present, the thecae dehisce by longitudinal slits and the stigma is sessile. Blume emphasized the different geographical distribution of the sections as then known, with sect. *Ischarum* in the eastern Mediterranean region and sect. *Biarum* in the western Mediterranean.

Boissier (1853) added two new species, *B. spruneri* and *B. alexandrinum*, but did not review any of the previous treatments. He placed *B. spruneri* in sect. *Biarum* (as sect. 'Eubiarum') with the note that *B. spruneri* was apparently intermediate between sect. *Biarum* and sect. *Ischarum*. *Biarum alexandrinum* was assigned to sect. *Ischarum*.

Schott and Kotschy (1854) raised Blume's sect. *Ischarum* to generic status with a single new species, *I. eximium*. No mention was made, however, of the three species previously described by Blume for the sect. *Ischarum* and Schott (1856) eventually made the necessary new combinations in the genus *Ischarum*.

In his *Synopsis Aroidearum*, Schott (1856) published seven new combinations and two new species for *Ischarum*. The new combinations included the two taxa described by Boissier (1853), *Arum haenseleri* published by Willkomm (1847) and *Biarum lehmannii* Bunge (1851). The last mentioned was later transferred to *Eminium* by Kuntze (1891). The new species were *I. kotschyi* and *I. dispar*.

With the publication of *Genera Aroidearum* (1858) Schott proposed two new genera, *Cyllenium* and *Leptopetion*, for *Biarum spruneri* and *B. alexandrinum* respectively. The differences between the genera concerned the presence or not of a style, the means of thecae dehiscence, i.e. slits as opposed to pores, and the shape and distribution of the pistillodes.

Engler (1879) adopted what was essentially Schott's system except that he reduced all Schott's segregate genera to subgenera of *Biarum* and dispensed with *Leptopetion* altogether, referring it to

subgen. *Ischarum*. Engler also reduced many of Schott's species to subspecific or varietal status or to synonymy.

Boissier (1882) also chose not to recognize Schott's separate genera, and in fact went a stage further than Engler (1879) in distinguishing them at the rank of section rather than subgenus. Boissier followed Engler in not accepting *Leptopetion* at any rank, also referring it to section *Ischarum*.

Engler's (1920) revision of *Biarum* for *Das Pflanzenreich* was the last comprehensive treatment of the genus. Although little had changed since his 1879 classification, he published one new species, *B. straussii*, and a number of subspecific taxa.

Since the *Pflanzenreich* account several floristic examinations of *Biarum* have been undertaken by various authors (e.g. Riedl 1963 & 1985, Mouterde 1966, Talavera 1976, Mill 1984 and Koach & Feinbrun 1986). Riedl (1980b) published a preliminary summary of the genus together with a key to the species. However, none of these accounts attempts a comprehensive treatment and new discoveries and interpretations during the last fifty years have made this revision necessary.

Typification

During the course of this revision it has been necessary to lectotypify a number of names. The majority of these are names published by Schott for which the types in Vienna (W) were destroyed during the closing stages of the Second World War. For lectotypes I have followed the advice of Riedl & Riedl-Dorn (1988) in selecting illustrations that were commissioned by Schott and prepared from living and herbarium specimens. These are known collectively as the *Icones & Reliquiae Aroidearum*. It has also been necessary to lectotypify names based on types destroyed in Berlin. In these cases it has not been possible to trace any authentic material, but in some instances drawings of the types exist and have been chosen to serve as the lectotype.

Future Research

Unlike the genus *Arum*, practically nothing has been done in connection with studying the pollinators of *Biarum*. The major reason is undoubtedly the inconvenient flowering period (from the botanical standpoint) of most of the genus, which, coupled with the fleetingness of the inflorescences and the often widely scattered individual plants, makes them difficult to study effectively. Koach

Biarum carduchorum showing pollination by Staphylinid beetles. Photograph by Peter Boyce.

(1986) in his study of the Israeli *Araceae* makes no comment as to pollinator type in *Biarum*. *B. carduchorum* (in Turkey at least) attracts Staphylinid beetles in some considerable numbers (pers. obs.), although it is unclear whether it is these, or the numerous *Diptera* also attracted by the foetid odour, that facilitate pollination. A similar situation exists with Greek populations of *B. tenuifolium* and *B. spruneri* and I strongly suspect that much the same is true for all the foetid species. Certainly many of the herbarium specimens I have seen during the course of this revision have had beetles, small flies and midges in the lower spathe. The situation with the sweet-smelling *B. davisii* is quite different. Observations of both the typical subspecies in Crete and subsp. *marmarisense* on the island of Simi in the

eastern Aegean have shown that bees and queen wasps are attracted by the sweet lilac-like perfume emitted by the inflorescences (pers. obs).

Some work has been done with the pollen of *Biarum* and so far the results suggest that palynology may not prove to be of significant use. If so, this is similar to the situation in *Arum* where there is depressingly little variation in the types of pollen-exine sculpture between species. Talavera (1976) studied four species in Spain and Portugal and showed them to have similar spinose pollen and Grayum (1986) found that there is little to separate the pollen between *Ischarum* and *Biarum*. Pollen of the morphologically distinct *B. davisii* is also quite similar to other species. However, *B. ditschianum* Bogner & Boyce (1989) has smooth pollen, suggesting that a complete survey of the pollen may provide useful data.

A more promising field of research is cytology. Although less than a third of the species have been studied to date the counts obtained (e.g. Talavera 1976) certainly support the separation of some of the more controversial taxa. In particular the problematic Afro-Iberian species are cytologically different from the eastern Mediterranean species that they are often merged with. At the present time research is being undertaken by Athanasiou in Patras University, Greece, into the cytology of the Greek taxa and already results have helped with the delimitation of some taxa and data has been used in this revision. To date the following counts have been found for the genus: 2n = 16, 20, 22, 24, 26, 32, 36, 74, c. 96, 98.

All specimens cited have been seen by the author unless otherwise stated.

Taxonomically Important Characters

The following characters are of importance in *Biarum* taxonomy at subgeneric level:-

1. Staminate flower structure, i.e. beaked or globose-oblong.
2. Dehiscence type, i.e. ventral longitudinal slit as opposed to apical pore.
3. Presence or absence of staminodes.
4. Shape of pistillodes, e.g. filiform or hooked.
5. Seed shape and size, e.g. ovoid or globose, more or less than 3.5 mm diam. or more or less than 5.5 mm.

The following characters are of importance in *Biarum* taxonomy at sectional level:-

1. Spathe tube shape and size in proportion to the spathe limb.
2. Spadix appendix shape, i.e. fusiform to slender filamentous and presence or not of additional epidermal structures.
3. Inflorescence odour, e.g. foetid-smelling, sweet-smelling or odourless.

The following characters are of importance in *Biarum* taxonomy at specific level:-

1. Degree of spathe tube margin connation.
2. Distribution of pistillodes.
3. Staminate-pistillate flower zone interstice length.

Suprageneric Classification

Biarum is interesting because, despite its Euro-Mediterranean distribution, it is not closely allied to other *Araceae* occurring in the area, displaying instead similarities to the Asiatic genera *Theriophonum* Blume, *Typhonium* Schott and *Sauromatum* Schott. It is my belief that *Biarum* has derived from a separate ancestral stock to *Arum* and *Eminium*, the genera most closely associated with *Biarum* in its natural range.

In attempting to understand the relationships between *Biarum* and rest of the *Arinae* it is logical to investigate first the other Mediterranean genera belonging to the subtribe. The difficulty is that on the basis of general morphology none of these genera are apparently closely related to *Biarum*.

The simple leaves of *Biarum* have no parallel in the Mediterranean *Arinae*. One genus, *Eminium* (Blume) Schott, has two Central Asian species with lanceolate undivided leaves, but all the Mediterranean *Eminium* species have helicoid-pedatifid leaves. *Arum euxinum* Mill, a species from north western Turkey, has leaves with poorly developed posterior lobes and occasionally produces leaves that are more-or-less unlobed. I would not suggest, however, that there is a link between *A. euxinum* and *Biarum* since the leaf shape is the only common character; the inflorescences and infructescences of *A. euxinum* are otherwise typical for *Arum*.

If inflorescences are compared, the closest genus to *Biarum* would appear to be *Eminium* which with its ground-level or partially buried vernal inflorescences is superficially similar to some species of *Biarum*,

for example the spring flowering *B. syriacum* (Spreng.) H.Riedl and *B. straussii* Engler. Aside from these phenological similarities, both *Eminium* and *Biarum* have uniovulate ovaries with a basal placenta. Well developed pistillodes are present in most species of *Biarum* and all species of *Eminium* and most taxa in both genera have a strongly foetid spadix appendix. In addition, the shape of the pistillodes in *Eminium* is very similar to that in *Biarum* subgenus *Biarum*. With regard to fruiting, both genera have subterranean to partially emergent infructescences consisting of silver-lilac to off-white berries and seeds with strongly developed elaiosomes. Both genera are adapted to seasonally arid conditions. *Biarum* and *Eminium* differ primarily in the staminate flowers, which, in *Eminium*, show none of the diversity present in *Biarum* and in fact are virtually indistinguishable from the staminate flowers present in *Arum*. There is also some disparity with regard to the pistillate flowers; the oblong ovaries with sessile stigmas found in subgen. *Biarum* and some taxa in subgen. *Ischarum* are not dissimilar to the ovaries in *Eminium*, but the bottle-shaped ovaries with a stigma borne on a long style that are typical of the majority of *Biarum* are quite unlike anything known in *Eminium*, or in the rest of the Mediterranean *Arinae*. It is also notable that the hemispherical arrangement of the pistillate flowers in *Biarum* is quite different to the oblong cluster of ovaries found in *Eminium* and in the other genera of the *Arinae* that occur in the area.

Arum, with parietal placentation, a highly evolved pollination system, hastate to sagittate leaves and displayed infructescences is, in my opinion, morphologically too far removed from *Biarum* to be anything but a distant relative. *Biarum*, for all its floral diversity, has a fairly simple pit-fall inflorescence with none of the specialization present in *Arum* (see Boyce 1991). Furthermore, in the *Arinae* parietal placentation is known only in *Arum*, all of the other genera have basal placentas (e.g. *Biarum*, *Eminium*, *Sauromatum* Schott, *Typhonium* Schott) or basal and apical placentas (e.g. *Dracunculus* Miller, *Helicodiceros* Schott, *Theriophonum* Blume). At this juncture it is worth noting that, despite the anomalous autumn flowering strategy and the anthers dehiscing by apical pores, it seems unlikely that *A. pictum* represents a close link between the genus *Biarum* and the remainder of *Arum*. These features aside, *A. pictum* is, morphologically, a fairly typical *Arum*.

The other Mediterranean representatives of the *Arinae*, *Dracunculus* and *Helicodiceros*, are probably the least tenable as regards a close affinity with *Biarum*. Both *Dracunculus* and *Helicodiceros* show considerable

morphological dissimilarities to *Biarum* which include a well developed pseudostem, strongly divided leaves, apical and basal placentation, few-ovulate ovaries and large, displayed, infructescences. The staminate flowers in *Dracunculus* and *Helicodiceros* are virtually indistinguishable from those in *Arum* and *Eminium*, as too are the pistillate flowers.

Engler's opinion underwent an important change concerning the position of *Biarum* relative to the other genera of the subtribe *Arinae*. Until the *Pflanzenreich* treatment, he had placed *Biarum* before *Arum*, suggesting that he regarded *Biarum* as less specialized than *Arum*. In the *Pflanzenreich*, however he placed the genus at the end of the *Arinae* after *Eminium*.

It is my belief that the closest links with *Biarum* lie with *Typhonium*, *Theriophonum* and *Sauromatum*. Vegetatively there are few similarities between *Biarum* and these three genera, although the simple leaves of *Biarum* have parallels in the Indian and Sri Lankan genus *Theriophonum* (*T. sivaganganum* (Ramam. & Seb.) Bogner and in the juvenile leaves *T. fischeri* Sivadasan) and in two Australian *Typhonium* species (*T. liliifolium* F. Muell. and *T. alismifolium* F. Muell.). Reproductively, however, *Sauromatum*, *Typhonium* and *Theriophonum* share a number of common features with *Biarum* such that it is difficult to determine to which *Biarum* is closest. The staminate flower structure of *Biarum* is variable. The majority of species possess two thecae joined by an inconspicuous connective, similar to *Sauromatum* and many *Typhonium* species, although subgen. *Biarum* and subgen. *Cyllenium* have elongated connectives of a type found in some *Typhonium* species, e.g. *T. flagelliforme* (Lodd.) Blume and in *Theriophonum minutum* (Willd.) Baillon, a species widespread in India and Sri Lanka. In *Biarum*, beaked connectives are associated with thecae dehiscing by longitudnal slits while in *Typhonium* and *Theriophonum* they are associated with dehiscence via apical pores.

Looking to pistillode structure, the odd, club-shaped pistillodes found in *Sauromatum* and some species of *Typhonium* (e.g. *T. flagelliforme*) are unknown in *Biarum*, where the pistillodes are usually filiform (in subgen. *Ischarum*) or thickened and hooked (in subgen. *Biarum*). This latter type of pistillode is also found in *Theriophonum*, specifically in *T. sivaganganum*.

The pistillate flowers of *Biarum* show some similarity to those in *Theriophonum* as well as to some species of *Typhonium*. On the basis of placentation and ovule number *Typhonium* would appear to be

closest to *Biarum*, in possessing a basal placenta with one or two ovules. *Sauromatum* has similar placentation but generally has between two and four ovules per ovary. *Theriophonum* has apical and basal placentation with up to six ovules per locule. One feature not found in any of the genera under discussion, except *Biarum*, is a distinctive style. The stigmas in *Sauromatum*, *Typhonium* and *Theriophonum* are always sessile. It should be noted, however, that this character is not found in all *Biarum* species and that species with sessile stigmas are found in both subgenera.

The connation of the spathe-tube margins that features prominently in *Biarum* is found only in *Sauromatum*. To date no species unequivocally attributable to *Typhonium* or *Theriophonum* has been found to possess this character. The odd, hairy-leaved *Typhonium hirsutum* (S.Y. Hu) J. Murata & Mayo, which is notable in having partially connate spathe-tube margins, will require more study before its position can be properly evaluated. Interesting also is *Sauromatum brevipes* (Hook.f.) N.E. Br. a remarkable, little-collected species from Sikkim. In leaf *S. brevipes* is similar to a dwarf plant of *S. venosum* (Ait.) Schott but in flower the similarity to *Biarum davisii* Turrill, both in shape and colouration, is quite remarkable.

Cultivation. *Biarum* species can be divided into three groups for the purpose of cultivation. Some species, notably *Biarum tenuifolium* and some of its allies, are easy to grow and in sheltered positions in milder parts of Europe are hardy when planted in the open. However, the majority of species require some winter protection, ideally frost free, and are best grown in pots in a cool greenhouse or planted directly into a sheltered cold frame. Lastly there are a few species that tax the grower and require cosseting in a cool greenhouse; *Biarum olivieri* is typical of this third group.

Biarum tenuifolium is one of three species, the others being *B. arundanum* and *B. rhopalospadix*, which can be successfully grown outdoors in favourable areas. The tubers require quite deep planting, 5–7 cm down, and a rich well drained soil. If the soil tends towards 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* in particular will spread freely both by offsets and from seed. Not all subspecies of *B. tenuifolium* are equally successful out doors. Subsp.

Biarum marmarisense cultivated at the Royal Botanic Gardens, Kew. Photograph Richard Wilford.

tenuifolium and subsp. *abbreviatum* are best, while subsp. *zelebori* and particularly subsp. *idomenaeum* require extra care in siting and vigilance to ensure good growth. *B. rhopalospadix* grows well in conditions similar to those which suit *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. fraasianum*, *B. kotschyi* and *B. marmarisense*.

All the above, together with most of the other species, will do very well in pots in a frost-free greenhouse. Most do best in rather deep pots with the tuber planted quite deeply (3–4 cm) in an open rich loam-based soil. If sufficient tubers are available most species seem to be better planted several to a large, deep clay pot. Generally plants grown in solitary confinement, one to a pot, seem less vigorous. Annual repotting is advantageous and also permits an inspection of the tubers for signs of rotting. Potting is best carried out in summer (before August). The later it is left the more chance there is of root damage occurring. A good mix is: 45% loam based compost, 40% humus, 15% potting grit (all percentages by volume). The mix should be damp at the time of potting. The pots should be filled to within 2 cm of the rim and then topped off with grit. This will allow moisture to drain away from the 'neck' of the plants. After potting place the pots somewhere cool and do not water until growth becomes visible.

Once growth has begun, water sparingly until flowering is over or growth is beginning to accelerate. Too much water early on can result in root loss. It is good to encourage the plants to grow as vigorously as possible before the start of winter. This will ensure that the plants remain stout and that a good sized tuber is produced for the next season. Watering should be continued and the plants not allowed to become dry at the roots. A feed at every watering with a fertilizer designed for tomatoes will encourage robust growth. Keep the greenhouse or frame well ventilated at all times. This will discourage damp-related problems such as *Botrytis*.

Plants grown at Bonn, Munich, Kew and in a number of private collections in Germany and the UK succeed best in a relatively narrow but deep clay pot – i.e. a 'long-tom' – in a compost of equal parts sterilized loam, humus and sharp grit. 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 plant should continue growing throughout the winter. Towards early spring growth will slow down and by mid-June the leaves will turn yellow and wither. At this time watering should be more or less stopped. The compost should be kept just moist by plunging the pot to the rim in sand and keeping the sand damp. In some species the inflorescence will emerge soon after the foliage dies, and in these, once flowering is over, the compost 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. Propagation is best effected by seed, although some species produce offsets which can be removed during repotting and grown on.

Taxonomic Treatment

Biarum Schott *nom. cons.* in Schott & Endlicher, Melet. Bot. 17 (1832) & Syn. Aroid. 6 (1856) & Gen. Aroid. t.7 (1858) & Prodr. Syst. Aroid. 60–64 (1860); Pfeiffer, Nomen. Bot. 1(1): 403–404 (1873); Engler in A. & C. DC., Monog. Phanerog. 2: 571–580 (1879) & in Engler & Prantl., Die Natürl. Pflanzenfam. 149 (1889) & in Engler, Pflanzenr. 73(IV.23F): 132–143 (1920); Riedl in Aroideana 3(1): 24–31 (1980); Mayo, Bogner & Boyce, The Genera of Araceae, 266–268, pl.96 (1997). Type: *B. tenuifolium* (L.) Schott.

Homaïd Adans., Fam. Pl. 2:470 (1763) *in syn. nom. rejic.*; Pfeiffer, Nomen. Bot. 1(2): 1658 (1874). Type: *H. tenuifolium* (L.) Adans.

Ischarum Schott & Kotschy, Oesterr. Bot. Wochen. 4: 81 (1854); Schott, Syn. Aroid. 6–8 (1856) & Gen. Aroid. t.10 (1858) & Prod. Syst. Aroid. 65–70 (1860); Pfeiffer, Nomen. Bot. 1(2): 1764 (1874). Type: *I. bovei* (Blume) Schott (See Nicolson 1967).

Leptopetion Schott, Gen. Aroid. t.8 (1858) & Prodr. Syst. Aroid. 64 (1860). Type: *L. alexandrinum* (Boiss.) Schott.

Cyllenium Schott, Gen. Aroid. t.9 (1858) & Prodr. Syst. Aroid. 64–65 (1860). Type: *C. spruneri* (Boiss.) Schott.

Stenurus Salis., Gen. Pl. 5 (1866). Type: *S. tenuifolium* (L.) Salis.

Homaida Adans. emend O. Kuntze, Rev. Gen. Pl. 2: 742 (1891). Type: *H. tenuifolium* (L.) Adans. emend O. Kuntze.

Description. Dwarf tuberous stemmed herbs. *Tuber* dorsoventrally compressed-discoid to ± globose, encased basally by remains of the previous season's tuber, growth point central, peripheral adventitious buds none to many, usually giving rise to independent tubers, tuber apex coated with moderate to copious amounts of waxy farina and bearing the remains of the previous season's cataphylls; roots simple, emitted in a ring around the growth point, contractile or feeding; contractile roots fusiform, usually thick,

feeding roots slender, cylindrical. *Foliage* hysteranthous, occasionally synanthous, rarely proteranthous, petiolate; petiole sometimes ± subterranean, leaves erect or, rarely, reflexed; petioles enclosed proximally by several cataphylls, the inner papery and the outer fibrous, these often emerging above ground and encasing the basal part of the aerial shoot, petioles terete proximally, canaliculate and expanded into a membranous wing distally, petioles enclosing one another, forming a weakly defined aerial pseudostem in some species; leaf lamina linear, lanceolate, elliptic-oblong or spathulate, decurrent, ± cuneate, rounded or ± truncate apically, acute to obtuse basally, margins smooth to undulate, rarely crispulate, mid-, light, bright or deep green, rarely with green or black-purple bullae or silver-grey spotting. *Inflorescence* ± sessile on the tuber or borne on a short to rather long, subterranean peduncle, rarely peduncle emerging above ground, smelling foetid or sweet. *Spathe* divisible into a tubular lower portion (spathe tube) and a ± expanded upper portion (spathe limb); *spathe tube* narrow to inflated, sometimes greatly so, constricted distally or not, emergent to partially buried, rarely entirely subterranean, margins partially to fully connate, sometimes convolute distally, exterior deep purple to dirty green or greenish purple above, ± white below, interior off-white below, purple above, or wholly purple or off-white with purple staining at the base around the pistillate flowers; *spathe limb* large to small, rarely ± absent, linear, lanceolate or elliptic, erect, reflexed or deflexed, flat to recurved and coiled or strongly involute; exterior dirty green, more rarely mid-green, dirty white, dull yellow or pinkish brown sometimes with purple spotting and staining; interior deep purple-brown, yellow or pale greenish, sometimes purple with a green apex, apex subacute, acute to acuminate, margins smooth to undulate, rarely crispulate. *Spadix* shorter than, equalling or exceeding the spathe limb, divided into distinct zones; a sterile terminal appendix, an zone of staminodes (subgenus *Biarum*), a fertile male zone, a stamino-pistillate interstice, a further zone of staminodes (sometimes absent) and a fertile female zone; *terminal appendix* sessile to stipitate, cylindrical to fusiform, erect to flexuous, apex acute to rounded, tapering, base rarely rounded or sub-truncate, smooth, very rarely furnished with filamentous processes proximally, deep purple, brown-red or brown, occasionally greenish, rarely dirty yellow. *Flowers*: supra staminal *staminodes* present only in subgen. *Biarum*, arranged in few to several irregular whorls, simple or 1–2-branched, hooked, peg-like or filamentous, partially expanded proximally, glossy, cream; *staminate flowers* arranged in a cylindrical, globose or oblong zone, each comprising two anthers, connective short to ± absent, rarely prolonged into a ± prominent beak, thecae dehiscing by coalesced or separate apical pores (subgen. *Ischarum*) or ventral longitudinal slits (subgen. *Biarum*), cream to purple; *pollen* free or in strands, exine spinose or smooth, interflora *staminodes* usually confined to the base of the stamino-pistillate interstice, more rarely arranged evenly over the whole area or absent, slender-filiform to hooked, simple to 1–3-branched, recurved, decurved or tangled, cream, off-white or purple; *pistillate flowers* arranged in a hemispherical cluster at the base of the spadix, ovary oblong, sub-globose or bottle-shaped, off-white to purple, uniovulate with a basal placenta, ovules orthotropous, style slender to rather

stout or absent, stigma capitate, pale greyish or purple. *Infructescence* subterranean or partially emergent, globose berries many, globose to pyriform, white to lilac- or purple-stained, stigmatic remnents slightly prominent or not; seed ovoid to globose, large to small with a large elaiosome at the hilum, testa leathery, ± smooth to reticulate, pale to dark brown, endosperm copious, embryo straight; eophyll lanceolate to spathulate.

Twenty-one species of dwarf tuberous-stemmed strongly seasonal herbs occurring in semi-arid and seasonally dry areas of southern Europe, North Africa, the Near and Middle East.

