

TAXONOMY AND DISTRIBUTION OF EUROPEAN *DAMASONIUM* (*ALISMATACEAE*)

T. C. G. RICH* & F. L. NICHOLLS-VUILLE†

A review of the taxonomy and distribution of the European species of *Damasonium* Mill. has been carried out to provide background information for conservation. *Damasonium alisma* Mill., *D. bourgaei* Coss. and *D. polyspermum* Coss. are recognized as distinct species, and descriptions and a key are presented. Lectotypes are designated for *D. bourgaei* and *D. polyspermum*. *Damasonium alisma* is the most northerly taxon, predominantly occurring in France and England, but extending eastwards to Russia. *Damasonium bourgaei* is widespread around the Mediterranean eastwards at least to India. *Damasonium polyspermum* occurs mainly in the western Mediterranean.

Keywords. Conservation, starfruit, thrumwort.

INTRODUCTION

Damasonium Mill. is a small genus of the *Alismataceae*. The number of species it contains depends on the number of taxa recognized in Europe, where the main differences of opinion are whether to include *D. polyspermum* Coss. and *D. bourgaei* Coss. within *D. alisma* Mill. or not. Historically, most authors have accepted *D. polyspermum* as a distinct species, but *D. bourgaei* was either treated as distinct or as a subspecies or variety of *D. alisma* (e.g. Buchenau, 1903). In *Flora Europaea*, Dandy (1980) included *D. polyspermum* and *D. bourgaei* within a variable *D. alisma*, but more recently Vuille (1987) provided new morphological, cytological and biological evidence showing that they would be better treated as species.

The taxonomic status of these taxa is important as the conservation of the genus *Damasonium* is a matter of some concern in Europe, being rare and threatened in many countries. For instance, *D. alisma sensu lato* is either protected or 'Red-listed' in England (Birkinshaw, 1994; Wigginton, 1999), France (Reduron, 1995) and Greece (Raus, 1991; Phitos *et al.*, 1995), and is listed as a typical species of the European Habitats Directive priority habitat 'Mediterranean Temporary Ponds' (European Commission, 1995).

The inclusion of all three taxa in *D. alisma sensu lato* in *Flora Europaea* has resulted in little recent information about the distributions or relative frequencies of the segregates, which can be used to inform conservation decisions and priorities. A review was therefore carried out of the distribution of the European taxa from herbarium specimens and literature to provide relevant information. The specimens also provided the opportunity to present a formal taxonomic treatment of the European taxa as

* Department of Biodiversity and Systematic Biology, National Museum & Gallery of Wales, Cardiff CF10 3NP, UK.

† 49 Leam Terrace, Leamington Spa, Warwickshire CV31 1DG, UK.

defined by Vuille (1987). The North American *D. californicum* Torr. and the Australasian *D. minus* Buch. (*D. australe* Salisb.) have not been investigated.

METHODS

Material was requested from national herbaria in countries in which *D. alisma sensu lato* has been recorded, and selected other British and Irish herbaria were also investigated. Specimens examined from Birmingham University, England (BIRM), Natural History Museum, London, England (BM), Bristol Museum, England (BRISTM), University of Cambridge, England (CGE), Instituto Botánico da Universidade de Coimbra, Portugal (COI), National Botanic Gardens, Glasnevin, Ireland (DBN), Royal Botanic Garden Edinburgh, Scotland (E), Museo Botanico Dell'Univeristà, Firenze, Italy (FI), Royal Botanic Gardens, Kew, England (K), The Rijksherbarium, Leiden, the Netherlands (L), Liverpool Museum, England (LIV), Royal Botanic Garden, Madrid, Spain (MA), National Museum of Wales, Cardiff, Wales (NMW), Oxford University, England (OXF), Muséum National d'Histoire Naturelle, Paris (P), Scientifique Institut, Rabat, Morocco (RAB), Reading University, England (RNG), Trinity College, Dublin, Ireland (TCD) and Naturhistorisches Museum Wien, Austria (W).

