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The genus *Alisma* L. (Alismataceae) in South Australia

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Abstract

The genus *Alisma* L. (Alismataceae) is revised for South Australia, with several populations previously incorrectly identified as the introduced weed *A. lanceolatum* With. (narrow leaved water plantain) found instead to be the native *A. plantago-aquatica* L. (common water plantain). The distinguishing features for these taxa and related Alismataceae in South Australia are given and the implications for their conservation and/or weed status are discussed.

Keywords: South Australia, *Alisma plantago-aquatica*, *Alisma lanceolatum*, Alismataceae, taxonomy.

Introduction

The monocot family Alismataceae consists of herbaceous aquatic macrophytes and is represented by 11–14 genera and ~100 species worldwide (Haynes et al. 1998, Jacobson & Hedrén 2007, Mabberley 2008), of which five genera and 11 species occur in Australia (Jacobs & McColl 2011). The genus *Alisma* L. (water plantains) has 9–11 species (Björkquist 1968, Wang et al. 2010), mostly widely distributed throughout the Northern Hemisphere of the Old World (Wang et al. 2010), but with three native species recognized for North America (Rubtsoff 1964, Haynes & Hellquist 2000). In particular, *A. plantago-aquatica* L. and *A. lanceolatum* With. are widespread throughout Eurasia with the former extending to Australia and the latter to North Africa, and both species are also introduced weeds in a number of places including North America (Haynes & Hellquist 2000) and New Zealand (Allan Herbarium 2000). *Alisma plantago-aquatica* has a natural range extending from Europe across to subtropical and temperate areas of SE Asia including China, Burma, Japan, Korea, Thailand and Vietnam and south-eastern Australia and its wide distribution (and presence in Australia) may be the result of long-distance transport of the fruits by migratory wetland birds (Green et al. 2002), but this requires further study.

In Australia, *A. plantago-aquatica* is considered to be native to at least New South Wales and Victoria (Aston 1973), as well as possibly introduced to south-east Queensland and Tasmania (Jacobs & McColl 2011), but its natural distribution requires further investigation.

Alisma has been the subject of some taxonomic controversy in South Australia and it is unclear if it is native or an early introduction. However, based on the native distribution of *A. plantago-aquatica* in Victoria and its presence in the upper Murray and Wimmera River drainage systems, it should be expected to occur naturally in South Australia. *Alisma plantago-aquatica* was recorded in South Australia by Black (1922, as *A. plantago* non L.); however, there are early 20th century collections at AD made by him of both *Alisma plantago-aquatica* and *A. lanceolatum*. In contrast, Eichler (1965), Aston (1973), Jessop (1986) and Jacobs & McColl (2011) considered that the South Australian *Alisma* accessions all represented the introduced weed *A. lanceolatum*, also apparently failing to notice the presence of collections of both species.

As a result of field work by the author in wetlands across the Southern Lofty and South East regions, it quickly became apparent that there were two *Alisma* species in South Australia: the introduced *A. lanceolatum*, but also the native *A. plantago-aquatica*. Examination of all the *Alisma* collections at AD further supported this, as well as providing historical data on some now extinct localities for *A. plantago-aquatica*. Because the recent *Flora of Australia* account only lists one species in the State (Jacobs & McColl 2011), a revised account for South Australia is necessary both to update distributions, as well as to detail known localities of the native species for conservation. This is especially relevant as several native populations are the target of eradication programs due to misidentification as the introduced weed.

Taxonomy

Key to the species of Alismataceae in South Australia

1. Carpels weakly coherent into a star-like ring
 *Damasonium minus* (R.Br.) Buchenau
- 1: Carpels distinct, forming heads or rings on a receptacle 2
 2. Flowers unisexual; carpels in a convex head
 **Sagittaria platyphylla* (Engelm.) J.G.Sm.
- 2: Flowers all bisexual; carpels arranged in a flattened ring 3
 3. Leaf blade narrowly elliptic to lanceolate, apex acute to acuminate, base cuneate, tapering; petals usually acuminate 2. **Alisma lanceolatum* With.
- 3: Leaf blade ovate to broadly lanceolate, apex bluntly acute to rounded, base ± rounded to cordate; petals usually broadly rounded 4
 4. Flowers pink; style longer than the ovary
 1. *Alisma plantago-aquatica* L.
- 4: Flowers white; style shorter than or equalling the ovary *Alisma triviale*¹ Pursh

Alisma L.