Subgenus Biarum

Species:

1a. *tenuifolium* subsp. *tenuifolium*
1b. *tenuifolium* subsp. *arundanum*
1c. *tenuifolium* subsp. *galianii*
1d. *tenuifolium* subsp. *zelebori*
1e. *tenuifolium* subsp. *abbreviatum*
1f. *tenuifolium* subsp. *idomenaeum*
2. *rhopalospadix*

Subgenus Ischarum

3. *aleppicum*
4. *angustatum*
5. *carduchorum*
6. *eximium*
7. *bovei*
8. *crispulum*
9. *dispar*
10. *olivieri*
11. *straussii*
12. *syriacum*
13. *carratracense*
14. *kotschyi*
15. *fraasianum*
16. *pyrami*
17. *mendax*
18. *auraniticum*
19. *ditschianum*
20. *davisii*
21. *marmarisense*

KEY TO SPECIES

1. Staminodes occurring above and below the staminate flower zone **2**
   Staminodes absent above the staminate flower zone; present or absent below **7**
2. Staminodes hooked **3**

Staminodes not hooked **6**

3. Staminodes simple, very rarely branched **4**
   Staminodes always 2–3 branched **5**
4. Leaf lamina 15–25 cm × 11–15 mm; spadix appendix 10–41 cm × 2–3 mm; leaves in mature individuals oblong-lanceolate early in the season, linear-lanceolate later in the season .... **1a. tenuifolium subsp. tenuifolium**
   Leaf lamina 20–40 cm × 16–21 mm; spadix appendix 10–12 × 4–9 mm; leaves in mature individuals always oblong-lanceolate. .... **1d. tenuifolium subsp. zelebori**
5. Leaf lamina oblanceolate to linear-lanceolate; staminodes 2-branched, arranged in c. 8 regular whorls. Plants of heavy terra rossa soils .... **1b. tenuifolium subsp. arundanum**
   Leaf lamina linear; staminodes 2–3-branched, arranged in c. 7 irregular whorls. Plants of loose sandy soils .... **1c. tenuifolium subsp. galianii**
6. Staminodes peg-like; leaf lamina spathulate, erect, margins gently undulate ..... **1e. tenuifolium subsp. abbreviatum**
   Staminodes filamentous; leaf lamina linear-oblong, usually adpressed to the ground, margins strongly undulate-crispulate .... **1f. tenuifolium subsp. idomenaeum**
7. Staminodes hooked, stiff, thickened. Thecae dehiscing by ventral longitudinal slits, connective rostrate ..... **2. rhopalospadix**
   Staminodes filiform, flexuous, or absent, never hooked and thickened. Thecae dehiscing by apical pores, connective barely prominent or flush with the anther surface **8**
8. Spadix appendix massively thickened with reflexed basal 'hairs'; spathe limb much reduced, recurved ..... **19. ditschianum**
   Spadix appendix with no ornamentation; spathe limb well developed or, if reduced, then erect, cucullate **9**
9. Spathe limb usually much shorter than the spathe tube, margins recurved, spathe tube enclosing much of the spadix..... **10**
   Spathe limb exceeding the spathe tube in length, flat or with the margins inrolled, spathe tube enclosing the base of the spadix only **11**
10. Spathe 5–6 cm long, spadix appendix 3–3.5 cm × 2 mm ...**20. davisii**
    Spathe 7–8 cm long, spadix appendix 3.5–5 cm × 0.5 mm .... **21. marmarisense**
11. Spathe tube not inflated, the sides ± parallel..... **12**
    Spathe tube inflated, the sides ± gibbous **14**
12. Spathe tube margins free ± to the base; stigmas not borne on a stipe .. .. **3. aleppicum**
    Spathe tube margins free for a quarter of their length; stigmas borne on a short to moderately long stipe **13**
13. Staminodes directed downwards; leaves narrowly lanceolate-elliptic..... ..... **4. angustatum**
    Staminodes directed upwards; leaves elliptic to broadly oblong-elliptic ..... **5. carduchorum**

14. Spathe tube distinctly wider than the spathe limb, the margins joined for their entire length; spathe limb appearing linear due to inrolled margins; spadix appendix filiform ..... **10. olivieri**
Spathe tube as wide as or narrower than the spathe limb, the margins free for at least a quarter of their length **15**
15. Foliage proteranthous **16**
Foliage hysteranthous or synanthous **17**
16. Leaf lamina ovate-elliptic, oblong or linear; staminodes restricted to the bottom quarter to third of the interstice ..... **11. straussii**
Leaf lamina in mature plants linear to linear-elliptic; staminodes distributed over the basal half of the interstice ..... **12. syriacum**
17. Staminodes distributed evenly over the interstice separating the staminate and pistillate flower zones ..... **6. eximium**
Staminodes arranged mostly above the pistillate flower zone, intersticial staminodes adjacent to the staminate flower zone much reduced or vestigial, or staminodes absent..... **18**
18. Spathe limb interior greenish white, spadix appendix yellow .... **18. auraniticum**
Spathe limb interior deep purple-brown; spadix appendix similarly coloured..... **19**
19. Spathe tube margins free for quarter to half their length **20**
Spathe tube margins free for three quarters their length **21**
20. Spathe tube margins free for half their length, staminodes few, SW Spain ..... **13. carratracense**
Spathe tube margins free for a quarter of their length, S Greece .... **15. fraasianum**
21. Spadix appendix c. 2–4 mm in diam., slender-cylindric, to slender-fusiform, appearing ± consistent diameter **22**
Spadix appendix more than 4 mm in diam., fusiform, widest below the middle **24**
22. Spathe tube globose; interstice twice as long as the staminate flower zone; staminodes very few or absent ..... **9. dispar**
Spathe tube oblong; interstice equalling the staminate flower zone; staminodes many..... **23**
23. Foliage hysteranthous; spathe limb lanceolate, margins smooth .... **7. bovei**
Foliage synanthous; spathe limb linear-lanceolate, margins crispulate ... . **8. crispulum**
24. Spathe tube oblong, spathe limb narrowly lanceolate, acute, seldom exceeding 10 cm ..... **14. kotschyi**
Spathe tube globose, spathe limb lanceolate, acuminate, exceeding 12 cm **25**
25. Spathe tube margins fully fused; spathe limb remaining erect during flowering ..... **17. mendax**
Spathe tube margins for ¼ of their length ; spathe limb reflexing and curling during flowering ..... **16. pyrami**

1. BIARUM TENUIFOLIUM

Biarum tenuifolium is now generally considered to consist of one variable species. Talavera (1976) separated the western Mediterranean plants into two different species, *B. arundanum* and *B. galianii* Talavera, leaving *B. tenuifolium* in the eastern Mediterranean. This geographical division should not be trivialized and when combined with the respective morphology and cytology of the taxa, makes for a sound taxonomic system. Field studies together with examination of the available material has convinced me that the lumping together of the western and eastern elements is unsatisfactory.

As here defined *Biarum tenuifolium* comprises six subspecies: *tenuifolium*, *arundanum*, *galianii*, *abbreviatum*, *zelebori* and *idomenaeum*, separated on the basis of leaf shape and size, spathe size, spathe limb/spadix length ratio, degree of staminode development and phytogeography.

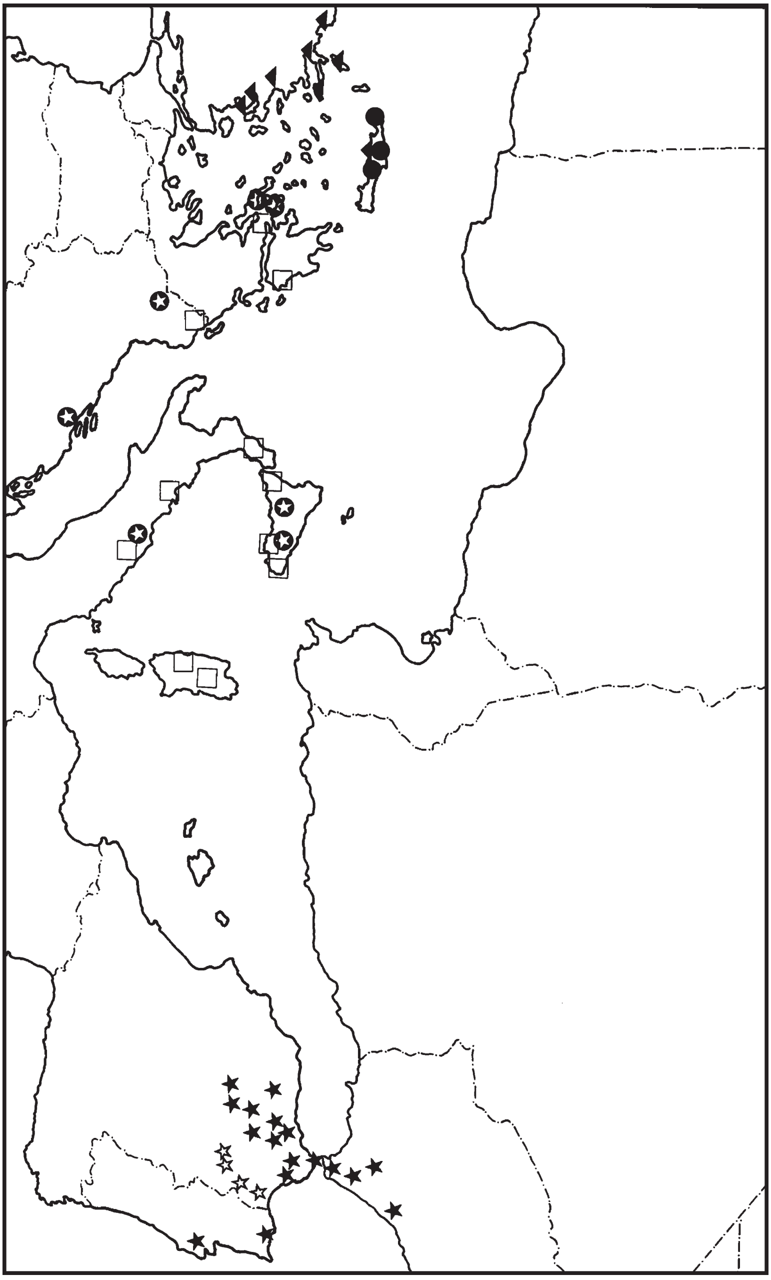
The typical subspecies has a long-exserted slender spadix appendix and densely arranged, well developed, simple, curving staminodes. Early in the growing season leaf blades are elliptic-lanceolate, later emerging leaves are linear-lanceolate. In immature plants the leaf blade is always elliptic-lanceolate.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

The westernmost element is subsp. *arundanum*. It has a spadix appendix that does not or only barely exceeds the spathe limb and branching staminodes. Subsp. *arundanum* is one of two common *Biarum* in southern and western Spain (the other is *B. carratracense)* where it grows on heavy terra rossa soils.

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

Subsp. *abbreviatum* has erect, short spathulate leaves, usually with undulate to rarely somewhat crispulate margins. The spathe limb averages 9 × 1.5 cm and is notable for its bicoloured interior, deep purple brown below with a striking green apical portion. The spadix appendix is generally only slightly longer than the

Fig. 1. **Biarum tenuifolium**: subsp. **tenuifolium**. A, habit, × 0.6; B, spadix, × 2; C, anther, × 18; D, ovary, × 18, all from *Huet de Pavillon* 1856; E, fruiting habit, × 0.6, from *Prior* 1845: subsp. **zelebori**: F, habit, × 0.6, from *Bornm.*10,0039; G, habit, with fully developed leaves × 0.6; H, spadix, × 2; I, anther, × 12; J, ovary, × 12; H, I, J from *Stevens* 57,556. Drawn by Christine Grey-Wilson from material at K.



Map 1. Distribution of *Biarum tenuifolium*; subsp. *tenuifolium*, ✪; subsp. *arundanum* ★; subsp. *galianii*, ☆; subsp. *zeleborii*, ▲; subsp. *abbreviatum*, □; subsp. *idomenaeum* ●.

spathe limb and, compared to its length, rather stout. The staminodes are rather poorly developed and peg-like. Subspecies *abbreviatum* occurs in Italy (where it has been called *B. cupanianum* Guss. ex Paglia), Yugoslavia, Macedonia, northern mainland Greece and on 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 in Albania.

Italian populations of *Biarum tenuifolium* have been referred to as *B. cupanianum* Guss. ex Paglia. Work by Monti & Gabari (1974) concluded that *B. cupanianum* could not be maintained at specific rank and they reduced it to synonymy in *B. tenuifolium*. However, the Italian populations are somewhat different from typical subsp. *tenuifolium*, and require further scrutiny. Paglia (1909) separated *B. cupanianum* from *B. tenuifolium* on differences in the leaf emergence (hysteranthous vs synanthous), leaf lamina shape (lanceolate-elliptic vs lanceolate to linear), leaf length (7–8 cm vs 20 cm or more), spathe limb size and colour (limb small, short, violet or dark purple vs limb large, long, brown), features of the spadix appendix (1/3 longer than the spathe limb thin, cylindrical, erect, dark purple with a dull grey bloom vs 3–4 times longer than the spathe limb, thick, procumbent, reddish) and phenology (spring flowering, inflorescence odourless or smelling of goats vs autumn flowering, inflorescence smelling of dung). Comparison of these data with the description below shows the majority of characters used by Paglia fall within the variation found in *B. tenuifolium* in the eastern Mediterranean. The morphological and phenological characters listed indicate that *B. cupanianum* agrees closely with subsp. *abbreviatum* as here defined. The one disparity concerns Paglia's description of a goat-like odour produced by *B. cupanianum* in flower. According to my own observations Italian plants of subsp. *tenuifolium* smell almost identical to plants from Greece, producing a powerful smell of horse-dung. *Biarum* plants referable to *B. cupanianum* have a sharper, more urine-like odour when in flower. A range of diploid chromosome numbers has been recorded for *B. tenuifolium*, e.g. 16, 20, 26 (Petersen 1989) and thus the count of 2n = 16 recorded for *B. cupanianum*. (Del Caldo 1971) does not exclude its amalgamation in *B. tenuifolium*. Given the number of similarities between the taxa I feel it best to regard *B. cupanianum* as a synonym of *B. tenuifolium* subsp. *abbreviatum*.

The remaining subspecies of *B. tenuifolium* are of more limited distribution. Subsp. *idomenaeum*, from Crete, is notable for its strongly undulate-crispulate leaves that are closely adpressed to the ground. The spathes are generally of similar size to those of subsp. *abbreviatum*, but the staminodes are densely arranged and slender. Most authors, e.g. Prime & Webb (1980); Barclay (1986)) and Greuter (1973), have referred these Cretan populations to subsp. *zelebori* but this is incorrect. Although subsp. *zelebori* occurs on Crete it is quite different in appearance. Mill (1984) suggested that the smaller plants might be referable to subsp. *abbreviatum*. Morphologically, subsp. *idomenaeum* is closest to subsp. *abbreviatum* but readily separable by the filamentous staminodes. Other data including cytology (see Boyce & Athanasiou 1991) also support this.

Two subspecies occur in the Iberian peninsula: subsp. *arundanum* and subsp. *galianii*. While clearly defined by their ecological requirements–subsp. *arundanum* is a plant of terra rossa soils while subsp. *galianii* is restricted to loose sandy soils–they are difficult to separate morphologically in the absence of ecological data. Talavera (1976) cites differing cytology, staminode branching and leaf lamina reduction as distinguishing characters of the then species-ranked *B. arundanum* and *B. galianii*, but the extent of disparity in the two taxa is rather insignificant. However, one feature not mentioned by Talavera, that of the arrangement of the staminodes, does appear to be characteristic. In all the material which I have examined the staminodes are always strictly whorled in Subsp. *arundanum* and irregularly scattered in Subsp. *galianii*. Quantitatively there are sufficient grounds to maintain these plants at subspecific rank.

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 odour similar to cattle dung.

Subsp. *galianii* occurs in the regions of Badajoz and Huelva near the Portuguese border where it is restricted to loose sandy soils.

1. Biarum tenuifolium (L.) Schott in Schott & Endl., Melet. Bot. 17 (1832) & Syn. Aroid. 6 (1856) & Prodr. Syst. Aroid. 60 (1860); Boiss., Fl. Or. 5:31 (1882); Engler in A. & C. DC., Monog. Phanerog. 2:573 (1879) & in Engler,

Plate 605 *Biarum tenuifolium* subsp. *tenuifolium* & subsp. *abbreviatum* ANN FARRER

Das Pflanzenr. 73 (IV.23F): 134 (1920); Polunin, Fl. Europe t.183 no.1820 (1969); Riedl in Aroideana 3(1): 26 (1980).

Arum tenuifolium L., Sp. Pl. ed.1: 967 (1763). Type: *König* 77 (syntypes: Herb. Linn. 1079.13, 1079.14).

Arum gramineum Lam., Encyc. 3:10 (1789). Type: no data (P).

Biarum gramineum (Lam.) Schott in Schott & Endl., Melet. Bot. 17 (1832).

Biarum constrictum C.Koch, Ind. Sem. Hort. Berol. App. 2 (1853). Type: Italy. Plantam in regno Neapolitano sponte crescentum ex horto Societ. reg. bot. Ratisbonensis ante decenium accepimus. In horto sub diu cultum sero autumno floret. (holotype B destroyed; isotype K (tracing of Koch's drawing of the type).

Biarum spruneri Schott, Gen. Aroid. t.7 (1858) non Boiss. (1853). Type: Greece, *Spruner* s.n. (holotype B).

Biarum anguillare Schott, Prodr. Syst. Aroid. 62 (1860). Type: Yugoslavia, Dalmatia (holotype W destroyed; lectotype W chosen here (Schott's Reliquiae Aroideae no. 360)). This pencil illustration is chosen in preference to the coloured illustrations (Schott's Icones Aroideae nos. 1493, 1494) and other pencil illustrations (Icones 1495, 1496 & 1497) since it combines inflorescence, infructescence and foliage in one plate.

Biarum tenuifolium (L.) Schott var. *typicum* Engler in Engler, Das Pflanzenr. 73 (IV.23F): 134 (1920). Type: as for *B. tenuifolium* (L.) Schott.

Biarum tenuifolium (L.) Schott var. *typicum* Engler subvar. *constrictum* (C. Koch) Engler in Engler, Das Pflanzenr. 73 (IV.23F): 136 (1920).

DESCRIPTION. *Tuber* dorsoventrally compressed discoid, with many offsets, 2–6 cm × 1.5–2.5 cm, mid-brown *Leaves* 4–20, hysteranthous, distinctly to rather obscurely long petiolate, bases encased by 3–many 2–8 × 0.5–2 cm oblong-lanceolate sub-fleshy, later papery, cataphylls, these pale green drying off-white to pale straw-yellow; *petiole* 1–8 cm × 2–5 mm, adaxial surface channelled distally, expanded proximally into a membranous wing, mid-green; *leaf lamina* oblong-lanceolate, linear-lanceolate, spathulate or linear-oblong, 2.5–49 cm × 2–21 mm, apex acute to obtuse or rounded, base long decurrent to cuneate, margins smooth, gently undulate or strongly undulate-crispulate, c. 5–9 primary lateral veins per side, mid to dark green. *Inflorescence* appearing in late summer to mid-autumn, occasionally in spring, usually strongly foetid of cattle dung; Italian populations of subsp. *abbreviatum* reported to smell goat-like (Paglia 1909). *Peduncle* 6–10 cm × 3–5 mm, white, clothed with few to several oblong-lanceolate sub-fleshy, later papery, cataphylls, 4–12 × 1.5–2 cm, these pale green drying off-white to pale straw-yellow. *Spathe* 3–30 cm long; *spathe limb* 2–25 × 0.5–6 cm, apex acute to acuminate exterior mid-green heavily stained deep brown-purple, sometimes paler to green apically, interior deep brown-purple, green towards the apex in subsp. *abbreviatum*; *lower spathe* cylindric to oblong cylindric, usually constricted above the pistillate flowers, sometimes further constricted c. ¾ along its length, margins fused for their whole length, 2–6 × 1–1.25 cm, exterior white, stained purple towards the apex, interior white. *Spadix* shorter than to greatly exceeding the spathe limb, 4–40 cm long; *spadix appendix* cylindrical to stoutly fusiform, 3–41 cm × 1.5–9 mm,

deep brown-purple, often somewhat paler than the spathe limb, rarely olive green or dirty yellow. Upper *staminodes* in a zone 3–17 mm long, in 2–10 regular to rather irregular whorls, hooked, peg-like or filamentous, cream to ivory. *Staminate flowers* in a zone 3–20 × 1–6 mm, cream to ivory. *Interstice* usually ± absent, occasionally up to 15 mm long above the pistillate flowers or below the staminate flowers, cream. Lower *staminodes* in a zone 2–23 × 1–4 mm, in 2–13 regular whorls, hooked, peg-like or almost filamentous, cream to ivory. *Pistillate flowers* in a hemispherical to slightly cylindric-hemispherical zone 3–7 × 2–5 mm; *ovary* oblong, 0.5–2 × 0.25–2 mm, cream; *stigma* sessile, capitate, 0.25–0.33 mm in diam., cream. *Infructescence* globose, 1.5–4 cm in diam., consisting of 15–45 berries; *berry* oblong to oblong-globose, 3.5–9 × 2.5–5.5 mm, white when ripe; *seed* ovoid, 2.5–4.5 × 3–6 mm, pale brown, barely reticulate.

Key to the subspecies of *Biarum tenuifolium*

1. Staminodes hooked **2**
   Staminodes not hooked **5**
2. Staminodes simple, very rarely branched **3**
   Staminodes always 2–3 branched **4**
3. Leaf lamina 15–25 cm × 11–15 mm; spadix appendix 10–41 cm × 2–3 mm; leaves in mature individuals oblong-lanceolate early in the season, linear-lanceolate later in the season ..... **1a. subsp. tenuifolium**
   Leaf lamina 20–40 cm × 16–21 mm; spadix appendix 10–12 × 4–9 mm; leaves in mature individuals always oblong-lanceolate ..... **1d. subsp. zelebori**
4. Leaf lamina oblanceolate to linear-lanceolate; staminodes 2-branched, arranged in c. 8 regular whorls. Plants of heavy terra rossa soils… ..... **1b. subsp. arundanum**
   Leaf lamina linear; staminodes 2–3-branched, arranged in c. 7 irregular whorls. Plants of loose sandy soils… ..... **1c. subsp. galianii**
5. Staminodes peg-like; leaf lamina spathulate, erect, margins gently undulate… ..... **1e. subsp. abbreviatum**
   Staminodes filamentous; leaf lamina linear-oblong, usually adpressed to the ground, margins strongly undulate-crispulate…..... **1f. subsp. idomenaeum**

a. subsp. tenuifolium

Description. *Leaf lamina* 15–25 cm × 11–15 mm; spadix appendix 10–41 cm × 2–3 mm; leaves in mature individuals oblong-lanceolate early in the season, linear-lanceolate later in the season. *Spadix appendix* 10–41 cm × 2–3 mm. *Staminodes* hooked, simple. 2n = 26 (Marchant 1972), 16, 20, 26 (Monti & Gabari 1974). Fig. 1.

Distribution. S Italy, Sicily, Serbia, Bosnia, Macedonia, Albania, Greece. Map 1.

Plate 606 *Biarum tenuifolium* subsp. *arundanum* ANN FARRER

Biarum tenuifolium subsp. *tenuifolium*

Fig. 2. **Biarum tenuifolium** subsp. **arundanum**. A, flowering habit, × 0.6, from *Herbier de Maroc*; B, spadix, × 2; C, anther, × 12; D, ovary, × 12, both col. *Tucker*; E, fruiting habit, with fully developed leaves, × 0.6, from *Campo* no. 2. Drawn by Christine Grey-Wilson from material at K.

Plate 607 *Biarum tenuifolium* subsp. *zelebori* & subsp. *idomenaeum* ANN FARRER

Fig. 3. **Biarum tenuifolium** subsp. **galianii**. A, flowering habit, × 0.6; B, spadix, ×2; C, anther, × 12; D, ovary, × 20, all from *Talavera* 16929; E, fruiting habit, × 0.6, from *Galiano et al.* 24331. Drawn by Christine Grey-Wilson from material at K.

ECOLOGY. Limestone-derived terra rossa soils in garigue, open maquis, grazed hillsides, olive groves, shallow-ploughed fields, along the margins of deep-ploughed fields. Alt. 25–1220 m.

ETYMOLOGY. From the Latin *tenuis* (slender) and *folium* (leaf), referring to the slender foliage.

b. subsp. arundanum (Boiss. & Reuter) Nyman, Consp. Fl. Europ. 755 (1882).

Biarum arundanum Boiss. & Reuter, Pug. Pl. Nov. Afr. Bor. 110 (1852); Talavera in Lagascalia 6(2): 586–8, t.1, A, A1 (1976) & Talavera, Valdés & Galiano, Fl. Vasc. Andal. Occ. 3:209 (1987). Type: Spain, Grazelema, June 1849, *Boissier & Reuter* s.n. (lectotype G-BOIS! chosen here). Boissier and Reuter (*loc. cit.*) cite two specimens in the protologue, the other being 'circa Ronda, *Reuter* s.n.'. I have been unable to locate the whereabouts of Reuter's herbarium and, in the absence of the second specimen, have selected the *Boissier & Reuter* specimen in the Boissier Herbarium, Geneva to serve as the lectotype.

Biarum bovei Blume subsp. *dispar* (Schott) Engler *var. discolor* Maire in M.C. 640 (1930). Type: not cited.

DESCRIPTION. *Leaf lamina* oblanceolate to linear-lanceolate. *Staminodes* hooked, 2-branched, arranged in c. 8 regular whorls. Plants of heavy terra rossa soils. 2n = 22 (Marchant 1972 as *B. carratracense*; Talavera 1976; Elena & Gallego 1984). Fig. 2.

DISTRIBUTION. SW Spain, Gibraltar, S Portugal, N Morocco. Map 1.

ECOLOGY. Restricted to terra rossa soils derived from the decomposition of limestone, usually in open situations, particularly along field margins or in long-fallow fields. Alt. 50–1200 m.

ETYMOLOGY. The specific epithet is derived from the Roman name for Ronda, a town in southwestern Spain and the type locality of this species.

c. subsp. galianii (Talavera) P.C. Boyce, Aroideana 29: (2006)

Biarum galianii Talavera in Lagascalia 6(2): 289, t.1 B,B1 (1976); Talavera, Valdés & Galiano, Fl. Vasc. Andal. Occ. 3:209 (1987). Type: Spain, Huelva, entre San Bartolomé de la Torrey Alosno, 1 June 1976, *Talavera* s.n. (holotype SEV 24330).

DESCRIPTION. *Leaf lamina* linear. *Staminodes* 2–3-branched, arranged in c. 7 irregular whorls. Plants of loose sandy soils. 2n = 26 (Talavera 1976; Elena & Gallego 1984). Fig. 3.

DISTRIBUTION. Badajoz and Huelva districts, SW Spain. Map 1.

ECOLOGY. Subspecies *galianii* occurs in loose sandy soils on open hill slopes, alt. c. 600 m.

ETYMOLOGY. Named for the Spanish botanist Emilio Fernández-Galiano Fernández (1923–2006).

d. subsp. zelebori (Schott) P.C. Boyce in R. Govaerts & D.G. Frodin, World Checklist Bibliogr. Araceae 245 (2002). Type: Turkey, prope Smyrnam (Izmir).