Distribution information was abstracted from specimens that could be named with confidence. Latitude and longitude were taken from gazetteers or read from maps. Where detailed information was not available, latitude and longitude are given for provinces or as a best approximation. Distribution information was also abstracted for *D. alisma sensu lato* from Floras held in the library at the National Museum of Wales to indicate the wider range.

RESULTS

Morphology

The diagnostic descriptions below combine measurements from herbarium specimens and Vuille (1987). Vuille also gives other useful data, primarily related to reproductive biology.

It is easier to identify fresh material than herbarium specimens. Material with both flowers and fruit is easier to name than that with flowers or fruit alone, and vegetative material cannot be identified. The expanded floating leaves are similar in all species, although those of *D. polyspermum* are possibly more acute at the apex than the other species.

Plant height is variable depending on growth conditions. *Damasonium polyspermum* is rarely more than 15cm tall, but *D. alisma* and *D. bourgaei* are more variable in size and both may grow from c.5cm to 30–50cm or more. The inflorescence structure and consequently the number of flowers (cf. Vuille, 1987) is related to plant size, and consequently of limited taxonomic value, although large *D. alisma* and *D. bourgaei* can usually be distinguished from *D. polyspermum*. *Damasonium bourgaei*

usually has densely crowded whorls of flowers (rarely more lax) that give its inflorescences a distinctive appearance. The lowest pedicels are usually the longest in all taxa, and our measurements, which include these, tend to mask the clustered nature of the *D. bourgaei* inflorescences.

Petal colour is a useful character in fresh material, but the petals rarely persist on herbarium specimens and only rarely are colour notes available. Petals persist for one day only, and like other Alismataceae may fade during the day (L. Medina Domingo, personal communication, 1999). Anthers often persist on young fruits, and their length proved useful for distinguishing *D. bourgaei* and *D. alisma*, although their small size made them difficult to measure.

The carpels provide key characters. Length was measured on ripe carpels with brown seeds, although on many specimens carpels are distorted by pressing. *Damasonium polyspermum* has large, narrowly triangular carpels tapering from the base gradually to the apex. *Damasonium alisma* and *D. bourgaei* have smaller, triangular to broadly triangular carpels that have an indistinct or distinct 'beak' at the apex. In *D. polyspermum*, the carpels are usually patent, whilst in *D. alisma* and *D. bourgaei* they are cupped upwards (most easily seen on fresh material). Seed number is most easily counted by dissecting ripe carpels (seeds may fall out of adjacent carpels too), but sometimes ovules can be counted in immature carpels.

The seeds differ significantly in size (Vuille, 1987, expressed this as seed weight). The seeds of *D. polyspermum* are smaller, and there is some overlap between those of *D. bourgaei* and *D. alisma*. The basal seed in the last two species is usually larger than the distal seed (measurements for both were lumped).

Distribution

The records traced for each species are plotted in Figs 1–3 (details of the specimens on which they are based can be obtained from T. Rich). Approximately 20% of the localities could not be traced or were illegible, and some may have been wrongly located. A map of all records combined, including literature sources, is given in Fig. 4 to indicate the wider range. Most of the records are based on material from north-western European herbaria and literature. Data are sparse for Asia.

KEY AND DESCRIPTIONS

- 1a. Carpels with (4–)5–8 seeds; seeds 0.9–1.2(–1.4)mm long × 0.5–0.7(–0.9)mm wide _____ **3. *D. polyspermum***
- 1b. Carpels with 1–2 seeds; seeds 1.2–2.5 × 0.7–1.2mm _____ **2**
- 2a. Fresh petals white with a yellow spot at base; inflorescence lax; anthers c.0.7–0.9mm _____ **1. *D. alisma***
- 2b. Fresh petals pink at top, white in middle and with a yellow spot at base; inflorescence usually densely crowded; anthers c.0.3–0.5mm _____ **2. *D. bourgaei***