Sp. Pl. 1: 342 (1753).

Perennial, evergreen or geophytic, glabrous, rhizomatous herbs. Leaves emergent to submerged and floating, sessile or petiolate; lamina linear to ovate, margins entire, base attenuate to rounded or cordate, apex obtuse to tapering-acute. Inflorescence an erect, generally emergent, pyramidal compound panicle of 2–10 verticillate whorls; bracts acuminate. Flowers bisexual; pedicels spreading; pedicel bracts lanceolate, short, acuminate; sepals erect to spreading, sometimes recurving in fruit; petals pink or white, entire to apically subdentate; stamens 6, in pairs opposite the petals, filaments filiform, glabrous; carpels 12–20 around margin of flattened receptacle; ovule 1; style lateral to terminal. Fruits laterally compressed, abaxially 2–3-ribbed achenes. $x = 7$.

1. *Alisma plantago-aquatica* L.

Sp. Pl. 1: 342 (1753).

A. lanceolatum auct. non With.: Jessop in Jessop & Toelken, Fl. S. Austral. 4: 1709 (1986), partly.

‘*A. plantago*’ orth. var.: L., Syst. Nat. ed. 10, 2: 993 (1759), cf. Richt., Codex Bot. Linn. 351 (1835–1839); R.Br. in Flinders, Voy. Terra Austral. 2: 592 (1814); Woolls, Contrib. Fl. Austral. 150 (1867); Benth, Fl. Austral. 7: 185 (1878); F.Muell., Syst. Cens. Austral. Pl. 121 (1882) & Syst. Cens. Austral. Pl. ed. 2, 205 (1889); J.M.Black, Natural. Fl. S. Austral. 143 (1909); Fl. S. Austral. 1: 49 (1922) & Fl. S. Austral. ed. 2, 1: 52 (1943).

Perennial aquatic herbs to 1.5 m, rhizome thick, corm-like, to 5 cm diam. Leaves emergent, petioles 5–40 cm long, 4–16 mm diam.; blade lanceolate to broadly

elliptic or ovate, 2.5–30 × 1–12 cm, apex bluntly acute to rounded, base obtuse-tapering to cordate; venation acrodromous, mostly with 2 basal pairs and a single, strong suprabasal pair of secondary veins. Inflorescence to 150 × 50 cm. Flowers numerous in ~10 mm diam. clusters of 2–5, pedicels 3–45 mm; sepals ovate-lanceolate, green, 1.5–3.5 × 1.5–2 mm; petals broadly obovate, purplish-white to pink, 3.5–6.5 × 3.5–6 mm, margins entire to denticulate, apex obtuse to broadly rounded; anthers ellipsoid, 0.7–1.4 mm; style ± straight, 0.5–1.5 mm, ovary 0.4–0.6 mm long. Fruiting heads 4–7 mm diam.; achenes obovoid, 1.7–3.1 mm long, abaxial keels broadly rounded, with usually 1 median groove, beak ± erect. $2n = 14$. **Common water plantain. (Fig. 1A–C).**

Distribution. S.A.: NL, SL, SE; Qld; N.S.W.; Vic; Tas; Europe and Asia. Naturalised in North and South America and New Zealand.

Habitat. Grows in damp ground or shallow water. Plants in permanently damp areas are evergreen, those in drier areas dying back to the thick, corm-like rhizome.

Conservation status. Rare in South Australia and apparently locally extinct at several localities. Threatened by habitat loss and eradication due to misidentification as *A. lanceolatum*.

Flowering and fruiting period. Dec.–Mar.