Fig. 4. **Biarum tenuifolium** subsp. **idomenaeum**. A, inflorescence, × 0.6; B, spadix, × 2; C, anther, × 12; D, ovary, × 12; E, habit, with fully developed leaves, × 0.6; F, fruiting habit, × 0.6, all from *Davis* 1056: subsp. **abbreviatum**: G, inflorescence, × 0.6; H, spadix, × 2; I, anther, × 6; J, ovary, × 6, all from *Baxter* 621A; K, fully developed leaves, × 0.6 from *Mathew & Tomlinson* 4629. Drawn by Christine Grey-Wilson from material at K.

Zelebor s.n. (holotype W destroyed; lectotype W (Schott's Icones Aroideae no. 1532). The plate chosen as the lectotype is annotated *Zelebor* 56. The plates present in Vienna are Icones nos 1528–1534, Reliquiae no. 362 and an un-numbered Icon depicting germination and subsequent development of the seedlings.

Biarum zelebori Schott in Oesterr. Bot. Wochenbl. 7:245 (1857).

Biarum tenuifolium (L.) Schott var. *zelebori* (Schott) Engler in A. & C. DC., Monog. Phanerog. 2: 574 (1879) ["*zeleborii*"] & in Engler, Das Pflanzenr. 73 (IV.23F): 136 (1920) ["*zeleborii*"]; Mill, *Flora of Turkey* 8:56, t.2 no.12 (1984) ["*zeleborii*"].

DESCRIPTION. *Leaf lamina* 20–40 cm × 16–21 mm; spadix appendix 10–12 × 4–9 mm; leaves in mature individuals always oblong-lanceolate. 2n not recorded. Fig. 1.

DISTRIBUTION. Crete, Rhodes, Cos, SW Turkey (provinces of Aydin, Izmir and Mugla). Map 1.

ECOLOGY. As for the typical variety. Alt. 300–1350 m.

ETYMOLOGY. Named for the collector of the type material.

e. subsp. abbreviatum (Schott) K. Richt., Pl. Eur. 1: 174 (1890).

[*Arum cupanianum* Guss., Fl. Sic. Syn. 2(2): 598 (1844) nom. nud.]

Biarum abbreviatum Schott, Prodr. Syst. Aroid. 62 (1860). Type: Greece, *Heldreich* s.n. (holotype B destroyed; lectotype W (Schott's Icones Aroideae no. 1491)). The plate selected is the most complete of those in Vienna. Other plates there are Icones no. 1492, Reliquiae no. 361 and an un-numbered Icon depicting germinating seeds.

[*Biarum tenuifolium* (L.) Schott var. *cupanianum* Nicotra in Malpighia 22: 541 (1908), *nom. nud.* ['*cupaniana*']]

Biarum cupanianum Guss. ex Paglia in Riv. Ital. Sci. Nat. 29: 24 (1909). Type: Ic. 284 in Barralier, *Plantae Galliam, Hispaniam et Italiam observertae* (1714) (lectotype).

Gussone (1844) cites the illustrations in Clusius' *Rariorum Plantarum Historia* (1601), an unspecified volume by Dodoens, and Barralier's *Plantae Galliam, Hispaniam et Italiam observertae* (1714). Of the available plates, no 284 in Barralier's work, with the caption *Arum angustifolium maii*, is the best candidate as the lectotype since it closely matches the spring flowering *Biarum* present in southern Italy. Although it is not stated that the plate was drawn from Italian material, I feel that it can be assumed that this is the case since *Biarum* is absent from France and there are no spring blossoming *Biarum* species in Spain.

Biarum tenuifolium (L.) Schott var. *abbreviatum* (Schott) Engler in A. & C. DC., Monog. Phanerog. 2: 574 (1879).

Biarum tenuifolium (L.) Schott var. *cupanianum* (Guss. ex Paglia) Nicotra ex Fiori, Nuova Fl. Anal. Ital. 1: 210 (1923).

DESCRIPTION. *Leaves* erect, 10 cm × 14 mm, lamina consistently oblanceolate to spathulate, margins smooth to gently undulate. *Staminodes* peg-like. 2n = 26 (Marchant 1972 as var. *abbreviatum*). Fig. 4.

DISTRIBUTION. Sardinia, S Italy, Sicily, Macedonia, W Greece. Map 1.

ECOLOGY. As for the typical variety. Alt. 120–1200 m.

ETYMOLOGY. From the Latin *abbreviatus* (shortened), referring to the smaller inflorescences compared with the type.

f. subsp. idomenaeum P.C. Boyce & Athanasiou in Flor Med. 1: 6 (1991). Type: Greece, Crete, Rethymnou, Mt. Psiloritis, above the village of Vizari, 650–750 m, *Athanasiou & Anagnostopoulos* 566, (holotype UPA!, isotype K! (photo)).

[*B. tenuifolium* (L.) Schott var *zelebori auct. Crete. non* (Schott) Engler (1879)]

DESCRIPTION. *Leaves* adpressed or parallel to the ground, lamina linear to linear-oblong, margins strongly undulate. *Staminodes* filamentous. 2n = 26 (Athanasiou, unpublished). Fig. 4.

DISTRIBUTION. Crete. Map 1.

ECOLOGY. Grazed maquis on stony limestone-derived terra rossa. Alt. 100–300 m.

ETYMOLOGY. Named in honour of the mythical Cretan King Idomeneus.

2. BIARUM RHOPALOSPADIX

The hitherto obscure name *Biarum rhopalospadix* C. Koch must now be used for *Biarum spruneri* Boiss. *B. rhopalospadix* is superficially similar to *B. tenuifolium*, especially to subsp. *abbreviatum*. It may be readily distinguished by the 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 syndrome is also useful in distinguishing *B. rhopalospadix* from the majority of the Greek mainland populations of *B. tenuifolium*.

Boissier published this species as *Biarum spruneri* in sect. *Biarum* based on anther dehiscence via ventral longitudinal slits and hook-like staminodes, but noted that the lack of staminodes above the staminate flower zone and the well-developed style and suggested that it was intermediate between sect. *Biarum* and sect. *Ischarum*. Schott (1858) took this observation further by creating a new genus, *Cyllenium*, for *B. spruneri* citing the rostrate anther connective, the style and absence of upper staminodes as the main diagnostic features of his new genus.

2. Biarum rhopalospadix C. Koch, Ind. Sem. Hort. Berol. App. 2 (1853). Type: 'Greece' (holotype B destroyed; isotype K (tracing of Koch's specimen).
Biarum spruneri Boiss., Diagn. 13:5 (1853); Engler in A. & C. DC., Monog. Phanerog. 2: 574 (1879); Boiss., Fl. Or. 5: 32 (1882); Engler in Engler, Das Pflanzenr. 73 (IV.23F): 136 (1920). Type: Greece, "in collibus apricis Atticae ad Phalerum portum ubi duce amiciss. Spruner florere incipientem Maii initio legi," (lectotype G-BOIS). There are several sheets collected from Faliron in the Boissier herbarium. The sheet chosen is the only Spruner collection and thus is the logical lectotype.
Ischarum spruneri (Boiss.) Schott, Syn. Aroid. 7 (1856).
Cyllenium spruneri (Boiss.) Schott, Gen. Aroid. t.9 (1858).

Description. *Tuber* dorsoventrally compressed-discoid, 1.5–3 × 1–1.5 cm, with few offsets, mid-brown. *Leaves* 3–5, hysteranthous, short-petiolate, bases encased by 3–4, 5–8 cm × 5–10 mm lanceolate, sub-fleshy, later papery, cataphylls, these mid-green drying to very pale green or creamy-white; *petiole* 3–5 cm × 2–3 mm, adaxial surface channeled distally, expanded proximally into a membranous wing, mid to rather dark green; *leaf lamina* oblong to oblong-spathulate, 5–11 × 1.5–2.5 cm, apex obtuse to sub-acute, base decurrent to cuneate, 5–6 primary lateral veins per side, margins smooth to slightly undulate, lamina mid-green. *Inflorescence* appearing in spring, moderately foetid of cattle dung. *Peduncle* 3–9 cm × 2–4 mm, encased by 2–4, 4–11 × 1–1.5 cm lanceolate, sub-fleshy, later papery, cataphylls, these mid-green drying to pale straw-yellow. *Spathe* 7–24 cm long; *spathe limb* oblong-lingulate to elliptic-oblong, 5–14 × 1–4 cm, acute to shortly acuminate, exterior green with dense purple-brown staining, especially towards the magins and apex, interior concolorous purple-brown, occasionally very

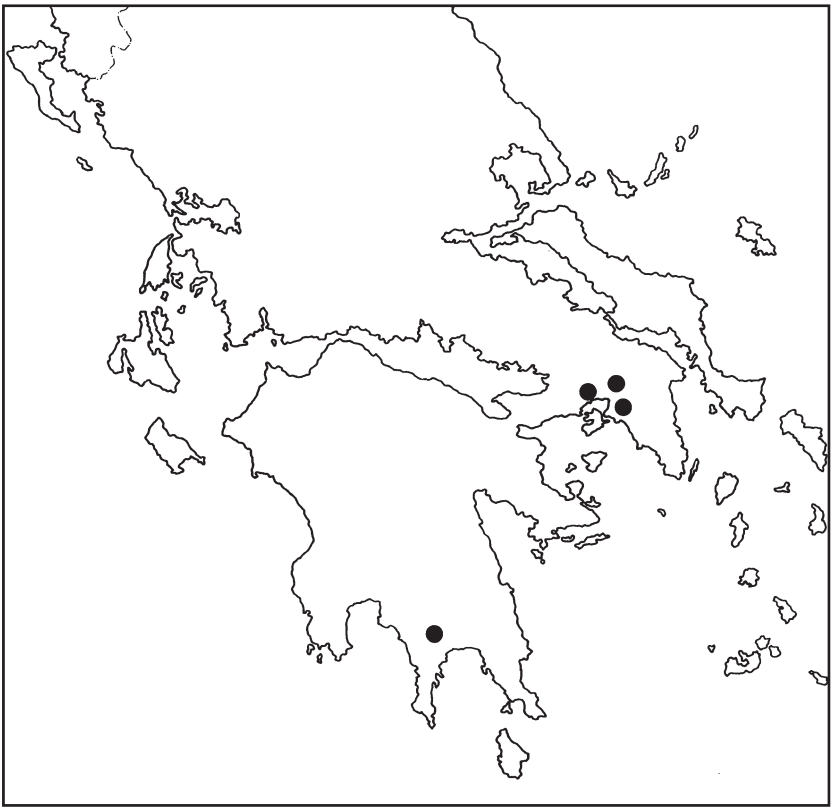
Plate 608 *Biarum rhopalospadix* ANN FARRER

slightly greenish distally; *spathe tube* narrowly cylindrical, slightly inflated, 3–5.5 cm × 7–9 mm, margins connate for ¾ of their length, exterior off-white below, purple-brown flushed above, interior white, slightly purple stained distally. *Spadix* sub-equal to shorter than the spathe limb, 8.5–14.5 cm long; appendix fusiform, ± sessile, though tapering in some specimens, 6–10.5 cm × 2 –6 mm, deep purple. *Staminate flowers* in an oblong-cylindric zone 6–12 × c. 4 mm, cream. *Interstice* 11–25 × 3–4 mm, cream. *Staminodes* covering the proximal half of the interstice, recurved, falcate, pointed, 1.5–3 mm long, mostly simple but occasionally bifid, cream. *Pistillate flowers* in a hemispherical cluster c. 5 mm wide, 3 mm high; *ovary* globose, slightly dorso-ventrally flattened, 0.25 mm wide and tall, cream; *stigma.* c. 0.25 mm in diam., borne on a 0.25–0.5 mm long style, stigma greyish, style purple. *Infructescence* not seen. 2n not recorded. Fig. 5.

DISTRIBUTION. S Greece, (Attica, Peloponnese). Map 2.

ECOLOGY. Limestone-derived terra rossa in grazed fields, open hillslopes, abandoned olive groves and field margins. Alt. 150–450 m.

ETYMOLOGY. From the Greek, ῥόπαλον–a club or cudgel–and σπαδιξ, in allusion to the club-like spadix.



Map 2. Distribution of *Biarum rhopalospadix* ●.

Fig. 5. **Biarum rhopalospadix**. A, flowering habit, × 0.6, from *Reuter* 1842; B, flowering habit, × 0.6, from *Reuter* 1842; C, spadix, × 2; D, anther, × 12; E, ovary, × 12, all from *Mathew* 57563(cult.); F, fully developed leaves, × 0.6, from *Reuter* 1842. Drawn by Christine Grey-Wilson from material at K.

3. BIARUM ALEPPICUM

Biarum aleppicum, *B. carduchorum* and *B. angustatum* form a closely allied group of taxa. The suite of characters used to define them is not found elsewhere in the genus and the possession of a narrow spathe tube, densely arranged pistillodes on the proximal portion of the interstice and a broadly lanceolate spathe limb in three species occurring in a single geographical region suggests close relationship, and probably recent divergence from a common ancestor. Since the only morphological differences separating the taxa are somewhat minor and are concerned with reproduction, viz. the direction of the pistillodes, the presence or absence of a style and the degree of spathe tube margin connation, it seems reasonable to presume that speciation within the subsection has occurred in response to pollinator type.

From *Biarum carduchorum* and *B. angustatum*, *B. aleppicum* is readily distinguished by having the spathe tube margins free almost to the base and by the sessile stigmas. *Biarum aleppicum* has many more leaves than either *B. angustatum* or *B. carduchorum*, although the leaf shape approaches that of *B. angustatum*.

3. Biarum aleppicum Thiébaut in Bull. Soc. Bot. Fr. 95: 21 (1948); Mouterde, Nouv. Fl. Liban et Syrie 1: 193 (1966); Riedl in Aroideana 3: 28 (1980). Type: Syria, Alep, *Fr. Louis s.n.* (lectotype P!). Thiébaut cited two separate collections in the protologue. There are four collections of *B. aleppicum* present in Paris, including both syntypes. The specimen chosen as the lectotype is the most complete of the cited specimens, consisting of flowering, vegetative and fruiting material.
[*B. bovei* Blume var. *aleppicum* (Thiébaut) Gombault, *in sched. nom. nud.*]

Description. *Tuber* slightly dorsoventrally compressed-globose, 3–4 × 1.5–2.5 cm, apparently without offsets, mid-brown. *Leaves* 10–35, hysteranthous, long but obscurely petiolate, bases encased by 5–7, 2–15 cm × 10–13 mm, narrowly lanceolate cataphylls; inner cataphylls sub-fleshy, later papery, pale greenish white drying pale straw-yellow, outer cataphylls fibrous, dark brown; petiole 3–7 cm × 1–3 mm, abaxial surface slightly channelled distally, expanded into a membranous wing proximally, dull green, expanded portion tinged purple basally; leaf lamina linear-lanceolate to oblanceolate-elliptic, 7–13 cm × 3–10 mm, apex obtuse to subacute, base long-decurrent, c. 5 primary lateral veins per side, margins crispulate, rarely smooth, lamina mid-green. Inflorescence appearing in mid-autumn. *Peduncle* 4–17 cm × 3–5 mm, whitish, clothed with several 2–16 cm × 10–13 mm fibrous brown outer and papery, pale straw-yellow inner cataphylls. *Spathe* 14–16.5 cm long; spathe limb oblong-lanceolate, 12–13.5 × 4–5 cm, apex sub-acute, exterior pale green ± heavily spotted deep purple, interior deep purple, occasionally with

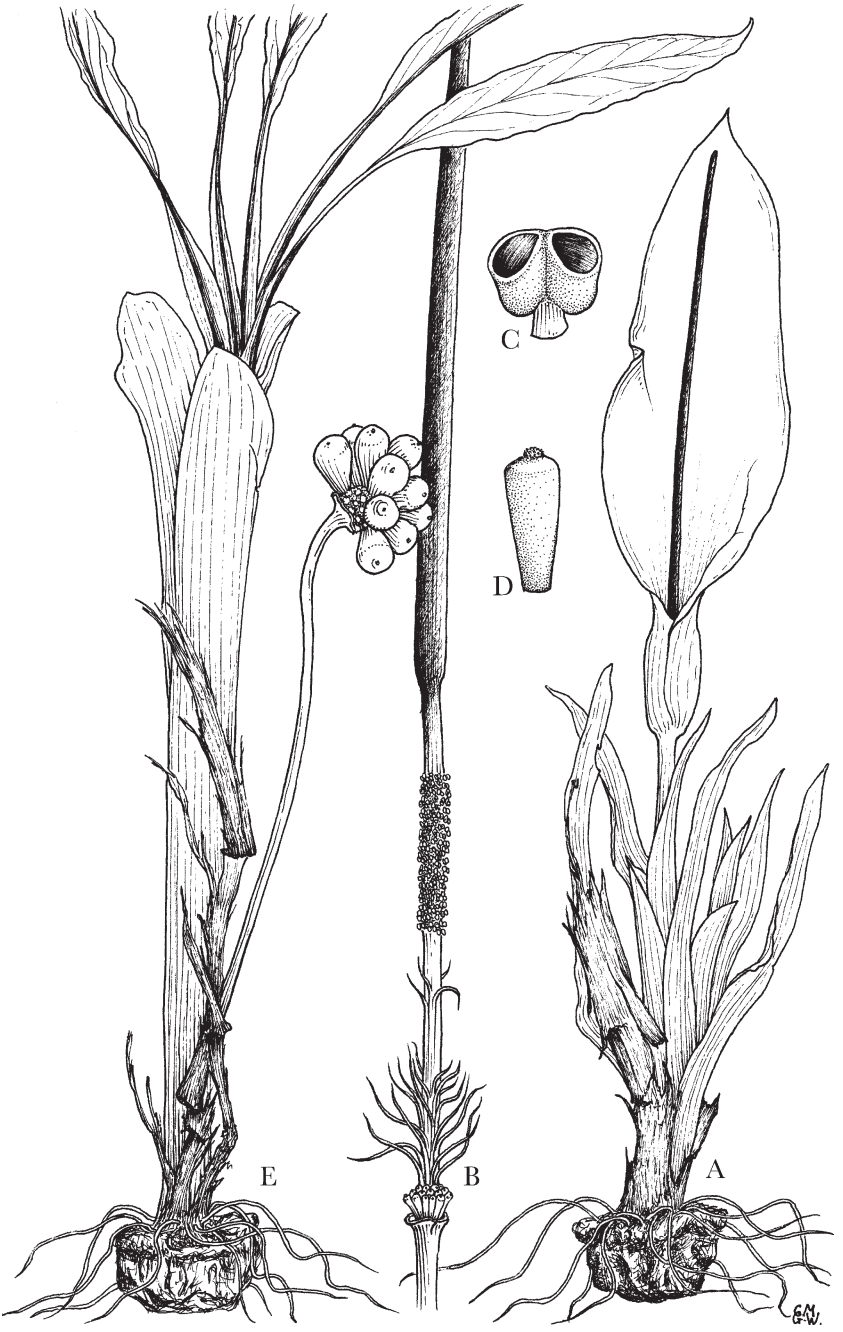


Fig. 6. **Biarum aleppicum**. A, flowering habit, × 0.6; B, spadix, × 2, both from *Frère Louis* 25.6.1949; C, anther, × 18; D, ovary × 12; E, fruiting habit, × 0.6, all from *Frère Louis* 1947. Drawn by Christine Grey-Wilson from material at K.

pale green mottling and spots; spathe tube slender, 2.5–3 × c. 1.5 cm, margins free to the base, exterior white below ground, deep purple above, interior white. *Spadix* sub-equal to the spathe limb, 11–12 cm long; spadix appendix sessile, fusiform, 8–8.5 cm × 2–6 mm, deep purple. *Staminate* flowers in a zone c. 12 mm × 1.5 mm, anthers cream. *Interstice* c. 16 × 2 mm, pale cream. *Staminodes* clothing the basal half of the interstice, densely arranged, slender, 4.5–5 mm long, purple, often a few 1–1.5 mm staminodes present high up on the interstice. *Pistillate* flowers in a hemispherical cluster c. 2.5 × 7–9 mm; ovaries oblong, 1.5 mm × 0.5 mm, pale cream, stigma sessile, 0.25–0.33 mm, capitate, deep purple. *Infructescence* globose, c. 2 cm diam. when semi-mature, consisting of c. 40 berries; berries 4 × 5 mm, pale lilac when ripe; seed ovoid, 5 mm × 5–6 mm, testa slightly reticulate, mid-brown. 2n not recorded. Fig. 6.

DISTRIBUTION. NW Syria. Map 3.

ECOLOGY. Bare fields and plains on limestone-derived terra rossa soils. Alt. 250–450 m.

ETYMOLOGY. The specific epithet comes from Aleppo, a major town in northwestern Syria and the type locality of the species.

4. BIARUM ANGUSTATUM

Although fairly common in the wild, this large-flowered species, *Biarum angustatum,* has been seldom collected; it is outwardly very similar to *B. carduchorum* when in flower but is easily separated by the downward directed staminodes and narrower leaves with only 4 to 5 primary lateral veins per side. Another point of separation concerns the distribution of the species. *Biarum angustatum* is essentially a 'coastal' species, restricted to Syria and Israel. *Biarum carduchorum* is an inland species, distributed from south-eastern Turkey and north-western Syria through Iraq and into Iran.

4. Biarum angustatum (Hook.f.) N.E.Br. in Journ. Linn. Soc. 18: 255 (1881); Engler in Engler, Das Pflanzenr. 73 (IV.23F): 142 (1920); Koach & Feinbrun in Feinbrun, Fl. Palaestina 4: 338 (1986); Koach in Rotem 28 t.19,20 (1988). Type: Israel, Tiberias, September-October 1860, *Hooker & Hanbury s.n.* (holotype K!).
Ischarum angustatum Hook.f. in Bot. Mag. 104, t.6355 (1878).

DESCRIPTION. *Tuber* dorso-ventrally compressed-discoid, 2–5(–7) × 1.5 cm, sparsely offsetting, mid-brown. *Leaves* 3–5, hysteranthous, long- petiolate, bases encased by 3–6, 4.5–8.9 cm × 7.5–15 mm, lanceolate-elliptic cataphylls, inner cataphylls subfleshy, later papery, dirty white drying straw-yellow, outer cataphylls fibrous, brown, drying slightly darker; petiole 13–17 cm × 2.5–3

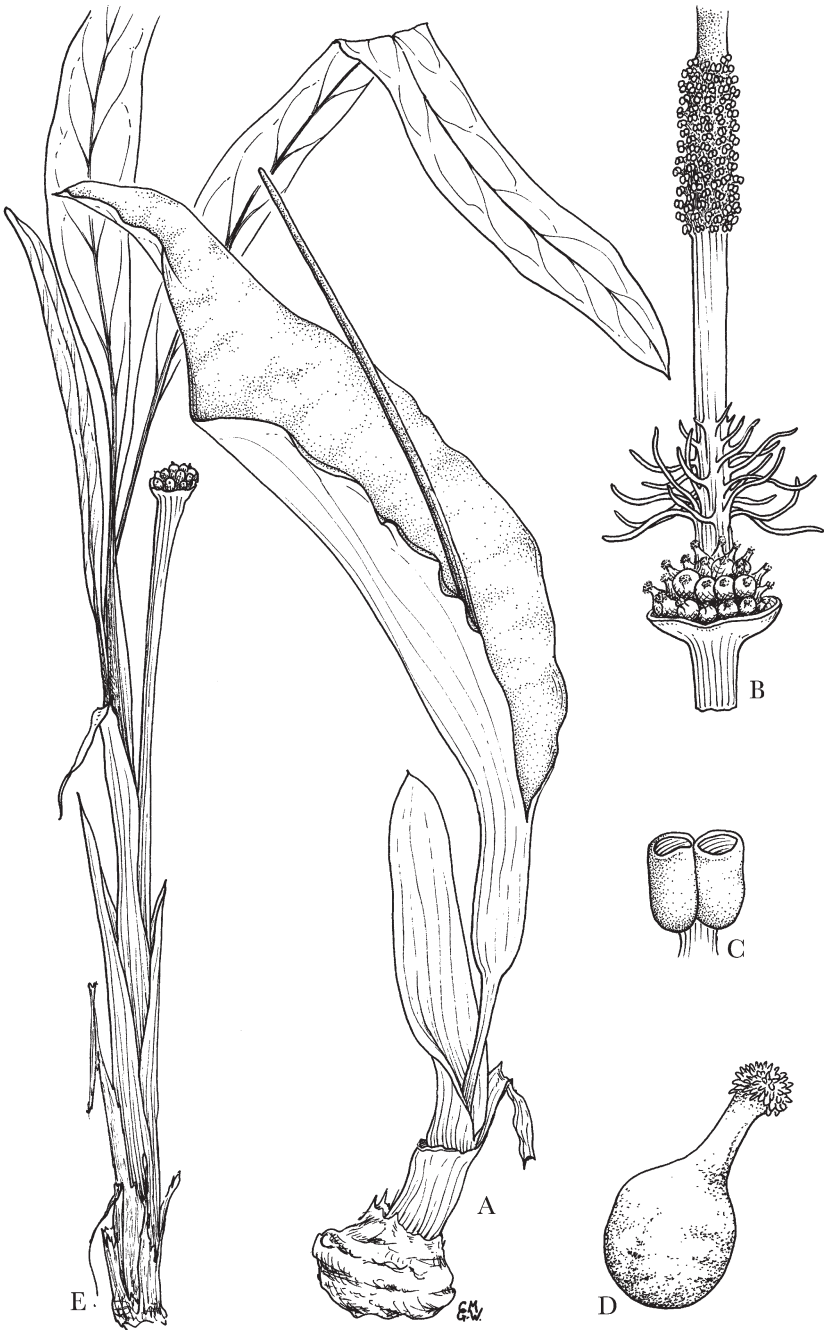
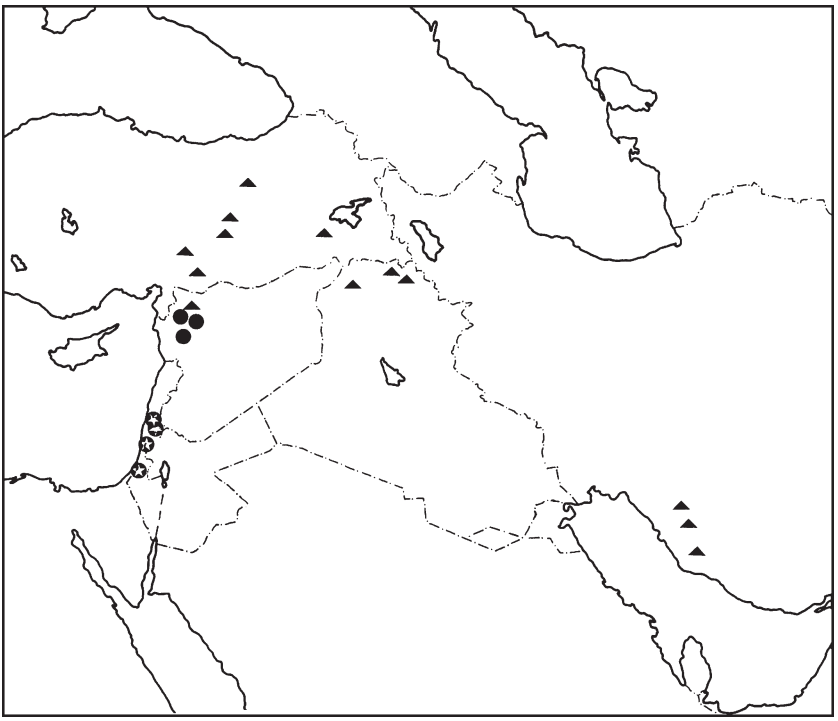