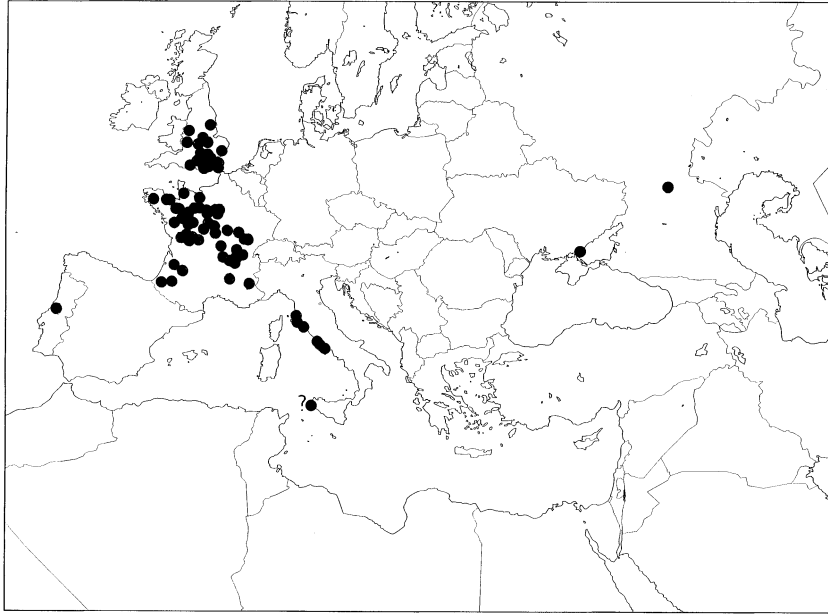


FIG. 1. Distribution of *Damasonium alisma sensu stricto*.

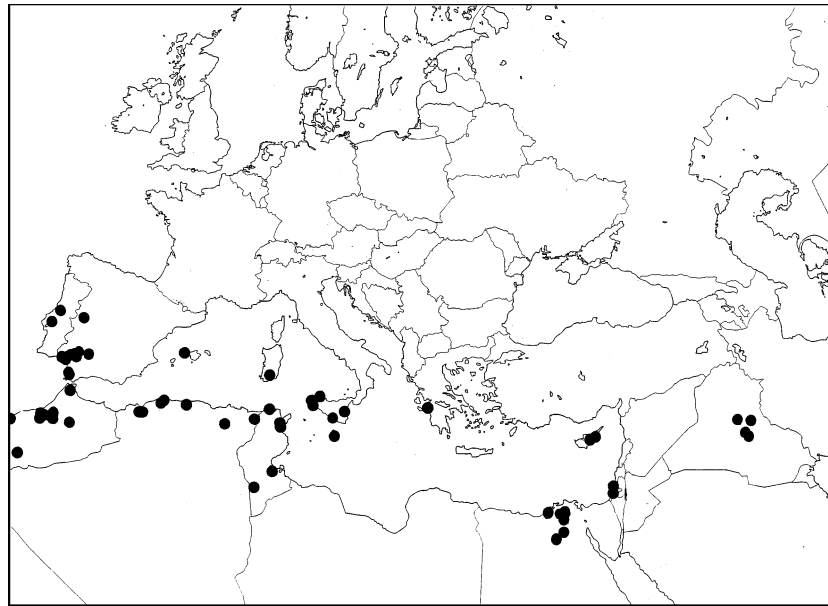


FIG. 2. Distribution of *Damasonium bourgaei*.

