HYDROCLEYS NYMPHOIDES (BUTOMACEAE) IN AUSTRALIA

by

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SUMMARY

The first known naturalized occurrence of the South American aquatic monocotyledon *Hydrocleys nymphoides* in Australia is reported from Valencia Creek, Central Gippsland, Victoria. As the species has been a cultivated ornamental in Australia since at least 1896 without, until now, being recorded as naturalized, it is thought unlikely ever to become a major troublesome weed. However, deliberate planting in natural situations should be avoided. The apparent inability of Australian populations to set seed is probably a major factor in preventing naturalization as the plant is able to thrive in varied climates. A note of caution is sounded against the importation of any fresh strains of *H. nymphoides*.

A full botanical description and illustration are provided. A brief account of naturalization in other countries is given.

INTRODUCTION

The South American genus *Hydrocleys* Commers. ex L.C. Rich. (also spelt *Hydrocleis* by some authors) contains about nine species (Pedersen, 1961), of which only *H. nymphoides* is widespread in cultivation. The glossy foliage and yellow flowers of *H. nymphoides* make it attractive for ornamental ponds and it was introduced into horticulture soon after it was described (as *Stratiotes nymphoides*) in 1806. Hooker (1833) reports successful flowering in April 1833 in the aquarium of the Botanic Garden of Liverpool, England, of plants grown from seed obtained near Buenos Aires. Cook (1974) states that *H. nymphoides* has been grown in heated greenhouses in Europe since 1830. In Australia it has been cultivated since at least 1896.

DESCRIPTION

Hydrocleys nymphoides (H. & B. ex Willd.) Buch. in *Abhandlungen des Naturwissenschaftl. Vereines zu Bremen* 2: 2 (1868).

BASIONYM: *Stratiotes nymphoides* H. & B. ex Willd. 'Linn. Spec. Pl.' 4 (2): 821 (1806).

SYNONYMS: *Hydrocleys commersonii* L.C. Rich. in *Mém. Mus. Hist. Nat.* 1: 368 and 373, t.18 (1815).

Limnocharis humboldtii L.C. Rich., l.c. 1: 369, t.19[1] (1815).

ENGLISH VERNACULAR NAME: "Water Poppy".

Robust, perennial, emergent, stoloniferous, freshwater, aquatic, usually with a milky sap. *Stolons* to several metres long, terete, rooting at the nodes, the internodes to 60 cm long x 5-6 (–11) mm diameter; nodes each producing a cluster of perhaps 5 to 7 leaves and several flowers with the petioles and peduncles subtended by membranous, ovate to lanceolate bracts c. 3-4.5 (–6.5) cm long. *Leaves* floating or erect; petioles terete, sheathed at the base, to 60 cm long x 8 mm diameter, with many fine longitudinal cavities and with transverse septa at intervals of a few –10 mm, the septa visible externally; blades broad-elliptic to broad-ovate to suborbicular, 3.5-13.5 cm long x 3-12 cm broad, obtuse to rounded at the summit, shallow-cordate (or rounded on younger leaves) at the base, medium to dark green,

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Muelleria 4 (3): 285-293 (1980).

thick-textured, glabrous, smooth, glossy above (and also, at least in the erect leaves, below), swollen with spongy tissue on the undersurface along the midrib and particularly at the junction of the midrib and petiole; blades with 3-4 curved-longitudinal veins on either side of the midrib (the fourth vein when present being close to the leaf margin and sometimes only in the basal portion of the blade) and with many close-set transverse veins radiating from along the whole length of the midrib. *Flowers* bisexual, c. (4–)5-6 cm across, solitary in the leaf axils but appearing crowded at each node, held well above the water surface on terete peduncles to 24 cm long x 4 mm diameter, the peduncles with longitudinal cavities and transverse septa similar to those of the petioles. *Sepals* 3, imbricate, ovate, obtuse, deep green and coriaceous with very narrow translucent margins, c. 16-20(-25) mm long x 6-10 mm broad, persistent even in fruit. *Petals* 3, alternate to and almost twice as long as the sepals, pale yellow with deeper yellow at the base, extremely broad-obovate (± fan-shaped, usually a little broader than long), imbricate and together forming a bowl-shaped flower, thin-textured and lasting only one day (perhaps two), shrivelling in the afternoon, c. (3-)3.5-4 cm long x (3-)4.5-5 cm broad. *Stamens* hypogynous, many, about two-thirds as long as the sepals, in several series surrounding the gynoecium, the outer ones sterile, the inner ones fertile; sterile stamens reduced to flattened, awl-shaped staminodes, about as many as the fertile ones; fertile stamens (c. 24 on specimens seen) with dorsiventrally-flattened, linear, deep purple filaments c. 3-4 mm long and anthers 5-6 mm long; anthers deep purple, narrow-linear, basifixed, bilocular, the two locules connected along their full length by a connective which is about as broad as each of the locules, each locule dehiscing by a longitudinal slit; pollen yellow. *Gynoecium* superior, c. 11-13 mm long, of 6 carpels on specimens seen (5-8 reported by other authors), the carpels free or attached only at the base; carpel with a ± narrow-ovoid ovary tapered into a short, thick style; stigma purple, papillate, capping the style and also extending a short way down its adaxial surface; ovules numerous, scattered over the carpel wall. *Fruits and seeds* not found on Australian material but from other descriptions the fruiting carpels are free or nearly so, beaked by the persistent style, c. 15 mm long, and open by the adaxial suture; seeds are several to numerous, small, horseshoe-shaped.