Fig. 7. **Biarum angustatum**. A, flowering habit, × 0.6; B, spadix, × 2; C, stamen, × 12; D, ovary, × 12; E, fruiting habit, × 0.6, all from *Hooker & Hanbury*. Drawn by Christine Grey-Wilson from material at K.

mm, adaxial surface slightly channeled distally, expanded into a narrow wing proximally, mid-green; leaf lamina narrowly lanceolate-elliptic, 13.5 × 1.5 cm, apex acute, base long-decurrent, 4–5 primary lateral veins per side, margins smooth, mid-green. Inflorescence appearing in the autumn, strongly foetid of horse dung and urine. *Peduncle* 5.5–9 cm × 2.5 mm, encased by several 3–10 cm × 8–15 mm sub-fleshy, later papery, cataphylls, these very pale greenish white, pale creamy white on drying. *Spathe* 19–24 cm long; spathe limb narrowly lanceolate, 12–18 × 3–5 cm, apex acute, exterior mid-green spotted and stained brownish purple, interior deep brownish purple, sometimes fading to green apically; spathe tube narrowly cylindric, 3–3.5 × c. 1 cm, margins connate for c. ¾ of their length, exterior whitish, stained deep purple towards the apex, interior white, slightly purple stained near the apex. *Spadix* slightly shorter than the spathe limb, 11.5–17 cm long; spadix appendix slender-cylindric, 13–14.5 × c. 1.5 mm, deep brownish purple. *Staminate* flowers in zone 13–15 × 3–3.5 mm, anthers off-white. Interstice 12–15 × 1–2 mm, off-white. *Staminodes* arranged mostly at the base of the interstice though with scattered rudimentary filaments higher up; filaments slender, 2.5–4 mm long, directed downwards, white. *Pistillate* flowers in a hemispherical cluster, c. 8 mm × 4 mm high; ovaries



Map 3. Distribution of *Biarum aleppicum* ●; *Biarum angustatum* ✪; *Biarum carduchorum* ▲.

bottle-shaped 2–2.5 × 1–1.25 mm, purple, style 1.5–2 mm × c. 0.2 mm wide, purple, stigma sub-capitate, c. 0.3 mm in diam, white. *Infructescence* slightly compressed-globose, consisting of c. 40 berries; berries c. 5 × 6 mm, dirty white, seeds globose, c. 5 mm diam., testa brown, slightly reticulate. 2n not recorded. Fig. 7.

DISTRIBUTION. Syria, Israel. Its presence in Lebanon has yet to be confirmed. Map 3.

ECOLOGY. Limestone-derived terra rossa in open, grazed, sometimes almost completely bare fields, undisturbed lake side fields. Alt. 75–350 m.

ETYMOLOGY. The specific epithet comes from the Latin *angustus*, narrow, in allusion to the narrow leaves in comparison to the remainder of *Ischarum*, the genus in which the name was first published.

5. BIARUM CARDUCHORUM

Biarum carduchorum is fairly widespread, occurring from southern and southeastern Turkey to southern Iran. There is some variation in the populations and names have been published to account for this. However, any variation present is generally of little or no taxonomic significance. The type of the plant described by Parsa (1949) as var. *baktaryanum* on the basis of a narrow spathe with a whitish yellow exterior, is almost identical to the illustration in Vienna that serves as the type of *B. carduchorum*. *Biarum platyspathum* is a particularly vigorous form of *B. carduchorum*.

Biarum carduchorum is most readily separated from *B. angustatum* by the upward-directed staminodes and the considerably wider leaves. As pointed out above, *B. carduchorum* is found further inland than B. *angustatum*.

5. Biarum carduchorum (Schott) Engler in A. & C. DC., Monog. Phanerog. 2: 575 (1879) & in Engler, Das Pflanzenr. 73 (IV.23F): 137 (1920); Mill in Davis, Flora of Turkey 8: 57 t.2 no.14 (1984); Riedl in Townsend, Flora of Iraq 8: 194 (1985).

Cyllenium carduchorum Schott, Prodr. Syst. Aroid. 65 (1860). Type: Turkey, Kurdistania, Schirwan (Şirvan), *Kotschy s.n.* (holotype W destroyed; lectotype W, chosen here, Schott's Icones no. 1825)). There are four illustrations present in Vienna (Icones nos. 1824–1827), the one selected is annotated 'Kurdistan Schirwan bei Karüg'.

Biarum platyspathum Bornm. in Feddes Rep. Nov. Sp. 5: 57 (1908). Type: Iran, Persiae austro-occidentalis provincia Farsistan, ad Bascht et Fahliun, 12 November 1905, *Herzfeld s.n.* (holotype B destroyed; lectotype B (selected here (drawing of the holotype made by Bornmüller)).

Fig. 8. **Biarum carduchorum**. A, inflorescence, × 0.6; B, spadix, × 2; C, stamen, × 12; D, ovary, × 18, from *Boyce* 22; E, fruiting habit, × 0.6, from *Mouterde* 5791. Drawn by Christine Grey-Wilson from material at K.

B. carduchorum (Schott) Engler var. *platyspathum* (Bornm.) Engler in Engler, Pflanzenr. 73 (IV.23F): 137 (1920).
B. platyspathum (Schott) Engler var. *bakhtyarum* Parsa in Kew Bull. 4: 36 (1949). Type: Iran, Fars, Abé Bariq (Abibarik, about 6 miles from E Assupas), 1 September 1885, *Stapf s.n.* (holotype K).
[*B. angustatum* (Hook.f.) N.E.Br. var. *kurdistanicum* Zohary, *in sched. nom. nud.*]
[*B. bakhtyarum* Stapf, *in sched. nom. nud.*]

DESCRIPTION. *Tuber* dorsoventrally compressed-discoid, 4–7 cm × 1.5–2.5 cm, sparsely offsetting. *Leaves* 3–5, hysteranthous, long- petiolate, bases encased by 3–5, 6–14(– 24) × 1–2 cm sub-fleshy, later papery, cataphylls, these pale whitish green, pale straw- yellow on drying; petiole slender, 5–9(–26) × 2–4 mm wide, expanded proximally into a membranous wing, dull green, wing paler; leaf lamina elliptic to spathulate-elliptic, 5–12 × 2.5–5 cm, apex subacute to rather obtuse, base briefly decurrent, 5–7 primary lateral veins per side, margins smooth, dull mid-green. *Inflorescence* appearing in late autumn. *Peduncle* 4–13(–24) cm × 2–4 mm, dirty white, clothed with several 3–11(23) × 1–2 cm sub-fleshy, later papery, cataphylls, these whitish green, pale straw-yellow on drying. Spathe 12–18(–31) cm long; spathe limb lanceolate to lanceolate-elliptic, 8–14(–25) × 2–3(–4.5) cm wide, apex acute to attenuate, exterior pale green to whitish yellow usually ± speckled with dull purple, interior deep brown purple, becoming paler and eventually green distally; spathe tube slender, 4–6 × 0.75–1.5(–2.5) cm wide, margins connate for c. ¾ of their length, exterior dirty white where buried, purple where exposed, interior white, stained purple especially basally and towards the opening. *Spadix* sub-equal to but rarely exceeding the spathe limb, 13–18(–32) cm long, spadix appendix slender cylindric, 9–12(–28) cm × 2–4 mm, deep purple. *Staminate flowers* in a zone 15–25 × 2–3.5 mm, anthers cream ± stained deep purple. *Interstice* 2–3 cm × 2–3 mm, deep purple, occasionally somewhat paler than the appendix. *Staminodes* densly arranged at the base of the interstice directly above the pistillate flowers and usually extending c. half way up the insterstice; filaments directed upwards, 3–7 mm long, those higher up the interstice shorter than those lower down, purple. *Pistillate flowers* in a hemispherical cluster c. 7 × 7 mm; ovaries squatly bottle-shaped, 1.5–2 × 0.75 mm, pale cream, style c. 0.33 mm long, purple, stigma subcapitate, c. 0.25 mm in diam, purple. *Infructescence* not seen. 2n = 24 (Marchant 1972 as *B. platyspathum*). Fig. 8.

DISTRIBUTION. S and SE Turkey, Syria, Iraq, W Iran. Map 3.

ECOLOGY. Bare terra rossa fill slopes, in open situations, field margins, long-follow fields. Alt. 290–2750 m.

ETYMOLOGY. After the name of an ancient tribe, the Carduchi, that inhabited the region of south-eastern Turkey from where the type was gathered.

6. BIARUM EXIMIUM

Biarum eximium has been little collected and were it not for the large number of isotypes from near Adana, it would be poorly known.

The other collections in European herbaria are *Siehe* 22 (dry sterile material with a single spirit-preserved inflorescence in B) and *Dinsmore* 11725 from Jordan. This latter collection is most interesting since, to date, *B. eximium* has not been collected in the area between the type locality in southern Turkey and this Jordanian site. Al-Eisawi (1981) cites another collection (Thab'a (Dab'a) Reserve, c. 50 km south of Amman, along the road to Aqaba, *Al-Eisawi* 8861) which is deposited in the University of Jordan herbarium (AMM). Although I have not seen this specimen, I have examined living plants collected by Salmon and Lovell very close to the same site in 1988. Further collections of *B. eximium*, particularly from Turkey, would be most desirable.

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. Examination of a wide range of material of other species, particularly *B. carduchorum* and *B. angustatum*, revealed that although the main area of staminode distribution was directly above the pistillate flowers, in many individuals staminodes were present on the upper portion of the interstice, although usually in a depauperate condition.

6. Biarum eximium (*Schott & Kotschy*) *Engler* in A. & C. DC., Monog. Phanerog. 2: 576 (1879) & in Engler, Das Pflanzenr. 73(IV.23F): 139 (1920); Mill in Davis, Fl. Turkey 8: 57 (1984); Mathew, The Smaller Bulbs 16 (1987).
Ischarum eximium Schott & Kotschy in Oesterr. Bot. Wochenbl. 4: 81 (1854). Type: Turkey, Taurus, [prope Adana, in via romana versus Miaret Chan, 60 m, 28 September 1853, *Kotschy 343*] (holotype W destroyed; isotypes G-BOIS, K, M, P).

Tuber dorsoventrally compressed-discoid, 3–7 × 2–3 cm, rarely with sets. *Leaves* hysteranthous, long-petiolate, bases encased by several 5–7 cm × 7.5–12 mm lanceolate-elliptic cataphylls, these pale greenish white, occasionally purple-spotted apically, drying dark straw-yellow; *petiole* 5–11 cm × 4–6 mm, mid-green, adaxial surface broadly channeled distally, expanded into a narrow membranous wing proximally, *leaf lamina* elliptic, 10–12.5 × 3–3.5 cm, apex sub-acute, base decurrent, c. 9 primary lateral veins per side, margins smooth, mid-green. *Inflorescence* appearing in autumn, strongly foetid; *peduncle* 1–3 cm × 3–5 mm, off white, encased by several 2–4 cm × 5–9 mm wide smooth pale straw-yellow cataphylls. *Spathe* 9–13 cm long; *spathe tube* cylindrical, 4–4.5 cm long, c. 2 cm wide, moderately inflated, margins connate for c. ½ their length, exterior green with much purple staining and spotting distally; interior white, stained purple proximally; *spathe limb* broadly elliptic, 8–11 × 3.75–5 cm wide, rounded distally, exterior green with numerous irregular purple spots, interior deep brown-purple. *Spadix* slightly shorter than the spathe limb, 9–10.5 cm long; *spadix appendix* fusiform, 7–7.5 cm × 5–7 mm, purple,

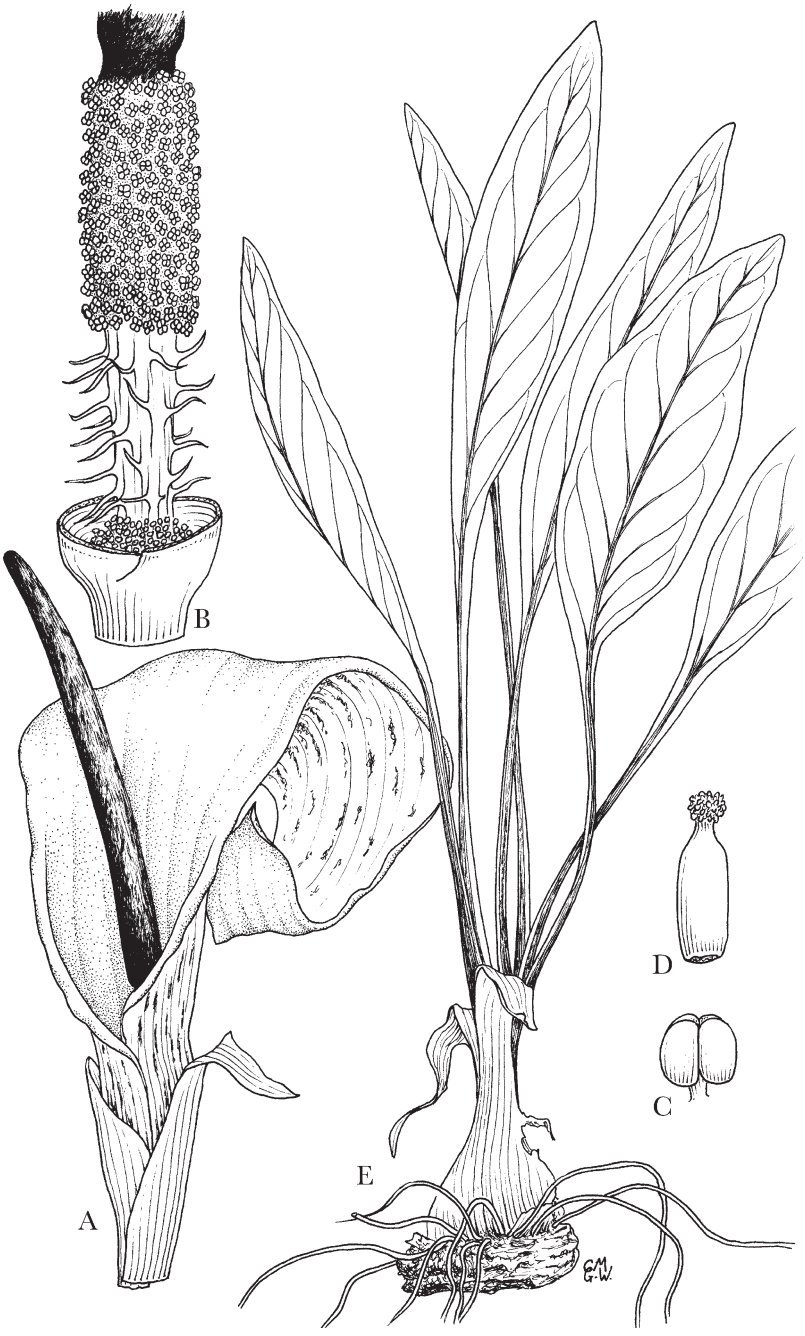


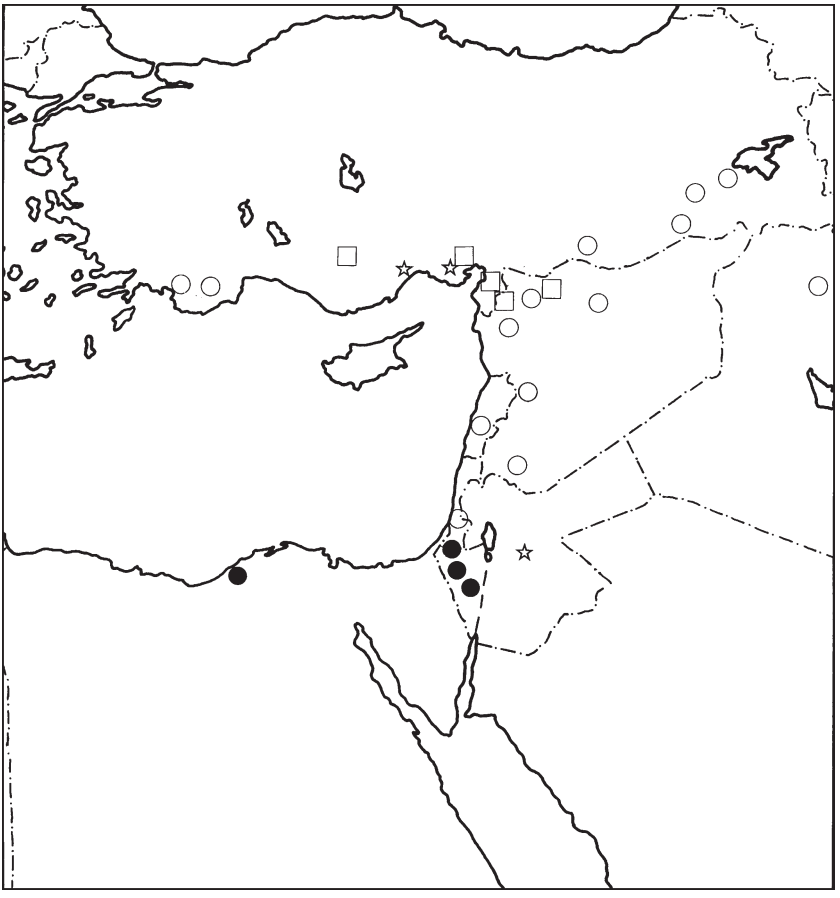
Fig. 9. **Biarum eximium**. A, inflorescence × 0.6; B, spadix × 2; C, stamen × 8; D, ovary × 8; E, leaves and tuber × 0.6. Drawn by Christine Grey-Wilson from material at K.

sometimes slightly paler than the spathe limb. *Staminate flowers* in a zone 12–14 mm × 4–5 mm wide, purple; *Interstice* 25 mm long, c. 4 mm wide, purple. *Staminodes* distributed ± evenly over the entire length of the interstice, filaments c. 5 mm long, purple. *Pistillate flowers* in a hemispherical cluster, c. 10 mm × 3 mm tall; ovaries oblong, c. 2 mm × 0.7 mm, cream below, purple above, style c. 1–1.5 mm long, purple, stigma capitate, purplish grey. *Infructescence* a globose cluster of c. 40 pyriform berries 2.5–3 cm in diam.; berries c. 5 × 8 mm, dull white ± stained purple; seeds ovoid, c. 4–5 mm in diam., mid-brown, testa reticulate. 2n = 16 (Marchant 1972). Fig. 9.

DISTRIBUTION. S Turkey, Jordan. Map 4.

ECOLOGY. Terra rossa in open habitats. In Jordan it occurs in stony loamy soils in semi-desert. Alt. c. 200 m.

ETYMOLOGY. Either from the Latin *eximius* (unexpected) or *eximie* (exceptionally). The exact derivation is unclear.



Map 4. Distribution of *Biarum eximium* ☆; *Biarum bovei* ○; *Biarum crispulum* □; *Biarum olivieri* ●.

7. BIARUM BOVEI

Biarum bovei has been confused with *B. kotschyi* and *B. pyrami* both in the field and in herbaria. Part of the trouble appears to stem from the scarcity of true *B. bovei* in herbaria coupled with the fact that most of the type specimens are pressed in such a way that comparative analysis is rather difficult. In addition, 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. Schott understood this and published names to account for the various populations; e.g. *Ischarum crispulum* and *I. carsaami* (Kunth) Schott. *Biarum crispulum* is morphologically constant in the field and restricted to a small region: the provinces of Adana and Hatay in southern Turkey and in northern Syria. There is, however, a western extension to Cappadocia in the Siehe collection in Berlin, discussed below. The differences that distinguish *B. crispulum* from *B. bovei* are rather minor.

The supposed presence of *B. bovei* in Sardinia (Monti & Gabari 1974) is problematic and, on the basis of material flowered in cultivation, would appear to be the result of a misidentification. There is, as far as I can ascertain, no material in any of the main European herbaria. Monti & Gabari (1974) only briefly discussed the Sardinian populations of *B. bovei*. Recently, I have been sent living material of *B. bovei* collected in Sardinia by Josef Bogner. On flowering it was clearly referable to *B. dispar*.

7. Biarum bovei *Blume*, Rumphia 1: 114 (1836); Engler in A. & C. DC., Monog. Phanerog. 2: 577 (1879) & in Engler, Das Pflanzenr. 73(IV.23F): 140 (1920); Mill in Davis, Fl. Turkey 8: 58 (1984); Riedl in Townsend, Fl. Iraq 8: 195 (1985); Koach & Feinbrun in Feinbrun, Fl. Palaestina 4: 337 (1986); Koach in Rotem 26 t.17,18 (1988). Type: Lebanon, Mt Liban, 1832, *Bové* 379 (holotype P; isotypes G, K, L). The material in Leiden has been annotated as the isotype by Nicolson. Blume (1836) states that the material that he based the description of *B. bovei* on was in both the Leiden and Paris herbaria. Both sets of material have been annotated by Blume and furthermore Blume worked out of Leiden. Since the Leiden specimens are in reasonably good condition while those in Paris are rather poor, it is preferable that the Leiden material is regarded as the holotype.

Biarum homeid Blume, Rumphia 1: 115 (1836). Type: Syria, Aleppo, *Rauwolff* s.n. (holotype not traced).

Caladium bovei (Blume) Steud., Nomen. Bot. ed.2, 1: 249 (1840).

Ischarum bovei (Blume) Schott, Syn. Aroid. 7 (1856).

Fig. 10. **Biarum bovei**. A, flowering habit × 0.6; B, spadix × 2, both from *Frère Louis* Nov. 1937; C, fruiting habit × 0.6, from *Frère Louis* 10.2.1937; D, anther × 6; E, ovary × 6, both from *Boyce* 156. **Biarum crispulum**. F, spathe × 0.6; G, spadix × 2; H, stamen × 8; I, ovary × 8,. Drawn by Christine Grey-Wilson from material at K.

Ischarum homeid (Blume) Schott, Syn. Aroid. 8 (1856) ["*homaid*"].
Biarum bovei Blume var. *blumei* Engler in A. & C. DC., Monog. Phanerog. 2: 577 (1879). Type: as for *B. bovei* Blume.

Tuber globose, slightly compressed dorsally, 1.5–3.5 cm in diam., with few offsets. *Leaves* 3–12, hysteranthous, bases encased by several 4–11 × 1–1.5 cm sub-fleshy, later papery, cataphylls, these pale green to dirty white, drying to off-white; *petiole* 5–9 cm × 3–5 mm, adaxial surface slightly to rather strongly channeled distally, expanded proximally into a wide membranous wing, mid-green, wing paler; *leaf lamina* lanceolate-oblong to ovate-lanceolate with 6–8 primary lateral veins per side, 5–10 × 1.5–4 wide, margins smooth to undulate, more rarely crispulate, mid-green. *Inflorescence* appearing in late autumn, 7–19 cm long, strongly malodourous of horse dung. *Peduncle* 4–7 cm long, encased by numerous 5–9 × 1–1.5 cm sub-fleshy, later papery, cataphylls, these pale green, dull straw-yellow on drying; *spathe limb* lanceolate to linear-lanceolate, 5–14.5 × 1.75–3 cm, margins flat and ± smooth, exterior dull green with some purple staining or spotting, especially towards the margin, interior deep purple-brown; *spathe tube* globose-cylindric to globose, margins connate for c. ¼ of their length, 2.5–4 × c. 1.5 cm in diam., exterior off-white, dull green with slight purple staining where exposed, interior pale green, heavily stained purple at the base. *Spadix* 9–14 cm long; *spadix appendix* narrowly fusiform, 6–10 cm × 2.5–3 mm, deep purple. *Staminate flowers* in a zone 8–12 × 3–4 mm, cream. *Interstice* 1.5–2 cm × 2–3 mm, cream, stained purple in the lower quarter. *Staminodes* few to many, clustered in a zone c. 1 cm long directly above the pistillate flowers; bristles filiform, 5–15 mm long cream, tinged purple basally. *Pistillate flowers* in a hemispherical cluster c. 9 × 6 mm, ovaries pale cream, style 1.5 × 0.25 mm, purple, stigma capitate, purple. *Infructescence* a globose cluster of c. 40 pyriform-globose berries 2.5–3 cm in diam.; berries c. 7 × 4 mm, pale lilac-grey with purple tinges when ripe; seeds globose, c. 4–4.5 mm in diam., pale brown, testa reticulate. Fig. 10.

