



The genus *Callitriche* (Plantaginaceae, Callitricheae) in Australasia and Oceania

RICHARD V. LANSDOWN^{1,2}

[✉ rvlansdown@gmail.com](mailto:rvlansdown@gmail.com); [ORCID https://orcid.org/0000-0003-0984-4552](https://orcid.org/0000-0003-0984-4552)

¹Ardeola Environmental Services, 45 The Bridle, Stroud, Gloucestershire, UK. GL5 4SQ.

²Honorary Research Associate, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE

Abstract

Callitriche is a genus of about 75 species of small herbs, ranging from aquatic to amphibious and terrestrial, with a complicated and incompletely resolved taxonomy. This work contributes to the taxonomic knowledge of the genus *Callitriche* in Oceania and Australasia by presenting descriptions and maps, together with information on habitats and the conservation status of 21 species, including taxonomic novelties, as well as revision of some critical species. *Callitriche fuliginea* and *C. insularis* are described as new species from New Guinea and French Polynesia, respectively, *C. chathamensis* and *C. petriei* are recognised as separate species, *C. capricorni* and *C. cyclocarpa* are reinstated.

Key words: nomenclature, distribution, overlooked species, taxonomy, conservation

Introduction

Callitriche von Linné (1753: 969) (Plantaginaceae Juss., Callitricheae Dumort.) is a sub-cosmopolitan plant genus occurring throughout temperate regions of both hemispheres, including the peri-Antarctic islands but typically mainly at high elevation in the tropics (Fassett 1951, Bean 2007, Lansdown 2008, Hassemer & Lansdown 2018). Approximately 75 species have been recognized worldwide (Bean 2007, Lansdown 2008, Hassemer & Lansdown 2018).

There have been a number of proposals for subdivision of the genus *Callitriche* based mainly on vegetative morphology or growth form (e.g. Hegelmaier 1868, Schotsman 1967). However, the validity of these has been undermined by taxa showing characters intermediate between all the proposed groups. Some species of the genus occurring in Australasia and Oceania show characters which would initially support sub-division of the genus, such as toothed leaves (*C. muelleri* Sonder [1856: 229]), tri-locular anthers (*C. capricorni* Mason [1959: 307], *C. cyclocarpa* Hegelm. [1868: 116], *C. sonderi* Hegelm. [1867: 18]), pedunculate flowers (*C. capricorni*, *C. cyclocarpa*, *C. cycloptera* Schotsm. [1985d: 116], *C. sonderi*) and dioecy (*C. petriei* Mason [1959: 315]). However, strict application of divisions based on these characters would result in two groups including only single species and given that phylogenetic work to-date has, at most, only poorly supported these sub-divisions (e.g. Ito *et al.* 2017), it seems better to treat the genus as a single group.

The taxonomy of *Callitriche* has largely been based on morphological characters (e.g. Schotsman 1967) with relatively few studies to-date employing molecular methods (e.g. Philbrick 1993, Philbrick & Jansen 1988, Philbrick & Jansen 1991, Prančl 2012, Prančl *et al.* 2020). The reduced morphology of *Callitriche* (e.g. Miller 2001), combined with morphological plasticity of vegetative parts means that the morphology of the fruit, particularly the distribution and nature of the wing, forms the basis of taxonomy in the genus (e.g. Hegelmaier 1864, Mason 1959, Schotsman 1967). The fruit of *Callitriche* is a schizocarp, composed of four mericarps (Miller 2001). The wing is an external expression of processes derived from the exine (here used to refer to the layer of strengthened tissue surrounding the ovule, *sensu* Lansdown 2008), it may be present only along the apex of each mericarp (e.g. *C. palustris* von Linné [1753: 969] var. *palustris*), extend down the sides to varying degrees (e.g. *C. anisoptera* Schotsman 1988: 7–10), extend from the apex to the base (e.g. *C. stagnalis* Scopoli 1772: 251) or extend right around the exterior of mericarps into the commissural groove (e.g. *C. cycloptera* Schotsman 1985c: 116–120). Relatively few other parts have taxonomic significance, other details of reproductive parts are important, as are some vegetative characters such as leaf venation in *C. cribrosa* Schotsman (1965: 317) and *C. oreophila* Schotsman (1985b: 292) or leaf shape, e.g. *C. muelleri*.

Information presented here has been based entirely on study of herbarium specimens and consequently has adopted a traditional morphological approach, however there would be undoubted benefits to our understanding of species distinctions and relationships between species from molecular analysis, combined with morphological characterisation based on fresh material.

The region covered by this account includes Australia and New Zealand with their island dependencies, the island of New Guinea, including West Papua and Papua New Guinea, as well as French Polynesia. No *Callitriche* records have been found from Micronesia, Melanesia or Polynesia outside these areas, in fact the only known populations of *Callitriche* species from Pacific Ocean Islands are *C. insularis* sp. nov. described here from Rapa and Tautarau, as well as non-native populations of *C. deflexa* A. Braun ex Hegelmaier (1864: 58) in the Galapagos (e.g. Eliasson 1972). Twenty-one species of *Callitriche* have been reported from the region (Table 1), of which seven are non-native, although *C. platycarpa* Kütz. (1831: 38), has been reported from a single site, is supported by few specimens, and the identification would benefit from formal confirmation. All species credibly reported from the region are described here, even if known only from single sites or from cultivated habitats, or if it has not been possible to confirm their identity. This is to enable recognition of these species if they occur elsewhere in the region. The taxonomy of the genus has been relatively well studied in Australia (Mason 1959, Orchard 1980 and Bean 2017) and New Zealand (Mason 1959), with relatively little research from other parts of the region. All confirmed records of native *Callitriche* from mainland Australia are from the eastern states, with no confirmed records of native species from Western Australia or Northern Territory.

TABLE 1. The number of native and non-native *Callitriche* species for each of the regions covered.

	Native species	Non-native species
Australia	7	4
New Zealand	5	4
West Papua	1	
New Guinea	3	
French Polynesia	2	

TABLE 2. The number of gatherings of each *Callitriche* species native to the region seen by the author from each region (NB/ some gatherings involve more than one specimen).

	Australia	New Zealand	West Papua	New Guinea	French Polynesia	Total
<i>C. antarctica</i>	22	8				30
<i>C. aucklandica</i>		5				5
<i>C. brachycarpa</i>	9					9
<i>C. capricorni</i>	17					17
<i>C. chathamensis</i>		7				7
<i>C. cyclocarpa</i>	18					18
<i>C. cycloptera</i>				2		2
<i>C. fuliginea</i>				1		1
<i>C. insularis</i>					3	3
<i>C. muelleri</i>	111	31			2	144
<i>C. papuana</i>			2	14		16
<i>C. petriei</i>		17				17
<i>C. sonderi</i>	87					87
<i>C. umbonata</i>	47					47
Total	311	68	2	17	5	403

In spite of the work which has already been done on the genus in Australia and New Zealand, many species are still represented by relatively few specimens. Most collections are dominated by *C. stagnalis* which is very widespread and abundant, or *C. muelleri*, which is easy to identify (Table 2).

This article is the final geographical account in a series (Lansdown 2006a, Lansdown 2006b, Lansdown 2009, Lansdown *et al.* 2017a, Lansdown *et al.* 2017b, Hassemer and Lansdown 2018, Lansdown and Hassemer (2021) which, together with work by H.D. Schotsman (Schotsman 1985a, Schotsman 1985b, Schotsman 1988) provides a first thorough revision of the genus since the 1860s (Hegelmaier 1864, Hegelmaier 1867, Hegelmaier 1868), together with clarification of nomenclatural and taxonomic issues. The format and data presentation reflect those of previous publications, particularly Lansdown and Hassemer (2021). Most of this work, including the present study, has been based mainly or exclusively on review of herbarium material, an approach which brings with it a number of problems in a genus which is morphologically so reduced. The fruit typically develop diagnostic characters, particularly those of the wing, when the fruit is mature, at which point it typically changes colour from bright green to brown, greyish or blackish, depending on the species. Immature fruit may also appear to have a struma (in this case, a swelling or distortion of the lower part of the mericarp of mature fruit, appearing as a lump; also referred to in the literature as an umbo) in taxa where this is lost on maturity and the exine of immature fruit may give the impression of a wing where this is not the case in mature fruit. This situation is often exacerbated in dried and pressed material and reliable identification can only be made from mature fruit.

In addition, most taxa are represented by very few specimens in herbaria and most of the specimens were collected before 1970, few include large enough numbers of reproductive structures to enable thorough assessment of the variation within species and relatively few specimens are in good condition. Morphological and morphometric data based on living material can revolutionise understanding of variation in the dimensions and appearance of reproductive structures (e.g. Lansdown *et al.* 2017b). The review completed to-date provides a foundation for global research into the genus *Callitriche* and should establish a stable taxonomic basis. However, there remains a need for collection of morphometric data from living material of those species for which few specimens have been consulted, as well as to collect data on the ecology and conservation condition of all species within their native ranges.

Material and methods

To inform the global revision of the genus *Callitriche* collections kept at AD, ALA, ANSP, ASE, ATHU, BM, BOL, BR, BRI, BSB, BUNS, C, CANB, CGE, CHR, E, EAC, EFC, F, FI, FLOR, FT, FURB, G, GB, GH, GOET, HAST, HBR, HIB, HO, HRB, HUA, HURB, JEPS, K, L, LE, LINN, LIV, MA, MAU, MBM, MEL, MICH, MO, NAS, NMW, NSW, NU, NY, ORE, P, PA, PE, PH, PP, PRE, RNG, SEV, SI, STU, TAI, TAIF, TAMU, TEPB, TNM, TNU, TRE, TUB, UAM, UBC, UC, UESC, UPS, US, V and WTU (acronyms according to Thiers 2019+) were studied. The minimum aim was to review at least a representative sample of material from each region. Most of this work was achieved through inter-herbarium loan with visits to herbaria limited by funding constraints. Material for review was therefore constrained by the material which herbaria made available (in most cases herbaria would not make type material available on loan). In addition, a large number of herbaria did not respond to requests for loans, possibly in part due to the changes in working practices imposed during the coronavirus pandemic.

For all taxa except *C. stagnalis*, all specimens from the region (and where relevant some from without) are listed. For *C. stagnalis* over a hundred specimens were confirmed and comprehensive documentation of every specimen confirmed would only have been possible at the expense of collection of other data. Determination slips were attached to all specimens, including those of *C. stagnalis* and where this represents a change from previous determinations, the determination has been added to the Australian Virtual Herbarium. Type material seen by the author is indicated by an exclamation mark. Additional material studied has all been seen by the author.