Seedlings produce ribbon-like, juvenile leaves. Mature adult plants can revert to a juvenile-leaved state when subjected to conditions of poor nutrition, e.g. immersion in deep or heavily-shaded water; transference to a barren substrate; drastic pruning of foliage or roots (Arber, 1920; Sculthorpe, 1967). Neither seedlings nor ribbon leaves have been noted in Australian populations.

Mature plants in cultivation may produce small plantlets along the stolons. These plantlets detach and float to the surface and may eventually take root. They seem more abundant towards the end of the growing season and when nutrition levels are low. Plantlets have not been noted in the Malmsbury or Valencia Creek populations (see later).

FLOWERING TIMES: *Brisbane* — about Sept. to end of April, with some flowers produced beyond then if the season remains warm. *Sydney* — (Nov.) Dec. to March; Jan. to March under lower nutrient levels. *Valencia Creek* — Jan. (also earlier?) to March and possibly early April.

More detailed descriptions on some aspects are supplied by Argue (1973, pollen), Stant (1967, anatomy), Sattler & Singh (1974, floral development) and Charlton & Ahmed (1973, developmental morphology).

EXTRA-AUSTRALIAN OCCURRENCES

Hydrocleys nymphoides occurs naturally from Venezuela to Brazil and south to Buenos Aires, Argentina. It might therefore be expected to grow best in tropical to subtropical climates. However, it can become naturalized in warm temperate or even cool temperate regions. Perry (1961) states that in England it will grow outside in summer but generally must be wintered indoors although "we have often wintered it outdoors in mild winters . . .". Muenscher (1944) reports the species as naturalized in ponds and pools in the southern United States of America, but in the north it "grows well in shallow water but

Fig. 1. *Hydrocleys nymphoides*. a — habit of flowering plant, x 0.4. b — fertile stamen, x 4. c — gynoecium, x 2. d — style and stigma, x 10. e — carpel, with portion of wall removed to show scattered ovules, x 3. f — leaf, abaxial surface, showing venation and swollen midrib, x 1. g — portion of flower showing the sepals, 6 carpels, several fertile stamens and 2 staminodes; the petals and most of the stamens and staminodes removed for clarity, x 2. From Aston 2006, Valencia Creek, 9.v.1979 (MEL 1512178-84) and Miles, Valencia Creek, 14.iii.1979 (MEL 1512174-5).

will not survive the winter in the open''. Sculthorpe (1967) lists *H. nymphoides* as naturalized in the warmer regions of U.S.A., in New Zealand and in Japan. In Fiji (Smith, 1979) the species is sparingly naturalized and regarded as probably a fairly recent introduction, the only collection having been made in 1969.

Cheeseman (1914) first recorded the naturalization of *H. nymphoides* in New Zealand. It was then plentiful in several lagoons or backwaters near the Thames River, at Te Aroha, (37° 32′ S.; 175° 43′ E.) North Island, and apparently rapidly increasing. It had been planted nearly twenty years previously in one of the lagoons where by 1914 it covered an acre or more in area and was blocking drains and water-channels. Because of its attractiveness it had been transferred to other lagoons and was rapidly increasing at each new location. R. Mason (pers. comm., 1973) indicates that nothing more was heard of the species in New Zealand until 1961 when a specimen was forwarded from the Te Aroha district, and again in 1971 when it was recorded in Glen Eden, west of Auckland, where it was blocking drainage in a hydro station. Mason had not found the species in the Te Aroha district when searching for it a year or so prior to 1961 so the 1914 infestations may have died out or declined, and the 1961 collection have been made from a fresh infestation.

