A new classification of *Arum* with keys to the infrageneric taxa

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Summary. A revision of the names and infrageneric, but supraspecific, taxa in *Arum* L. is presented; keys to the subgenera, sections, subsections and species are provided. Earlier systems of classification are discussed.

INTRODUCTION

The purpose of this paper is to present a new infrageneric classification of *Arum* as a precursor to a revision of *Arum* (Boyce in prep.). The infrageneric classification of *Arum* has been investigated by several authors in the past, resulting in a number of different systems. However, there is no satisfactory modern revision. The first major attempt to define and restrict the limits of the genus *Arum* was that of Schott (1832). He removed all the Linnaean elements, except for *A. maculatum* L., from the genus, using these to form the basis of several new genera. Schott's early work, apart from effectively lectotypifying *Arum*, set the stage for Blume (1836), who divided *Arum* into two sections. Blume's concept of *Arum* is somewhat wider than is currently recognized, and includes species now belonging to *Eminium* (Blume) Schott and *Peltandra* Rafin.

As early as 1855 Schott recognized that *A. pictum* L.f. displayed features suggesting that it was perhaps misplaced in the then-accepted circumscription of *Arum*. Accordingly he proposed the establishment of a new genus, *Gymnomesium* Schott, to accommodate it. Later authors chose to reject this and *Gymnomesium*, as with many of Schott's genera, was placed into synonymy. During research for this revision I had ample opportunity to make detailed studies of this taxon and it became apparent that while *A. pictum* differs on several morphological points from Schott's concept of *Arum*, none is sufficient to justify the maintenance of *Gymnomesium* at the generic level. Nevertheless, a suitable rank is needed for *A. pictum* to emphasize the fact that it displays several unique features (see key to subgenera below). Engler's 1889 subgeneric status for *Gymnomesium* is the most acceptable.

Schott (1856) made no attempt at an infrageneric classification, the arrangement being based on the overall similarity between taxa. By this time Schott was treating *Gymnomesium* as a genus discrete from *Arum* (Schott 1855). This distinction was not upheld by later monographers, although Schott retained it for the Prodromus Systematis Aroidearum (1860) and both Ender (1864) and Pfeiffer (1874) recognized *Gymnomesium*.

Schott (1860) placed great emphasis on geographical distribution in grouping the species while giving lower priority to morphological characteristics. This resulted in sections and subsections composed of taxa now regarded as only distantly related. Schott emphasized tuber structure, pedun-

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cle length and the presence or absence of an appendix stipe, all features that are given priority in the classification presented here.

While Engler accepted, on a modified basis, Schott's classification for his 1879 and 1889 studies, he opted for a radically different treatment in the Pflanzenreich (Engler 1920). The latter classification is based on staminode morphology, with emphasis on the shape of the staminodes and pistillodes, and the degree of sculpturing of their expanded bases. These characters are also regarded as of considerable taxonomic importance in the present revision, but Engler's interpretation resulted in a somewhat artificial classification. 'Section' *Tenuifila* is a very heterogeneous taxon, encompassing eight taxa which share one or two common features, but which I believe are not closely related. This 'section' constitutes the greater portion of the genus. His separation of *A. dioscoridis* Sm. and *A. palaestinum* Boiss. into separate taxa also seems odd. No reason was given for the change from his earlier treatment, in which he placed them close together in the same subsection.

Hruby (1912) presented a system based on the supposed phylogenetic relationships of the species. He proposed three 'infra-glacial' evolutionary groups, derived from a hypothetical 'pre-glacial *Arum*'. The resultant groups are based upon *A. maculatum, A. orientale* Bieb. and *A. dioscoridis* and are distinguished by features of spathe shape and spadix morphology. I broadly agree with the group based on *A. maculatum* but regard the other groups as artificial. His *A. maculatum* group consists of four species closely allied by their horizontal-rhizomatous tubers, and urine-like smell produced by the spadix appendix. Hruby included a fifth species, *A. nigrum* Schott, in this group on the basis of its resemblance to *A. maculatum*. However, the discoid tuber, strong faecal smell and deep purple spathe of *A. nigrum* indicate a link to *A. orientale* and *A. elongatum* Steven rather than *A. maculatum*.