Affinities. Species taxonomy in *Alisma* has been problematic (Hendricks 1957, Voss 1958, Rubtzoff 1964), with the native North American former representatives of the very widespread and variable Old World taxon *A. plantago-aquatica* now regarded as separate species on stylar and other morphological characteristics (Björkqvist 1967, Haynes & Hellquist 2000), although the Eurasian species is also naturalised there (Haynes & Hellquist 2000). This separation is further supported cytologically, as *A. plantago-aquatica* is a diploid ($2n = 14$), whereas the North American segregate species *A. triviale* is a tetraploid ($2n = 28$), as is *A. lanceolatum* ($2n = 26, 28$) (Baldwin & Speese 1955, Jacobson & Hedrén 2007).

Molecular analyses of evolution in the genus are still unclear, with evidence of relatively low genetic divergence between many taxa. The *A. plantago-aquatica* species complex was distinct and thought to be possibly more derived phylogenetically than *A. lanceolatum* (Jacobson & Hedrén 2007), but the origins of most of the polyploid taxa are uncertain. However, the phylogenetic study of *Alisma* by Jacobson & Hedrén (2007) did not include any native Australian material of *A. plantago-aquatica*, so its precise relationship to the European and Asian members of the complex are still unknown.

Note. The name of this species was published by Linnaeus as “*Alisma Plantago* Δ”, which translates to “*Alisma plantago-aquatica*” (Art. 23.3, McNeill et al.

¹ Although not recorded as naturalised in Australia, *A. triviale* is cultivated at the Mount Lofty Botanic Gardens (accession no. G843495; listed in Sandham & Kellermann 2010 as *A. plantago-aquatica* var. *americanum* Schult. & Schult.f.), where it self-seeds freely in an artificially maintained bog and along an associated creek and dam (along with *Sagittaria platyphylla*). It is keyed here because of its very close resemblance to *A. plantago-aquatica* when not in flower and its possible weed potential.

2006). However, from the 10th edition of his *Systema Naturae* (1759), Linnaeus only used “*plantago*” as epithet of the species, a fact already noted by Richter (1835–1839). This orthographic variant of the name has been used by numerous authors throughout the years; the major publications relevant to Australia are listed in the synonymy.

Specimens examined.

SOUTH AUSTRALIA. **Northern Lofty:** 1 km from Wirrabarra Forest Headquarters, 25 Apr. 1994, *R.J.Bates 37061* (AD 99522058). **Southern Lofty:** Reedbeds at Fulham (c. 8 km W of Adelaide), 18 Oct. 1908, *J.M.Black s.n.* (AD 97623463); Reservoir near Mount Lofty Railway Station, 13 Apr. 1960, *E.H.Ising s.n.* (AD 96220135, AD 96220136); Cresswell Park, Gilberton, 14 Jan. 1976, *A.G.Spooner 4525* (AD 97621406); Thomas Gully, Mt Bold Reservoir Track 43, 14 Nov. 2007 *D.J.Duval 946 & T.S.Te* (AD 214871, AD 214872); Woorabinda Res., Stirling Linear Park, 8 Oct 2011, *J.G.Conran 3142* (AD, ADU). **South East:** Millicent, town drain running toward Lake Bonney, 27 Nov. 1996, *D.Guerin s.n.* (AD 212157, AD 99650378).

2. **Alisma lanceolatum* With.

Arr. Brit. Pl. ed. 3, 2: 362 (1796).

A. plantago-aquatica auct. non L.: R.Br. in Flinders, Voy. Terra Austral. 2: 592 (1814); Woolls, Contrib. Fl. Austral. 150 (1867); Benth, Fl. Austral. 7: 185 (1878); F.Muell., Syst. Cens. Austral. Pl. 121 (1882) & Syst. Cens. Austral. Pl. ed. 2, 205 (1889); J.M.Black, Natural. Fl. S. Austral 143 (1909); J.M.Black, Fl. S. Austral. 1: 49 (1922) & Fl. S. Austral. ed. 2, 1: 52 (1943), pro parte, as ‘*plantago*’ (orth. var.).