Morphometrics given are based as much as possible on material from the region, even for species known only from a small number of sites. Where relevant, these are supplemented by data from outside the region, mainly for a small number of non-native species. Data were derived from specimens where possible and whilst published morphometrics were taken into account, widespread mis-identification of material means that published descriptions could consistently not be considered reliable. A standardised approach has been adopted in description of the morphology of the species treated here, where comparable information is presented for each taxon except in the rare cases (e.g. the lower leaves of *C. antarctica* Engelm. *ex* Hegelmaier 1867: 20) where a unique character of a species may be important. Where a previous description has been published by the author and applies to a taxon occurring within the region, it is reproduced or summarised here with an indication of the source. In these descriptions wing width is included in the fruit dimensions. Lingulate or linear leaves are by definition single-veined (Lansdown 2008), these and all other leaves have a single central vein. All expanded leaves, except those of a few species, including *C. antarctica*, then develop

secondary veins which arise at the top of the petiole, loop outwards and then re-join the central vein near the leaf apex. Additional veins then vary widely. Thus, in the text when the venation of expanded leaves is described as simple, this refers to a central vein and a pair of secondary veins.

There has been a degree of confusion in the literature as to whether the stalks supporting the flowers of *Callitriche* should be referred to as pedicels or peduncles (e.g. Schotsman 1967, Lansdown 2008). Within the genus, five species are now known to have flowers in which the filament arises from the same stalk as the female flower. For the purposes of clarity, such flowers are referred to here as pedunculate, while stalks supporting solitary flowers are referred to here as pedicels.

Maps were plotted using DIVA GIS Version 7.5, either plotting the locations from which individual herbarium specimens were collected or accepting all records held by the Australian Virtual Herbarium (AVH), different approaches are indicated in the titles of the maps. In the map titles, the term “confirmed” refers to specimens confirmed by the author. Maps are not provided for the following taxa which are known only from a single location: *C. deflexa*, *C. heterophylla*, *C. insularis*, *C. peploides* and *C. platycarpa*.

The nomenclature presented here follows the *Shenzhen Code* (Turland *et al.* 2018).

Taxonomic treatment

1. *Callitriche antarctica* Engelm. ex Hegelmaier (1867: 20)

Type:—FRANCE. ÎLES KERGUELEN: 1839–1843, *J.D. Hooker s.n.* (lectotype [designated by Lansdown and Hassemer 2021: 88] MEL 2409648! [Figure 2]; isolectotype W 0122126!). Epitype (designated Lansdown and Hassemer 2021: 88): FRANCE. ÎLES KERGUELEN: Grande Terre, Port-aux-Français, elephant seal wallows next to greenhouses, 5 m, 30 December 2011, *R.C. Winkworth & F. Hennion 42* (P 02432590! [Figure 3]).

Description (from Lansdown and Hassemer 2021):—Stem and leaf scales present, at least in some populations. Leaf bases broadly connate, forming a cup. Lower leaves reduced to scarious, spatulate, evanescent scales. Lingulate leaves unknown; expanded submerged or floating leaves somewhat fleshy, 2.3–10.0(–18.0) mm long × 1.3–4.8 mm wide, irregularly 3-veined and sometimes additional free veins from the midrib and side nerves, apical leaves may form a floating rosette; terrestrial leaves somewhat fleshy, similar to expanded leaves but generally smaller. Flowers solitary; upper flowers ♂, lower ♀. Bracts lacking. Styles erect, persistent, 1.4–3.2 mm long. Filament short and stout before dehiscence, lengthening to 14 mm long and becoming more delicate after dehiscence; anthers 0.6–0.7 mm long × 0.7–0.8 mm wide, quadrilocular; pollen yellow. Fruit not strumose, subsessile, as wide as or wider than high, dull brown or blackish when mature, 0.7–1.3 mm long × 0.7–1.5 mm wide, unwinged.

Illustrations:—Plates 1169(11) and 1171(9) in Fassett (1951); Figures 6(a–b) and 6A(a–e) in Mason (1959); Figure 6 in Bacigalupo (1979); Figure 1(b) in Lansdown and Hassemer 2021. Fig. 1a.

Recognition:—*C. antarctica* can be distinguished from all other *Callitriche* species except *C. aucklandica* by the fleshy leaves with connate bases. *C. aucklandica* differs from *C. antarctica* in the narrow wing on the fruit, however this can be difficult to discern, particularly on herbarium specimens, which is why doubt remains as to the occurrence of *C. antarctica* on the Auckland Islands.

Distribution:—Native. Within the region, this species has been confirmed only from islands south of mainland New Zealand, including Antipodes Island (Godley 1989), Chatham Island, Macquarie Island and The Snares (Hay *et al.* 2004) (Fig. 2). Elsewhere, it occurs on islands from 40° south to Antarctica (Fassett 1951, Mason 1959, Bacigalupo 1979, Pisano & Schlatter 1981) and has been recorded from Argentina: Tierra del Fuego; Chile: Patagonia (Domínguez & Aravena 2012); France: Crozet Islands and Possession Island, Kerguelen; South Africa: Prince Edward Islands. UK: Falkland Islands, South Georgia (van Mieghem & van Oye 1965). See map on page 167 in Fassett (1951). Records of *C. antarctica* from the Auckland Islands are discussed by Mason (1959). However, whilst she states that “that *C. antarctica* does occur on the Auckland Islands is established beyond doubt by a specimen of Hooker’s at Kew, which according to Dr. R. Melville (personal communication) is conspecific with the Campbell Island syntype”, there is no specimen in Kew collected by Hooker which can be unambiguously be identified as *C. antarctica* and which was unequivocally collected on Auckland Island. The condition of Hooker’s collections of *Callitriche antarctica* is discussed by Lansdown and Hassemer (2021) but it is considered prudent to dismiss records of *C. antarctica* from the Auckland Islands unless this can be confirmed with good fruiting material.

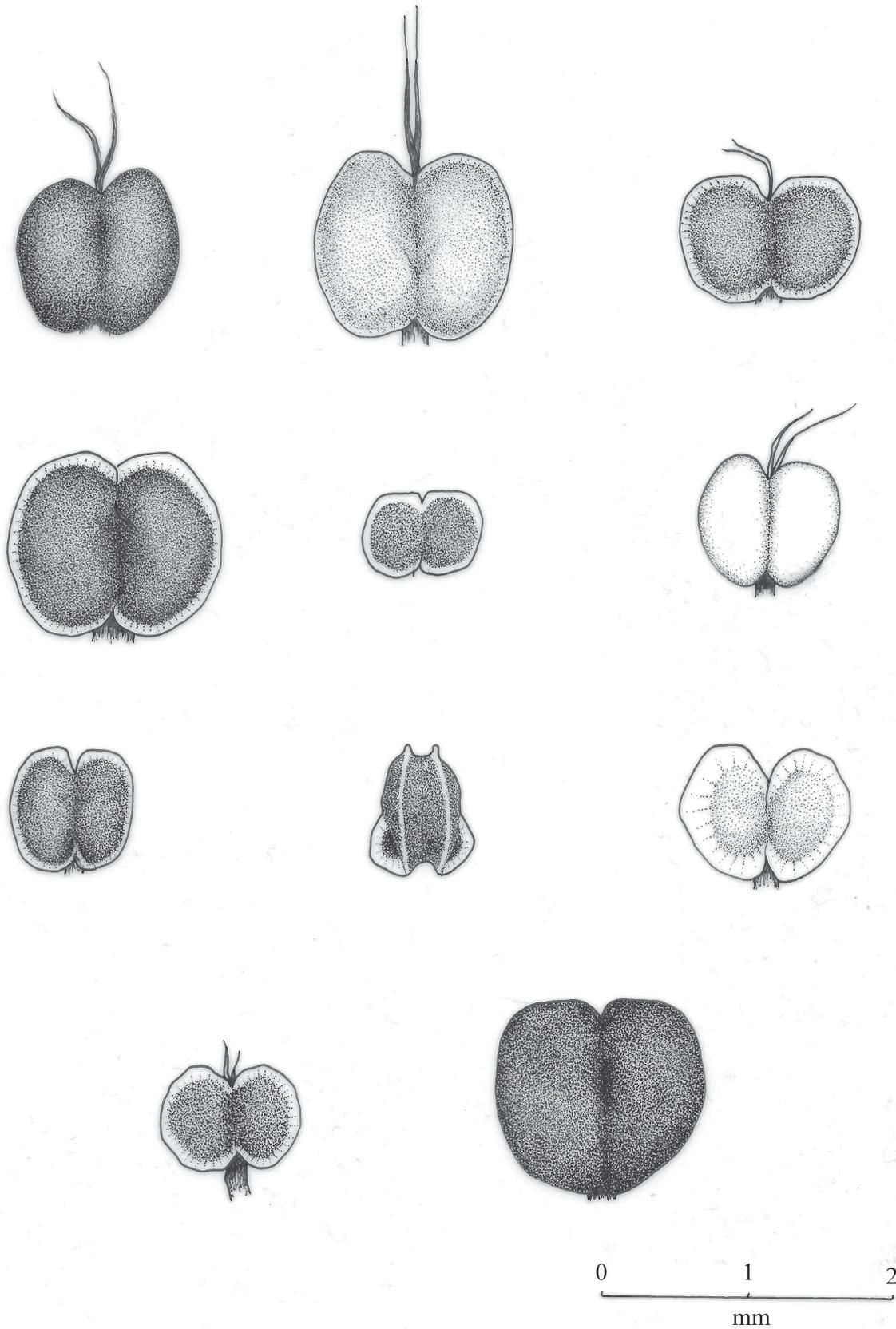


FIGURE 1. Fruits of *Callitriche* in Oceania and Australasia: a—*C. antarctica*, b—*C. aucklandica*, c—*C. brachycarpa*, d—*C. brutia*, e—*C. capricorni*, f—*C. chathamensis*, g—*C. cyclocarpa* i face on and ii end on, h—*C. cycloptera*, i—*C. deflexa*, j—*C. fuliginea*.