Hruby's other groups are heterogeneous. The one based on *A. orientale* contains two species with horizontal-rhizomatous tubers and three with vertical-discoid tubers. Furthermore, two of the discoid-tubered species, *A. orientale* and *A. elongatum*, are, on the basis of their purple spathes, bicoloured ovaries and faecal smell, closely related, while the third, *A. creticum* Boiss. et Heldr., is a species of such singular appearance that it seems best placed in its own section.

In the *A. dioscoridis* group, consisting only of discoid-tubered taxa, the isolated *A. pictum* (*Gymnomesium* of Schott) is placed next to *A. cyrenaicum* Hruby, a species allied to *A. orientale*. These highly foetid plants of seasonal-habitats are, in turn, placed next to *A. hygrophilum* Boiss., a scentless hygrophyte. Hruby does, however, recognize the similarity between *A. dioscoridis* and *A. palaestinum* and groups them together accordingly. The informal sections used by Hruby have been included below in the synonymy in cases where all their constituent species can be assigned to the same section without ambiguity.

A NEW CLASSIFICATION OF ARUM

Perhaps the greatest difference between this and past revision lies in the fact that all but one species, *A. hainesii* Agnew & Hadač ex H. Riedl, have been studied as living plants. It is almost certain that most of the work done by Engler, and probably Schott as well, was based on herbarium material.

Many characters of considerable taxonomic importance are obscured in pressed material, overall architecture is often difficult to interpret and data such as scent, ecology and colour is often lacking. Working predominantly with living plants has enabled me to investigate a wider range of characters than was possible in the past. A further advantage I have had over previous researchers is that new species described in the last few decades have effectively filled 'gaps' in the genus and made it easier to establish species groups. The characters I have placed greatest emphasis on are tuber morphology, growth period, peduncle length at anthesis, spadix shape and smell and staminode and pistillode architecture.

The separation of *Arum* into two subgenera is based mainly on the markedly different flowering habit of *A. pictum* (the sole species in subgenus *Gymnomesium*) compared to the remainder of the genus. All the species in subgenus *Arum* flower at the completion of the growth season in early summer, the spathe emerging from the petiole sheath of the terminal leaf. Subgenus *Gymnomesium* flowers at the start of the growth period, the spathe emerging through two or three cataphylls apically from the previous seasons growth. The new growth emerges laterally to the inflorescence.

Sectional separation is on the basis of tuber structure. There are two distinct tuber types in *Arum*. The five species that comprise section *Arum* have a horizontal-rhizomatous tuber while the twenty species in section *Dioscoridea* have a vertical-discoid tuber. This morphologically-based separation is broadly supported by cytology. Bedalov (1973, 1975a, 1975b, 1981) found that the species with horizontal-rhizomatous tubers are mostly polyploid, with $2n = 56$ and $2n = 84$, and generally widespread, (e.g. *A. maculatum*), and that species with vertical-discoid tubers are mostly diploid with $2n = 28$ and have more-or-less restricted distributions, (e.g. *A. nigrum*). There are exceptions however; *A. alpinum*, a diploid, vertical-discoid tubered species has a huge distribution from Spain to western Turkey (Bedalov 1983; Boyce pers. obs.). *A. apulum* (Carano) Boyce, another vertical-discoid tubered species with a very limited distribution in southern Italy is a tetraploid (Bedalov 1980), as is the Libyan endemic *A. cyrenaicum* (Marchant 1973). Finally *A. byzantinum* Blume, a horizontal-rhizomatous tubered species with apparently limited distribution has a count of $2n = 28$ (Alpinar 1986).

Subsectional circumscriptions are based on the possession of a combination of characters rather than the presence of just one. Staminode and pistillode architecture is almost certainly an adaptation to pollinator type (Knoll 1926; Prime 1960), and thus also useful in establishing species groupings. The number of whorls of staminodes and pistillodes and their colour has proved to be a stable diagnostic feature, especially with regard to critical taxa (e.g. *A. rupicola* Boiss. and *A. jacquemontii* Blume). Field studies suggest that peduncle length is an important factor in pollination biology (Boyce in prep.) and research by Koach (1987) has shown that spadix appendix odour is of considerable importance in determining the predominant pollinator group.