Perennial aquatic herbs to 1.5 m, rhizome thick, corm-like, to 5 cm diam. Leaves emergent, petioles 5–50 cm long, 4–16 mm diam.; blade lanceolate, 3–25 × 1–6.5 cm, apex acute to acuminate, base cuneate, tapering; venation pinnate, mostly with 1 basal pair and two well-spaced suprabasal pairs of secondary veins. Inflorescence to 120 × 50 cm. Flowers numerous in clusters of 2–5, ~9 mm diam., pedicels 3–45 mm; sepals ovate-lanceolate, green, 1.5–3.5 mm; petals broadly oblanceolate to obovate, purplish-white to pink, 3.5–6.5 mm, margins entire to irregularly subdentate, apex acuminate to rounded acute; anthers ellipsoid, 0.6–1.1 mm; style ± curved, 0.5–1.5 mm, ovary 0.4–0.6 mm long. Fruiting heads 4–8 mm diam.; achenes obovoid, 2–3 mm long, abaxial keels broadly rounded, with 1–2 median grooves, beak ± erect. 2n = 28. **Narrow leaved water plantain. (Fig. 1D–F).**

Distribution. S.A.: SL; W.A.; Qld; N.S.W.; Vic; Tas.; native to Europe, North Africa and Asia.

Habitat. Grows in damp ground or shallow water. Plants in permanently damp areas are evergreen, those in drier areas dying back to the thick, corm-like rhizome.

Conservation status. A naturalised weed which appears to be spreading widely throughout the Onkaparinga River catchment

Flowering and fruiting period. Dec.–Mar.

Affinities. A phylogenetically somewhat isolated tetraploid species of uncertain origin (Jacobson & Hedrén 2007).

Specimens examined.

SOUTH AUSTRALIA. **Southern Lofty:** Leslie Creek, Mylor, 7 Mar. 1986, *R.J.Bates 6784*, (AD 98631080); Mylor, banks of Onkaparinga River, 4 Feb. 1979, *L.D.Williams 10196* (AD 98426341); R[iver] Onkaparinga, n[ear] Longnook, 31 Dec. 1906, *S.A.White s.n.* (AD 97919317); Bridgewater, 20 Jan. 1919, *J.M.Black s.n.* (AD 97623464); Onkaparinga River, 31 Dec. 1906, *H.H.D.Griffith s.n.* (AD 97623462); Mylor, “Rockford” (property of Mr C.G. Little), at the Onkaparinga River, 14 Dec. 1967, *Hj.Eichler 19715* (AD 97616010); Clarendon Weir, 3 Dec. 1928, *J.B.Cleland s.n.* (AD 97236070); Onkaparinga River at Mylor, 2 Dec. 1938, *J.B.Cleland s.n.* (AD 97236071); Onkaparinga River, near Mylor, c. 20 km SE of Adelaide, 9 Dec. 1944, *J.B.Cleland s.n.* (AD 967510057, AD 95852022, AD 95852023); Onkaparinga River near the bridge of the road from Mylor to Echunga, 19 Mar. 1957, *Hj.Eichler 13699* (AD 95814005); Mylor, Aldgate Creek, near the bridge on the road to Aldgate, 19 Mar. 1957, *Hj.Eichler 13690* (AD 95813059, AD 95813049, AD 95813050, AD 95813051, AD 95813052, AD 95813043); Onkaparinga River at Verdun, 15 Feb. 1967, *B.Grivell s.n.* (AD 96932472, AD 96932463, AD 96932459, AD 96932456); Aldgate Valley reserve in creekline, 12 Mar. 2010, *C.J.Brodie 1528* (AD 235326); SE corner of Happy Valley Reservoir c. 15 km S of Adelaide, 11 Jan. 1959 *R.Schodde 1069* (AD 96027072, AD 96027073, AD 96027074, AD 96027075, AD 96027076, AD 96027077); Creek crossing just S of Verdun on Onkaparinga Valley Rd c. 100 m N of turnoff to Mount Barker Rd, 2 Jan. 2012, *J.G.Conran 3240* (AD, ADU); Aldgate Valley Reserve, 7 Jan. 2012, *J.G.Conran 3241* (AD, ADU); Leslie Ck, Mylor Parklands, cnr Stock Rd and Strathalbyn Rd, 7 Jan. 2012, *J.G.Conran 3243* (AD, ADU); Cooper Reserve, Silver Lake Rd, Mylor, 7 Jan. 2012, *J.G.Conran 3244* (AD, ADU); Outfall creek/drain from Happy Valley Reservoir near cnr Chandlers Hill and Serpentine Rd, 18 Jan. 2012, *J.G.Conran 3245* (AD, ADU).