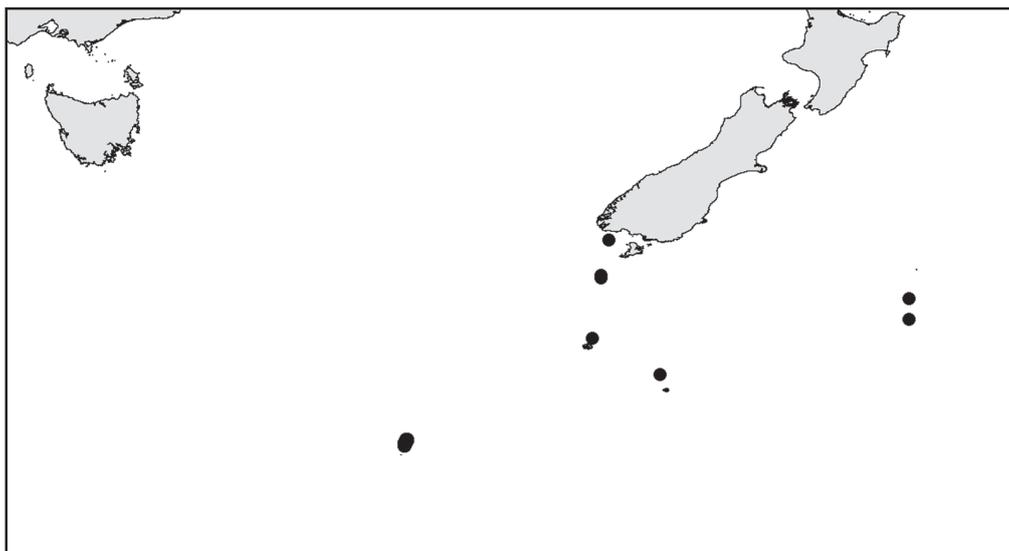


FIGURE 2. The distribution of confirmed specimens of *C. antarctica* in Oceania and Australasia

Habitats and Ecology:—*Callitriche antarctica* occurs as a terrestrial (Schotsman 1961), marginal, or less often aquatic plant to a depth of 2.5 m (Whinam 1989, Scott 1990, Dominguez and Aravena 2012) on bare peat, sand, gravel or rocks. Throughout much of its range, it is strongly associated with wet areas which are enriched with dung from marine mammals such as seal wallows (Hughes 1986, Selkirk, Seppelt and Selkirk 1990, Mukhadi 2011, M. Fountain pers. comm.). It is also found in pool complex vegetation subject to low intensity use by moulting seals (Scott 1990) and wandering albatross (*Diomedea exulans* von Linné 1758: 132) (Warham 1996), as well as petrel nests (Gressitt and Clagg 1970) and abandoned penguin colonies (Hay, Warham and Fineran 2004, Ewans and Lake 2011). It often occurs where areas that are kept wet by seepages around the base of *Poa cookii* (Hook.f.) Hook.f. (1879: 14), *P. foliosa* (Hook.f.) Hook.f. (1864: 338) or *P. flabellata* (Lam.) Raspail (1829: 76) tussocks are damaged by animals (Pisano and Schlatter 1981, Scott 1990, Selkirk, Seppelt and Selkirk 1990). It occurs in and on the margins of still or slow-flowing water of seepages, streams, lakes, ponds and pools. It will occur in wetlands associated with raised beaches (Whinam 1989) and coastal rocks with species such as *Plantago barbata* G.Forst (1789: 25) or *Ranunculus crassipes* Hook.f. (1844: 224), in bog pools with *Azorella selago* Hook.f. (1844: 284), *Colobanthus kerguelensis* Hook.f. (1844: 249), *Poa cookii* and *Pringlea antiscorbutica* R.Br. ex Hook.f. (1844: 239), wet *Deschampsia antarctica* É.Desv. in Gay (1854: 338) swards and flushes, bogs characterized by *Juncus scheuchzerioides* Gaudich. (1825: 100) and *Rostkovia* Desv. (1809: 324) sp. (Whinam 1989, Upson 2012), on seepages over rocks with *Poa litorosa* Cheeseman (1906: 902, 1156), *Bulbinella rossii* (Hook.f.) Cheeseman (1906: 717) and *Polystichum vestitum* (G.Forst.) C.Presl (1836: 83) and on disturbed ground such as roadsides. 0–620 m elevation.

Conservation Status:—*C. antarctica* is classed as Least Concern as it is widespread with stable populations and does not face any major threats (IUCN 2012). It is classed as Naturally Uncommon, Range Restricted, Secure Overseas in New Zealand (de Lange *et al.* 2018).

Additional material studied:—For a list of confirmed specimens, see Lansdown and Hassemer (2021).

2. *Callitriche aucklandica* Mason (1959: 307).

Type:—NEW ZEALAND. AUCKLAND ISLANDS. Auckland I., *J.B. Hair s.n.*, Nov. 1954. (Holotype: CHR 89341, isotypes: CHR 89342!, CHR 89344!).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves unknown; expanded submerged or floating leaves unknown; leaves of terrestrial plants slightly fleshy 3.7–8.0 mm long × 1.2–4.0 mm wide, 3-nerved, occasionally with short free veins, blade and petiole poorly differentiated. Flowers solitary or sometimes ♂ and ♀ together. Bracts caducous, 0.3 mm long. Styles persistent, erect, 2.0–2.5 mm long. Filament erect, < 9 mm long; anthers, 0.6–0.8 mm long × 0.5–0.8 mm wide, number of locules unknown; pollen yellow. Fruit not strumose, subsessile, wider than high, dark brown, 1.1 mm long × 1.2–1.3 mm wide, narrowly winged throughout.

Illustrations:—Figures 7(a–b) and 7A(a–b) in Mason 1959. Fig. 1b.

Recognition:—*C. aucklandica* can be distinguished from all other *Callitriche* species except *C. antarctica* by the fleshy leaves with connate bases. *C. aucklandica* differs from *C. antarctica* in the narrow wing on the fruit.

Distribution:—Native. *Callitriche aucklandica* is endemic to the Auckland Islands, where it has been recorded from Dundas Island (Falla *et al.* 1979), Ewing Island and Auckland Island but its occurrence on the other islands cannot be discounted.

Habitats and Ecology:—*C. aucklandica* is described as common in wet ground at low altitude (Johnson and Campbell 1975), it occurs in coastal to montane areas on exposed ground, in pools and on sodden peat, in heavy shade under both young and mature *Olearia* Moench (1802: 254) forest, as well as in *Metrosideros umbellata* Cavanilles (1797: 20) mixed forest and with *Stellaria media* (von Linné) Vill. (1789: 615) between *Poa foliosa* tussocks (Falla *et al.* 1979, Johnson and Campbell 1975, Webb *et al.* 1988, Lee *et al.* 1991). It often occurs near bird colonies and in areas recovering after use by sea lions but also on exposed mud within forest and scrub (Johnson and Campbell 1975). There is no information available on the elevation range of this species, but the maximum elevation in the Auckland Islands is 705 m.

Notes:—There is, as yet, no confirmation that *C. antarctica* occurs on the Auckland Islands (see above). If *C. antarctica* is confirmed from the islands then it is possible that information on *C. aucklandica* may need to be revised as many identifications in the literature and on herbarium specimens appear to have been based on the assumption that *C. aucklandica* is the only *Callitriche* species represented on the Auckland Islands.

Conservation Status:—*Callitriche aucklandica* is endemic to the Auckland Islands in New Zealand, where it occupies a limited geographic area on three islands, each of which is treated as a single location (IUCN 2012). Due to the inherent vulnerability caused by this limited geographic range and possible real threat from factors such as alien plants and climate change, this subspecies is assessed as Vulnerable D2 (IUCN 2012). In New Zealand, it is classed as Naturally Uncommon, Island Endemic, Range Restricted, Sparse (de Lange *et al.* 2018).

Additional material studied:—NEW ZEALAND: AUCKLAND ISLANDS. (P03304423); 1839–1843, *J.D. Hooker s.n.* (CANB277895); 1874, *H. Krone s.n.* (STU15648); Musgrave Peninsula, 22 November 1943, *W.H. Dawbin s.n.* (CHR251989).

3. *Callitriche brachycarpa* Hegelmaier (1868:115).

Type: AUSTRALIA. VICTORIA. tributary of the Plenty towards Mt Disappointment, 6 February 1853, *F. Mueller s.n.* (Lectotype [designated by Bean 2007: 547] STU 83916; Isolectotypes: MEL 50295 & 50296).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves unknown, expanded submerged or floating leaves unknown; leaves of terrestrial plants obovate, 1.6–7.0 mm long × 0.7–5.0 mm wide, 3-nerved, sometimes with free veins from the midrib, as well as free and looped veins from the outer nerves. ♂♀ flowers usually in the same axil. Bracts linear, hyaline, caducous, 0.3–0.5 mm long. Styles persistent, erect, 1.2–1.5 mm long. Filament erect, 0.5–2.5 mm long; anthers 0.2–0.3 mm long × 0.2–0.3 mm wide, possibly trilobular; pollen yellow. Fruit not strumose, sessile, wider than high, light brown to blackish when mature, 0.6–1.0 mm long × 0.8–1.3 mm wide, narrowly winged throughout.

Illustrations:—Figures 4(a–b) and 4A(a–b) in Mason (1959). Fig. 1c.

Recognition:—*C. brachycarpa* can be distinguished from other *Callitriche* species in the region by the combination of the small, unwinged, sessile fruit which is blackish when ripe, and ± isodiametric or wider than high and not umbonate, together with most leaf axils containing both ♀ and ♂ flowers.

Distribution:—Native. *Callitriche brachycarpa* is endemic to Australia, where it occurs throughout the western lowlands and on King Island in Tasmania (Fig. 3). It is also known from six locations across Victoria State; three on the Otway Coast and three in the Port Phillip area (Curtis and Morris 1975, Parks Victoria 2000, Aston 1973). It formerly occurred at a site subject to inundation on the northern outskirts of Melbourne (Jeanes 1999, Bean 2007, Threatened Species Section 2012) but has apparently been lost from this site.

Habitats and Ecology:—*Callitriche brachycarpa* occurs in creeks and rivers or in damp hollows (Bean 2007), often in or near wet forest, but also in moist areas of dry sclerophyll forest and riparian scrub. It has been recorded with a range of *Eucalyptus* L'Hér. (1788: 18) and *Olearia* species, as well as species such as *Acacia dealbata* Link (1822: 445), *Atherosperma moschatum* Labill. (1806: 74) and *Nothofagus cunninghamii* Oerst. (1873: 355). There is no information available on the elevation range of *C. brachycarpa*.



FIGURE 3. The distribution of confirmed specimens of *C. brachycarpa*.

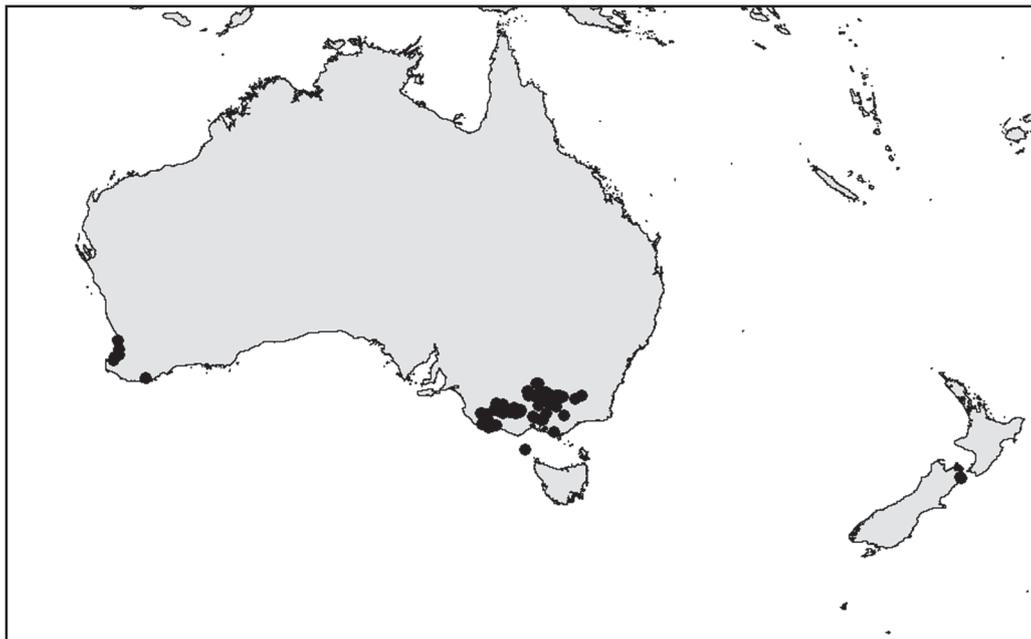


FIGURE 4. The distribution of specimens of *C. brutia* in Oceania and Australasia based on records held by AVH.