AUSTRALIAN OCCURRENCES

Cultivated

In Australia *H. nymphoides* has been in cultivation since at least 1896, as a mixed collection (MEL 1512176-7) contains material grown in the Melbourne Botanic Gardens in December 1896 and February 1908. Early collections from the Sydney Botanic Gardens show that it was cultivated there in February 1899 (NSW 143692) and February 1904 (NSW 143691). More recently there is a December 1949 collection (NSW 143690) from the Sydney Botanic Gardens and a November 1957 collection (NSW 143693) from Castle Hill, Sydney, while Oakman (1958) listed the species amongst those ''commercially obtainable plants which can be easily grown in Queensland garden pools''. Today *H. nymphoides* is still commercially obtainable and widely grown as an ornamental in outdoor ponds, for example at the Mt. Cooth-tha Botanic Gardens, Brisbane, the Royal Botanic Gardens, Sydney, at Malmsbury, central Victoria and in the Burnley Gardens, Melbourne.

Brisbane — Three pieces were planted in an ornamental lagoon at the Mt. Cooth-tha Botanic Gardens in January 1976 and within two years they had covered an area of 2000-2500 square metres. The original pieces were obtained from a public garden in Southport, south-east of Brisbane. At Mt. Cooth-tha nutrient levels in the lagoon are high due to seepage through adjacent thick mulches of sewerage sludge, manures and animal stall litter. Because of the excessive rapidity of spread *H. nymphoides* is now being eradicated with herbicide. Plant sections which, at times, were washed over the lagoon wall and down the creek below the lagoon have not survived as the creek dries out. (B. Dangerfield, pers. comm.).

Sydney — In about 1973 several pieces planted in a pond in the Royal Botanic Gardens made very rapid growth. The gardens plants are grown in rotted manure covered in sand while other plants grown by one of us (S.W.L.J.) at Carlton, near Botany Bay, Sydney, are potted into a mixture of about 75% blood and bone and 25% sand to produce good flowering.

Malmsbury — In a large ornamental lake at Malmsbury (37° 11′ S.; 144° 23′ E.), about 20 km south-east of Castlemaine, central Victoria, very little *H. nymphoides* was present in early 1973. By June 1979 it had spread to form dense growth over four patches c. 12 x 6, 12 x 6, 5 x 5 and 1 x 1 metres, thus occupying a total surface area of approximately 170 square metres (Aston, pers. obs.: MEL 1513587-90; BRI; CANB; NSW). The lake is filled by stormwater drainage from the adjacent sealed highway and has no nutrients added to it (Kyneton Shire Secretary and R.H. Wood; pers. comm.). Overflow is to the nearby Coliban River but a search of this in June 1979 for about 0.5 km downstream from the lake revealed no sign of *H. nymphoides*.

Naturalized

There is only one naturalized occurrence of *H. nymphoides* known in Australia. It is at 37° 48-49′ S., 147° 00-00.5′ E., in Central Gippsland, Victoria, about 2-3 kilometres north-east of Valencia Creek township and approximately 17-18 kilometres north of Maffra. Plants are well-established over a distance of approximately one kilometre in a gully which lies to the east of the Valencia Creek stream. The gully runs south-west into the Creek, which then runs south to join the Avon River just north of Valencia Creek township (Fig. 2).

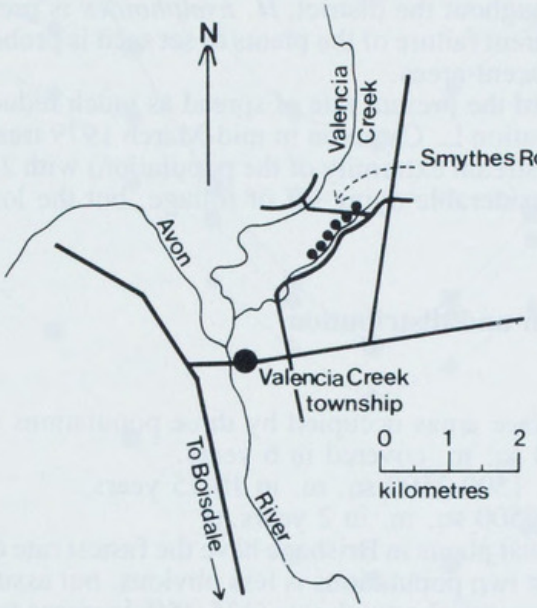

Fig. 2. Map showing the full extent, May 1979, of the naturalized occurrence of *Hydrocleys nymphoides* at Valencia Creek. Extent indicated by row of dots.