Discussion

All the Alismataceae listed here mainly occur in seasonally moist to permanently wet bogs and wetlands, where they grow in shallow water along creeks, lake or swamp margins, or in ditches. Although the *Alisma* species are all perennial, they can also behave as annuals and/or geophytes in climates with seasonal drought (Jacobs & McColl 2011).

Germination in *Alisma* often requires a combination of stratification and alternate drying/wetting cycles (Björkqvist 1967); *A. plantago-aquatica*, however, has different and more specific germination requirements than *Alisma lanceolatum* (Moravcová et al. 2001). Nevertheless, these studies were conducted for European populations where there are strong seasonal effects and the germination biology of the species in southern Australia has not been studied in detail.

Alisma lanceolatum, along with the noxious weed *Sagittaria platyphylla* and the native *Damasonium minus* are all considered to be weeds of rice fields in New South Wales (McIntyre & Newnham 1988), with *S. platyphylla* also regarded as a weed in Western Australia (Sage et al. 2000). *Alisma* and *Damasonium* species

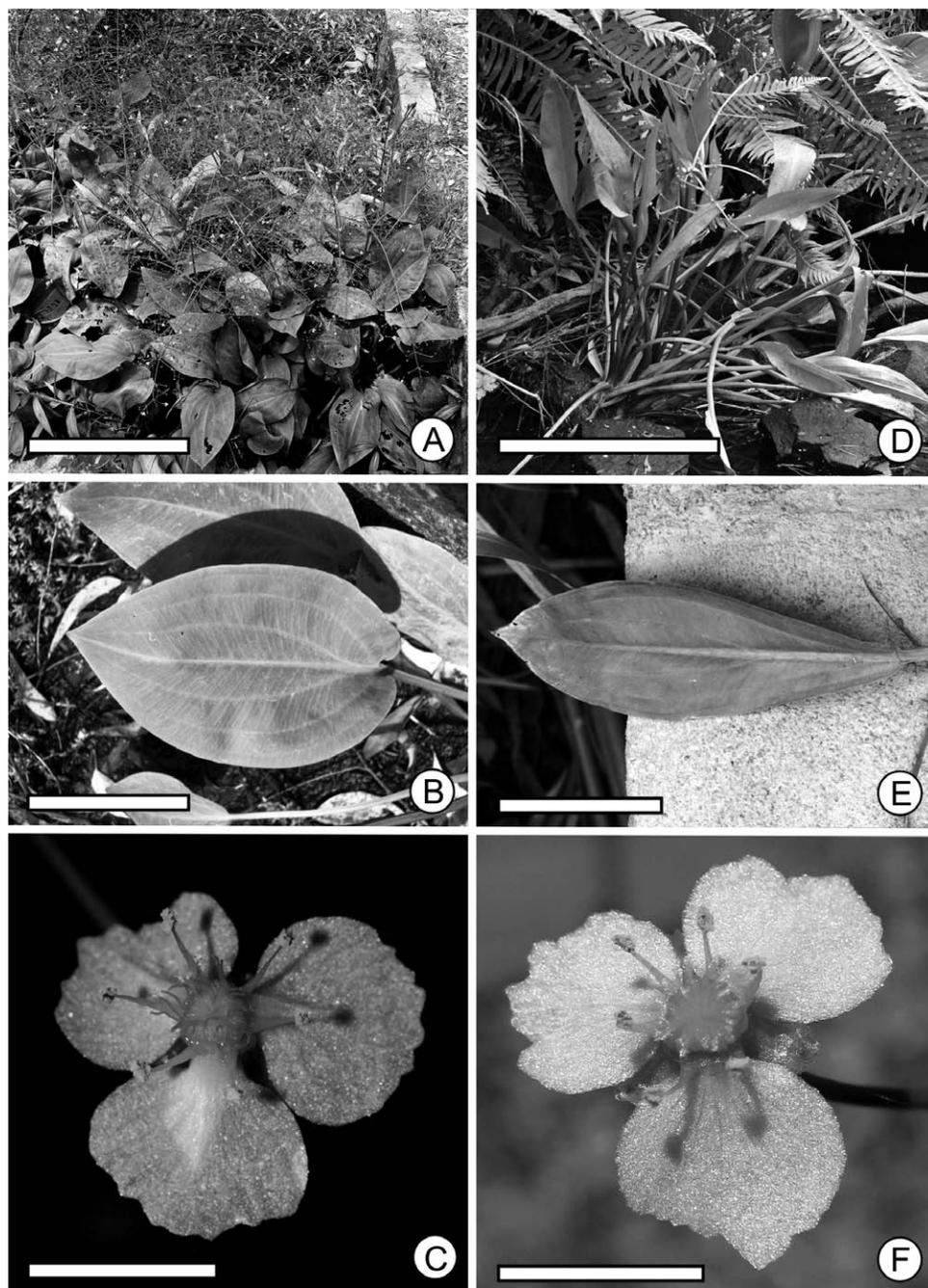


Fig. 1. *Alisma* species in South Australia. **A–C** *A. plantago-aquatica*: **A** habit; **B** leaf showing sub-cordate leaf with two pairs of basal and one suprabasal secondary leaf vein pair and percurrent tertiary venation; **C** flower showing rounded petals and more or less straight stigmas. **D–F** *A. lanceolatum*: **D** habit; **E** leaf showing lanceolate leaf with one pair of basal and two pinnate suprabasal secondary leaf vein pairs and percurrent tertiary venation; **F** flower showing \pm acuminate petals and curved stigmas. Scale bars: **A, D** 20 cm; **B, E** 5 cm; **C, F** 5 mm.

have been found to show herbicide resistance and are the subject of studies for biocontrol (Ash et al. 2008), but this also has implications for the conservation of the native species in southern Australia.

The collections of *Alisma plantago-aquatica* in the State Herbarium of South Australia (AD) indicate that from the few collections made, it was probably never very common. Populations are no longer present in the Torrens River catchment and the vast majority of suitable habitat locations for the species in the Onkaparinga River catchment only appear to support *A.*