Notes:—H.D. Schotsman took extensive notes which accompany the specimen HO 34457 suggesting that the anther of this species is trilocular. However, this requires confirmation based on fresh material.

Conservation Status:—*Callitriche brachycarpa* is very poorly-known throughout its range, with no recent data on the conservation status of populations. It is therefore classed as Data Deficient.

Additional material studied:—AUSTRALIA: TASMANIA. s.d., s.coll. s.n. (NSW33820); Gippsland, February 1877, *F. von Mueller* 250 (NSW33821); Nr. Martin, 1881, *F. von Mueller* s.n. (G); Picton River December 1903, *L. Rodway* s.n. (HO 72958, HO 8145); Kindred, January 1910, *L. Rodway* 250 (HO 72956, HO 8147); Forth River, December 1911, *L. Rodway* s.n. (HO 34457, HO 72959); Fisherman's Varna Bay, 25 January 1984, *A.M. Buchanan* 2773 (HO 83798); Jackeys Creek, 2 March 1986, *A. Moscal* 12540 (HO 403083).

4. *Callitriche brutia* Petagna (1787: 10).

Type:—ITALY. CALABRIA. Ex herb. Petagna (lectotype [designated by Schotsman (1967: 84)]: FI).

4a. *Callitriche brutia* subsp. *brutia*

Description (after Lansdown 2008):—Stem, leaf and axillary scales present. Leaf bases connate. Lingulate leaves 4–16 mm long \times 0.1–1.7 mm wide, narrowly linear, more or less parallel-sided, apex expanded, with a long, fine, broad or narrow notch; expanded submerged or floating leaves narrowly elliptic to oblong 1.8–17.8 mm long \times 0.8–3.6 mm wide, 3(–5)-veined, petiole 0.1–10.2 mm long; apical leaves form a floating rosette; leaves of terrestrial plants linear-elliptic to elliptic, 2.4–5.5 mm long \times 0.3–0.8 mm wide, 1(–3)-veined. Flowers generally solitary, a ♂ and ♀ in a pair of axils occasionally more than one in an axil. Bracts translucent, whitish, falcate, caducous, 0.2–1.8 mm long. Styles persistent, tightly reflexed and appressed to sides of fruit from the initial stages of development, so that the styles pass either side of the stem to touch the anther in the opposed axil, \leq 4.1(–4.3) mm long. Filament erect, \leq 1.2 mm long; anthers 0.1–0.5 mm long \times 0.1–0.6 mm wide, quadricellular; pollen colourless, translucent. Fruits not strumose, subsessile or with pedicel \leq 12 mm long, more or less as wide as or wider than high, blackish or maroon when mature, 0.7–1.6 mm long \times 0.7–1.8 mm wide, narrowly winged.

Illustrations:—Figures in Lansdown (2008) pages 132–135; Figures 11(a–b), 11A(a–c) in Mason (1959); figures 1J–L in Orchard (1980). Fig. 1d.

Recognition:—*C. brutia* can be distinguished from all other *Callitriche* species by the reflexed style which initially crosses the stem to contact an anther in the opposite leaf axil and of which the remains are typically appressed to the commissural groove of mature fruit (Fig. 1d). No other *Callitriche* species in the region has colourless pollen.

Distribution:—Non-native to the region, where it occurs throughout Victoria and southern New South Wales (Webb *et al.* 1988, Jeanes 1999), with a few records from South Australia and a cluster of records south of Perth in Western Australia, as well as from between Matakoho and Ruawai near the Karipara Harbour on North Island and Lake Elterwater on South Island in New Zealand (Fig. 4). Outside Oceania, *C. brutia* is native throughout much of Europe, from Iceland and the Faroe Islands, through Scandinavia to Poland and the Czech Republic and throughout the Mediterranean basin east to Greece, as well as from Greenland, Morocco, Iran and the Caucasus. *C. brutia* also occurs as a non-native on the west coast of North America, from Oregon north into British Columbia (Lansdown 2009).

Habitats and Ecology:—In Australia *C. brutia* is described as growing in water or on mud (Walsh and Entwistle 1999) in drains, creeks and dams (Bean 2007). Herbarium specimen labels indicate that it occurs in water up to 50 cm deep, typically in seasonally inundated areas, in swamps, roadside pools, ponds, lake margins and floodplains, in open woodland, such as *Eucalyptus camaldulensis* Dehnh. (1823: 20) stands or in sedge-lands. In its native range, *C. brutia* subsp. *brutia* typically occurs in ephemeral water bodies and in the draw-down zone of standing waters on the margins of lakes (Lansdown 2008). 0–950 m elevation in its native range; no information on elevation in the region.

Notes:—Most records on the Australian Virtual Herbarium appear to have been correctly determined and they are mainly accepted here for mapping purposes.

Conservation Status:—Least Concern (LC) (Lansdown 2014a).

Additional material studied:—AUSTRALIA: NEW SOUTH WALES. Western Wanganella Swamps, 17 September 1990, *J. Roberts 671* (CANB 601529); Albany, 24 November 1993, *S.W. Jacobs 6989* (NSW). VICTORIA. near Dimboola, 18 September 1892, *F.M. Reader 8* (MEL 2248528); Winton Swamp, Benalla, 18 September 1960, *H.I. Aston 621* (NSW 674137, US 610390); 26 August 1967, *C. den Hartog 195* (MEL 2380258); Victoria Valley, Dunkeld, 21 October 1969, *B.L. Briggs 2905* (NSW 131720); Snowfields Mt. Reynard, 16 December 1992, *D.E. Albrecht 5330* (CANB 9405439). NEW ZEALAND: SOUTH ISLAND. Lake Elterwater, Marlborough, 23 January 1955, *R. Mason 3160* (CANB 589572, MEL 2387238, NSW 674138).

5. *Callitriche capricorni* Mason (1959: 307, figs. 3, 3A).

Type:—AUSTRALIA. QUEENSLAND. Brisbane River, July 1874, *F.M. Bailey s.n.* (holotype: BRI 151).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves unknown, expanded submerged or floating leaves unknown, leaves of terrestrial plants spatulate or obovate, 2.0–4.9 mm long × 0.8–2.8 mm wide, 3-nerved, sometimes with free veins on the midrib and outer side of the outer nerves, petiole 0.4–1.0 mm long. ♂ and ♀ flowers together in most leaf axils. Bracts triangular, blunt, c. 0.2 mm long, caducous. Styles erect, 0.1 mm long, caducous. Filament arising from peduncle, erect, 0.3–1.5 mm long; anthers trilobular, 0.1 mm long × 0.1 mm wide; pollen yellow. Fruit not strumose, sessile, much wider than high, dark reddish brown to blackish when mature contrasting with pale wing, 0.5 mm long × 0.7–0.9 mm wide, broadly winged throughout.

Illustrations:—Figures 3(a–b) and 3A(a–b) in Mason (1959); Plate 2(E–L) in Schotsman (1985c). Fig. 1e.

Recognition:—*C. capricorni* can be distinguished from all other *Callitriche* species in the region by the very small fruit which are blackish, not strumose, ± isodiametric or wider than high and clearly winged. It most closely resembles *C. sonderi* from which it differs in the mature fruit with faces that are convex and not strumose, as well as the short styles, although immature fruit may appear strumose.

Distribution:—*C. capricorni* is endemic to mainland Australia, where confirmed records extend from southern Queensland to eastern Victoria (Fig. 5). However, fewer than 20 records have been confirmed and there is an urgent need for field surveys to confirm the distribution of this species.



FIGURE 5. The distribution of confirmed specimens of *C. capricorni*

Habitats and Ecology:—*C. capricorni* typically occurs in seasonal wetlands. Confirmed material has been recorded from sandy soil, white powdery clay loam, rich loam and grey clays in seasonally inundated hollows, gilgai (ephemeral lakes), small creeks and erosion gullies, as well as on the margins of larger permanent standing and flowing water. It typically occurs in or near woodland characterised by species such as *Acacia harpophylla* F.Muell. ex Benth. (1864: 389), *Callitris glaucophylla* Joy Thomps. & L.A.S.Johnson (1986: 731), *Casuarina cristata* Miq. (1848: 70), *Eucalyptus camaldulensis*, *E. tereticornis* Sm. (1795: 41), *E. woodsiana* (F.M. Bailey) Brooker (2000: 137) and *Lantana* von Linné (1753: 626) sp., with *Alectryon diversifolius* (F.Muell.) S.T.Reynolds (1987: 335), *Eucalyptus elegans* A.R.Bean (2005: 113) and *E. longirostrata* (Blakeley) L.A.S.Johnson & K.D.Hill (1988: 509) in the north of its range. Associated species include *Alternanthera* Forssk. (1775: 59) sp., *Calandrinia eremaea* Ewart (1931: 486), *Danthonia* DC. (1805: 32) species such as *D. setacea* R.Br. (1810: 177) and *D. caespitosa* Gaudich. (1829: 408), *Elatine gratioloides* A.Cunn. (1839: 26), *Eleocharis* R.Br. (1810: 224–225) sp., *Euchiton sphaericus* (Willd.) Holub (1974: 271), *Gratiola pedunculata* R.Br. (1810: 435), *Paspalidium jubiflorum* Hughes (1923: 317), *Triglochin* von

Linné (1753: 338) and *Wahlenbergia* Schrad. ex Roth (1821: 399–400) sp., as well as grasses and sedges. 150–470 m elevation.

Notes:—*C. capricorni* has been subsumed within *C. sonderi* based on the variability of fruit in *C. sonderi* (Bean 2007: 548). However, previous authors have noted the more conspicuous wing (Stanley and Ross 1986) and the fact that the mature fruit are not umbonate (strumose) in *C. capricorni* Mason (1959: 307). The confusion appears to arise from the fact that, at least on herbarium specimens, some immature fruit of *C. capricorni* do appear to be strumose and the wing is less clearly defined. Comparison of mature fruit shows a clear distinction and the shape of the fruit of *C. capricorni* is closer to that of *C. deflexa* A. Braun ex Hegelm. (1864: 58), as noted by Mason (1959: 307) than that of *C. sonderi*, which itself is similar to some varieties of *C. peploides* Nutt. (1835: 141). A character of note which became evident in the course of work for this publication and is particularly evident on *Hosking 3398*, is that the leaves on the main stem of *C. capricorni* may be significantly larger than those of the branches and up to twice the size of the maximum recorded for those of *C. sonderi*. These differences are more than adequate to justify re-establishment of *C. capricorni*.

This is one of three species with *C. muelleri* and *C. sonderi* described by H.D. Schotsman (1985) as having a trilobular anther and based on notes accompanying specimen HO 34457, possibly also *C. brachycarpa*. It also resembles *C. cyclocarpa*, *C. muelleri* and *C. sonderi*, having the filament arising from the peduncle.

Conservation Status:—*Callitriche capricorni* is widespread in eastern Australia and there is no evidence of a consistent threat throughout its range, it is therefore classed as Least Concern (LC) (IUCN 2012).