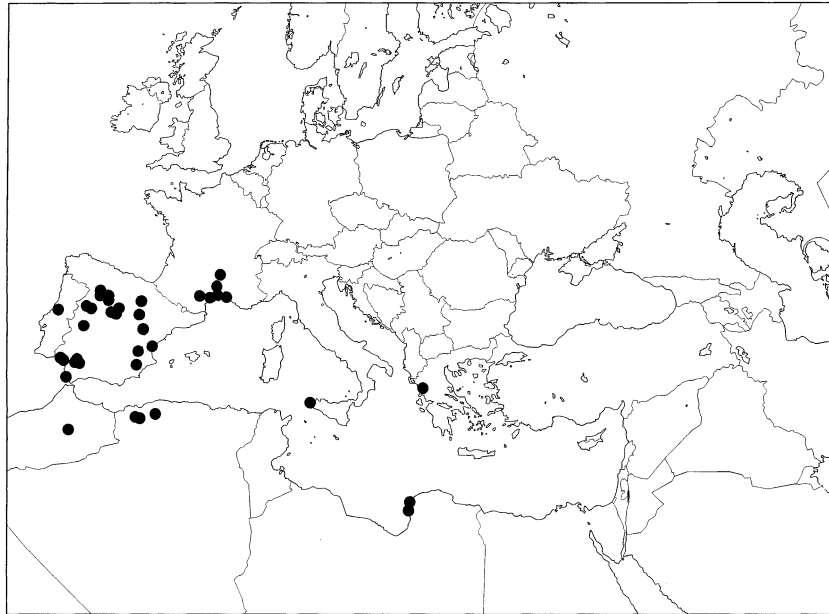


FIG. 3. Distribution of *Damasonium polyspermum*.

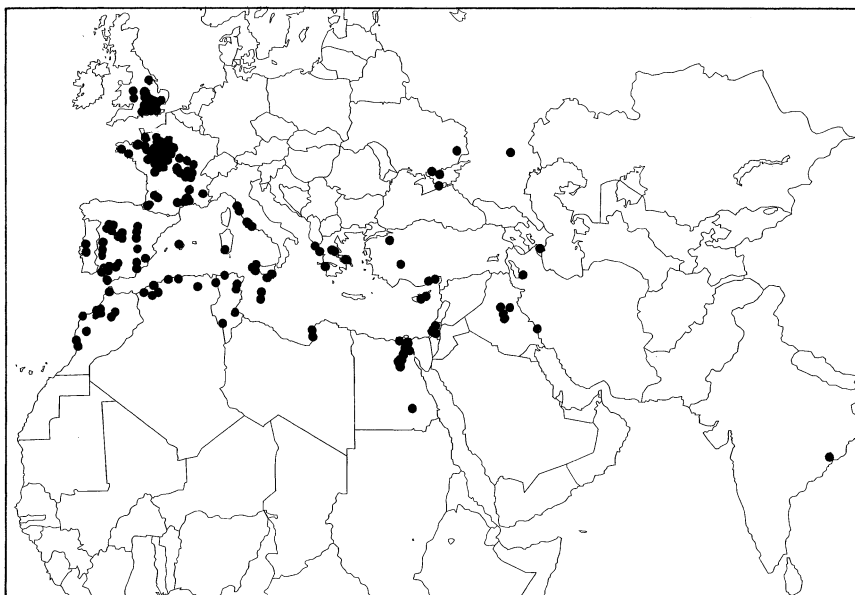


FIG. 4. Distribution of *Damasonium* aggregate (*D. alisma*, *D. polyspermum*, *D. bourgaei* and indeterminate records).

1. *Damasonium alisma* Mill., Gard. Dict., ed. 8, no. 1. (1768).

Type: Siddiqi & Ghafoor (1980) cited the Linnean Herbarium specimen 473.3 (LINN) as the type of *Damasonium alisma* Mill. They presumably accepted Miller's name as a *nomen novum* for *Alisma damasonium* L., made necessary when he introduced the new genus *Damasonium*, even though he did not cite the Linnaean binomial (Miller, 1768). The specimen consists of one fruiting plant with a lax inflorescence, anthers c.0.7mm and carpels probably 2-seeded (not dissected), and is clearly *Damasonium alisma* Mill. *sensu stricto* as interpreted here. It is confusingly marked by Linnaeus '*Damasonium 2*' (the '2' in this case refers to *Alisma flava* L., = *Limnocharis flava* (L.) Buchen.) rather than '*Damasonium 3*', the number expected from *Species Plantarum*.