The species was first reported from this location in January 1979 by L. Cameron, a local farmer concerned with its growth on his property. Mr. Cameron, through M. Hitchins and T. Miles, both of the State Rivers and Water Supply Commission, provided a voucher specimen (NSW 143340). Subsequent specimens were collected by T. Miles on 14th March 1979 (MEL 1512174-5; NSW) and H. Aston on 9th May 1979 (MEL 1512178-84; AD; BRI; CANB; NSW).

The gully where *H. nymphoides* grows runs through cleared dairying farmland and contains a small watercourse. In its upper region this watercourse is perhaps only 0.5-1 metre wide, with water from a few centimetres to a metre deep, and in the shallower places may dry out almost completely in summer. In its lower region several sections have been widened and deepened to form water-storages for stock. Growth of *H. nymphoides* is most prolific in these storages. In March 1979, with high water level, several storages united to form a 300 metre long lagoon completely edged with *H. nymphoides*. Plants were rooted in edgewaters from a few to c. 60 cm deep and extended floating stolons out over water to three metres deep. Edging plants were densely massed with intertwined stolons and leaves, the crowded leaves typically standing erect and up to 45 centimetres above the water surface. Less-crowded stolons over deep water produced leaves with the blades typically

floating flat on the water surface. Growth was luxuriant and plants were flowering well although seed was not being set.

There are apparently high nutrient levels in the storages as the surrounding farmland is top-dressed with superphosphate while washings from the farm dairy flow directly into the storages.

The Valencia Creek population originated from a few plants placed in the watercourse approximately 10 to 15 years ago by the late Mrs. H. Smythe, a water-lily fancier on an adjacent property. This planting was just north of Symthes Road, at or near the upstream limit of the present population. From here the species spread fairly rapidly downstream. In March and May 1979 a search was made downstream from the present population along the gully, Valencia Creek and Avon River to the road crossing of the Avon immediately west of Valencia Creek township. *H. nymphoides* was not located during this search.

Although there have been at least two major floods which could have assisted further spread of the species throughout the district, *H. nymphoides* is presently restricted to the gully described. The apparent failure of the plants to set seed is probably the major cause of non-establishment in adjacent areas.

Local residents regard the present rate of spread as much reduced compared with the initial rate, but as a precaution L. Cameron in mid-March 1979 treated plants in his lower storage (sited at the downstream extremity of the population) with 2,4-D. The initial effect of this treatment was considerable dying-off of foliage, but the longer-term effect is yet unknown.

Factors affecting growth and distribution

Nutrition and Climate

Estimates of the surface areas occupied by three populations are:

Malmsbury: 170 sq. m. covered in 6 years.
Valencia Creek: 1500-2500 sq. m. in 10-15 years.
Brisbane: 2000-2500 sq. m. in 2 years.

These figures show that plants in Brisbane have the fastest rate of growth. Comparison of growth rates of the first two populations is less obvious, but assuming an initial surface area of 1 sq. m. and a geometrical growth rate (135.35% increase per year calculated from the above data), and extrapolating, it is estimated that the area which would be covered by the Malmsbury population in 9 years is 2215 sq. m. and in 10 years is 5214 sq. m., i.e. coverage at Malmsbury could be similar to that at Valencia Creek. Although accurate information is lacking, the data available suggest that there is probably no major difference between the growth rates of these two populations.

For successful cultivation *H. nymphoides* requires high nutrient levels. Perry (1961) reports that rich loam is required. Plants in Sydney and Brisbane (p. 288) need high nutrient levels for growth and flowering while the naturalized occurrence at Valencia Creek has a high nutrient inflow. In contrast the Malmsbury population continues to grow and flower without added nutrient; the nutrient level has not been measured but there is no circumstantial evidence to indicate that it is particularly high. The considerable difference in growth rates between the Brisbane and Valencia Creek populations, both with seepage or inflow from manures, suggests that nutrient-enrichment, although beneficial, is not the only limiting factor in the growth of *H. nymphoides* in Australia (see next paragraph). This suggestion is supported by comparison of the Valencia Creek and Malmsbury populations, which apparently have similar growth rates but different nutrient inputs.