Additional material studied:—AUSTRALIA: QUEENSLAND. Gracemere, 20 August 1867, *P. O'Shanesy 115* (MEL 276113A); Tingoora, 21 May 1996, *A.R. Bean 10317* (BRI AQ489204, MEL 285257); Brisbane, 27° 28' S, 153° 02' E, 20 May 1969, *D. Hockings s.n.* (BRI AQ02707); Durong, 9 May 2009, *A.R. Bean 28734* (BRI AQ820937); Darling Downs, October 1978, *M.G. Lithgow s.n.* (BRI AQ264770); Condamine, 4 September 2010, *A.R. Bean 30323* (BRI AQ821930); Brisbane, 12 August 2009, *J.P. Lahey JPL56* (BRI AQ749802); Bendidee State Forest, 19 August 2009, *P.I. Forster PIF36006* (BRI AQ814656); Samford, 27° 22' 09" S, 152° 47' 54" E, 155 m, 25 August 2013, *S.P. Phillips 2464* (BRI AQ819810). NEW SOUTH WALES. Casino, 26 September 1999, *A.R. Bean 15429* (BRI AQ678279, MEL 301693, NSW 674129); Brigalow Park Nature Reserve, 9 October 2010, *J.R. Hosking 3398* (CANB 726002, MEL 2361659); Macquarie Marshes, 17 August 1979, *K. Pajmans 3175* (CANB 286090). VICTORIA. Horseshoe Lagoon Flora and Fauna Reserve, 30 March 1983, *A.C. Beaglehole 70653* (MEL 626740); Tocumwal, 4 June 1979, *A.C. Beaglehole 63972* (MEL 651590); Junction of Goulburn and Murray Rivers, 6 December 1988, *E. Chesterfield 2516* (MEL 1564927); Tallangatta, 16 May 1972, *P. Lumley 6* (MEL 2241779).

6. *Callitriche chathamensis* (Mason) Lansdown comb. and stat. nov.

≡ *Callitriche petriei* subsp. *chathamensis* Mason (1959:317).

Type:—NEW ZEALAND. CHATHAM ISLANDS. Tupuangi Lagoon, Pitt. I., Chatham Is., 1 February 1957, *B.G Hamlin. 692* (Holotype: WELT SP003332, isotype CHR 121104).

Description:—Stem and axillary scales present. Leaf bases connate. Lingulate leaves slightly wider toward apex, 1.0–1.4 mm long × 8.0–9.7 mm wide; expanded submerged or floating leaves ovate-elliptic 2.2–4.1 mm long × 0.8–2.5 mm wide, venation complex with frequent branches arising within and outside the secondary veins, secondary veins sometimes undulating, petiole 1.6–4.5 mm long; leaves of terrestrial plants unknown. Monoecious, flowers solitary, often alternating ♀ and ♂ along stem. Bracts lacking. Styles erect, 1.1–2.3 mm long. Filament erect, 4.5–6.8 mm long; anthers 0.5–0.6 mm long × 0.5–0.6 mm wide, quadrilocular; pollen yellow. Fruit not strumose, subsessile, wider than high, pale brown when mature, 0.6–0.9 mm long × 0.7–1.1 mm long wide, unwinged.

Illustrations:—Figure 4A(h) in Mason (1959). Fig. 1f.

Recognition:—*C. chathamensis* can be distinguished from all *Callitriche* species in the region by the pale or golden brown unwinged fruit which are wider than high, combined with the lack of bracts and the presence of both ♀ and ♂ flowers on the same plant.

Distribution:—Native. *Callitriche chathamensis* is endemic to the Chatham Islands east of mainland New Zealand, where it occurs throughout Rekohu (Chatham Island) and Rangihau (Pitt Island) (Champion and Clayton 2004), as well as on Mang're (Mangare) and Hokoreoro (South East Island) (P. de Lange pers. comm.) (Fig. 6).

Habitats and Ecology:—*Callitriche chathamensis* occurs on bare peat and mud on wet, peaty ground, commonly at the edges of streams and lakes, and on steep cliff faces, ledges and rubble near the sea. It was described as occurring

in a turf community in shallow water in lakes characterized by *Chara globularis* Thuiller (1799: 472), *Lilaeopsis novae-zelandiae* A.W.Hill (1927: 549), *Myriophyllum triphyllum* Orchard (1979: 259), *Nitella hyalina* (De Candolle) C.Agardh (1824: 126) and *Ruppia polycarpa* R.Mason (1967: 524) with a range of other species, including *Limosella australis* R. Br. (1810: 443), *Myriophyllum pedunculatum* subsp. *novae-zelandiae* Orchard (1979: 274), *Potamogeton cheesemanii* A.Benn. (1883: 66) and *Triglochin striata* Ruiz & Pav. (1802: 72) (Champion and Clayton 2004). There is no information available on the elevation range of this species, but the maximum elevation on the islands is 299 m.

Notes:—Mason (1959: 317) combined *C. chathamensis* as a subspecies under *C. petriei*, however this combination is difficult to maintain as the differences between these two taxa are much greater than those between many other *Callitriche* species. The most significant difference is that *C. petriei* is dioecious, which is otherwise unknown in the genus. In addition, both the linear and expanded leaves of *C. chathamensis* are typically larger than those of *C. petriei* and often show complex venation, in contrast to the simple venation of *C. petriei*. The filament and anther may be larger in *C. chathamensis* and the fruits are typically larger. These differences are more than adequate to justify recognition of these as two separate species.

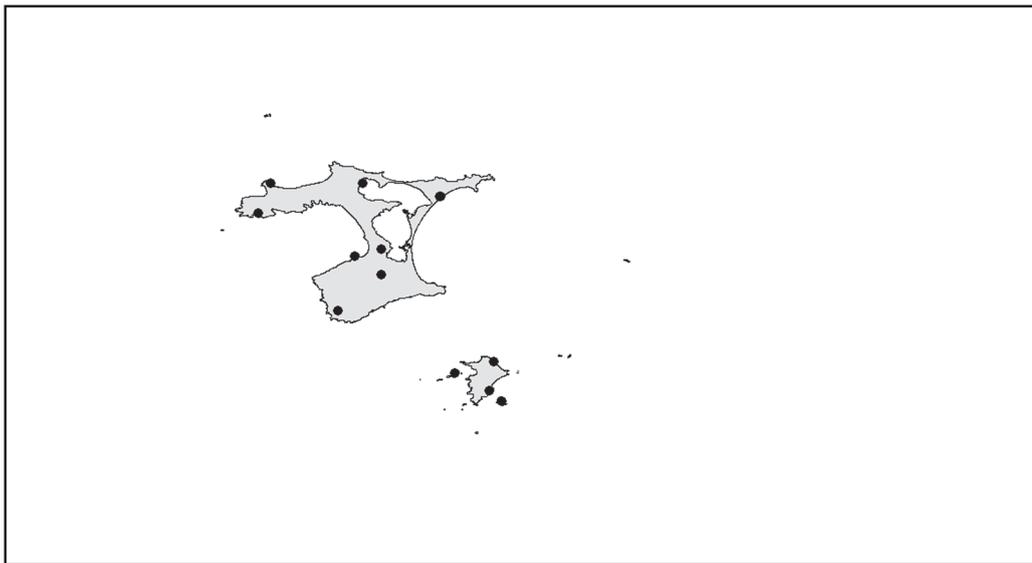


FIGURE 6. The distribution of *C. chathamensis* based on records held by AVH, supplemented by P. de Lange (pers. comm.)

The information presented here is based on a very small sample size, such that individual specimens show characters which differ from the majority of measurements. For example, on *Courtney s.n.* (CHR 436463), all flowers are female and immature, which suggests that female flowers develop first followed by male flowers (as appears to be the case with *C. cyclocarpa*). It is clear that, as with so many of the *Callitriche* species native to the region, there is a need for extensive research into morphological variation based on living material.

Conservation Status:—Native. *Callitriche chathamensis* is endemic to the Chatham Islands, New Zealand, where it occupies a limited geographic area with an Area of Occupancy (AOO) estimated at less than 4 km². Due to the inherent vulnerability caused by this limited geographic range and possible real threat from alien plants, this subspecies is assessed as Vulnerable D2 (IUCN 2012). It is classed as Naturally Uncommon, Island Endemic, Range Restricted, Sparse (de Lange *et al.* 2018).

Selected specimens examined:—NEW ZEALAND: CHATHAM ISLANDS. 1872, *H. H. Travers s.n.* (MEL); Chatham Island, Waitangi, 1901, *L. Cockayne & F.A.D. Cox 1480* (WELT SP051433, WELT SP003299); South East Island, December 1961, *B. Bell s.n.* (CHR 158307); Chatham Island, Lake Te Roto, 20 m, 27 February 2003, *P.D. Champion CH2403* (CHR 568034); South East Island (Rangatira), Watercress Bay, 26 February 1986, *S. Courtney s.n.* (CHR 436463).

7. *Callitriche cyclocarpa* Hegelmaier (1868: 116).

Type:—AUSTRALIA. VICTORIA, Yarra Yarra, *s. dat.*, *F. Mueller s.n.* (holotype: STU83917; isotype: MEL224504)

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves 11.4–18.4 mm long \times 0.5–0.7 mm wide, expanded submerged or floating leaves spatulate, 5.5–7 mm long \times 2.4–2.9 mm wide; venation complex, secondary veins with abundant curved branches joined only at one end, petiole 1.4–3.2 mm long; leaves of terrestrial plants unknown. ♀ flowers only in axils of lower leaves, ♂ and ♀ together in axils of upper leaves. Bracts caducous 0.6–1 mm long. Styles erect, deciduous c1.5 mm long. Filament \leq 2 mm long, much longer than fruit; anthers, 0.2–0.3 mm long \times 0.3–0.4 mm wide, number of locules unknown; pollen yellow. Fruit strumose, occasionally shortly pedicellate, more or less isodiametric, dark brown when mature, 0.8–0.9 mm long \times 0.8–0.9 mm wide, narrowly winged throughout.

Illustrations:—Figures 12(a–b) and 12A(a–c) in Mason (1959). Fig. 1g.

Recognition:—*C. cyclocarpa* can be distinguished from all other *Callitriche* species in the region by the fruit which are large, blackish, \pm isodiametric or wider than high and winged, combined with both ♀ and ♂ flowers at least in upper axils. It most closely resembles *C. umbonata* from which it can be distinguished by the fruit of that species which are typically higher than wide and the venation which is typically complex in *C. cyclocarpa* but relatively simple in *C. umbonata*.

Distribution:—Native. *Callitriche cyclocarpa* is endemic to Australia where it has a scattered distribution in Victoria with a small number of records in each of New South Wales and South Australia (Mason 1959, Willis 1972, Jeanes 1999) (Fig. 7).