Distribution. Turkey, Syria, Lebanon, Israel, Iran and Iraq. Map 4.

Ecology. Limestone-derived terra rossa in open situations, hill slopes, grazed pasture, field margins; alt. 800–1750 m.

Etymology. Named for the collector of the type material, Nicolas Bové (1812–1841), who visited Algeria, Egypt and the Yemen, and was one of the first to study the flora of the Sinai peninsula (His great-great nephew is the French anti-GM activist and 2007 presidential candidate Jose Bové).

8. BIARUM CRISPULUM

Since its publication *Biarum crispulum* has been universally treated as a synonym of *B. bovei* although *B. crispulum* is readily separable by its synantherous leaves, the narrow, incurved and heavily crispulate spathe margins, and a spadix appendix smelling of sour milk (dung in *B. bovei*).

Plate 609 *Biarum crispulum* ANN FARRER

Biarum crispulum in habitat in Syria. Photograph Peter Boyce.

Biarum crispulum is the commonest *Biarum* in NW Syria, forming extensive colonies in bare red soil to the north of Aleppo.

The type locality stated by Schott for *Ischarum crispulum* is possibly in error. Several of Schott's *Ischarum* protologues state the type locality to be Semiramis but, as pointed out by Mill (1984) when discussing *B. pyrami*, Semiramis is in Iraq, whereas the annotations on the type material of *B. pyrami* state that it was collected near the Ceyhan River, Adana, in southern Turkey. Given the paucity of authenticated Iraqi *B. bovei* (with which *B. crispulum* is much confused) collections, it seems likely that *I. crispulum* originated from either north-western Syria or south-eastern Turkey. This is further supported by more recent records of this taxon from these areas but not, as yet, from Iraq. The illustration in Vienna (W) of living material of the lectotype (Schott, *Icones Aroideae* no. 2141), is annotated in Schott's hand as *I. crispulum* with the data 'Kassan Oghlu, Gorumse, Kotschy 1859', i.e., from Gürümze, Adana, southern Turkey.

8. Biarum crispulum (Schott) Engl. in Bot. Jahrb. 5: 334 (1884). Type: 'Iraq, ad Arcem Semiramidis' (but see note above), *Kotschy*, cult. Schoenbrunn (holotype W destroyed; lectotype G-BOIS: Turkey: Adana, Kassan Oghlu (Hasanoglu) Gorumse (Gürümze) valley, 21 May 1859, *Kotschy* 442).

Ischarum crispulum Schott, Prodr. Syst. Aroid. 68 (1860).

Calla orientalis L., Sp. Pl. ed.2: 1373 (1763). Type: '*Arum carsami*' *Rauw* it. 115. Halepi in montosis (L), *nom. rejic.*

Arum carsaami Kunth, Enum. Pl. 3: 25 (1841), *nom. illeg.* Type as for *Calla orientalis*.

Eminium carsaamii (Kunth) Schott, Syn. Aroid. 17 (1856), *nom. illeg.*

Ischarum carsaamii (Kunth) Schott, Prodr. Syst. Aroid. 67 (1860), *nom. illeg.*

Biarum bovei Blume ß *carsaami* (Kunth) Boiss., Fl. Or. 5: 34 (1882) ['*karsaamii*'].

Biarum orientale (L.) Druce in Bot. Exc. Club Brit. Isles 3(5): 415 (1914).

[*Ischarum christmannii* Siehe in sched. Berol. *nom. nud.*] A flowering specimen collected by Siehe (*Siehe* s.n.) preserved in alcohol in Berlin (B) is annotated *Ischarum* (*Biarum*) *christmannii* Siehe. I have been unable to trace any publication place for the name. The specimen is clearly referable to *B. crispulum*.

Description. *Tuber* globose, slightly compressed dorsally, 1.5–3.5 cm in diam., with few offsets. *Leaves* 3–12, synanthous, bases encased by several 4–11 × 1–1.5 cm sub-fleshy, later papery, cataphylls, these pale green to dirty white, drying to off-white; *petiole* 5–9 cm × 3–5 mm, adaxial surface slightly to rather strongly channelled distally, expanded proximally into a wide membranous wing, mid-green, wing paler; *leaf lamina* lanceolate-oblong to ovate-lanceolate with 6-8 primary lateral veins per side, 5–10 × 1.5–4 wide, margins smooth

Biarum crispulum flowering in Syria. Photograph Peter Boyce.

Biarum crispulum in fruit. Photograph Brian Mathew.

to undulate, more rarely crispulate, mid-green. *Inflorescence* appearing in late autumn to early winter, weakly odourous of sour milk, 7–11 cm long. *Peduncle* 4–7 cm long, encased by numerous 5–9 × 1–1.5 cm sub-fleshy, later papery, cataphylls, these pale green, dull straw-yellow on drying; *spathe limb* linear-triangular, 5–14.5 × 1–1.5 cm, margins incurved and strongly crispulate, exterior dull green with some purple staining or spotting, especially towards the margin, interior dark greenish purple; *spathe tube* globose-cylindric to globose, margins connate for c. ¼ of their length, 2.5–4 × c. 1.5 cm in diam., exterior off-white, dull green with slight purple staining where exposed, interior pale green, heavily stained purple at the base. *Spadix* 4–10 cm long; *spadix appendix* narrowly fusiform, 3–8.5 cm × 2.5–3 mm, deep greenish purple. *Staminate flowers* in a zone 8–12 × 3–4 mm, cream, thecae tipped deep purple. *Interstice* 1.5–2 cm × 2–3 mm., cream, stained purple in the lower quarter. *Staminodes* few to many, clustered in a zone c. 1 cm long directly above the pistillate flowers; bristles filiform, 5–15 mm long cream, tinged purple basally. *Pistillate flowers* in a hemispherical cluster c. 9 × 6 mm, ovaries pale cream, style 1 × 0.5 mm, purple, stigma capitate, purple. *Infructescence* a globose cluster of c. 40 pyriform-globose berries 2.5–3 cm in diam.; berries c. 7 × 4 mm, pale lilac-grey with purple tinges when ripe; *seeds* globose, c. 4–4.5 mm in diam., pale brown, testa reticulate. Fig. 10.

DISTRIBUTION. S Turkey (provinces of Adana, Hatay and Konya), NW Syria. Map 4.

ECOLOGY. On bare ground, in terra rossa; alt. 650–900 m.

ETYMOLOGY. The epithet *crispulum* refers to the crispulate spathe limb margins.

9. BIARUM DISPAR

This interesting species has been much confused with the closely allied *Biarum bovei* from the eastern Mediterranean. It can be distinguished readily by the interstice which is approximately twice as long as the staminate flower zone, the presence of fewer and more scattered staminodes, and 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 a previously overlooked taxon, *B. mendax*, which displays dimensions in excess of both *B. dispar* and *B. bovei* and is readily separable from either. References to *B. bovei* in the *Flora of Libya* (El Gadi 1977) are referable to *B. dispar*.

Plate 610 *Biarum dispar* ANN FARRER

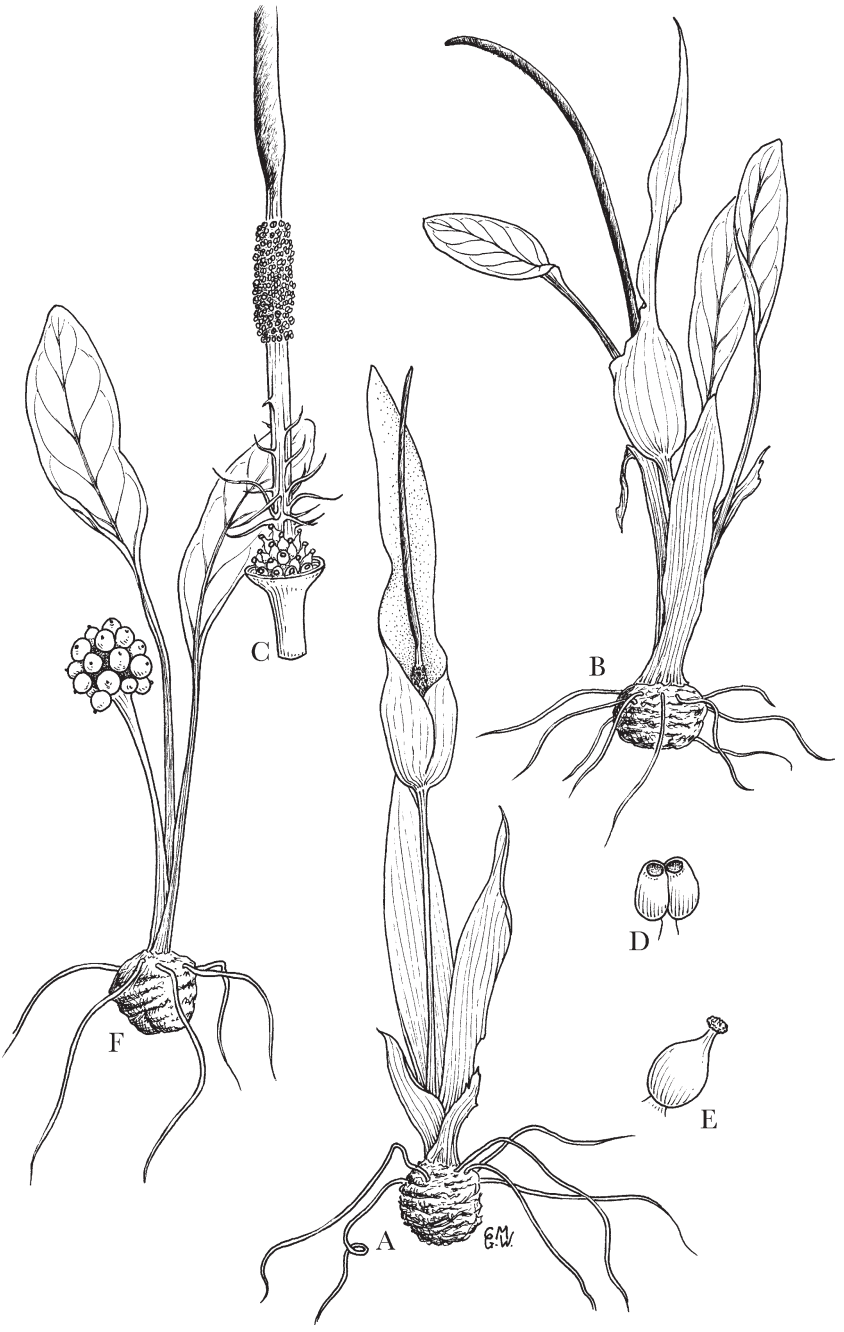


Fig. 11. **Biarum dispar**. A, flowering habit, × 0.6 from *Munby* 1856; B, flowering habit, × 0.6 from *Warren s.n.*; C, spadix, × 2; D, stamen, × 18; E, ovary, × 12, all from *Willmott* 1863; F, fruiting habit, × 0.6, from *Munby* 1856. Drawn by Christine Grey-Wilson from material at K.

9. Biarum dispar (Schott) Talavera in Lagascalia 6(2): 293 t.1, D, D1 (1976); Talavera, Valdés & Galiano, Fl. Vasc. de Andal. Occ. 3: 210 (1987).
Ischarum dispar Schott, Syn. Aroid. 7 (1856). Type: Algeria, Constantine, mountains, October 1838, *Bové s.n.* (holotype W destroyed; isotypes FI, G, OXF, P).
Biarum numidicum Parl., Fl. Ital. 2: 243 (1857) ("1852") nom. superfl. Type: as for *B. bovei* Blume.
B. macroglossum Pomel, Nouv. Mat. Fl. Atlant. 2: 390 (1874). Type: Algeria, Vallé du Chélif, Tell, terrains argileux (holotype not traced).
B. longifolium Pomel, Nouv. Mat. Fl. Atlant. 2: 391 (1874). Type: Algeria, Nador de Tiaret, au pied des rochers (holotype not traced).
B. rupestre Pomel, Nouv. Mat. Fl. Atlant. 2: 391 (1874). Type: Algeria, Miliana, Boghar, cavités des rochers calcaires (holotype not traced).
B. bovei Blume subsp. *dispar* (Schott) Engler in A. & C. DC., Monog. Phanerog. 2: 587 (1879).
B. bovei Blume subsp. *dispar* (Schott) Engler var. *viride* Battandier in Bull. Soc. Bot. Fr. 28:269 (1881) ["*viridis*"]. Type: not designated (AL?).
B. bovei Blume subsp. *dispar* (Schott) Engler var. *rupestre* (Pomel) Battandier & Trabut in Trabut, Fl. d'Alger 17 (1884) ["*rupestris*"].
B. bovei Blume subsp. *dispar* (Schott) Engler var. *zanonii* Pamp. in Nuov. Giorn. Bot. Ital. 24:124 (1917). Type: Libya, Raaba, steppe, 2 December 1916, *Pampanini* 216 (lectotype FI). Pampanini cites two specimens in the protologue, the other (Guarcia, 27 December 1916, *Pampanini* 189) consists of leaves and fruit, while that chosen is in flower and thus the better choice as lectotype.
B. bovei Blume subsp. *dispar* (Schott) Engler var. *purpureum* Engler in Engler, Pflanzenr. 73(IV.23F): 141 (1920). Type: Algeria, Thikilmouth, Constantine, in pasquis argilloso-petrosis summi montis Mansourah, 10 November 1868, *Paris* 293 (lectotype B; isolectotypes FI, G, K, P). The collection selected is the best of those cited by Engler. I have chosen the Berlin specimen as the lectotype since it was undoubtedly seen by Engler.
B. bovei Blume subsp. *dispar* (Schott) Engler var. *macroglossum* (Pomel) Maire & Weiller, Fl. de l'Afr. Nord 4: 247 (1957). Type: Not cited.
B. bovei Blume subsp. *dispar* (Schott) Engler var. *macroglossum* (Pomel) Maire & Weiller f. *longifolium* (Pomel) Maire & Weiller, Fl. de l'Afr. Nord. 4: 247 (1957). Type: Not cited.

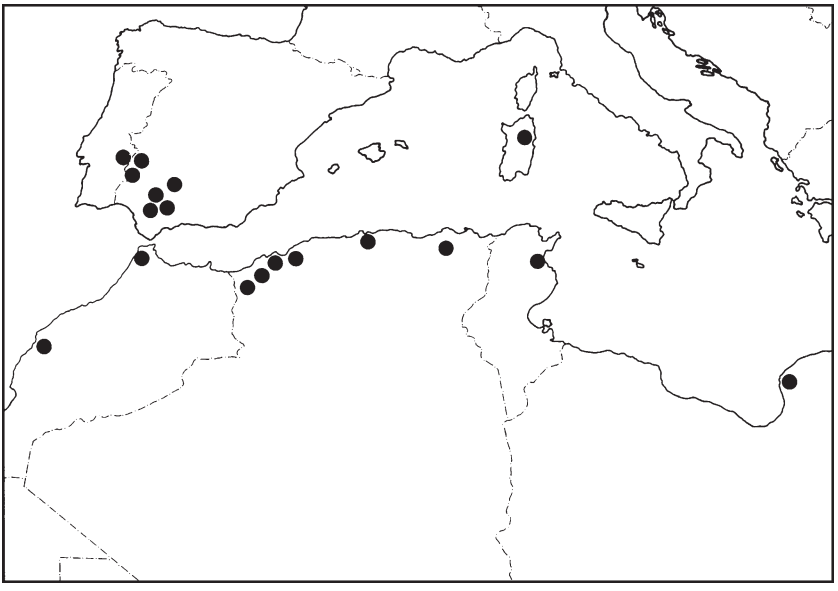
DESCRIPTION. *Tuber* globose-discoid, 2.5–4 × 2–3.5 cm, mid-brown. *Leaves* 4–10, hysteranthous, long petiolate, bases encased by 3–5, 8–14(–16) cm × 3–10(–15) mm lanceolate sub-fleshy, later papery cataphylls, these pale greenish white at first, drying pale straw-yellow; *petiole* 10–17 cm long, 2–3 mm wide, adaxial surface strongly channeled distally, expanded into a wide membranous wing proximally, mid-green; *leaf lamina* oblong-elliptic, 6–8 × 3–3.5 cm, apex cuneate to rounded, base obtuse to sub-acute, c. 3–6 veins per side, margins smooth, lamina mid-green, very rarely bullate. *Inflorescence* appearing in late summer to autumn, smelling moderately of cattle dung and carrion. *Peduncle* 3–9 cm × 3–5 mm, clothed by few to many 2–9 cm × 5–12 mm papery, pale creamy white cataphylls. *Spathe* 8–10(–14) cm long; *spathe*

limb lanceolate, 6–8(–12) cm × 4–12 mm, apex acute to acuminate, exterior green ± heavily blotched and stained purple-brown, rarely unstained, interior deep purple-brown, paler distally, rarely entirely dull green; *spathe tube* oblong-globose, strongly inflated, 2–3 × 1.5–2.5 cm wide, margins fused for ¼ of their length, exterior pale green, occasionally stained purple-brown towards the opening, interior off-white distally, deep purple proximally. *Spadix* sub-equal to just exceeding the spathe limb, 8–12 cm long; *spadix appendix* slender fusiform, 6.5–11 cm × 3–5 mm, deep purple-brown. *Staminate flowers* in a zone 9–13 × 3–6 mm, deep purple. *Interstice* 12–20 × 3–6 mm, deep purple. *Staminodes* situated at the base of the interstice, few to many, thickened-filiform, 2–10 mm long, deep purple. *Pistillate flowers* in a hemispherical cluster 2.5–4 × 3–7 mm wide; ovary 2–3 mm long, cream; style 1–1.5 × 0.25 mm, purple, stigma capitate, c. 0.5 mm in diam., grey-purple. *Infructescence* globose, 1.6–3 cm in diam., consisting of c. 35 berries; berries 4–6 × 4–5 mm, pale whitish lilac when ripe; seed globose, c. 5 mm in diam, testa reticulate, pale brown. 2n = 74 (Chiappini & Scrugli 1972, Talavera 1976). Fig. 11.

Distribution. SW Spain, N Morocco, N Algeria, N Tunisia, N Libya, Sardinia. Map 5.

Ecology. Open stony fields, rocky hill slopes, crevices and chimneys in limestone rocks, field margins, track sides, disused olive groves. Alt. 25–250 m.

Etymology. From the Latin *dispar*, unlike, unequal, but in which context is not known.



Map 5. Distribution of *Biarum dispar* ●.

10. BIARUM OLIVIERI

Biarum olivieri is a curious species that, although allied to *B. bovei*, *B. dispar* and *B. crispulum*, is separable by the linear to linear-lanceolate leaves, the much thinner, almost papery, spathe texture, the fully connate spathe tube margins and the filamentous spadix appendix. The floral odour produced by *B. olivieri* is also distinctive. Both *B. dispar* and *B. bovei* produce a dung-like odour which, although unpleasant, is not nauseating; *Biarum olivieri* produces a disgusting smell of soured milk when in blossom, similar to that produced by *B. crispulum*. The habitat favoured by *B. olivieri*, consolidated sand, is quite different to the heavy red terra-rossa favoured by *B. bovei*, *B. dispar* and *B. crispulum*.

To date *B. olivieri* is known from three locations. The type 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, while in 1995 Chris Lovell collected *B. olivieri* in Jordan on the road from Ibria to Rauble.

10. Biarum olivieri Blume, Rumphia 1: 115 (1836); Engler in A. & C. DC., Monog. Phanerog. 2: 580 (1879) & in Engler, Pflanzenr. 73 (IV.23F): 142 (1920); Koach & Feinbrun in Feinbrun, Fl. Palaestina 4: 339 (1984); Koach in Rotem 26, t.21, 22 (1988). Type: Egypt, *Olivier & Bruguière* s.n. (holotype P; isotypes K, L).

B. alexandrinum Boiss., Diag. 13: 6 (1853). Type: Egypt, near Alexandria, *Cadet de Fonteney s.n.* (holotype not traced).

Ischarum alexandrinum (Boiss.) Schott, Syn. Aroid. 8 (1856).

I. olivieri (Blume) Schott, Syn. Aroid. 8 (1856) & in Miq., Ann. Mus. Bot. Lugd.-Bat. 1: 278 (1864).

Leptopetion alexandrinum (Boiss.) Schott, Gen. Aroid. t.8 (1858).

Description. *Tuber* globose to somewhat sub-cylindric, 7.5–20 × 5–25 mm. *Leaves* 3–8, hysteranthous to synanthous, long-petiolate, bases encased by 2–4, 5–14 cm × 5–13 mm, lanceolate, sub-fleshy, later papery, cataphylls, these green at first, drying greenish white; petiole 4–11(–16) cm × 1–2 mm, adaxial surface channeled distally, expanded proximally into a membranous wing, pale green; leaf lamina linear to linear-lanceolate, rarely lanceolate, 7–14 cm × 2.5–10 mm, apex acute to sub-acuminate, base decurrent to rounded or sub-truncate, c. 3–5 veins per side, margins undulate to crispulate, lamina pale to mid-green. *Inflorescence* partially encased by 2–3 cataphylls, the spathe tube often partially to completely buried. *Spathe* 3–8 cm long; spathe limb linear, the margins incurved, 1–6 cm × 1.5–3 mm, exterior mid-green; interior dull purple,

Biarum olivieri, in flower (above) and in full leaf (below). Photographs Peter Boyce.

Fig. 12. **Biarum olivieri**. A, flowering habit, × 0.6; B, spadix, × 2; C, stamen, × 18; D, ovary × 12, all from *Asson* 1877; E, fruiting habit, × 0.6; seedlings, × 0.6. Drawn by Christine Grey-Wilson from material at K.

rarely olive green; spathe tube ovoid, strongly inflated, 1–2.5 × 0.75–1.5 cm, margins connate for their whole length, exterior pale to mid-green, sometimes flushed purple towards the opening, interior deep purple. *Spadix* subequal the spathe limb, 2.5–8 cm long; spadix appendix filiform, 2–6.5 cm × 0.5–1 mm, deep purple. *Staminate* flowers in a zone 3–4 mm × c. 1 mm, anthers scattered to rather dense, purple. *Interstice* 4–5 × c. 0.75 mm, deep purple. *Staminodes* few, often absent, filiform, situated at the base of the interstice, 2–3 mm long, purple. *Pistillate* flowers in a hemispherical cluster 2–4 × 3–4 mm; ovaries bottle-shaped, c. 1–5 × 0.75 mm, cream, style c. 1 × 0.15 mm, purple, stigma capitate, c. 0.33 mm in diam., purple-grey. *Infructescence* globose, c. 1.1–2 cm in diam., often enclosed in the persistent spathe tube, head consisting of c. 25–30 berries; berries globose, c. 5 mm in diam., pale whitish-purple when ripe; seed spherical, c. 3 mm in diam., testa ± smooth, elaiosome barely developed, pale brown. Chromosome number not recorded. Fig. 12.

Distribution. N Egypt, S Jordan, S Israel. Map 4.

Ecology. In consolidated sand in open situations, often close to the coast. Alt. 5–500 m.

Etymology. Named after Guillaume Antoine Olivier (1756–1814), a French naturalist who travelled extensively in Asia Minor and Iran during the late eighteenth century.

11. BIARUM STRAUSSII

Biarum straussii and *B. syriacum* both flower in spring when the leaf rosette is still living. The only other species of *Biarum* that flower at this period are *B. rhopalospadix* and *B. ditschianum*. *Biarum rhopalospadix* has so many differences from either of these species that it can be dismissed from this discussion. *Biarum ditschianum*, while having rather narrow leaves and an inflated spathe tube similar to that found in *B. syriacum* and *B. straussii* is otherwise quite different, with a much reduced spathe limb, a short, stout spadix appendix and no pistillodes, features shared in part with *B. dispar* and *B. auraniticum*.

Biarum straussii and *B. syriacum* are notable for having narrow, grass-like foliage and in producing inflorescences in early to mid-spring while the leaves are still present. Both species are restricted to the Middle East; *B. straussii* in Iraq and Iran, *B, syriacum* in Syria. Both possess an inflated spathe tube, a wide, conspicuous spathe limb and rather a stout fusiform spadix appendix. Despite these similarities *B. straussii* is readily separated from *B. syriacum* by its broader leaves, presence of a style and the longer, narrower staminate flower zone. The spathe tube margins are completely connate in both

species, contrary to Riedl's (1980) statement that the spathe tube margins in *B. syriacum* are free for more than half their length. This mistake may have arisen due to misinterpretation of the 'type' of *B. russellianum* (see note under *B. syriacum* below).

The distinctive appearance of *B. straussii* in flower–the infloresence emerging from the middle of a mature leaf rosette–provides little chance of confusing it with any other species of *Biarum*, except perhaps *B. syriacum* from which it differs by the much broader leaf lamina.

Confusion might occur with species of *Eminium*, especially with the entire-leaved forms of *E. intortum*. 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.

11. Biarum straussii Engler in Engler, Das Pflanzenr. 73(IV.23F): 142 (1920); Riedl in Townsend, Fl. Iraq. 8: 196–7 t.51 (1985). Type: Iran, "tal des Drehemschur bei dem Dorf Meikham auf Brachen", 25 May 1906, *Strauss* 590 (lectotype B). All the syntypes listed by Engler are present in Berlin. The specimen selected is the most complete of these.