I recognize two types of inflorescence: scentless and displayed (termed 'flag'), and scented and hidden (termed 'cryptic').

The 'flag' group contains six taxa which can be divided into three alliances. *A. jacquemontii*, *A. kokolkowii* Regel and *A. rupicola* all have a stout spadix appendix, lanceolate spathe limb, white spathe tube interior and slender staminodes and pistillodes. These are placed in subsection *Tenuifila*.

Of the other species in the 'flag' group, *A. euxinum* R. Mill and *A. hygrophilum* are allied on the basis of the slender sessile spadix appendix, tapering spathe tube and densely arranged staminodes. These two species constitute subsection *Hygrophila*. The sixth species in the 'flag' group, *A. alpinum*, has long been regarded as allied to, or synonymous with, *A. maculatum*. However, the vertical-discoid tuber, scentless inflorescence, slender, long-stipitate spadix appendix and autumn growth period clearly distinguishes it. The combination of features displayed by *A. alpinum* is not shared by any other species and the most suitable position for it is a monotypic subsection: *Alpina*.

The 'cryptic' group, containing twelve species, is divisible into two. *A. dioscoridis* and *A. palaestinum* are very similar, with stout spadix appendices, subulate staminodes and pistillodes and a strong, foetid smell. These form subsection *Poeciloporphyrochiton*. The ten species that constitute subsection *Dischroochiton* are all rather similar in overall appearance, being separated on staminode and pistillode architecture, spadix appendix shape and size and geographical distribution. I must admit that, despite its overall homogeneity, subsection *Dischroochiton* is the least satisfactory of the subsections, this stemming from the fact that many of the species that form subsection *Dischroochiton* are still inadequately known. It could be argued that the subsection should be further divided, perhaps following Engler (1920) in removing *A. nigrum* to form a monotypic taxon. In addition *A. apulum* and *A. cyrenaicum*, which share a chromosome count of $2n = 56$, could conceivably form a further subsection. I have declined from further division because several of the constituent species are inadequately known and to form them into finely divided groups only tentatively is undesirable.

The two remaining species, *A. creticum* and *A. idaeum* Coust. & Gandoger are isolated from the rest of the genus. Both lack staminodes and pistillodes and display more or less contiguous staminate and pistillate flower zones. The strongly fragrant, displayed inflorescences of *A. creticum* and the unscented, hidden inflorescences of *A. idaeum* are unique in the genus. Despite these, presumably pollination-linked, differences these two species share a remarkably similar inflorescence morphology and I feel that they are best placed in their own subsection: *Cretica*.

Palynology has proved to be less useful. All the species studied to date have similar, spinulose, pollen. Bedalov (1985) published photographs of the pollen of eight species noting that the difference between them is primarily number, shape and distribution of the spines. Grayum (1984) examined five species, including *A. palaestinum* which was not investigated by Bedalov. He also noted the similarity in the pollen of different species. To date, neither species of subsection *Cretica* has been investigated palynologically. It will be interesting to see if this morphologically isolated subsection has distinctive pollen. The new classification is presented in tabular form (Table 1) and a key to the recognized species is provided below.

NOMENCLATURAL PROBLEMS

One of the major difficulties encountered during the preparation of this infrageneric revision of *Arum* was relating the past revisions to modern nomenclatural rules. During the period when the earlier treatments were written the typification of specific and supraspecific names was not compulsory. One objective of the present treatment was the lectotypification of the

TABLE 1. A New Infrageneric classification of *Arum*

Subgenus **Gymnomesium**	*A. pictum*
Subgenus **Arum**	
Sect. **Arum**	*A. maculatum, byzantinum, italicum concinnatum*
Sect. **Dioscoridea**	
Subsect. **Alpina**	*A. alpinum*
Subsect. **Discroochiton**	*A. orientale, gratum, lucanum, apulum, nigrum, cyrenaicum, purpureospathum, balansanum, hainesii, elongatum*
Subsect. **Tenuifila**	*A. rupicola, jacquemontii, kokolkowii*
Subsect. **Hygrophila**	*A. hygrophilum, euxinum*
Subsect. **Poeciloporphyrochiton**	*A. dioscoridis, palaestinum*
Subsect. **Cretica**	*A. creticum, idaeum*

validity published infrageneric names.