Habitats and Ecology:—Confirmed specimens of *C. cyclocarpa* are all aquatic plants with apical leaf rosettes and many with linear lower leaves. It will occur in water at least 40 cm deep, as well as on drying mud of rivers, pools, drainage ditches and wet tracks, typically set in *Eucalyptus camaldulensis* or occasionally *E. microcarpa* (Maiden) Maiden (1923: 438) woodland and at least once in a freshwater coastal *Melaleuca* von Linné (1767: 507, 509) wetland. It has been recorded growing with species such as *Damasonium minus* (R.Br.) Buchenau (1871: 20), *Lilaeopsis* sp., *Muehlenbeckia florulenta* Meisn. (1856: 116) and *Nitella* (C.Agardh ex Bruzelius) C.Agardh (1824: 124) sp. in water bodies, as well as with *Paspalidium jubiflorum* along river banks and *Austrodanthonia setacea* (R.Br.) H.P.Linder (1997: 273) and *A. caespitosa* (Gaudich.) H.P.Linder (1997: 271) on less-frequently inundated ground. There is no information available on the elevation at which this species occurs.

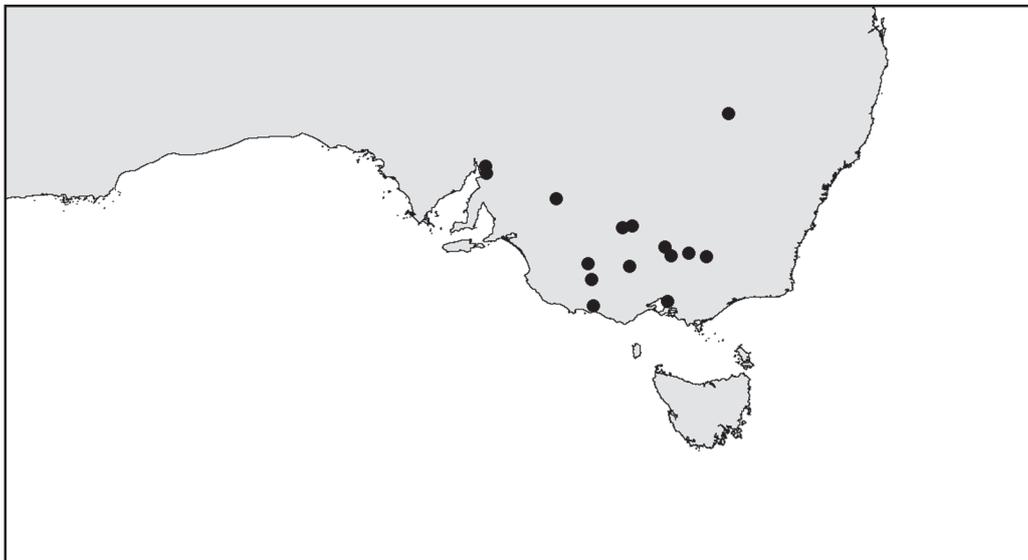


FIGURE 7. The distribution of confirmed specimens of *C. cyclocarpa*

Conservation Status:—The information available is not adequate to assess the conservation status of the species and it is therefore classed as Data Deficient (IUCN 2012). Prior to synonymisation with *C. umbonata*, *C. cyclocarpa* was classed as Vulnerable in the state of Victoria (Threatened Species Scientific Committee 2008). It was removed from the Environment Protection and Biodiversity Conservation Act 1999 list of threatened species on 16 September 2015 (Department of the Environment 2020) but the need for it to be reinstated should be considered.

Notes:—*Callitriche cyclocarpa* was subsumed within *C. umbonata* Hegelm. (1867: 20) based on the suggestion that fruits of the type of *C. cyclocarpa* are immature and on variability of fruit in *C. umbonata* (Bean 2007: 548). However, comparison of more than 50 mature fruit of both species (Fig. 8) shows that although there is a slight overlap, fruit size differences are generally consistent. In particular, the fruit of *C. umbonata* are typically longer than wide and generally longer than the fruit of *C. cyclocarpa*. Although based on a relatively small sample and entirely based on herbarium material, there are other differences between the two taxa, for example, the lingulate leaves of *C. cyclocarpa* are typically longer, while expanded leaves show complex venation compared to fairly simple venation in *C. umbonata*. There are also differences in the length of the style, filament and possibly the anther, although more information is needed based on living material to clarify this. It appears that in *C. cyclocarpa* female flowers start to develop before the males, so the lower nodes typically only have female flowers in the axils, but the upper nodes have both male and female flowers in one or both axils. It also appears likely that *C. cyclocarpa* can flower under water. As with many *Callitriche* species in Oceania, there is a need for detailed morphological research, based on living material.

Selected specimens examined:—AUSTRALIA: NEW SOUTH WALES. Macquarie Marshes, 31 August 2007, *M.B. Thomas 3721 & R.M. Dowling* (BRI AQ791575). SOUTH AUSTRALIA. Mount Monster Conservation Park, 4 October 1988, *J.H. Browne 167* (AD 98846132); Telowie Gorge Conservation Park, 10 October 1989, *R. Bates 20482* (AD 98940227); Mt Remarkable National Park, October 2003, *R. Bates 61233* (AD 155209). VICTORIA. Swan Hill, 3 September 1974, *N. Macfarlane 833* (MEL 545200); Edwards River, October 1895, *F. von Mueller s.n.* (MEL 2246477); Loch Garry State Forest, 10 October 1980, *G.K. Patterson 565* (MEL 626737); Dowdle Swamp Wildlife Reserve, 12 September 1985, *A.C. Beauglehole 80337* (MEL 717648); Hawkesdale, December 1903, *H.B. Williamson s.n.* (NSW 935610); Spring Vale, September 1910, *A.J. Tadgell s.n.* (MEL 224507); Hawkesdale, November 1903, *Williamson s.n.* (MEL 2247539); Mount Pilot Multi-Purpose Park, 6 September 1981, *A.C. Beauglehole 88300 & P. Ward* (MEL 717646); Wail State Forest Reserve, 15 October 1986, *A.C. Beauglehole 86116* (MEL 717652); Kooyoora - Melville Caves State Park, 24 October 1981, *A.C. Beauglehole 69440* (MEL 597290); Hawkesdale, November [19]03, *H.B. Williamson s.n.* (MEL 224508); Glenorchy, 9 September 1961, *A.C. Beauglehole 6772* (MEL 2246472); Barmah Regional Park, 20 November 1985, *A.C. Beauglehole 82406* (MEL 2299326).

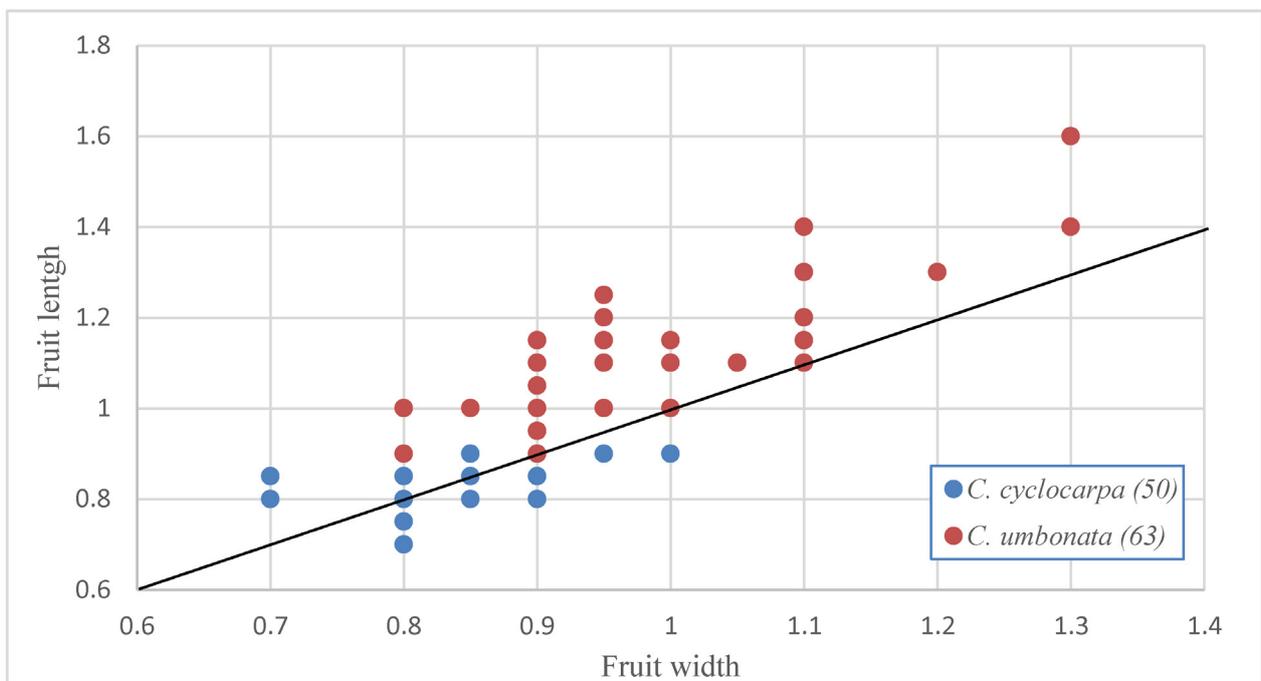


FIGURE 8. Dimensions of fruit of *C. cyclocarpa* and *C. umbonata*, numbers in brackets indicate the number of fruit measured, the line shows equal length and width

8. *Callitriche cycloptera* Schotsman (1985d: 116).

Type:—NEW GUINEA. OROBE PROVINCE. Goropu Mountains (Mt. Suckling), Pumpunipon grassplain, in shade of forest edge in boggy paces; 2065. m, ca. 9°40' S-148°56' E, 14 June 1972, *J.F. Veldkamp & P.F. Stevens 5594* (Holotype: L 249923).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves unknown; expanded submerged or floating leaves unknown; leaves of terrestrial plants spatulate, up to 6.0 mm long × 2.8 mm wide; secondary veins do not rejoin the central vein, toward the centre of the blade small veins may arise from the primary vein, these may be free or join the secondary veins, petiole 0.4–0.7 mm long. Flowers pedunculate, ♂ and ♀ in the same axil. Bracts probably lacking. Styles divergent or erect, 0.4–0.5 µm long. Filament arising from peduncle, slightly curved, 0.5–0.6 mm long; anthers quadricellular, 0.1–0.27 mm long × 0.2–0.3 mm wide; pollen yellow. Fruit sessile, wider than high, maroon or chestnut when mature, 0.8–1.0 mm long × 1.2 mm wide, broadly winged throughout except for a very narrow part where mericarps are connected.

Illustrations:—Plates 2(M) and 3(3–4) in Schotsman (1985c), plate 1 in Schotsman (1985d), Fig. 1h.

Recognition:—*C. cycloptera* can be distinguished from all other *Callitriche* species in the region by the wing of the fruit which is very broad (approximately ½ the width of fruit) and extends completely around each mericarp except for the narrow point where the mericarps are attached. The maroon/chestnut colour of the fruit also helps to distinguish it from many species. It is most similar to *C. muelleri* but that species has leaves with a single tooth on each margin which is lacking in *C. cycloptera*.

Distribution:—*C. cycloptera* is endemic to New Guinea, where it is known from two areas: Mount Suckling (Goropi), the highest peak in the Goropu Mountains in the south east, and Mount Salawaket on the Huon Peninsula (Fig. 9).