Description. *Tuber* slightly compressed-globose, 2–4 × 1.5–3 cm, without offsetts (?), pale brown. *Leaves* 4–18, proteranthus, long petiolate, bases encased by 3–4, 6–14 × 1–1.5 cm rather fleshy, later papery, cataphylls, these pale greenish white at first, pale brown on drying; *petiole* 1–3 mm thick, adaxial surface barely channelled distally, the outer-most petioles expanded into membranous wing proximally, the inner-most ± the same width along their length, petiole mid-green, wing paler; *leaf lamina* ovate-elliptic to oblong to linear, 5–14 cm × 4–20 mm, apex obtuse to sub-acute, base decurrent to almost truncate, c. 6–8 veins per side, margins smooth to undulate or slightly crispulate, lamina dull green. *Inflorescence* emerging from the middle of the leaf rosette, peduncle 4–13 cm × 2–2.5 mm, subterranean or slightly emergent, whitish to pale green where visible. *Spathe* 8–16 cm long; *spathe limb* lanceolate, 6–12 cm × 5–10 mm, acute, exterior green, interior deep purple; *spathe tube* oblong, inflated, 3–5 × 1.75–2.3 cm, margins fully connate, exterior green, interior deep purple, occasionally paler than the spathe limb interior. *Spadix* sub-equal to slightly exceeding the spathe, 8–16 cm long; *spadix appendix* cylindric-fusiform, 6–13.5 cm × 2–3 mm, deep purple. *Staminate flowers* in a zone 12.5–15 × 2–4 mm, anthers cream. *Interstice* 1.5–3 cm × 2–3 mm, cream. *Staminodes* restricted to a 5–10 mm zone above the pistillate flower zone, few to many, 4–6 mm long, mostly pointing upwards, cream. *Pistillate flowers* in a hemispherical cluster 3–3.5 × 5–6 mm; ovaries oblong, 1–1.5 × c. 1 mm, cream with a purple apex, style c. 1 × 0.25 mm, purple, stigma capitate, c. 0.33 mm in diam, purple. *Infructescence* globose, 2.5–3 cm in diam., consisting of 40–50 berries; berries 7–10 × 4.5–6 mm pale purple-white when ripe; seed c. 4 mm in diam., ovoid, testa slightly reticulate. Fig. 13. Chromosome number not recorded.

Fig. 13. **Biarum straussii**. A, flowering habit, × 0.6; B, spadix, × 2; C, anther, × 12; D, ovary, × 12, all from *Hewer* 1953; E, fruiting habit, × 0.6, from *Strauss* 5.1897. Drawn by Christine Grey-Wilson from material at K.

DISTRIBUTION. Northern Iraq, northern Iran. Map 9.

ECOLOGY. Terra rossa and shales on rocky and stony limestone hills, in open situations, amongst low *Berberis* scrub or on grazed hillslopes; alt. 300–550 m.

ETYMOLOGY. Named for Theodor Strauss (1859–1911), the collector of the type material, who travelled in western Iran in 1905.

12. BIARUM SYRIACUM

The confused nomenclatural history of this species was discussed by Riedl (1980a). When Banks and Solander published the name *Arum gramineum* (1794), based on a Russell collection in the British Museum, they appear to have been unaware of Lamarck's *Arum gramineum* (1789). Schott (1860) proposed *B. russellianum* as a *nomen novum* for the Banks & Solander species, since the epithet *gramineum* was unavailable under either *Arum* or *Biarum*. However, Schott overlooked that Sprengel (1826) had proposed the name *A. syriacum* for the Russell material and that he should have adopted Sprengel's earlier name in *Biarum*.

Very little material of *Biarum syriacum* has been collected. The five sheets of material in Paris are all from the Aleppo area of northern Syria, one being the 'type' of Schott's *B. russellianum*. The only other material I have been able to trace is Russell's gathering, the type of *Arum syriacum*, in The Natural History Museum, London and four contemporary gatherings in Geneva. According to the notes on the various sheets it appears that *B. syriacum* is quite abundant, especially in the north of Syria.

If the unusual 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 Subgen. *Ischarum* have similar leaves.

Reidl (1980) stated that the spathe tube margins in *B. syriacum* were free for more than half their length. I suspect that this mistake arose due to a tracing of the "holotype" of *B. russellianum* that is present in the Herbarium at Kew and which depicts the spathe tube with free margins. Examination of the specimen in Paris that was used for the tracing reveals that the "free" margins are actually the result of creasing of the inflated spathe tube during drying; the margins are fully connate.

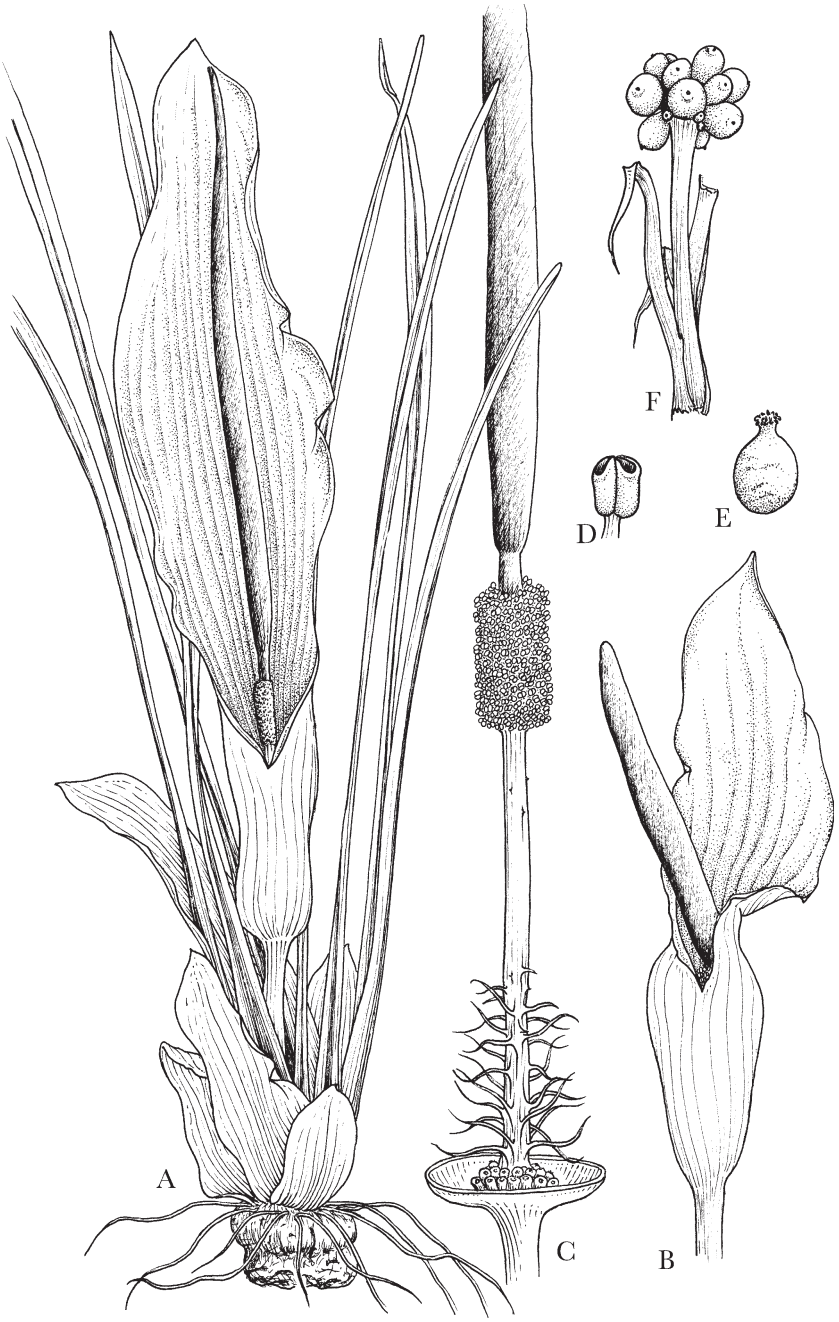


Fig. 14. **Biarum syriacum**. A, flowering habit, × 0.6; B, inflorescence, × 0.6, both from Mars 1947; C, spadix, × 2; D, anther, × 12; E, ovary, × 12, all from herb. *Barbey* Boissier; F, fruiting habit, × 0.6, from *Pabot*. Drawn by Christine Grey-Wilson.

12. Biarum syriacum (Spreng.) H.Riedl in Aroideana 3(1): 19 (1980). Type: (Syria) prope Aleppo, *Russell s.n.* (holotype BM).
Arum syriacum Spreng., Syst. Veg. 3: 768 (1826).
B. gramineum Banks & Sol. in Russell, Nat. Hist. Aleppo ed. 2, 2: 264 (1794), *nom. illeg.* Type as for *B. syriacum* (Spreng.) H.Riedl.
B. russellianum Schott, Prodr. Syst. Aroid. 63 (1860), *nom. illeg et superfl.*
B. gramineum (Banks & Sol.) Eig in Journ. Bot. Lond. 75: 189 (1937), *nom. illeg. et superfl.*

Description. *Tuber* dorso-ventrally compressed-discoid, 2–3.5 × 1.5–2 cm, without offsets (?), dark brown. *Leaves* 12–25, proteranthous, long-petiolate, the bases encased by 3–6 ligulate, 6–14 × 1.5–2 cm, sub-fleshy, later papery, whitish cataphylls and 2–3 ligulate 9–13 × 1–1.5 cm, fibrous brown cataphylls; *petiole* 6–15 cm × 1–3 mm, abaxial surface channeled distally, expanded into a membranous wing proximally, mid to dark green; *leaf lamina* linear to linear-elliptic, the first few leaves emerging spathulate, 6–14 cm × 2.5–4(–14) mm, apex acute, base long-decurrent to cuneate, 3–5 primary lateral veins per side, margins smooth to undulate, lamina mid- to dark green, rarely somewhat glaucous abaxially. *Inflorescence* appearing in spring; peduncle 3.5–6 cm × 2–3 mm, dirty white, emerging from amidst the foliage. *Spathe* 11.5–18 cm long; *spathe limb* elliptic to lanceolate-elliptic, 9–15 × 1.8–3.5 cm, exterior green, heavily stained deep purple, interior deep purple; *spathe tube* oblong, moderately inflated, 4–5.5 × 1.5–2.5 cm, margins fully connate, exterior dirty white, stained purple around the upper margins, interior white, stained mid-purple distally. *Spadix* sub-equal to just exceeding the spathe limb, 15.5–18 cm in total length; *spadix appendix* fusiform, sub-sessile to shortly stipitate, 8–15 cm × 6–9 mm, deep purple. *Staminate flowers* in a zone 9–14 mm long, 5–6 mm wide, anthers cream. *Interstice* 2–3.2 cm × 2–3 mm, dark cream. *Staminodes* arranged on the lower half of the interstice, moderately dense; bases barely to not swollen, dark cream, filaments filiform, spreading to erect, 3–6 mm long, the longest nearest to the pistillate flowers, cream. *Pistillate flowers* in a hemispherical cluster 1–2 × 4–5 mm; ovaries oblong, c. 1–2 × 0.5 mm, dark cream, stigma sub-sessile, capitate, c. 0.3 mm in diam. *Infructescence* known only from immature material, c. 10 × 7 mm; berries c. 3 × 1.5 mm, whitish; mature seed not seen. Chromosome number not recorded. Fig. 14.

Distribution. NW Syria. Map 9.

Ecology. Bare earth plains in limestone-derived terra rossa. Alt. 150–300 m. map 9.

Etymology. From Syria, alluding to the country of origin of the type and all other material.

13. BIARUM CARRATRACENSE

Biarum carratracense has been associated with *B. bovei* and *B. tenuifolium* but is quite clearly distinguishable from either. The oblong, slightly

Fig. 15. **Biarum carratracense**. A, inflorescence, × 0.6; B, spadix, × 2; C, anther, × 4; D, ovary, × 18, all from *De Coincy* 91; E, fruiting habit, × 0.6, from *De Coincy* 2.5.87. Drawn by Christine Grey-Wilson from material at K.

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 leaf lamina. 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 taxon almost lacks pistillodes except for a couple of vestigial bristles on the upper part of the interstice.

13. Biarum carratracense (Haenseler) Font Quer in Bull. Inst. Catal. Hist. Nat. 26: 53 (1926); Talavera in Lagascalia 6(2): 290–93 t.1, C, C1 (1976); Talavera, Valdés & Galiano, Fl. Vasc. Andal. Occ. 3: 210 (1987).

Arum carratracense Haenseler in Bot. Zeit. 4: 313 (1846). Type: Spain, "in agris cultis montuosisque ad Carratraca, jam Sierra de Agua dictis", 18 November 1839, *Haenseler s.n.* (holotype G).

Biarum haenseleri Willk., Bot. Zeit. 5: 49 (1847), *nom. illeg. et superfl.* Type: based on the same type as *B. carratracense* (Haenseler) Font Quer.

B. intermedium Amo, Fl. Fan. Penin. Iber. 1: 394 (1847). Type: Spain, crece en las Alpujarras, cerca Orgiva y tembien en Sierra Elvira, provincia de Granada, *Amo s.n.* (holotype not traced).

Ischarum haenseleri (Willk.) Schott, Syn. Aroid. 8 (1856), *nom. illeg.*

B. tenuifolium (L.) Schott var. *latifolium* Lange, Pugillus 81 (1860) ["*latifolia*"]. Type: Spain, Sierra Elvira prope Granada, *Lange* 147 (lectotype C; isolectotypes C, G, P). There are five sheets of this taxon present in the Copenhagen herbarium, representing many individual plants. The best preserved and most complete sheet has been chosen as the lectotype.

B. bovei Blume subsp. *haenseleri* (Willk.) Engler in A. & C. DC., Monog. Phanerog. 2: 578 (1879), *nom. illeg.*

Description. *Tuber* slightly dorso-ventrally compressed discoid to slightly compressed globose, 1.5–3 × 1–2 cm, mid-brown. *Leaves* 3–7, hysteranthous, very rarely synanthous, bases encased by 3–4. 7–12 × 1–2 cm, lanceolate, sub-fleshy, later papery, cataphylls, these pale greenish white to dull green, turning pale greyish yellow on drying; *petiole* 8–15 cm × 2–4 mm, adaxial surface channeled with slightly winged margins distally, expanded basally into a papery wing; *leaf lamina* elliptic, elliptic-ovate or oblanceolate, 5–12(–15) × 2–3 cm, c. 6 primary lateral veins per side, margins smooth, lamina rather dull mid-green. *Inflorescence* appearing in late autumn, 11–17.5 cm long, strongly foetid of horse dung and carrion, peduncle 3–7 cm × 2–3 mm. *Spathe* 10–17.5 cm long; *spathe limb* lanceolate, 8–13.5 × 1–2 cm, margins smooth, exterior ± green with much rich purple staining, especially towards the margin,

Plate 611 *Biarum carratracense* ANN FARRER

becoming paler towards the base near soil level; *spathe tube* elliptic-cylindric, slightly inflated, 2–4 × 1.5–2 cm, margins connate for c. ½ their length, exterior off white beneath soil level, exposed portion rich purple, interior white, stained purple at the base and towards the opening. *Spadix* 10–17 cm long; spadix appendix slender-fusiform, 8–13 cm × 1.4–3.5 mm, deep brown-purple. *Staminate flowers* in a zone 10–15 × 3–5 mm, anthers cream, stained purple in the region of the connective. *Interstice* 1–1.5 cm × 2–2.5 mm, purple. *Staminodes* few, scattered over the lower 1 cm of the interstice and directly above the pistillate flowers. *Pistillate flowers* in a hemispherical cluster c. 5–7 × 6 mm, ovaries ovoid, 0.5–1 mm in diam., purple, style c. 0.5 mm × 0.25, purple, stigma sub- capitate, c. 0.33 mm in diam., pale purple. *Infructescence* a globose cluster of c. 50 berries 3–3.5 cm in diam.; berries globose, c. 8–9 mm in diam., pale purple; seeds globose, c. 5–5.5 × 5 mm, testa strongly reticulate, mid-brown. 2n = 98 (Fernandez Piqueras & Ruiz Rejon 1976 & Palomeque Messia & Ruiz Rejon 1976), c. 96 (Talavera 1976), 36 (Fernandez Casas et al., 1978). Fig. 15.

Distribution. SW Spain. Map 8.

Ecology. Dry mountain pastures, field margins, track sides in limestone-derived terra rossa soils; alt. 300–1100 m.

Etymology. Originating from Carratraca in south-western Spain, the town closest to the type locality.

Map 8. Distribution of *Biarum carratracense* ★ and *Biarum mendax* ☆.

14. BIARUM KOTSCHYI

Due to Engler's misidentification of the type material as *Biarum bovei*, *B. kotschyi* has only recently been accepted as being a distinct species. *Biarum kotschyi* could 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. The rather slender spathe limb, fusiform spadix appendix and the arrangement of the staminodes is similar in both species. 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 their distinct geographical distributions.

Biarum kotschyi is a common species in parts of south-eastern Turkey and a search of a dry hillside will usually reveal this species. In light of this it might appear strange that Mill (1984) omitted *B. kotschyi* from the *Flora of Turkey* account were it not for the fact that almost all herbarium material of this species has hitherto been annotated as *B. bovei*.

Once again, Schott's citation of the type locality 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 southeastern Turkey.

14. Biarum kotschyi (Schott) B. Mathew ex H.Riedl in Aroideana 3(1): 28 (1980) ("*kotshcyi*").

Ischarum kotschyi Schott, Syn. Aroid. 7 (1856). Type: (Turkey?) Eastern Lebanon, *Kotschy s.n.* (holotype W destroyed; lectotype W). Schott's Icones Aroideae no. 2151. There are four Icones present in Vienna (nos 2150–2154) and a single reliquiae (no. 366). The Icon selected as the lectotype is by far the most informative plate.

DESCRIPTION. *Tuber* slightly dorso-ventrally compressed-discoid to ± globose-discoid, 2–5 cm in diam., 1–1.2 cm thick, pale brown. *Leaves* 5–15, hysteranthous, distinctly petiolate, bases encased by 3–6, 6–9 × 1.5–2 cm elliptic lanceolate, sub-fleshy, later papery, cataphylls, these pale greenish white at first, pale straw-yellow on drying; *petiole* 5–9(–22) cm × 4–5 mm, adaxial surface channeled and winged distally, slightly expanded into a wing proximally; *leaf lamina* elliptic to lanceolate-elliptic, rarely oblanceolate, 6–9.5 × 2.5–4 cm, apex sub-acute, base short-decurrent, c. 5–6 primary lateral veins on each side, margins smooth, lamina dull mid-green. *Inflorescence* appearing

Plate 612 *Biarum kotschyi* ANN FARRER

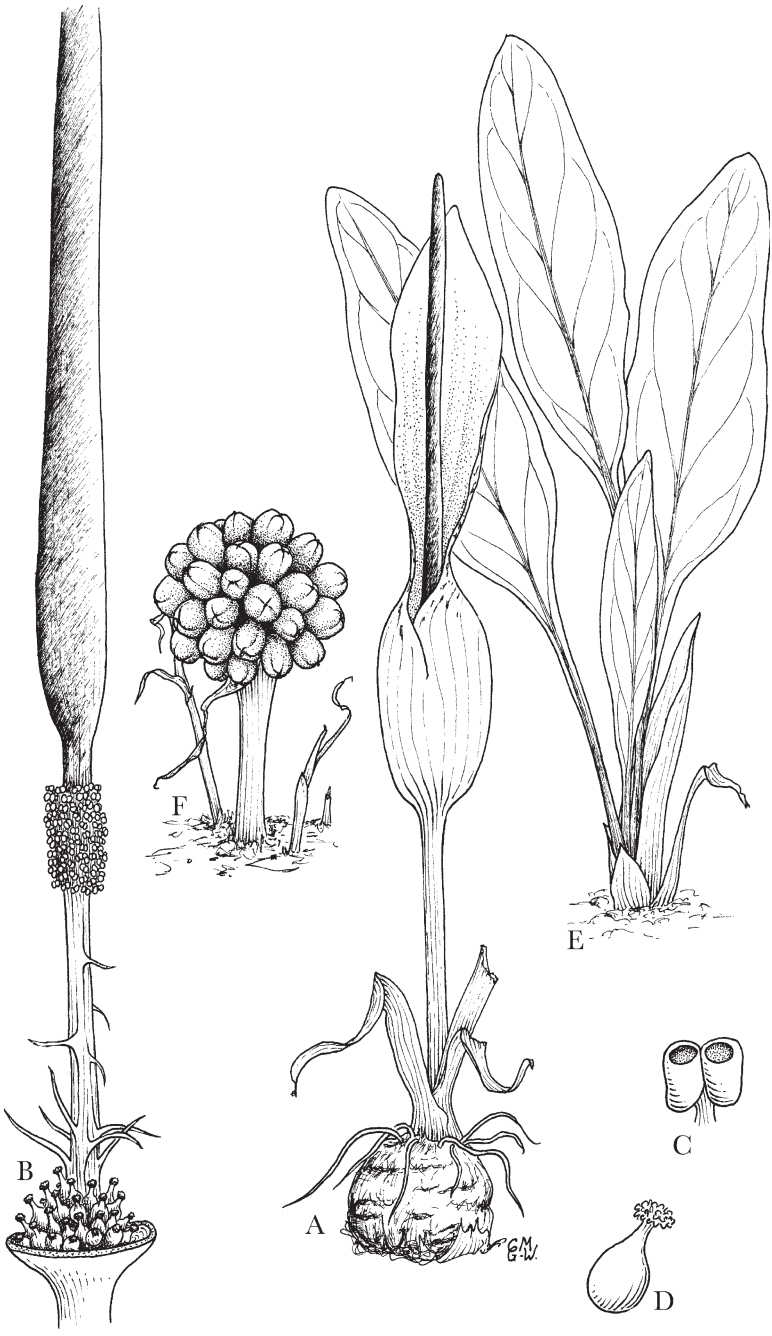
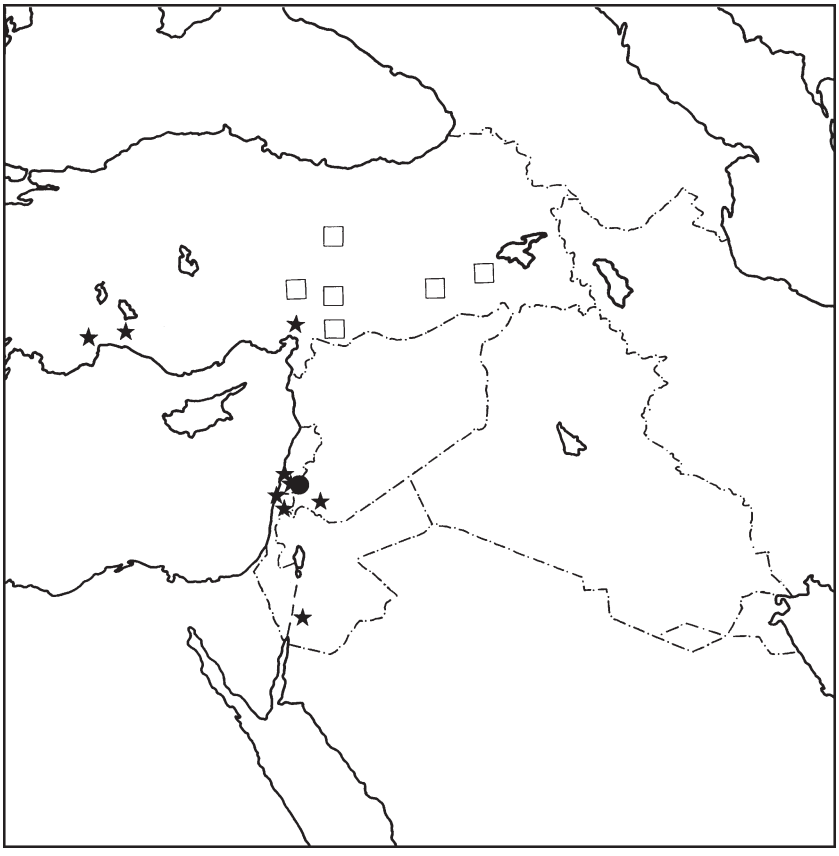


Fig. 16. **Biarum kotschyi**. A, flowering habit, × 0.6 from *Munby* 1856; B, spadix, × 2; C, stamen, × 6; D, ovary, × 6, all from *Baytop & Mathew* 14; E, leaves, × 0.6 from *Mathew & Tomlinson* 4101; F, fruiting habit, × 0.6, from cultivated specimen. Drawn by Christine Grey-Wilson from material at K.

in late autumn, smelling pungently of horse dung; peduncle 3–6(–17.5) cm × 4–6 mm, pale green to dirty white. *Spathe* 8.5–10 (–15) cm long; spathe limb lanceolate, 5.5–11 × 2–3.5 cm, apex acute, exterior pale dirty green with numerous small pale purple speckles and some purple staining, especially towards the margin, interior deep purple; spathe tube oblong, slightly inflated, 3–4.5 × 1.5–2.5 cm, margins connate for c. ¼ of their length, exterior white with some purple staining basally and apically, interior white stained purple at the base and apex. *Spadix* c. ¾ as long as, to just exceeding the spathe limb, 8–13 cm long; appendix ± sessile, slender-fusiform, 5–9 cm × 2.5–4.5 mm wide, deep purple. *Staminate flowers* in a zone 9–12 × 3–4.5 mm wide, anthers cream, tinged purple apically. *Interstice* 1.75–2.5 cm × 2 mm wide, purple. *Staminodes* arranged at the base of the interstice, directly above the pistillate flowers, filaments 3–6 mm long, purple. *Pistillate flowers* in a hemispherical cluster 12–15 × 7–9 mm; ovaries bottle-shaped, 1–1.5 × 0.75–1



Map 7. Distribution of *Biarum kotschyi* □; *Biarum pyrami*, var. *pyrami* ★; var. *serotinum* ●.