Miller's (1768) plant, '*DAMASONIUM (Alisma) stellatum*. Lugd' was described as 'a native of England; it grows commonly in standing waters, which are not very deep. It is sometimes used in medicine, but never cultivated in gardens...'. One sheet of *Damasonium alisma* is contained in the plants sent from Chelsea Physic Garden to the Royal Society, and thus probably seen by Miller (now in BM). It is labelled '*Damasonium stellatum* Lugd. 1058 *Plantago aquatica stellata* C. B. 190. 1760'. The sheet has a single specimen in good condition with leaves, flowers and immature fruit, a lax inflorescence, anthers c.0.8mm and 2-seeded carpels, and is also *Damasonium alisma* Mill. *sensu stricto* as interpreted here. Thus as both potential types refer to the same taxon, the typification by Siddiqi & Ghafoor (1980) is accepted.

Syn.: *Actinocarpus europaeus* Spreng. in Ersch & Gruber, Encyc. 1: 348 (1818).

Alisma damasonium L., Sp. Pl.: 343 (1753).

Alisma stellatum Lam., Fl. Fr. 3: 77 (1779).

D. dalechampii S. F. Gray, Nat. Arr. Brit. Pl. 2: 217 (1821).

D. damasonium Aschers. & Graebn., Mittel-Eur. Fl. 1: 389 (1898).

D. stellatum Pers., Syn. Pl. 1: 400 (1805).

D. stellatum Thuill., Fl. Par. ed. 2: 186 (1799).

D. vulgare Coss. & Germ., Fl. Env. Paris 2: 521 (1845).

Plant 5–50cm tall. Inflorescence 1–4(–6)-whorled, lax, with pedicels usually 2–4(–12)cm. *Petals* 4.2 ± 0.5 mm long \times 3.7 ± 0.5 mm wide, white with a yellow spot at base. *Anthers* c.0.7–0.9mm (mean 0.75 ± 0.06 mm). *Carpels* usually 6 in a whorl, each (1–)2-seeded, 7–11(–15)mm long \times 2.5–4mm wide, triangular to broadly triangular with a distinct to indistinct beak, glaucous when fresh. *Seeds* 1.7–2.5mm long \times 0.8–1.2mm wide, oblong to reniform.

Chromosome number. $2n = 28$ (tetraploid).

Only three collections have been seen from Russia and Ukraine, which fall morphologically within *D. alisma s.str.* as interpreted here, although the carpels are more swollen and unpublished notes by J. E. Dandy indicated that he was uncertain about stability in seed number in Asian material. The disjunction in distribution from the

western European populations suggests that their relationships may merit further investigation (see also *D. constrictum* below).

Distribution. England, France, Italy, Portugal, Russia and Ukraine (Fig. 1). The records indicate that *D. alisma* is the most northerly species, predominantly occurring inland in England and France, with scattered records from the western Mediterranean coast, Russia and Ukraine. It is very surprising that no material has been seen from Spain (records for the diploids referred to *D. alisma* subsp. *alisma* by Valdés *et al.*, 1987, are here referred to *D. bourgaei*). There is one specimen from Marsala, Sicily in COI, but every other collection seen from this site has been *D. bourgaei*, and there may have been confusion of labels or specimens although it does occur on the coast of Italy to the north.

2. *Damasonium bourgaei* Coss., Notes Pl. Crit. 2: 47 (1849).

Type: Cosson cited five collections that can be regarded as syntypes. The first of these was a set of exsiccatae collected from Puerto Santa Maria by E. Bourgeau in 1849 and distributed as 'Plants of Spain 1849 n. 458'; there are five sheets of this collection in P, of which two are from herb. Cosson. One of these sheets has two plants (one in flower and one in fruit) and the other has one flowering plant. This latter sheet is a typical example of the species and is hereby designated as the lectotype (isolectotypes in CGE, K, P, TCD).

Syn.: *Alisma damasonium* sensu Desf. non L., Fl. Atl.1: 324 (1798).