Blume (1836) published two sections. One of these, 'sectio 1' is to be regarded as informal since, without a name, Blume's concept cannot be lectotypified. Blume's section *Eminium*, although validly published, can be dismissed from the present treatment as the type is not referable to *Arum* (Nicolson 1967).

Schott's sectional concepts published in the Prodromus Systematis Aroidearum (1860) also lack names, being simply referred to as sections '1' and '2'. As with Blume's 'sectio 1' these can be regarded as informal. Schott's (1860) subsectional concepts, however, are named and thus can be lectotypified and it is these that form some of the subsections presented here. Schott's genus *Gymnomesium* becomes *Arum* subgenus *Gymnomesium* for the reasons discussed above.

Engler, in the Monographie Phanerogamarum (1879), used clearly-named sections and subsections for *Arum*. However, Engler's subsectional names are predated by Schott's and thus become synonyms of them. Engler's section '*Euarum*' becomes section *Arum*, an autonym because both are based on the type of the genus *A. maculatum*.

The system used by Engler in the Die Natürlichen Pflanzenfamilien (1889) was largely unchanged from that in the Monographie Phanerogamarum (Engler 1879), with the exception that he raised sections '*Euarum*' and *Gymnomesium* to subgeneric status and did not designate a rank to *Discotuberosae* and *Ootuberosae*. I have decided to regard the 1889 *Discotuberosae* and *Ootuberosae* as rankless, despite the fact that Engler gave them the rank of subsection in the Monographie Phanerogamarum treatment a decade earlier. My

reason for this is that if subsectional rank is retained for the taxa it results in an illogical 'jump' from subgenus to subsection.

In the Pflanzenreich (1920), Engler chose the symbol § to identify the infrageneric concepts without explaining the rank he intended for them. In previous Pflanzenreich volumes of the *Araceae* account this symbol designated a variety of ranks (e.g. in *Philodendron* it is most easily interpreted as indicating subsection) and I feel that it is arbitrary to assume that Engler intended § to mean section in *Arum*. I have opted to treat these taxa as rankless. To minimize name changes I have followed the example of Mayo (1986) in taking up some of the names of these rankless taxa, where necessary, and validating them as subsections.

Arum *L.* Spec. Pl. ed.1: 966 (1753); Schott in Schott & Endlicher, Melet. Bot. 17 (1832); Blume, Rumphia, 1: 116–20 (1836); Endlicher, Gen. Plantarum 1, 3: 235 (1837); Schott, Syn. Aroid. 9–16 (1856); Schott, Prodr. Syst. Aroid. 73–102 (1860); Ender, Index Aroid. 22–8 (1864); Pfeiffer, Nomen. Botanicus 1 (1): 283–4 (1873); Engler in A. & C. DC., Monog. Phanerog. 2: 580–97 (1879); Engler in Engler & Prantl, Die Natürlich. Pflanzenfam. 2, 3: 147 (1889); Hruby in Bull. Soc. Bot. Genève ii, 4: 113–60, 330–71 (1912); Engler, Das Pflanzenreich 73 (IV. 23F): 67–99 (1920).