Biarum kotschyi, Mathew ISTE27 flowering in Turkey. Photograph Brian Mathew.

mm, cream, stained purple, style c. 0.5 × 0.15 mm, purple, stigma capitate, c. 0.33 mm in diam., purple. *Infructescence* globose, c. 3–4.5 cm in diam., consisting of c. 40 berries; berries oblong-ovoid, c. 5–6 × 4–5 mm wide, pale purple with darker staining when ripe; seed globose, c. 4 mm in diam., strongly reticulate. 2n not recorded. Fig. 16.

DISTRIBUTION. SE Turkey, vilayets of Bitlis, Diyarbakir, Urfa and Gaziantep and Maraş. Map 7.

ECOLOGY. Dry clay-loam hillslopes, stony plateaux, long-fallow fields. Alt. 600–2000 m.

ETYMOLOGY. Described after the Austrian botanist Theodor Kotschy (1813–1866).

15. BIARUM FRAASIANUM

Until recently *Biarum fraasianum* was a species for which very little material was available for study. The Fraas' type collection was at Berlin and a search of the herbarium did not locate the material and it must be assumed it was among the material destroyed in the Second World War. Only two other contemporary herbarium collections of *B. fraasianum* exist. One of these, held at the Natural History Museum (BM), consists of a tuber, leaves and a semi-mature infructescence. The other, in Patras University Herbarium (UPA), is a flowering specimen. The type material was used to prepare two illustrations held in the Naturhistorisches Museum, Vienna (W).

The recent recollection of *B. fraasianum* has revealed numerous hitherto unknown characteristics, including spring flowering and a sweet smell at anthesis. The latter is particularly uncommon in *Biarum*, shared only with *B. davisii* and *B. marmarisense*.

The report of a chromosome count for *B. fraasianum* of 2n = 32 (Popova & Ceschmedjiev 1978) must be regarded as probably based on a misidentified plant. Nevertheless the Popova and Ceschmedjiev count is intriguing in that it is different from any species that might conceivably be misidentified as *B. fraasianum*.

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

Plate 613 *Biarum fraasianum* ANN FARRER

the greater overall similarity to *B. kotschyi* leads me to suspect that the closest relationship lies with the latter species.

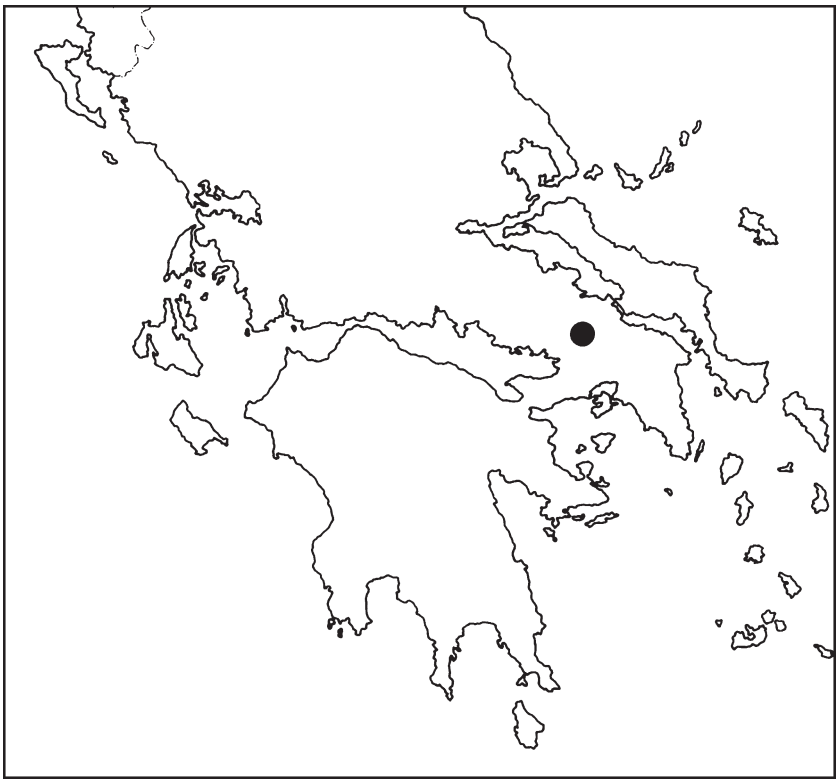
15. Biarum fraasianum (Schott) Nyman, Syll. Fl. Europ. suppl.: 68 (1865); Brown in Journ. Linn. Soc. 18: 254 (1881); Engler in Das Pflanzenr. 73 (IV.23F): 139 (1920).

Ischarum fraasianum Schott in Oesterr. Bot. Zeit. 9: 98 (1859). Type: Greece, in campis Thebaicis, *Fraas s.n.* (holotype B destroyed; lectotype W, Schott's Icones Aroideae no. 2147) There are two illustrations of this species in Vienna (Reliquiae 367 & Icones 2147). They are essentially the same illustration arranged in different ways. Nevertheless, the Icones 2147 is annotated '*Arum* 4 in campis Thebaicis (Gr.) comm. & coll. Fraas! Herb. Sartorii'.

Biarum fraasianum (Schott) N.E. Br. in Journ. Linn. Soc. 18: 254 (1881), *comb. superfl.*

Description. *Tuber* compressed discoid 4 × 2 cm, with few offsets, pale brown, older tubers with conspicuous, concentric brown rings. *Leaves* 13–20 cm, hysteranthous, long-petiolate, petioles clasping basally, enclosed by few, c. 3 cm × 2–4 mm linear-triangular to lanceolate pale brownish-cream papery cataphylls; *petiole* 7–9 cm × c. 2 mm; *leaf lamina* oblong to oblanceolate, 6–9 × 1.5–4 cm, apex obtuse to sub-acute, base short to long decurrent, c. 6 primary lateral veins per side, margins smooth, lamina mid-green. *Inflorescence* appearing in spring, smelling strongly of overripe fruit; peduncle c. 4–6 cm × 5–6 mm, swollen apically in fruit to c. 1 cm, clothed, together with the base of the spathe, by several 6–10 × 1.5–2 cm broadly linear cataphylls. *Spathe* 13–24 cm long; spathe limb ovate-lanceolate to oblong, 10–20 × 4–6 cm, shortly cuspidate, exterior greenish purple, interior dark brownish purple, upper part of spathe tinged green; spathe tube subcylindric, 3–4 × 1.5–2.5 cm, margins fused for ¾ their length, exterior whitish, tinged apically green and purplish brown, interior white above, deep purple below. *Spadix* approximately half as long as the spathe limb, 7.5–12 cm long; appendix briefly stiptate, fusiform, 4.5–10 cm × 4–7 mm, greenish purple-brown, stipe and base of appendix paler. *Staminate flowers* in a zone c. 15 × 4 mm, cream, slight stained purple towards the tips. *Interstice* 16–25 × 2–3 mm, white. *Staminodes* sparse, arranged mostly directly above the pistillate flowers, but with one or two scattered on the upper portion of the interstice; filaments slender, c. 4 mm long, white. *Pistillate flowers* in a hemispherical cluster 10–13 × 3–6 mm; ovaries bottle-shaped, c. 1.5 × 0.5 mm wide, green, style c. 0.5 × 0.15 mm, flushed purple, stigma globose, c. 0.25 mm in diam. *Infructescense* hemispherical, 2.5 × 1 cm, consisting of c. 30 fruits, berries pyrifrom-globose, c. 4 × 4 mm, pale silvery purple, stylar portion purple, stigmatic remains prominent, c. 1 × 0.5 mm; seeds globose, c. 3 mm in diam., pale brown, somewhat reticulate. 2n = 36 (Popova & Ceschmedjiev 1978) but see note below.

Distribution. Long thought to be restricted to the type locality, where extensive urban and agricultural development has almost certainly extin-



Map 6. Distribution of *Biarum fraasianum* ●.

guished most populations, *B. fraasianum* has recently been recollected in the Peloponnese by amateur bulb enthusiast Mike Salmon. Map 6.

ECOLOGY. Stony terra rossa soils derived from limestone. Alt. 50–260 m.

ETYMOLOGY. The species is named in honour of Carl Nicholaus Fraas (1810–1875), collector of the material used to describe the species.

16. BIARUM PYRAMI

This large, showy species is perhaps the most readily distinguishable of the autumn flowering *Biarum* species due to the globose, strongly inflated, spathe tube, large spathe and greatly attenuated spadix appendix. The bullate leaves of the typical variety 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 all readily distinguishable from one another.

Variety *serotinum* is maintained here with some reluctance. There is no denying that some Israeli material of *B. pyrami* is rather distinct from that of Turkish and Syrian origin. The lack of leaf bullae, used as one of the distinguishing characters for var. *serotinum*, is generally a stable character; however, the *Davis* 3844 collection from Israel cited above lacks leaf bullae although phenologically and ecologically it is clearly referable to var. *pyrami*, and the two varieties are apparently ecologically different. The floral characters used to distinguish var. *serotinum* seem less reliable, especially with regard to the flowering period on which Koach and Feinbrun laid great emphasis. Elsewhere in *Biarum*, phenology has proved to be variable, with some species (e.g. *B. straussii* and *B. syriacum*) displaying a rigid flowering cycle while others (e.g. *B. tenuifolium* and *B. arundanum*) have a wide degree of variability even in single populations.

The plant described as *Ischarum nobile* by Schott (1860) has been suggested by some authors (e.g. Mill 1984) as possibly representing a distinct species. Although the type material is no longer extant, the painting in Vienna (Schott's *Icones Aroideae* no. 2155) that serves as the type of *I. nobile* suggests that it is conspecific with *B. pyrami*. The illustrations of *I. nobile* and *I. pyrami* (Schott's *Icones Aroideae* no. 2161) are very similar. Apart from the slightly less inflated spathe tube and rather sparser pistillodes, the two illustrations almost certainly depict the same species.

16. Biarum pyrami (Schott) Engler in A. & C. DC., Monog. Phanerog. 2: 576 (1879) & in Engler, Pflanzenr. 73(IV.23F): 139 (1920); Koach & Feinbrun in Feinbrun, Fl. Palaestina 4: 337 (1984); Koach in Rotem 26 t.15,16 (1988). Type: "Juxta arcem Semeramidis [plantae ad Pyramum (Çeyhan river) in monte Nur lectae: inter Messis (Misis) et castellum Scheih Meran (Yilankale), 60 m]", *Kotschy s.n.* (holotype W destroyed, isotypes G (sterile fragments)). Since isotypes exist, albeit fragmentary, it is not possible to select a lectotype for *Ischarum pyrami* other than from this material (Art. 7.4, ICBN Code). This, due to the condition of the specimens, is a pointless exercise. Nevertheless, it is useful to have a fixed point on which to base an interpretation of the name *pyrami* and for this purpose I epitypified the Schott Illustration, *Icones Aroideae* no. 2161 in Vienna; it is ideal since it is annotated with the same data as the isotypic fragments in Geneva. As pointed out by Mill (1984) the locality cited in Schott's *Prodromus Systematis Aroidearum* (1860) is almost certainly wrong. The fragmentary isotype specimens in Geneva are annotated 'Messis

et Scheih Meran' and do not carry the data cited by Schott in the protologue.

Ischarum pyrami Schott, Prodr. Syst. Aroid. 66 (1860).

I. nobile Schott, Prodr. Syst. Aroid. 66 (1860). Type (Turkey) "juxta arcem Semiramidis," cult. Schoenbrunn, *Kotschy* s.n. (holotype W destroyed; lectotype W (Schott's Icones Aroideae no. 2157)). Of the plates present in Vienna, the one chosen bears the same data as given in the protologue and is thus the logical choice for the lectotype. The same confusion with localities detailed under *B. pyrami* apply to *I. nobile*.

DESCRIPTION. *Tuber* globose-discoid 2–4 × 2–2.5 cm, mid-brown. *Leaves* hysteranthous (var. *pyrami*) or synanthous (var. *serotinum*), long-petiolate, encased basally by numerous (2–)7–13 × 0.5–2 cm elliptic-lanceolate sub-fleshy, later papery, cataphylls, these pale greenish, occasionally with faint purple spots externally at first, later pale straw-yellow; petiole 8–16 cm × 2.5–4.5 mm, margins slightly winged, adaxial surface channeled distally, expanded proximally into broad membranous wing, mid-green; leaf lamina oblong-elliptic to ovate-elliptic, 6–18 × 3–8 cm, apex subacute to slightly rounded, base briefly decurrent to rounded, occasionally sub-truncate, c. 9–10 primary lateral veins per side, margins flat, occasionally crispulate, leaf lamina deep green, with black-purple or green bullae (var. *pyrami*) or smooth (var. *serotinum*). *Inflorescence* appearing in late autumn (var. *pyrami*) or early winter (var. *serotinum*), smelling strongly foetid of cattle dung and carrion; peduncle 4–7 cm × 3–4 mm, off white. *Spathe* 10–25 cm long; spathe limb lanceolate, (7–)15–18.5 × 2–3.5 cm, long-acuminate, erect at first but soon reflexing and coiling, exterior mid-green stained and spotted purple-brown, especially towards the margins (var. *pyrami*) or unspotted (var. *serotinum*), interior deep purple brown, sometimes with paler speckling along the middle and towards the apex; spathe tube globose, ventricose, 3–4 × 2.5–3.5 cm, margins connate for a ¼ of their length, exterior whitish below ground, purple-brown above, interior dark purple. *Spadix* equalling to slightly exceeding the spathe limb, 9–26 cm long; spadix appendix cylindric-fusiform 5.7–22 cm × (3–) 5–9 mm, deep purple-brown. *Staminate flowers* in a zone 10–15 × 5–6 mm, anthers purple. *Interstice* 14–16 × 2–3.5 mm, deep purple, rarely dull creamy yellow. *Pistillodes* in a zone 5–10 mm long at the base of the interstice, sparse; bases slightly swollen, purple; bristles filiform, flattened distally, 5–7 mm long, cream, sometimes flushed deep purple. *Pistillate flowers* in a hemispherical cluster c. 10 × 3–5 mm high, ovaries bottle-shaped, 1.5–2 × 1–1.25 mm, deep purple, paler below, style c. 1.5 × 0.33 mm, purple, stigma sub-capitate, c. 0.50 mm in diam., white. *Infructescence* globose, 2–3 cm in diam., consisting of c. 50 berries; berries oblong-pyriform, 7–10 × 5–6 mm, silvery-lilac, stained purple proximally, seed sub-turbinate, 5–6 × 4–5 mm wide, testa reticulate, dark brown.

a. var. pyrami

DESCRIPTION. *Leaves* hysteranthous, bullate. *Inflorescence* appearing in late autumn. *Spathe limb* exterior mid-green, stained and spotted purple-brown. Chromosome number not recorded. Fig. 17.

Plate 614 *Biarum pyrami* var. *pyrami* ANN FARRER

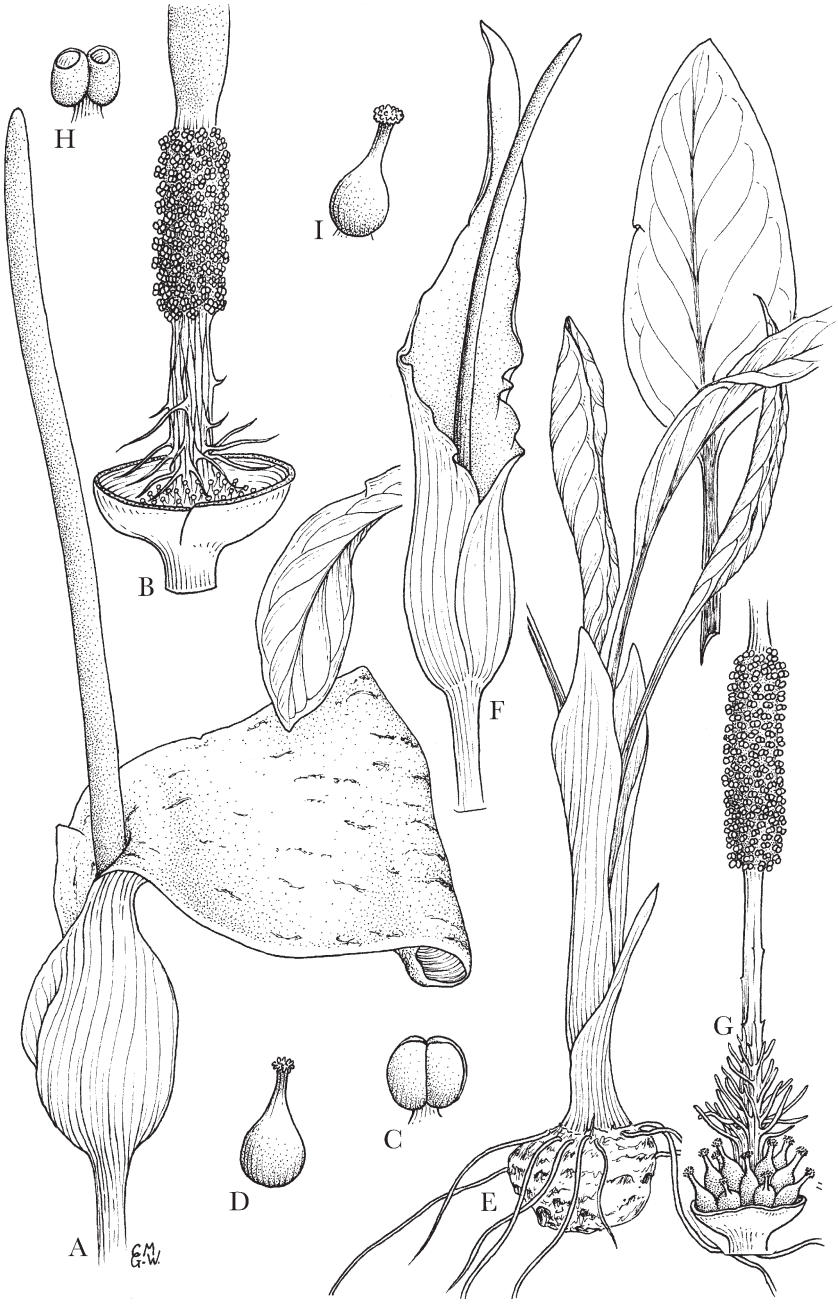


Fig. 17. **Biarum pyrami** var. **pyrami**. A, inflorescence, × 0.6; B, spadix, × 2; C, anther, × 6; D, ovary, × 4, all from Kew spirit coll.; E, habit of leaves and tuber, × 0.6, from *Davis* 3844: var. **serotinum**. F, inflorescence, × 0.6; G, spadix, × 2; H, ovary, × 4; I, anther, × 8, from *Feinbrun* 79. Drawn by Christine Grey-Wilson from material at K.

DISTRIBUTION. SW and central S Turkey, Syria, Lebanon, Jordan and Israel. Map 7, p. 90.

ECOLOGY. Garrigue or low maquis on terra rossa soils derived from limestone, limestone hill slopes, amongst loose stones or in disused fields. Alt. 30–450 m.

ETYMOLOGY. Named after Pyramus, the ancient name for the Çeyhan River in southern Turkey, the type locality.

b. var. serotinum Koach & Feinbrun in Feinbrun, Fl. Palaestina 4: 398 (1986). Type: Israel, Golan, near Katsrin, hills, basalt rocks and soil, 22 December 1979, *Heiman 79* (holotype HUJ).

DESCRIPTION. *Leaves* synanthous, lacking bullae. *Inflorescence* appearing in late winter. *Spathe limb* exterior concolorous mid-green. Chromosome number not recorded. Fig. 17.

DISTRIBUTION. Israel. Map 7, p. 90.

ECOLOGY. Hillslopes in soils derived from basalt rocks. Alt. 60 m.

ETYMOLOGY. From the Latin *serotinus* (late-coming), in allusion to the winter flowering of this variety.

17. BIARUM MENDAX

In herbaria, *Biarum mendax* has been 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* is bears the largest infloresence yet recorded in *Biarum*. From all three species it can be distinguished by the 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 in the inflated lower spathe.

17. Biarum mendax P.C. Boyce, Aroideana 22: 90 (1999). Type: Spain. Badajoz: Between Hobrón and Solana des los Barros, 15 October 1976, *Cabezudo et al.* 2201/76 (holotype SEV 25005; isotypes G, K).

DESCRIPTION. *Tuber* globose-discoid, 4 × 3.5 cm, mid-brown. *Leaves* not seen. *Inflorescence* appearing in late summer to autumn. *Peduncle* 12 cm × 5 mm, clothed by few to many 5–13 cm × 7–15 mm papery, pale yellowish white cataphylls. *Spathe* 16–24 cm long; *spathe limb* lanceolate, 18–20 cm × 15–18 mm, apex long acuminate, exterior green ± heavily blotched and stained purple-brown, interior deep purple-brown; *spathe tube* globose, strongly inflated, 4–5 × c. 3 cm wide, margins fused for their entire length, exterior pale green stained purple-brown especially towards the opening, interior off-white distally, deep purple proximally. *Spadix* sub-equal to exceeding the spathe limb, 16–21 cm long; *spadix appendix* slender fusiform-cylindric, 14–16 cm × 6–8 mm, deep

purple-brown. *Staminate flowers* in a zone 11–13 × 6–9 mm, deep purple. *Interstice* 23–25 × 5–6 mm, deep purple. *Staminodes* situated at the base of the interstice, few, filiform, 5–14 mm long, deep purple. *Pistillate flowers* in a hemispherical cluster 4–5 × 7–13 mm wide; ovary 2–3 mm long, cream; style 1 × 0.33 mm, purple, stigma capitate, c. 0.5 mm in diam., purple. *Infructescence* not seen. 2n not recorded.

DISTRIBUTION. SW Spain. Map 8, p. 85.

ECOLOGY. Rocky hill slopes on limestone-derived terra rossa. Alt. 50–75 m.

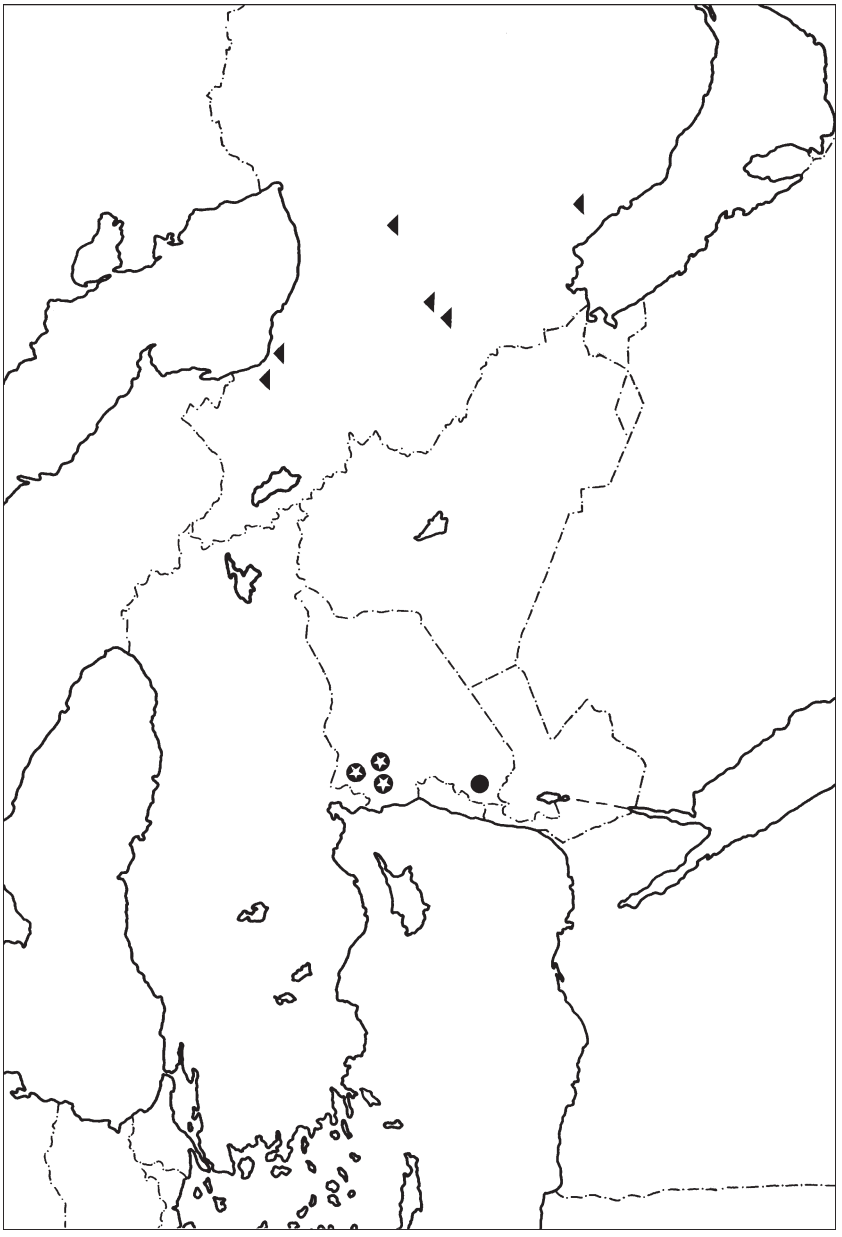
ETYMOLOGY. From the latin *mendax*, deceitful, in allusion to the similarity in the dried state between the new species, *B. bovei* and *B. dispar* which has resulted in it being hitherto overlooked.

18. BIARUM AURANITICUM

Biarum auraniticum is unique in possessing a white spathe limb. There is no doubt that this is a most singular species, not only from the inflorescence coloration but also because of the remarkably wide bottle-shaped ovaries. The odd inflorescence coloration and unusual appearance of the ovaries make it difficult to envisage a close relationship. The lack of pistillodes, the ovate-elliptic, long-petiolate leaves and slightly inflated spathe tube support a link to *B. bovei* or *B. kotschyi*.