lanceolatum. The single report for *A. plantago-aquatica* from the Northern Lofty in the Wirrabarra Forest needs investigation to see if the species is still extant there.

The South-East Region collections from Millicent were reported from the town drain running toward Lake Bonney, where it was noted on the specimen (AD 212157) that the population had grown rapidly and become locally dominant by 1996, despite an attempt to control with metsulfuron-methyl in 1994.

There are potential issues with the superficial similarity of sterile or juvenile *A. plantago-aquatica*

to the native *Plantago major* L. (Plantaginaceae) and the introduced *Zantedeschia aethiopica* (L.) Spreng. (Araceae), both of which grow in the same environments. Nevertheless, they are easily separated on leaf venation, as the tertiary veins in *A. plantago-aquatica* are strongly percurrent (ladder-like) between the secondaries (Fig. 1B), whereas they are reticulate in these others.

It is unfortunate that the failure in the past to realise that there were two *Alisma* species – one native and one weedy has meant that an already uncommon native plant in South Australia has possibly been targeted for removal due to its misidentification as a weed. Given that there are now very few localities for this species in the State, mainly due to habitat alteration/loss, it is probably just as well that it is resistant to the ALS inhibitor class herbicides that are commonly used to control aquatic weeds (Ash et al. 2008, Figueroa et al. 2008). Measures should be taken to encourage its conservation at those places where it still occurs, rather than physical or chemical removal.

More research, particularly cytological and genetic is needed to determine whether the specimens of *A. plantago-aquatica* are native to South Australia or an early introduction, as well as whether the species in Australia is the same as that in the Northern Hemisphere of the Old World. However, for the moment the species should be considered native until proven otherwise and conserved accordingly.

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