Air temperature and frost frequency comparisons are given in figures 3 and 4 respectively. Although air temperatures are not simply related to water temperatures the figures show the climatic extremes within which *H. nymphoides* is known to grow in Australia. The importance of warmer, subtropical weather in promoting growth is indicated by the greater growth rate of plants in Brisbane compared with those in Valencia Creek and Malmsbury. The species is certainly cold-sensitive and winter die-back occurs at all localities, regardless of frost. The Valencia Creek population exhibited luxuriant growth in mid-March but by 9 May foliage was partly-yellowed and decaying and only young leaves remained completely

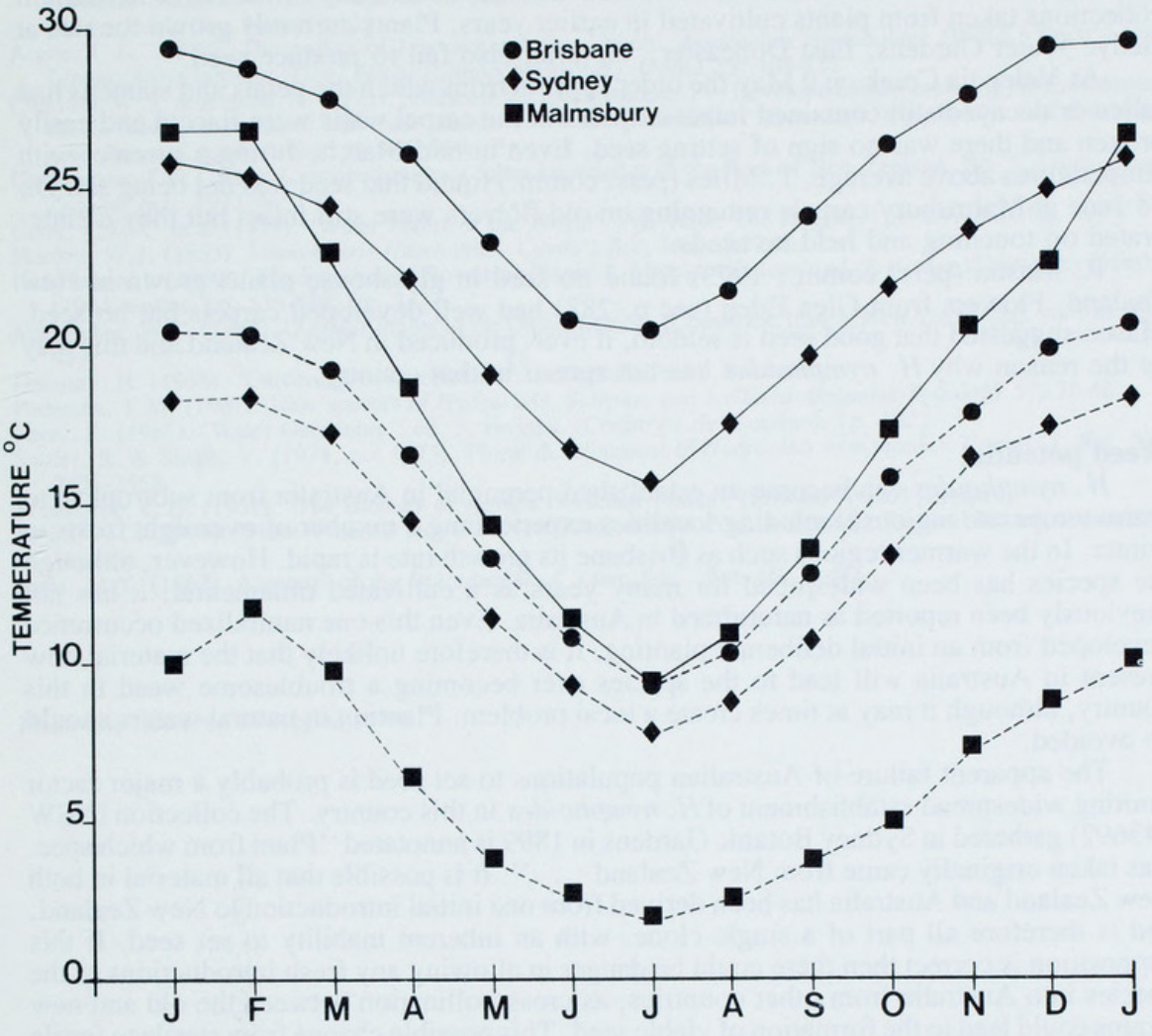

Fig. 3. Temperature variation with time of year at Brisbane, Sydney and Malmsbury. Exact figures for Valencia Creek are not available but they lie between those of Malmsbury and Sydney. *Solid line*: mean daily maximum temperature per month. *Broken line*: mean daily minimum temperature per month.

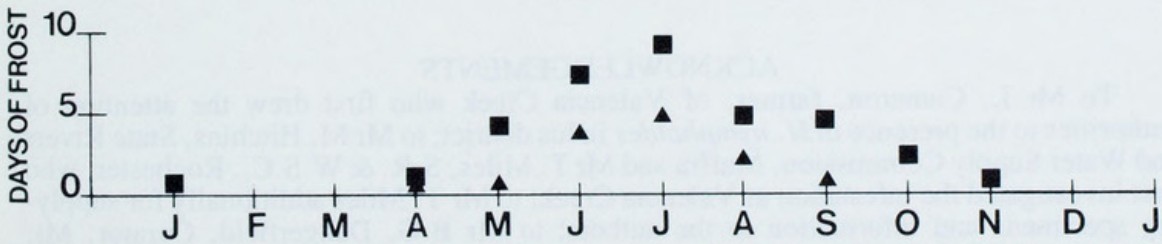

Fig. 4. Average number of days of frost per month at Kyneton (equivalent to Malmsbury) and Maffra (equivalent to Valencia Creek). Brisbane and Sydney are frost-free; the Sydney location may rarely experience a frost. Kyneton shown by *squares*, Maffra by *triangles*.

green. At Malmsbury on 18 June foliage was still abundant but yellowing and decay were evident. In Sydney plants cease growth and start to die back in winter. Brisbane plants also die back but always retain some floating leaves; leaves produced under low temperatures are usually smaller.

Seed Production

No seed was found in living material from any of the four locations examined, and no seedlings have been located. In addition we found no seed in any of the NSW herbarium collections taken from plants cultivated in earlier years. Plants currently grown for sale at Gedye Water Gardens, East Doncaster, Victoria, also fail to produce seed.

At Valencia Creek on 9 May the older flowers from which the petals and stamens had fallen or decayed still contained intact carpels but the carpel walls were flaccid and easily broken and there was no sign of setting seed. Even in mid-March, during a summer with temperatures above average, T. Miles (pers. comm.) found that seed was not being set. On 18 June at Malmsbury carpels remaining on old flowers were still intact but they disintegrated on touching and held no seeds.