Perennial tuberous herbs. *Tubers* discoid and vertically orientated or rhizomatous and horizontally orientated; roots annual, cylindrical, emitted from the base of the growth point, of two sorts: contractile and feeding; contractile roots thickened, simple; feeding roots slender to very slender, ± simple. *Vegetative growth* annual, emerging from early autumn to late winter, base enclosed by 1–4 fleshy, later papery, cataphylls; leaves sub-distichously arranged, few to many, ± erect, petiolate, petioles free to moderately clasping, terete to 'D' shaped in cross-section, furnished with a sheath basally; leaf lamina cordate to sagittate or hastate, acute to obtuse, margins entire, basal lobes well-defined to (rarely) almost absent, main veins indistinct to sunken adaxially, ± prominent abaxially. *Inflorescence* produced at the beginning or end of the growth season, emerging from the terminal leaf petiole sheath (subgenus *Arum*) or from 2–3 cataphylls apically from the previous season's growth (subgenus *Gymnomesium*), inflorescence sessile to long-pedunculate; spathe consisting of a well-defined tube and limb, spathe tube oblong-cylindric, somewhat ventricose, constricted apically, margins free; spathe limb moderate to large, linear-lanceolate, lanceolate, elliptic or ovate-elliptic, erect, cucculate, recurved or flopping forward, acute to obtuse. Spadix much shorter to exceeding the spathe, appendix cylindrical to clavate, sometimes massive, long-stipitate to sessile, sub-acute to obtuse, ± straight, erect, smooth, strongly foetid, sweetly scented or scentless; staminodes contiguous with the staminate flowers or separated by a naked axis, staminodes usually well-developed, rarely much reduced or absent, simple, reflexed, spreading or suberect, filiform to subulate, bases bulbiform to compressed-triangular, rarely absent, smooth to verrucate; staminate flowers in a cylindrical, oblong or globose zone, sessile, free, each consisting of 2–4 anthers, connective very narrow to ± absent, never prominent, theca opening by a longitudinal slit (subgenus *Arum*) or a sub-apical pore (subgenus *Gymnomesium*); pollen free, exine spinulose; pistillodes contiguous with the pistillate flowers or separated by a naked axis, well-developed to absent, simple, reflexed, spreading or ±

erect, filiform, aristate or subulate, bases bulbiform to compressed-triangular, rarely absent, smooth to verrucate. Pistillate flowers in a cylindrical zone at the spadix base, each consisting of a uniloculate, multiovulate ovary with a sessile, papillate stigma, which exudes a droplet when withered; ovules orthotropous, placentation parietal. *Infructescence* a cylindrical cluster of juicy, few-seeded, pyriform to globose, glossy berries, stigmatic remains apical, sunken; seeds moderately large, ovoid to globose, testa leathery, reticulate, endosperm copious, starchy, embryo straight; cotyledon elliptic, entire, concolorous green or green with silver-grey veins.

Twenty-five species occurring from the Azores to the USSR–Chinese border and from Jordan to southern Norway.

Type species: *Arum maculatum* L.

KEY TO THE SUBGENERA OF ARUM

1. Plant flowering prior to or with leaf emergence, flowering in the autumn; inflorescence situated at ground level, spathe tube partially buried and enveloped by two or three triangular, sub-fleshy cataphylls; peduncle barely extending during maturation of infructescence; staminodes present, subulate, thick, pistillodes absent; petioles with open, triangular sheaths, sheath margins not wing-like, sheath interior thus exposed ..... subgenus **Gymnomesium**
1. Plant flowering after leaf emergence, flowering in the spring or early summer; inflorescence situated above ground level, spathe tube fully exposed, no cataphylls present at inflorescence base; peduncle markedly extending during maturation of infructescence in those species with cryptic inflorescences; staminodes and pistillodes both present (except in subsect. *Cretica* where staminodes and pistillodes are absent), filiform to subulate, ± slender; petioles with closed, gladiate sheaths, sheath margins wing-like, concealing the sheath interior .. subgenus **Arum**

Arum *L.* subgenus **Gymnomesium** *(Schott) Engler* in Engler & Prantl, Die Natürlich. Pflanzenfam. 2, 3: 147 (1889). Type: *Arum pictum* L.f., Suppl. 410 (1782).

Gymnomesium Schott in Oester. Bot. Wochenbl. 5: 17 (1855). *Arum* section *Gymnomesium* (Schott) Engler in A. & C. DC. Monog. Phanerog. 2: 581 (1879).

Arum § *Gymnomesium* (Schott) Engler in Engler, Das Pflanzenr. 73 (IV. 23F): 68 (1920), rankless taxon.

Arum *L.* subgenus **Arum**

Arum subgenus '*Euarum*' Engler in Engler & Prantl, Die Natürlich. Pflanzenfam. 2, 3: 147 (1889).