Habitats and Ecology:—*C. cycloptera* forms lawns between mosses and liverworts on peaty soils under the overhanging branches of *Dacrycarpus expansus* de Laub. (1969: 334) trees on the edge of high-elevation peat bogs dominated by *Deschampsia klossii* Ridl. (1913: 268) tussocks in a region which air temperatures may vary from –5 °C (or even –8 °C) at night to 22 °C during the day (J.F.Veldkamp in litt. to H.D.Schotsman) (Schotsman 1985d: 119–102). It has also been found growing among liverworts and mosses in the bed of a dried-out oxbow (*ibid.*). 1660–2065 m elevation.

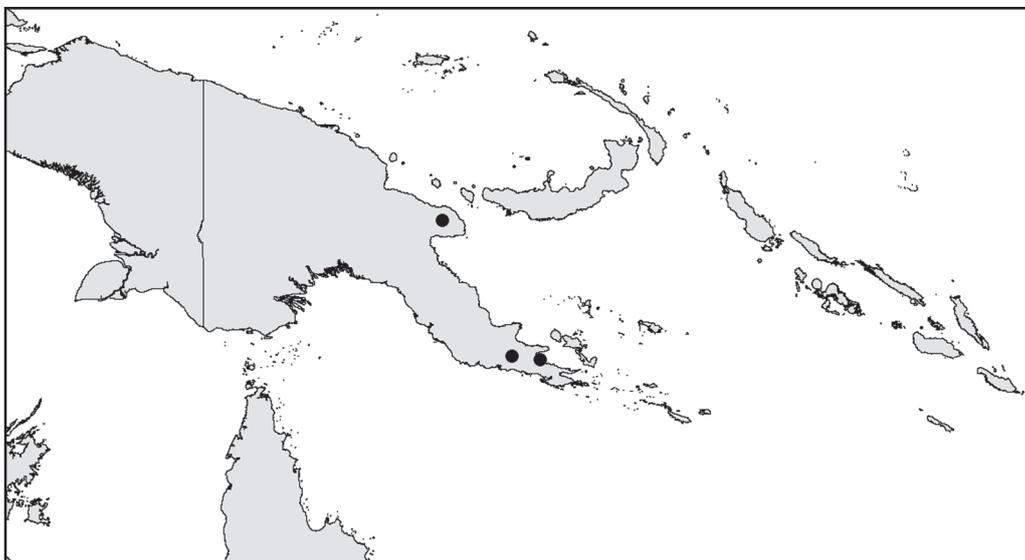


FIGURE 9. The distribution of confirmed specimens of *C. cycloptera*

Conservation Status:—This species is known from a small number of collections from two areas in Papua New Guinea. It is not known to face any particular threats but it has an estimated Extent of Occurrence (EOO) of 14,539 km² and AOO of 12 km² (IUCN 2012). The Pumpunipon Plain is considered to be a single wetland complex on the floodplain of the Pumpinawa River and is therefore treated here as a single location, with the Huon Peninsula as a second location. This species is likely to be vulnerable to climate change as it is restricted to high altitude, while areas where it has been recorded around Mount Suckling are threatened by forest clearance, it is therefore assessed as Vulnerable: B1ab(iii)+2ab(iii); D2 (IUCN 2012).

Selected specimens examined:—Mount Salawaket, Oro Province. s.d., *T.G. Hartley 11099* (GH!); Mt. Suckling, 1660 m, 21 July 1972, *P.F. Stevens and J.F. Veldcamp LAE 55723* (CANB! 247539).

9. *Callitriche deflexa* A.Braun ex Hegelmaier (1864: 58)

≡ *Callitriche deflexa* var. *brauniana* Hegelmaier (1867: 15)

Type:—BRAZIL. RIO DE JANEIRO: 1859, *F. Rudio s.n.* (lectotype [designated by Lansdown & Hassemer 2021]: STU 15655!; isolectotypes G, GH 00048927!, GH 00048928!, GH00048929!, K 000470002!, MO 1913776!, MO 1913777!, STU 15662).

Description (from Lansdown and Hassemer 2021):—Stem and leaf scales present. Leaf bases connate. Lingulate leaves unknown, expanded submerged or floating leaves unknown, leaves of terrestrial plants elliptic, (1–)2–4 mm long × 0.8–2.3(–3.0) mm wide, 3-veined, petiole 0.5–2.0 mm long. Usually one ♂ and one ♀ flower together in most leaf axils, occasionally solitary. Bracts lacking. Styles recurved, caducous, ≤ 1.8 mm long. Filaments erect, of undehisced stamens ≤ 0.2 mm long, of dehisced stamens ≤ 0.5 mm long; anthers quadrilocular, 0.1–0.4 mm diameter; pollen yellow. Fruits with pedicel ≤ 6.6 mm long, not strumose, wider than high, black when mature, 0.5–1.0 mm long × 0.7–1.0 mm wide, wing up to 0.1 mm throughout.

Illustrations:—Plate 1169(13) in Fassett (1951); Figure 8 in Bacigalupo (1979). Figures on pages 140 and 141 in Lansdown (2008); Figure 1(h) in Lansdown and Hassemer (2021). Fig. 1i.

Recognition:—*C. deflexa* can be distinguished from all other *Callitriche* species in the region by the small fruit, most or all of which are long-pedicellate, blackish when mature and wider than high (although some fruit may be almost isodiametric, combined with both ♀ and ♂ flowers at least in the upper axils).

Distribution:—Non-native to the region. Within the region, *Callitriche deflexa* is known only from flower beds in the Royal Botanical Gardens, Melbourne. Elsewhere, it is native to central South America in an area including southern Brazil, Paraguay, Uruguay and northern Argentina. It is also very widespread as a non-native, with records from Mauritius, Morocco (Cherrate Arboretum), Portugal, South Africa, Taiwan, Tanzania and the United Kingdom (Ascension Island) (Lansdown and Hassemer 2021). See map on page 147 in Fassett (1951).

Habitats and Ecology:—In its native range, this species occurs in low-lying, humid areas such as sandy beaches and dry river beds. Outside its native range it occurs in a wide range of seasonally or permanently moist conditions such as irrigated areas of nurseries, ornamental beds and greenhouses in botanical gardens, low lying disturbed soil in areas such as unmetalled parking areas and on roadsides. There are no elevation data available from its native range.

Conservation Status:—This species is widespread within its native range and there is no evidence that it faces any significant threats, it is therefore classed as Least Concern (LC) (IUCN 2012).

Additional material studied:—For a list of confirmed material, see Lansdown and Hassemer 2021.

10. *Callitriche fuliginea* sp. nov.

Type:—NEW GUINEA. MOROBE PROVINCE. Mt. Salawaket, shallow water of boggy pool in alpine grassland, 147° 10' E, 06° 20' S, 23 January 1963, *T.G. Hartley 11224* (Holotype CANB149567.1!; Isotype, GH 00969870!).

Etymology:—Named for the dark brown, almost black fruit.

Diagnosis:—*C. fuliginea* can be distinguished from all other *Callitriche* species by the fully-formed, lingulate lower leaves which are not fleshy, combined with the blackish mature fruit which are more than 1 mm high and wide. It most closely resembles *C. ecarinata* Lansdown and Hassemer (2021) from which it can be distinguished by its long lingulate leaves, solitary flowers and the larger blackish fruit.

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves 5.0–12.8 mm long × 1–1.8 mm wide; expanded floating or submerged leaves 2.0–4.5 mm long × 1.5–4.0 mm wide; venation simple with a few loops outside and occasionally within the secondary veins, petiole 1–7 mm long; leaves of terrestrial plants unknown. Flowers solitary. Bracts caducous, very narrow, 1.3 mm long. Styles erect, persistent 2.0–3.2 mm long. Filament erect, 1.5–2.3 mm long; anthers 0.3–0.4 mm long × 0.4–0.5 mm wide, number of locules unknown; pollen yellow. Fruit sessile, not strumose, slightly wider than long, black when mature, 1.2–1.3 mm long × 1.3–1.5 mm wide, unwinged.

Illustrations:—Fig. 1j.

Recognition:—*C. fuliginea* can be distinguished from all other *Callitriche* species in the region except *C. antarctica* and *C. heterophylla* by its large unwinged, blackish fruit. *C. antarctica* differs in its fleshy leaves, compared to those of *C. fuliginea* of which the leaves are thin and delicate. *C. heterophylla* typically has smaller and characteristically isodiametric fruit. *C. palustris* could be considered similar, but at least within the region, always has at least a narrow wing at the top of the fruit.

Distribution:—Native. *C. fuliginea* is endemic to New Guinea, where it is known only from the holotype which was collected on Mount Salawaket, on the Huon Peninsula.

Habitats and Ecology:—Shallow water of boggy pool in alpine grassland. Elevation 2990 m.

Conservation Status:—The information available is not adequate to assess the conservation status of the species and it is therefore classed as Data Deficient (DD) (IUCN 2012).

Notes:—*C. fuliginea* is extremely poorly known, the only specimens seen are both from the same gathering made in 1963. There is an urgent need to survey upland areas of New Guinea to establish whether it persists and whether it occurs elsewhere.

11. *Callitriche heterophylla* Pursh (1814: 3)

Type:—UNITED STATES OF AMERICA. PENNSYLVANIA. Aquatic herb in running water in rocky stream edge, Loyalsock Creek near Ogdonia, Hillsgrove Township, Sullivan County, ca. 800 ft., 10 June 1979, *T. Plowman 7836* (neotype [designated by Lansdown & Hassemer 2021: 98] BM 010763506!).

Description (from Lansdown & Hassemer 2021):—Stem and leaf scales present. Leaf bases connate. Lingulate leaves often long and very fine, 4.1–24.7 mm long × 0.3–1.1 mm wide; expanded submerged or floating leaves obovate or oblong, often of a very characteristic shape, with broadly spatulate blade tapering very abruptly or occasionally gradually into petiole 3.7–7.0 mm long × 1.0–3.5 mm wide, venation complex with numerous loops and anastomosing veins outside the secondary veins, apical leaves forming a floating rosette; petiole 2.5–5.2 mm long; leaves of terrestrial plants 4.1–6.2 mm long × 0.7–1.0 mm wide. Flowers usually solitary or occasionally 1 or more ♀ flowers and 1 ♂ flower in an axil. Bracts caducous, falcate or ovate, 0.1–1.3 mm long. Styles persistent or caducous, erect or spreading, ≤ 6 mm long. Filament ≤ 3.8 mm long; anthers 0.2–0.4 mm long × 0.2–0.4 mm wide, quadrilocular; pollen yellow. Fruit subsessile, not strumose, as wide as long, black when mature, 0.4–1.2 mm long × 0.4–1.2 mm wide, wing absent or only at apex, c. 0.1 mm wide.

Illustrations:—Plates 1167(4), 1168 and 1173(13) in Fassett (1951); Figures 9(a–b) and (A) in Mason (1959); Figure 3(a–i) in Bacigalupo (1979); Figure 1k in Lansdown and Hassemer. Fig. 10a.