R. Mason (pers. comm., 1973) found no seed in glasshouse plants grown in New Zealand. Flowers from Glen Eden (see p. 288) had well-developed carpels but no seed. Mason suggested that good seed is seldom, if ever, produced in New Zealand and this may be the reason why *H. nymphoides* has not spread in that country.

Weed potential

H. nymphoides can become an established perennial in Australia from subtropical to warm temperate regions, including localities experiencing a number of overnight frosts in winter. In the warmer regions such as Brisbane its growth rate is rapid. However, although the species has been widespread for many years as a cultivated ornamental, it has not previously been reported as naturalized in Australia. Even this one naturalized occurrence developed from an initial deliberate planting. It is therefore unlikely that the material now present in Australia will lead to the species ever becoming a troublesome weed in this country, although it may at times create a local problem. Planting in natural waters should be avoided.

The apparent failure of Australian populations to set seed is probably a major factor limiting widespread establishment of *H. nymphoides* in this country. The collection (NSW 143692) gathered in Sydney Botanic Gardens in 1899 is annotated "Plant from which spec. was taken originally came from New Zealand . . .". It is possible that all material in both New Zealand and Australia has been derived from one initial introduction to New Zealand, and is therefore all part of a single clone, with an inherent inability to set seed. If this supposition is correct then there could be danger in allowing any fresh introductions of the species into Australia from other countries, as cross-pollination between the old and new strains could lead to the formation of viable seed. This possible change from sterile to fertile individuals could change *H. nymphoides* into a potential weed species, particularly in warmer regions.

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