KEY TO THE SECTIONS AND SUBSECTIONS OF SUBGENUS ARUM

1. Rootstock consisting of a horizontal rhizomatous tuber with lateral adventitious shoots forming offsets which later become independent; established plants forming extensive spreading colonies . . . sect. **Arum**
Rootstock consisting of a vertically orientated discoid tuber with a clear-

ly apical growth point and peripheral adventitious shoots which sometimes form independent plants; established plants forming congested, compact colonies (sect. **Dioscoridea**) 2

2. Spadix appendix long-stipitate, sometimes obscurely so 3
   Spadix appendix short-stipitate or sessile 4
3. Peduncle longer than the petioles; inflorescence scentless; staminodes and pistillodes long, filiform, semi-rigid ..... subsect. **Alpina**
   Peduncle shorter than the petioles; inflorescence with foetid or oily odour; pistillodes long, slender-filiform, flexuous, staminodes either the same or short, aristate, stiff ..... subsect. **Dischroochiton**
4. Staminodes and pistillodes well developed 5
   Staminodes and pistillodes absent or barely developed subsect. **Cretica**
5. Spadix appendix stipitate, more than 5 mm in diam., spathe tube interior white or stained purple in the upper portion 6
   Spadix appendix sessile, less than 4 mm in diam., spathe tube interior wholly purple ..... subsect. **Hygrophila**
6. Peduncle sub-equal to or exceeding the petioles; staminodes and pistillodes filiform, flexuous; inflorescence scentless .... subsect. **Tenuifila**
   Peduncle shorter than the petioles, occasionally ± absent; staminodes and pistillodes subulate, stiff; inflorescence with strong odour, foetid or smelling of fermenting apples, very rarely scentless
   ..... subsect. **Poeciloporphyrochiton**

section **Arum**

Arum subsection *Chlorochiton* Schott, Prod. Syst. Aroid. 74 (1860). Lectotype: *A. italicum* Miller (chosen here). Schott lists seven species for the subsection, three in the informal 'Mediterraneo-Occidentalia' group and four in the 'Mediterraneo-Orientalia' group. In the present treatment all the species in the 'Mediterraneo-Occidentalia' group are referred to *A. italicum* and together agree better with the protologue than the 'Mediterraneo-Orientalia' group.

Arum section '*Euarum*' Engler in A. & C. DC., Monog. Phanerog. 2: 583 (1879).

Arum subsection *Ootuberosae* Engler in A. & C. DC., Monog. Phanerog. 2: 591 (1879). Lectotype: *A. italicum* Miller (chosen here). Engler's protologue states "Tuber ovoideum vel oblongum, horizontaliter protensum". Engler's concept of *A. italicum* consists only of species with horizontal-rhizomatous tubers (*A. italicum* and *A. concinnatum* Schott) but his concept of *A. maculatum* contains both species with horizontal-rhizomatous tubers (*A. maculatum*) and vertical-discoid tubers (*A. alpinum*). Thus on the basis of strict agreement with the protologue, *A. italicum* is the better choice as lectotype.

Arum 'Ootuberosae' Engler in Engler & Prantl, Die Natürlich. Pflanzenfam. 2, 3: 147 (1889), rankless taxon.

section **Dioscoridea** (*Engler*) *Boyce* stat. nov. Type: *A. dioscoridis* Sm.

['*Arum dioscoridis* group' Hruby in Bull. Soc. Bot. Genève ii, 4: 124 (1912).]

Arum § *Dioscoridea* Engler, Das Pflanzenr. 73 (IV. 23F): 68 (1920), rankless taxon. Type: *A. dioscoridis* Sm.

Arum § *Nigra* Engler, Das Pflanzenr. 73 (IV. 23F): 68 (1920), rankless taxon. Type: *A. nigrum* Schott.

subsection **Alpina** *Boyce* subsect. nov.; pedunculus quam petiolum longior; appendix spadicis clavatus, longe stipitatus; staminodia et pistillodia in longitudine medius evoluta, filiformia, semi-rigida; inflorescentia inodora. Typus: *A. alpinum* Schott et Kotschy.

subsection **Dischroochiton** *Schott,* Prodr. Syst. Aroid. 75 (1860). Lectotype: *A. orientale* Bieb. (chosen here). Of the twelve species listed by Schott for subsection *Dischroochiton* four are referable to *A. orientale*, four to *A. maculatum* and two to *A. alpinum*, leaving *A. gratum* Schott and one doubtful taxon, *A. besserianum* Schott. Schott subdivided subsection *Dischroochiton* into three informal geographical groups: *Orientalia, Europae mediae* and *Europae australioris*. The protologue of the subsection states "Spatha disco virens, marginem . . . sordide-rubro colorata. Tuber rotundatum". *A. orientale* matches this description best.