18. Biarum auraniticum Mouterde, Nouv. Fl. du Liban et Syrie 1: 193 (1966). Type: Syria, tel près du Zraikiyé, au nord de Sanamein, December 1954, *Pabot* 326 (holotype G!; isotypes G!, K! (photograph)).
[*Biarum luteum* Pabot, *in sched. nom. nud.*]

DESCRIPTION. *Tuber* slightly dorso-ventrally compressed discoid, 2–3 × 1.5–2 cm, mid-brown. *Leaves* 2–3, hysteranthous, short to rather long-petiolate, bases encased by 2–3, 6–12 cm × 7.5–20 mm, lanceolate, papery, cataphylls, these pale straw-yellow on drying; *petiole* 7–12 cm × 2–10 mm, adaxial surface slightly channeled distally, outer petioles expanded proximally into a broad membranaceous wing, inner ± the same width for their whole length, mid-green, paler below; *leaf lamina* elliptic, 4–8 cm long, 2–4.5 cm wide, apex rounded to sub-acute, base decurrent, 6–8 primary lateral veins per side, margins smooth, lamina mid- green. *Inflorescence* emerging in winter, peduncle 2-5 cm × 3-4 mm, off-white, intensely foul smelling of horse dung; spathe 8.5–17 cm long; spathe limb lanceolate to narrowly lanceolate, 9–13 × 1–3 cm, apex acute to rather acuminate, exterior greenish white, interior paler; spathe tube narrowly cylindric, wider at the mouth, slightly inflated in the mid-region, 2–3 cm × 8–13 mm, margins connate for c. 1/3 their length, exterior pale green, interior pale green distally, deep purple proximally. *Spadix* sub-equal to shorter than the spathe limb, 7.5–14 cm long; spadix appendix



Map 9. Distribution of *Biarum syriacum* ✪; *Biarum auraniticum* ●; *Biarum straussii* ▲.

Fig. 18. **Biarum auraniticum**. A, flowering habit, × 0.6; B, spadix, × 2; C, stamen, × 12; D, ovary, × 6; E, fruiting habit, × 0.6, all from *Pabot* 51-58. Drawn by Christine Grey-Wilson from material at K.

slender fusiform to fusiform, 5.5–10.2 cm × 2–7 mm, sub-sessile to briefly stipitate, yellow. *Staminate flowers* in a zone 18–22 × 3–3.25 mm wide, cream. *Interstice* 8–11 × c. 1.5 mm in wide, cream. *Staminodes* absent. *Pistillate flowers* in a hemispherical cluster 3–5 × 6–8 mm; ovaries globose, 1.5 × 1.5 mm, cream, style c. 1 × 1.25 mm, purple, stigma c. 0.5 mm in diam., purple. *Infructescence* known only from immature material, consisting of c. 35 globose berries in a globose cluster; berries sub-globose, 2–3 × 1.5–3 mm, dull purple. *Seed* (immature) spherical, c. 2 mm in diam., testa reticulate, mid-brown. Chromosome number not recorded. Fig. 18.

DISTRIBUTION. SW Syria, known only from the type locality. Map 9.

ECOLOGY. Open hillslopes and fields in stiff clay-like volcanic soils.

ETYMOLOGY. Named after the ancient region of Aurantis in southern Syria, the town of Sanamein, close to the type locality, being in this area.

19. BIARUM DITSCHIANUM

Biarum ditschianum was first collected in spring 1987 in southwestern Turkey by Friedrich Ditsch, then a student at Bonn University, Germany. A single tuber was grown on at Bonn by him and flowered in May that year. Unfortunately the plant died soon after flowering and no voucher specimen was preserved. However, colour photographs of the plant were made. Attempts to recollect the species in October 1987 failed but in April 1988 Manfred Koenen of the Bonn Botanical Garden succeeded in recollecting it. Plants flowered at Bonn in May 1988. Herbarium and spirit specimens were made and used to prepare a description of the plant (Bogner & Boyce, 1989).

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. Three other *Biarum* species have unusual inflorescences. *Biarum davisii* and *B. marmarisense* (Turrill, 1938; Boyce, 1987) have pinkish white spathes, a purple spadix appendix and produces a sweet, not foul, odour at anthesis. *Biarum auraniticum* (Mouterde, 1966) has a greenish white spathe and a yellow spadix, and smells of horse dung. All three 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 hair-like processes on the base of the spadix appendix. Such

Biarum ditschianum. Inflorescence and fruit, approx. life size. Photograph Manfred Koenen.

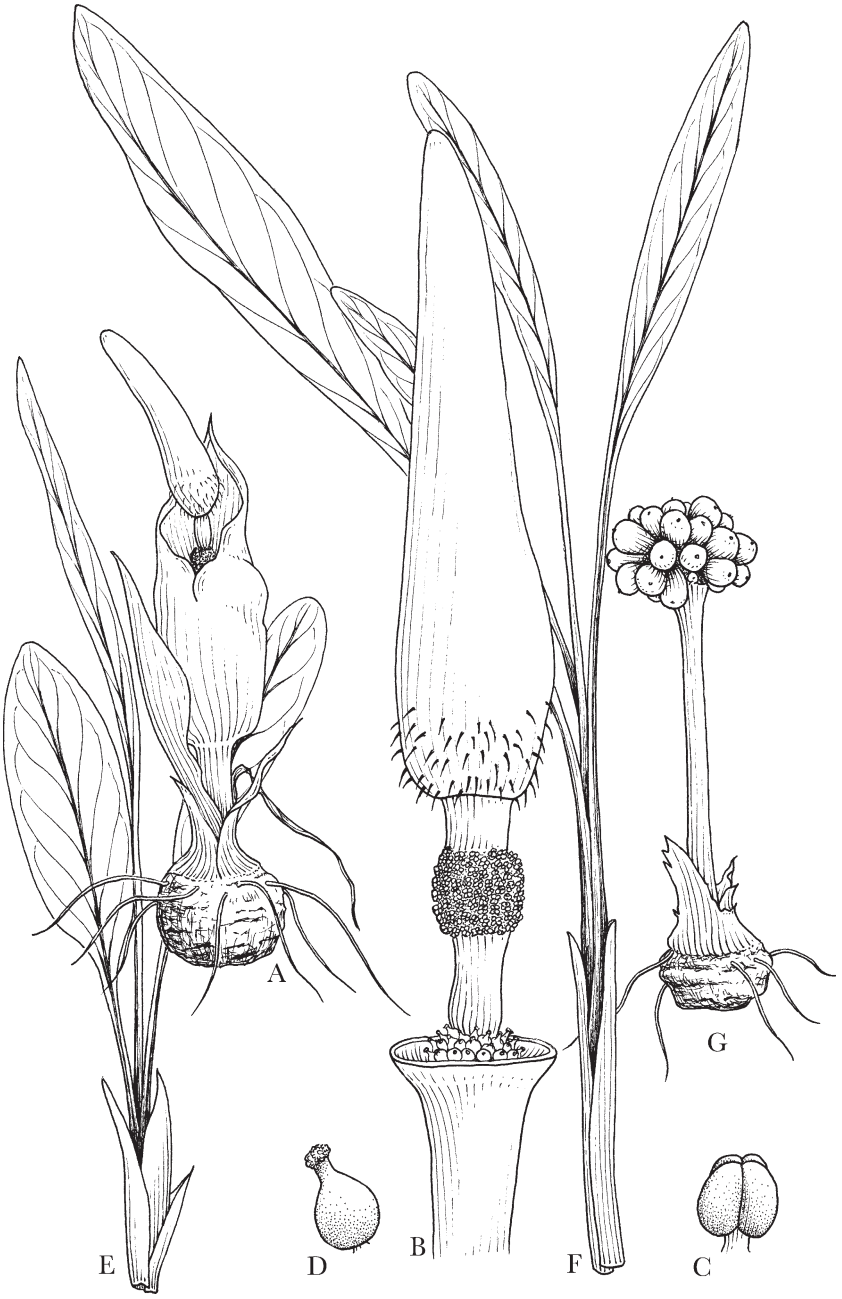


Fig. 19. **Biarum ditschianum**. A, flowering habit, × 0.6; B, spadix, × 2, both from *Koenen* Bonn acc. no. 22592; C, ovary, × 12; D, anther, × 7, both from a photograph; E, young leaves, × 0.6; F, older leaves × 0.6, G, fruiting habit, × 0.6, all from Koenen Bonn acc. no. 22592. Drawn by Christine Grey-Wilson.

Biarum ditschianum. Plants in habitat in Antalya, Turkey. Photographs Manfred Koenen.

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 inflorescence of *B. ditschianum* is also notable for being exceptionally foul smelling and produces a powerful odour of carrion and excrement which attracts carrion flies. Experiments undertaken in Bonn have shown that the spadix appendix absorbs UV light, suggesting that it contrasts well against the surrounding limestone in habitat. Carrion flies are known to perceive mainly UV light and it is possible that the appendix is the most visible part of the inflorescence to this type of fly.

19. Biarum ditschianum Bogner & Boyce in Willdenowia 18(2): 409 (1989). Type: Turkey, Antalya, Xanthos hill; in holes and crevices in limestone, 30 m, 24 April 1988, *Koenen* Bonn 22592 (holotype K; isotypes B, BONN, K, M). Boyce, Peter in Curtis's Botanical Magazine t.275 (1995).

Description. *Tuber* depressed-globular to sub-globular, 2.5–3 × 1.5–2 cm, light brown. *Roots* 1.4–2 mm in diam. *Leaves* 2–3, rarely up to 5, hysteranthous, long petiolate, bases partly encased by several 5–10 cm long, membranaceous, whitish cataphylls; *petiole* 8–20 cm × 1.5–3 mm, channelled, laterally compressed, mid-green, sometimes reddish tinged distally; *leaf lamina* oblanceolate early in the season, subsequent leaves linear, narrowly-elliptic or lanceolate, 6–15(–20) × 0.6–3(–3.5) cm, base cuneate, decurrent, apex acute to obtuse, 4–7 primary lateral veins on each side, leaf lamina mid-green, veins paler. *Inflorescence* appearing in spring, smelling strongly foetid, base enclosed by 5–6 cataphylls, these at first membranaceous, whitish, soon withering to become papery and brown, 1.5–6(–7) × c. 1.5 cm, the longest equalling the spathe. *Peduncle* subterranean, 2–5 cm × 3.5–5 mm, whitish. *Spathe* 4–5 cm long; *spathe limb* much reduced, 1.8–2 × c. 2 cm, sub-triangular, terminating in a c. 2 mm mucro, exterior greenish to light green, sometimes with a reddish tinge, interior purplish-red; *spathe tube* c. 3 × 1.8–2 cm, margins connate proximally for c. 2.5 cm, exterior whitish, sometimes slightly reddish tinged, interior reddish purple. *Spadix* exceeding the spathe, 7–8 cm long; *spadix appendix* elongate-conoid to somewhat sub-cylindric, shortly stipitate, 4–4.5 cm × 7–11 mm, apex obtuse, base rounded, the basal 7–10 mm furnished with reflexed, filiform, acuminate, 1–2.5 × 0.1–0.25 mm, transparent white 'hairs', appendix dark yellow except for the reddish purple basal 7–10 mm; stipe 5–6 × 3–4 mm, cream. *Staminate* flowers arranged in an oblong zone 5–6 × 7–9mm, stamens sub-sessile, yellow proximally, purple-red distally, occasionally entirely yellow. *Pollen* extruded in strands. *Interstice* 1.3–3.5 cm × 2.5–3.5(– 4) mm, light purple, fading to creamy white apically purple. *Staminodes* absent. *Pistillate flowers* arranged in a 2–2.5 mm high hemispherical cluster; ovary bottle-shaped, c. 1 mm in diam., purplish red, occasionally pale cream, styles and stigmas curved outwards, style 1.2–1.3 × c. 0.4 m, purplish, colour intensifying towards

Biarum ditschianum. Habitat in Antalya, Turkey. Photographs Manfred Koenen.

the ovary, occasionally cream, stigma sub-capitate, 0.6–0.5 mm in diam., yellow. *Infructescence* depressed-globular, 3–3.5 × c. 2 cm, consisting of c. 50 berries; berries obovoid, 6–10 × 4–7 mm, whitish, sometimes with a very slight reddish tinge proximally. *Seed* obovoid, 5.5–7.5 × 4–5.5 mm; testa with the upper part very slightly irregular-reticulate, lower part smooth. 2n = 26 (Petersen 1989). Fig. 19.

DISTRIBUTION. SW Turkey. Map 10, p. 125.

ECOLOGY. Low to middle-height garrigue, partly loam-filled chimneys or crevices in limestone; alt. 30–120 m.

ETYMOLOGY. Named in honour of Friedrich Ditsch, the original discoverer of the species.

20. BIARUM DAVISII

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

Riedl's (1980b) suggestion that *B. davisii* might eventually prove to be a subspecies of *B. olivieri* is highly improbable. The sessile stigmas, densely aggregated staminate flowers, rudimentary spathe limb, ovate to ovate-spathulate, long-petioled leaf blades and unique inflorescence colour are clearly very different to the states found in *B. olivieri*. Aside from these intrinsic floral and vegetative differences, the species occur in fundamentally different environments. *Biarum davisii* is a plant of limestone screes and terra rossa pockets on calcareous hillsides. *Biarum olivieri* occurs uniquely in consolidated sand and water-deposited silt in flat fields (pers. obs. & Koach (1988)).

The inflorescence colour and smell suggests that *B. davisii* has a different pollination syndrome from the remainder of the genus and *Biarum davisii* is visited by bees on Crete (Boyce per. obs.).

This species is widespread but rather local on Crete. Where it occurs it is often abundant, forming extensive colonies, however, the 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 the island. The Cretan populations of *B. davisii* are remarkably uniform, plants

Plate 615 *Biarum marmarisense* (left) & *B. davisii* (right). ANN FARRER

Biarum davisii wild in Crete. Photograph Brian Mathew.

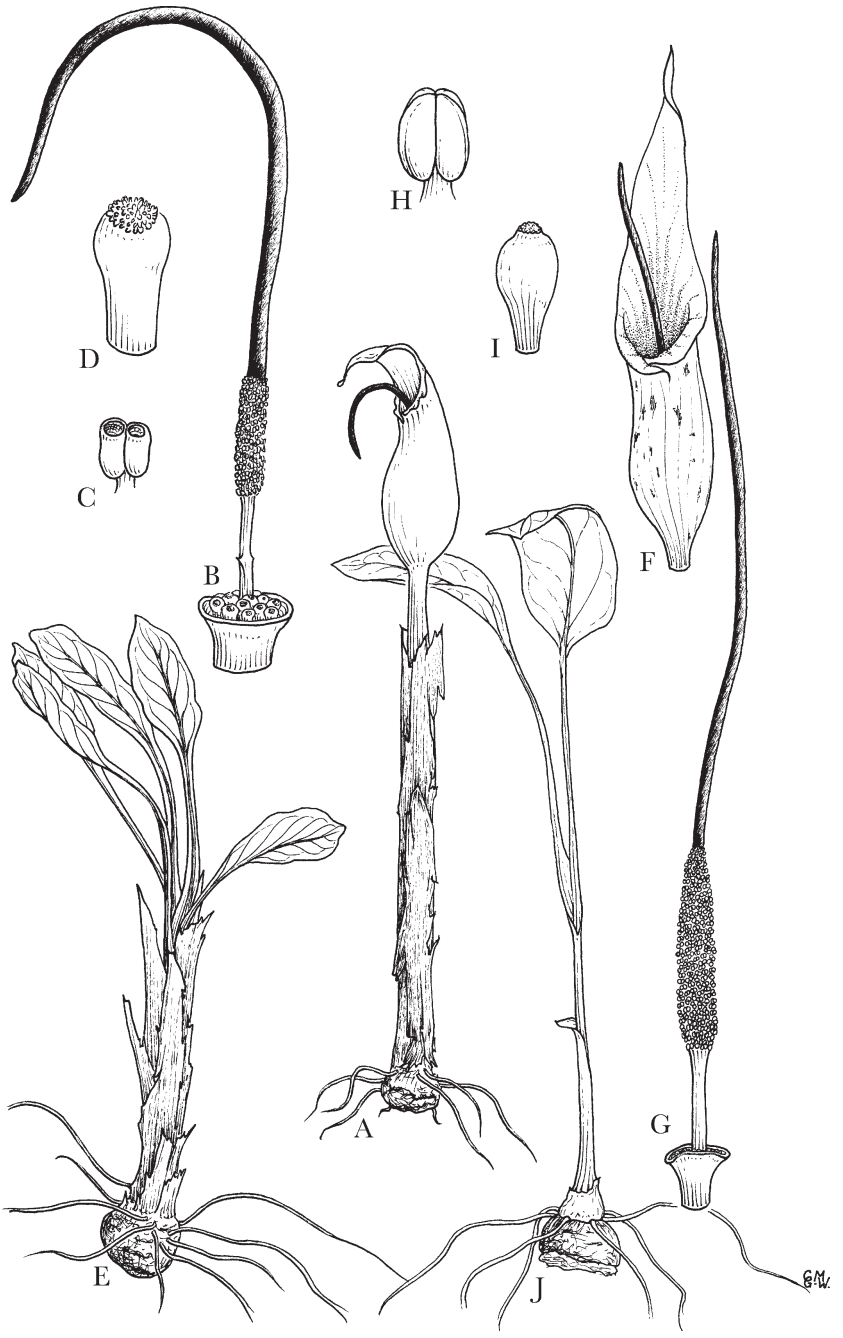


Fig. 20. **Biarum davisii**. A, flowering habit, × 0.6; B, spadix, × 2; C, anther, × 12; D, ovary, × 12, all from *Brickell & Mathew* 10,088; E, habit of leaves and tuber, × 0.6, from *Brickell & Mathew* 10,098. **Biarum marmarisense**. F, inflorescence, × 0.6; G, spadix, × 2; H, ovary, × 8; I, anther, × 12; J, habit of leaves and tuber, × 0.6, all from cultivated specimens. Drawn by Christine Grey-Wilson from material at K.

from opposite ends of the island being virtually indistinguishable morphologically.

20. Biarum davisii Turrill in Gard. Chron. ser.3, 104:437 (1938); Rix & Phillips, The Bulb Book 185 (1981). Type: Crete, above and north-east of Sphakia, amid rocks and amongst semi-scree, 23 April 1938, *Davis* 114 (holotype K; isotype E).

Description. *Tuber* globose to rather hemispherical, 1.5–3 × 1–2.5 cm. *Leaves* 5–9, hysteranthous, short petiolate, petiole bases encased by numerous linear-lanceolate cataphylls, these 3–4 cm × 7.5–10 mm; *petiole* 1.5–5 cm × 1–2 mm, pale to mid-green; *leaf lamina* ovate to ovate-spathulate, elliptic ovate or elliptic, 1.5–4 × 1–2 cm, apex obtuse to sub-acute, base cuneate, c. 3–5 primary lateral veins per side, margins smooth to somewhat crispulate, lamina mid to dark green, very occasionally spotted silver-grey. *Inflorescence* appearing in autumn, sweetly perfumed. *Peduncle* 2–7 cm × 3–5 mm, dirty white, clothed with numerous cataphylls. *Spathe* 5–6 cm long; *spathe limb* narrowly lanceolate, 2.5–3 cm × 5–7 mm wide, strongly cucullate, the margins recurved, apex acute, interior and exterior pale greenish white spotted and mottled pale purple; *spathe tube* ellipsoid, 2–3 cm × 1–2 cm wide, the margins fused for their entire length, interior and exterior pale greenish white ± mottled with pinkish brown, pale purple or purple-brown, the rim of opening stained brown or yellow. *Spadix* shorter than to sub-equal to the spathe, 3–5 cm long, appendix sessile, slender cylindric to filiform, 3–4 cm × 0.5–2.5, dull reddish brown, dark red to purple-red towards the apex. *Staminodes* absent. *Staminate flowers* in a cylindrical zone 8–10 × 2–3 mm, anthers cream. *Interstice* 5-11 × 0.5-2 mm, cream. *Staminodes* a few scattered vestigial filaments may be found on the interstice, usually above the pistillate flowers. *Pistillate flowers* in a hemispherical cluster 1–2.5 × 2–4 mm; ovaries oblong-ovoid, 1–1.25 × 0.5 mm, pale green, stigma sessile, sub-capitate, 0.25 mm in diam., pale green. *Infructescence* globose, 2–3 cm in diam., consisting of c. 30 berries; berries 3.5–4 × 3–4 mm, dirty white when ripe; seed ovoid, 3–4 mm in diam., testa slightly reticulate, pale brown. 2n = 26 (Petersen 1989). Fig. 20.

Distribution. Crete. Map 10.

Ecology. Open, grazed scrub, disturbed habitats, road and track margins in limestone-derived terra rossa and screes, often in terra rossa filled holes in limestone, clay soils, limestone pavement; alt. 0–1050 m.

Etymology. Named for Peter Davis (1918–1992), who collected the material used to described the species.

21. BIARUM MARMARISENSE

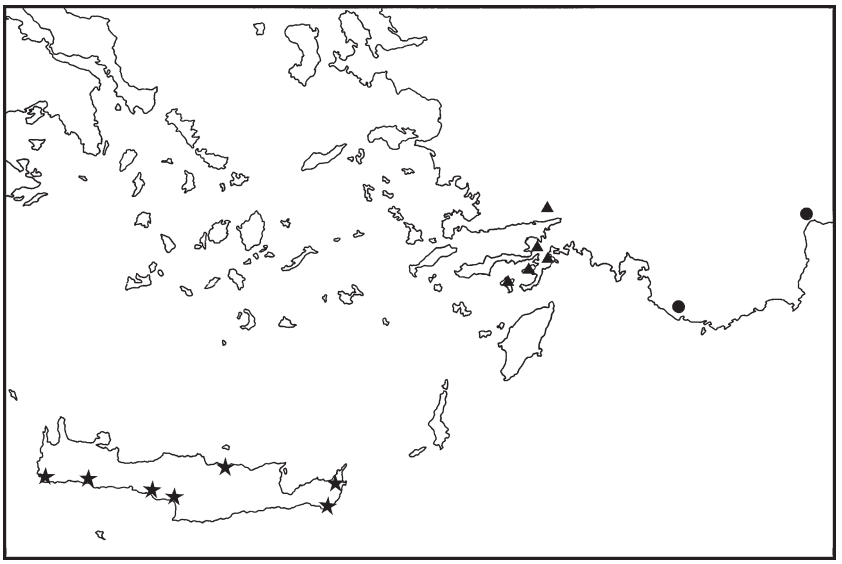
In an exhaustive study of *Biarum davisii*, Gill (1988) concluded that there were sufficient grounds for the recognition of the Simi population as a variety of *B. marmarisense*, using characters similar

to those used to distinguish *B. marmarisense* from *B. davisii*. My own view is that more research into the Turkish populations is required to evaluate the characters before such a move is made.

21. Biarum marmarisense (P.C. Boyce) P.C. Boyce in Aroideana 29: 34 (2006).

Biarum davisii subsp. *marmarisense* P.C. Boyce in Aroideana 10(4):14 (1987) ("*marmarisensis*"). Type: Turkey, Mugla, Marmaris, Bozburun, Taslica Köyü, *T. Baytop et al.* (holotype EGE (accession no. EGE 8796); isotypes E, K).

DESCRIPTION. *Tuber* globose to rather hemispherical, 1.5–3 × 1–2.5 cm. *Leaves* 5–9, hysteranthous, long petiolate, petiole bases encased by numerous linear-lanceolate cataphylls, these 3–9 cm × 7.5–15 mm; *petiole* 7–11 cm × 1–2.5 mm, pale to mid-green; *leaf lamina* ovate to ovate-spathulate, elliptic ovate or elliptic, 1.5–6.5 × 1–3 cm, apex obtuse to sub-acute, base cuneate to slightly cordate, c. 6–9 primary lateral veins per side, margins smooth to somewhat crispulate, lamina mid to dark green. *Inflorescence* appearing in autumn, strongly and sweetly scented. *Peduncle* 2–11 cm × 3–7 mm, dirty white, clothed with numerous cataphylls. *Spathe* 7–11 cm long; *spathe limb* narrowly lanceolate, 3–5 cm × 5–10 mm wide, strongly cucullate, the margins recurved, apex acute, interior and exterior pale greenish white spotted and mottled pale purple; *spathe tube* ellipsoid, 2–4.5 cm × 1–2.25 cm wide, the margins fused for their entire length, interior and exterior pale greenish white ± mottled with pinkish



Map 10. Distribution of *Biarum davisii* ★; *Biarum marmarisense* ▲, *Biarum ditschianum* ●.

Biarum marmarisense in the wild in Turkey, near Bozburun. Photograph Brian Mathew.

purple, the rim of opening stained purple-pink. *Spadix* shorter than to subequal to the spathe, 3.5–9 cm long, appendix sessile, slender cylindric to filiform, 3–7 cm × 0.5–2.5 mm, dull reddish brown, dark red to purple-red towards the apex. *Staminate flowers* in a cylindrical zone 15–16 × 2–3 mm, anthers cream. *Interstice* 5–11 × 0.5–2 mm, cream. *Staminodes* usually absent. *Pistillate flowers* in a hemispherical cluster 1–2.5 × 2–4 mm; ovaries oblong-ovoid, 1–1.25 × 0.5 mm, pale green, stigma sessile, sub-capitate, 0.25 mm in diam., pale green. *Infructescence* globose, 2–3 cm in diam., consisting of c. 30 berries; berries 3.5–4 × 3–4 mm, dirty white when ripe; seed ovoid, 3–4 mm in diam., testa slightly reticulate, pale brown. 2n = 22, 24 (Gill, 1988). Fig. 20.

DISTRIBUTION. SW Turkey, Greece (Simi Island.) Map 10.

ECOLOGY. Same as for the typical subspecies, although occurring at lower altitudes.

ETYMOLOGY. Coming from the Marmaris Peninsula of south-western Turkey.

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