D. alisma Miller subsp. *bourgaei* (Cosson) Maire in E. Jahandiez & R. Maire, Cat. Pl. Maroc. 1: 22 (1931).

D. alisma Mill. subsp. *bourgaei* (Coss.) B. F. Osorio & Seraphim, List Vasc. Pl. Cyprus 5 (1953).

D. alisma Mill. var. *compactum* Micheli in DC., Mon. Phan. 3: 43 (1881).

Plant 2–35cm tall. *Inflorescence* 1–5(–6)-whorled, usually densely crowded (rarely more lax) with short pedicels 0.2–2.5(–4)cm. *Petals* 3.5 ± 0.4 mm long \times 2.5 ± 0.4 mm wide, pink at top and white in middle with a yellow spot at base. *Anthers* c.0.3–0.5mm long (mean 0.37 ± 0.05 mm). *Carpels* usually 6 in a whorl, each (1–)2-seeded, 5–8.5mm long \times 2.2–3.2mm wide, triangular to broadly triangular, with a distinct to indistinct beak, glaucous when fresh. *Seeds* 1.2–1.8 \times 0.7–0.8mm, oblong.

Chromosome number. $2n = 14$ (diploid).

Quite variable in size and in pedicel development, although the small, crowded fruits are generally distinctive.

Distribution. Algeria, Cyprus, Egypt, Greece, India, Iraq, Israel, Mallorca, Malta, Morocco, Portugal, Sardinia, Sicily, Spain, Syria and Tunisia (Fig. 2). It is the most widespread species, predominantly occurring around the Mediterranean but also further east at least to India. Its absence from Libya is surprising but relatively little material has been seen from this area (all collections seen were *D. polyspermum*). Its

distribution is a southern counterpart to that of *D. alisma*, the differences being reminiscent of other diploid/tetraploid species pairs.

3. *Damasonium polyspermum* Coss., Notes Pl. Crit. 2: 47 (1849).

Type: Cosson cited a set of exsiccatae collected from Puerto Santa Maria by E. Bourgeau in 1849 and distributed as 'Plants of Spain 1849 n. 459'; of the four sheets of this collection in P, only one is from herb. Cosson, which is here designated as the lectotype. We have seen no duplicates of this exsiccate in other herbaria.

Syn.: *D. minimum* Lange, Kjoeb. Vidensk. Meddel. 65 (1860).

D. polyspermum Coss. var. *minimum* (Lange) C. Vicioso; publication not traced.

D. polyspermum Coss. var. *minimum* (Lange) Coss.; publication not traced.

D. alisma Mill. var. *polyspermum* auct.

Plant 3–15(–30)cm tall. *Inflorescence* 1–2(–4)-whorled, lax, pedicels c.1–4(–5)cm. *Petals* 5.4 ± 0.4 mm long \times 4.1 ± 0.6 mm wide, pink at top (at least when fresh) and white in middle with a yellow spot at base. *Anthers* c.0.7–1.2mm long (mean 0.82 ± 0.12). *Carpels* 6–9 in a whorl, each (6–) 8–14 (–17)mm long \times 1.7–4 (–5)mm wide, narrowly triangular without a beak (rarely weakly beaked in plants with very short fruits), not glaucous. *Seeds* (4–)5–8 in each carpel, 0.9–1.2(–1.4)mm long \times 0.5–0.7(–0.9)mm wide, oblong.

Chromosome number. $2n = 14$ (diploid).

Distribution. Algeria, France, Greece, Libya, Morocco, Portugal, Sicily and Spain (Fig. 3). It is predominantly a western Mediterranean plant.

Other taxa

Komarov (1968) includes another species, '*D. constrictum* Juzepczuk' from Kazakhstan, Siberia and central Asia, which Dandy (1980) included within *D. alisma sensu lato*. The description suggests that it is either close to *D. bourgaei* (short pedicels and fruits) or to *D. polyspermum* (seeds 7). We have seen no material and are unable to assess if it is a distinct species or can be included in an existing taxon.