Peduncle shorter than the petioles. Spadix appendix distinctly long-stipitate, usually stout; pistillodes very well developed, filiform, flexuous, long, staminodes either the same, or aristate, stiff. Inflorescence foetid or smelling oily.

subsection **Tenuifila** (*Engler*) *Boyce* stat. nov. Lectotype: *A. rupicola* Boiss. (chosen here). Engler's taxon contains eight species. Of these, *A. italicum* and *A. maculatum* differ markedly because of their horizontal-rhizomatous tubers, while *A. palaestinum* is clearly more allied to *A. dioscoridis* (in subsection *Poeciloporphyrochiton*) than to any of the species in subsect. *Tenuifila*. *A. hygrophilum* is an isolated species with no obvious affinities to any of the taxa in subsect. *Tenuifila*. *A. orientale* Bieb. and *A. cyrenaicum* Hruby, both with foetid, cryptic inflorescences belong with subsect. *Dischoroochiton*. This leaves *A. conophalloides* Kotschy ex Schott and *A. jacquemontii*. Of these, *A. conophalloides* is a closer match to the protologue than *A. jacquemontii*. The only change to be made is the adoption of Boissier's earlier name, *A. rupicola*, for the species.

Arum § *Tenuifila* Engler, Das Pflanzenreich, 73 (IV. 23F): 68 (1920), rankless taxon.

Peduncle longer than the petioles. Spadix appendix shortly stipitate or sessile, slender to stout, occasionally massive; staminodes and pistillodes moderately well developed, filiform, flexuous, rather short. Inflorescence scentless.

subsection **Hygrophila** *Boyce* subsect. nov. pedunculus petiolum aequans vel longior. Appendix spadicis sessilis pergracilis. Staminodia et pistillodia filiformia, flexuosa, longa. Inflorescentia inodora. Typus: *A. hygrophilum* Boiss.

subsection **Poeciloporphyrochiton** *Schott*, Prodr. Syst. Aroid. 74 (1860). Lectotype: *A. dioscoridis* Sm. (chosen here). Schott ascribes ten species to the subsection, half of which are referable to *A. dioscoridis*. The protologue states 'Spatha purpureo-maculata 1. purpurea', with such evidence there seems to be little doubt that the subsection was based predominantly on *A. dioscoridis*.

Arum subsection *Discotuberosae* Engler in A. & C. DC., Monog. Phanerog. 2: 583 (1879). Lectotype: *A. dioscoridis* Sm. (chosen here). Engler states that this subsection is 'subsect. *Poeciloporphyrochiton* Schott pr. p.'. Engler, however, adds rather than removes species. Engler's subsection *Dischroochiton* in fact includes the whole of Schott's subsection *Poeciloporphyrochiton* and must therefore have the same type.

Arum 'Discotuberosae' Engler in Engler & Prantl, Die Natürlich. Pflanzenfam. 2, 3: 147 (1889), rankless taxon.

Peduncle much shorter than the petioles, sometimes lacking. Spadix appendix short-stipitate, cylindrical, moderately stout; staminodes and pistillodes well developed, subulate, stiff, short to long. Inflorescence with foetid odour or smelling similar to fermenting apples, very rarely scentless.

subsection **Cretica** (*Engler*) *Boyce* stat. nov. Type: *A. creticum* Boiss. et Heldr.

Arum § *Cretica* Engler, Das Pflanzenr. 73 (IV. 23F): 68 (1920), rankless taxon.

Peduncle longer than the petioles or much shorter. Spadix appendix sessile to obscurely stipitate, cylindrical, laterally compressed, moderately stout; staminodes and pistillodes absent. Inflorescence sweetly scented or scentless.

KEY TO THE SPECIES OF ARUM

1. Tuber rhizomatous 2
   Tuber discoid 5
2. Spadix appendix massively conic-cylindric, more than ½ to subequal to the spathe limb ..... **A. concinnatum**
   Spadix appendix ± slender-clavate, ¼–½ length of the spathe limb 3
3. Staminate flowers yellow prior to anthesis; staminodes and pistillodes yellow ..... **A. italicum**
   Staminate flowers purple prior to anthesis; staminodes and pistillodes purple 4
4. Spathe limb pale green ± stained pale purple-green; leaves weakly hastate ..... **A. byzantinum**
   Spathe limb greenish white; leaves sagittate-hastate . . **A. maculatum**
5. Pistillodes and/or staminodes present 6
   Pistillodes and staminodes absent 25
6. Plant flowering in the autumn; staminodes present, pistillodes absent ..... **A. pictum**
   Plant flowering in the spring; staminodes and pistillodes present 7
7. Spathe limb interior distinctly blotched and spotted purple ..... **A. dioscoridis**
   Spathe limb interior ± unicolorous 8
8. Staminodes and pistillodes subulate 9
   Staminodes and pistillodes filiform or aristate 10
9. Spathe limb elliptic-ovate; spadix appendix clavate, long-stipitate, c. ½ spathe length ..... **A. nigrum**
   Spathe limb lanceolate; spadix appendix stoutly cylindrical, shortly stipitate, more than ½ to subequal to spathe limb .. **A. palaestinum**

10. Spathe tube interior distinctly bicolored, purple above, pale green to white below 11
Spathe tube interior ± unicolorous 16
11. Spadix appendix strongly clavate, inflorescence sweetly scented ..... **A. gratum**
Spadix appendix stout to slender-cylindric, inflorescence foetid .. 12
12. Spadix appendix stout-cylindric, subequal to spathe limb ..... **A. elongatum** subsp. **elongatum**
Spadix appendix slender-cylindric, up to ¾ as long as the spathe limb 13
13. Spathe limb interior pale green suffused pale to mid-purple 14
Spathe limb interior rosy or crimson 15
14. Ovaries stained purple apically, spathe limb evenly suffused pale purple; staminodes in 2 whorls, pistillodes in 3–4 whorls ..... **A. orientale**
Ovaries concolorous pale green, spathe limb margins and apex mid-green, centre purple; staminodes in 3–4 whorls, pistillodes in 1–2 whorls ..... **A. apulum**
15. Plant robust; spathe limb rosy ..... **A. cyrenaicum**
Plant delicate; spathe limb crimson . **A. elongatum** subsp. **alpinariae**
16. Spathe tuber interior greenish white, sometimes flushed pale purple above and along the margins 17
Spathe tube interior deep purple 21
17. Inflorescence borne above the foliage 18
Inflorescence borne below the foliage 23
18. Spathe limb elliptic; spadix appendix long-stipitate, clavate ..... **A. alpinum**
Spathe limb lanceolate to linear-lanceolate; spadix appendix short-stipitate or sessile, cylindrical 19
19. Spathe limb interior mid-green ..... **A. korolkowii**
Spathe limb interior purple or, rarely, greenish white with a thin purple border 20
20. Spadix appendix slender-cylindric, tapering basally, sessile; pistillode and staminode bases verrucate, purple ..... **A. jacquemontii**
Spadix appendix conic-cylindric, sometimes massively so; pistillode and staminode bases ± smooth, pale green to cream ..... **A. rupicola**
21. Spathe limb deep purple ..... **A. purpureospathum**
Spathe limb pale green 22
22. Inflorescence borne below the foliage; spathe limb with a 1–1·5 mm wide purple border; leaves with basal lobes more than a ⅓ as long as lamina ..... **A. hygrophilum**
Inflorescence borne above the foliage; spathe limb with a 2·5–3 mm wide purple border; leaves with basal lobes less than a ¼ as long as lamina ..... **A. euxinum**
23. Spadix appendix very slender, subequal to longer than the spathe limb ..... **A. lucanum**
Spadix appendix stout, shorter than the spathe limb 24
24. Leaves c. ⅔ as broad as long; spathe limb interior purple, exterior pale green; spadix appendix purple ..... **A. balansanum**
Leaves c. ¼ as broad as long; spathe limb interior and exterior pale greenish white; spadix appendix pale brown ..... **A. hainesii**
25. Spathe cream to pale yellow, limb reflexing at maturity; spadix appendix mid to dark yellow, sweetly scented ..... **A. creticum**

Spathe white, limb erect and cucculate at maturity; spadix appendix deep purple, scentless ..... **A. idaeum**

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