DISCUSSION

Damasonium alisma, *D. polyspermum* and *D. bourgaei* are accepted as species. *Damasonium polyspermum* is the most distinct taxon, by having numerous, small seeds in each carpel (usually two per carpel in the other species). *Damasonium bourgaei* is generally similar to *D. alisma*, at least from herbarium specimens, and could equally be treated as a subspecies of it. We retain it as a species due to its consistently different morphology, different chromosome number, different distribution, and its different reproductive biology (*D. polyspermum* and *D. bourgaei* being largely autogamous and *D. alisma* facultative xenogamous; Vuille, 1987). *Damasonium*

polyspermum and *D. bourgaei* are also closely related and may hybridize, further investigation of which is required (Vuille, 1987).

The few details published by J. E. Dandy and additional unpublished notes (archived at the Natural History Museum, London) indicate that his studies were based on herbarium material alone and that, in treating them as single species, he placed most emphasis on an apparent instability in seed number in each carpel. We have found only rare evidence of such instability, and find the three taxa generally distinct on a range of characters. There are plants intermediate between *D. alisma* and *D. bourgaei* from Portugal (COI), and one puzzling plant intermediate between *D. bourgaei* and *D. polyspermum* from Morocco (type specimen of *D. polyspermum* Coss. var. *medias* Maire, P). The instability noted by Dandy (1980) may be a consequence of hybridization, at least in western European plants.

Quin-feng *et al.* (1997) studied fruit morphology in the genus, and distinguished *D. polyspermum* and *D. alisma* using microscopic characters. However, their results must be treated with caution as it was based on very few specimens, they do not mention *D. bourgaei*, and they included some material named '*D. stellatum*' (a synonym of *D. alisma*) reputedly from Germany where it has never been recorded.

No attempt has been made to review the infraspecific variation of the species. It is likely that all three taxa vary in form depending on water levels and timing of germination, etc. For instance Bennett (1917) noted whilst watching *D. alisma s.str.* plants growing through the summer of 1887 on Mitcham Common, London 'In April it was the form *graminifolium* Glück; in May it began to make itself into the form *spathulatum* Glück; at the end of June it had become the form *natans* Glück; flowered through July and part of August; at the end of August the water became very low, and the plant here or there became stranded; it was now the form *terrestre* Glück. The only one I could not say I saw was the form *pumila* Glück...'. Separating genetic and phenotypic variation at this level would require an experimental approach using controlled growth conditions.

In terms of their ecology, all species are annuals of exposed mud in seasonal water bodies, such as shallow lakes, ponds, ditches, coastal marshes and river flood plains, which dry out in summer. *Damasonium polyspermum* tolerates at least weakly saline conditions, as well as fresh water. Herbarium specimens have usually been collected early in the year (January to April) in Africa and the Mediterranean, and later in the year (May to August) in northern Europe reflecting regional differences in climate. They are predominantly lowland taxa in Europe, but have been recorded to c.1900m altitude in the Lower Atlas mountains of Morocco and to c.1100m in Spain. It is likely that the seeds are dispersed inadvertently by wildfowl, and locally by water and possibly by animals moving around wetland sites. Thus although they have broadly similar ecological requirements, their detailed needs are likely to differ as does their reproductive biology (Vuille, 1987).

The maps indicate that the species have different distributions, and also differ in frequency. Sometimes *D. bourgaei* and *D. polyspermum* have been collected from the same site and probably grow together, and exceptionally, possibly only in Portugal,

all three taxa have been recorded in the same area. The Iberian Peninsula appears to be a centre of diversity for both this genus and the closely related *Baldellia*.

Further work is required to establish the full distribution of each species, especially in North Africa and Asia, as well as the current status. It is not possible to assess the current status of any of the species from herbarium specimens due to the predominance of historical material and the *ad hoc* nature of the collections, here further biased by the material held in predominantly western European herbaria. For instance, the maps indicate that *D. alisma sensu stricto* has occurred widely in both France and England but in both countries it is now rare and is regarded as a 'Red List' species. Nonetheless, this review now provides a firm basis for collecting further information needed to make conservation decisions about *Damasonium* species, and it is likely that some Red Lists will need to be revised. We will be happy to name further material and exchange information on their conservation and biology.

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