Recognition:—*C. heterophylla* can be distinguished from all other *Callitriche* species in the region by the characteristic small, unwinged, rounded, isodiametric fruit which are black when mature, within the native range of the species some plants may have large fruit but these have yet to be recorded outside the Americas. Some fruit, particularly on herbarium specimens, may appear narrowly winged at the apex. These may resemble fruit of *C. palustris*, from which they can usually be distinguished by the fruit which are more or less isodiametric, however some herbarium material of these two species cannot reliably be determined. The shape of the rosette leaves, with an abrupt transition from the petiole to the broadly almost circular blade is also a useful character.

Distribution:—Non-native to the region. Within the region, this species has been reported from the Waikato River, where it was first collected in 1900 (Webb *et al.* 1988) and the Chatham Islands (de Lange *et al.* 1988). It was thought to be endemic to the Americas, occurring from northern Canada and Greenland south throughout much of North America, through Central America to Chile and Argentina (Lansdown 2009, Lansdown & Christenhusz 2011, Lansdown and Hassemer 2021). See maps on pages 176 and 178 in Fassett (1951). However, it occurs on Sakhalin Island (WTU357850) suggesting that it may also be native to the eastern seaboard of Russia.

Habitats and Ecology:—This species will occur in most water body types, including fast-flowing rivers and streams, backwaters and ditches, swamps, *Sphagnum* bogs, lakes, ponds, springs and seepages and even seasonally damp soil in shade (Lansdown 2009). Known elevation range 100–4600 m.

Conservation Status:—Least Concern (LC) (Lansdown 2016a).

Notes:—No specimens of *C. heterophylla* have been confirmed from the region. Given the frequent problems with mis-identification of unfamiliar *Callitriche* species, even by specialists, it is important that the identity of the populations from New Zealand identified as *C. heterophylla* is confirmed.

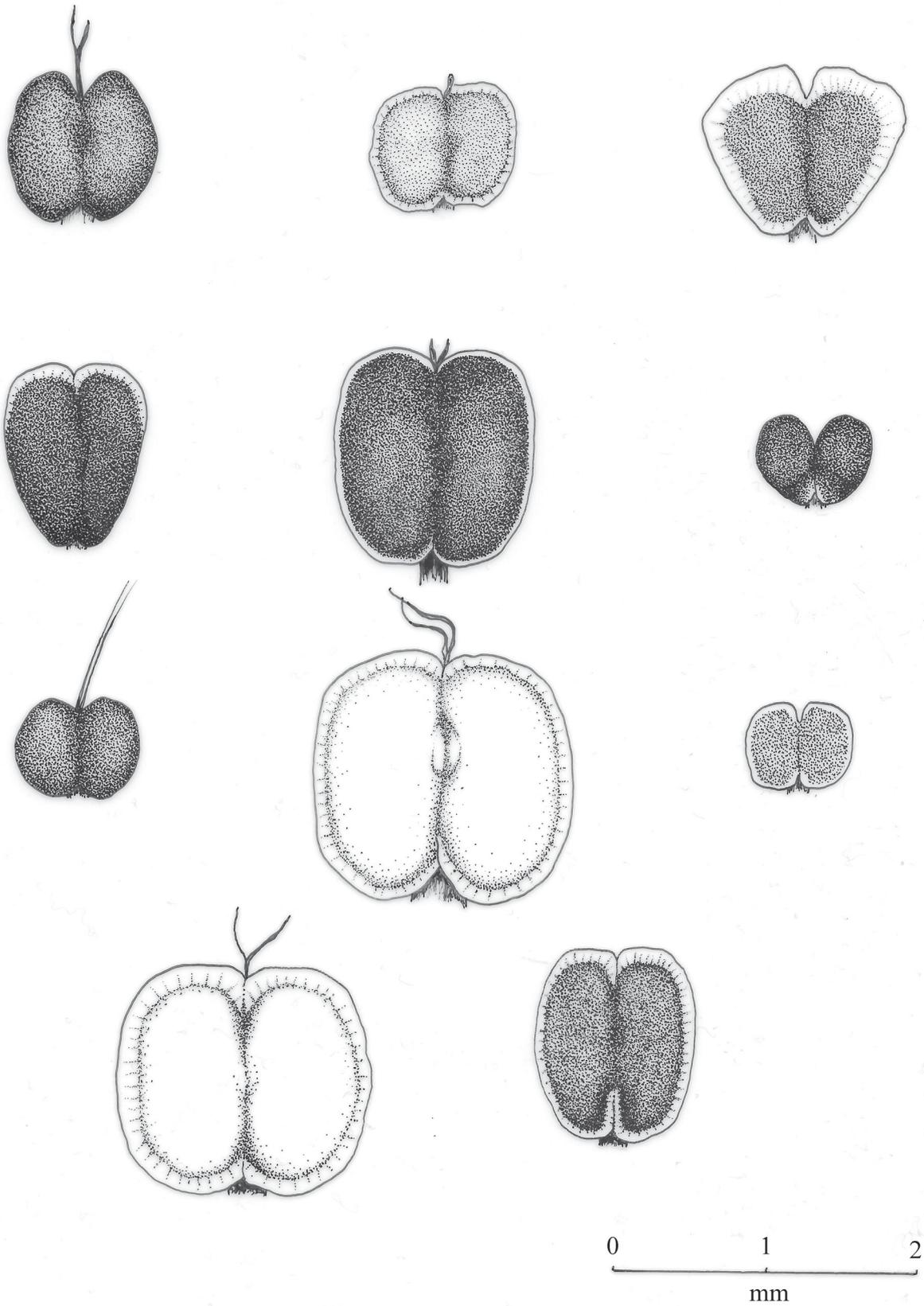


FIGURE 10. Fruits of *Callitriche* in Oceania and Australasia: a—*C. heterophylla*, b—*C. insularis*, c—*C. muelleri*, d—*C. palustris*, e—*C. papuana*, f—*C. peploides*, g—*C. petriei*, h—*C. platycarpa*, i—*C. sonderi*, j—*C. stagnalis*, k—*C. umbonata*.

12. *Callitriche insularis* sp. nov.

Type:—FRENCH POLYNESIA. AUSTRAL ISLANDS. Rapa, Stream draining taro patch by village, Ahurei, 8 July 1934, *H. St. John & J. Maireau* 15430 (US 610318!).

Etymology:—Named because of its occurrence only on French Polynesian islands.

Diagnosis:—This species can be distinguished from all other *Callitriche* species by the presence of stem and leaf scales, ♀ and ♂ flowers together in some axils, filament length, yellow pollen, and the lack of bracts, combined with the size and colour of mature fruit.

Description:—Stem and leaf scales present. Leaf bases connate. Linear leaves unknown; expanded floating or submerged leaves unknown, leaves of terrestrial plants expanded 2.0–3.2 mm long × 0.9–1.8 mm wide, venation simple, petiole 1.2–2.7 mm long; ♀ and ♂ flowers together in an axil opposed by a ♀ flower. Bracts apparently lacking. Styles erect, caducous ≤1.0 mm long. Filament erect, 0.1 mm long; anthers quadricellular, 0.1–0.2 mm long × 0.1–0.2 mm wide; pollen yellow. Fruit substrumose, sessile, slightly wider than high, uniform golden-brown when mature, 0.6–0.8 mm long × 0.8–1 mm wide, winged throughout.

Illustrations:—Fig. 10b.

Recognition:—*C. insularis* can be distinguished from all other *Callitriche* species in the region by the small, broadly winged fruit which are golden-brown when mature. It is most similar to *C. muelleri* but that species has leaves with a single tooth on each margin which is lacking in *C. insularis*.

Distribution:—Native. Known only from Rapa Island and its satellite Tautourau, French Polynesia.

Habitats and Ecology:—Specimens of *Callitriche insularis* have been collected from a stream draining a taro patch, from a moss-covered seepage from a basalt outcrop above the sea and from the margin of a stream flowing through marshes. 1–300 m elevation.

Conservation Status:—*Callitriche insularis* is known from only a very small number of specimens and is estimated to have an AOO significantly less than 20 km², such that it is very vulnerable to factors such as local land-use changes. It is therefore classed as Vulnerable D2 (IUCN 2012).

Specimens examined:—FRENCH POLYNESIA: Tautourau Island, 18 April 2002, *K.R. Wood* 9681 (NY, PTBG); *St. John* 15461 (K).

13. *Callitriche muelleri* Sonder (1856: 229, nom. cons).

Type:—AUSTRALIA. VICTORIA. Latrobe River, May 1853, *F. Müller s.n.* (lectotype [designated by Bean 2007: 547]: MEL 2289178; isolectotypes: K000348666!, MEL 2289179A & 2289180).

= *C. macropteryx* Hegelm. 1864. Hegelm. 1864. Mon. Gatt. *Call.* 59, fig. IV. 2. Type: Neuholland (Hawkesbury River, Ferd. Bauer; Herb. Vindob.) (W0008723).

= *C. microphylla* Colenso Trans. Proc. N. Z. Inst. 20: 190 (1888), Type: Dannevirke, County of Waipawa, *W. Colenso* 1887 (AK5076 annotated “type” and AK209397 annotated “separated from AK5076, 7 December 1992” WELT SP051450) “SYNTYPES, *Dannevirke, Hawkes Bay, W Colenso no date, AK 5076, AK 209397 (formerly AK5076)” (Herrick and Cameron 1994).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves unknown, expanded, submerged or floating leaves unknown, leaves of terrestrial plants characteristically rhomboidal 2.5–7.5 mm long × 1.5–4.8 mm wide, blade broader than long and cuneate at base, apiculate, with a small single tooth on either side (Fig. 11), 3–5 veined with a free vein running to each tooth, petiole 0.3–0.8 mm long. ♂ and ♀ flowers usually together in each axil. Bracts lacking. Styles erect, caducous, <0.2 mm long. Filament arising from peduncle, erect, caducous, <0.3 mm long; anthers 0.1–0.2 mm long × 0.1–0.2 mm wide, trilobular; pollen yellow. Fruit shortly pedunculate, wider than high, reddish-brown when mature, 1.1–1.2 mm long × 1.2–1.4 mm wide, wing very broad throughout.

Distribution:—Native. *Callitriche muelleri* is widespread throughout much of North Island and the north-west of South Island in New Zealand, also reaching the Kermadec Islands (Raoul Island) and Rekohu (Chatham Island) (Fig. 12). It is also found throughout coastal parts of eastern Australia from Gympie south and west to the Great Otway National Park, Victoria, with disjunct occurrences in Queensland including the Atherton Tableland and Carnarvon Gorge (Bean 2007: 548). There are also isolated records from New Caledonia.

Illustrations:—Figures 1(a–b) and 1A(a–c) in Mason 1959; Plates 1(A–M) and 4(1–4) in Schotsman (1985c). Fig. 10c.

Recognition:—*C. muelleri* is the only species of *Callitriche* which has toothed leaves, which combined with the fruit which are very broadly-winged and reddish-brown or maroon when mature make it unmistakable.



FIGURE 11 *C. muelleri* Tiritiri Matangi, North Island, New Zealand, 2011 © R.V. Lansdown

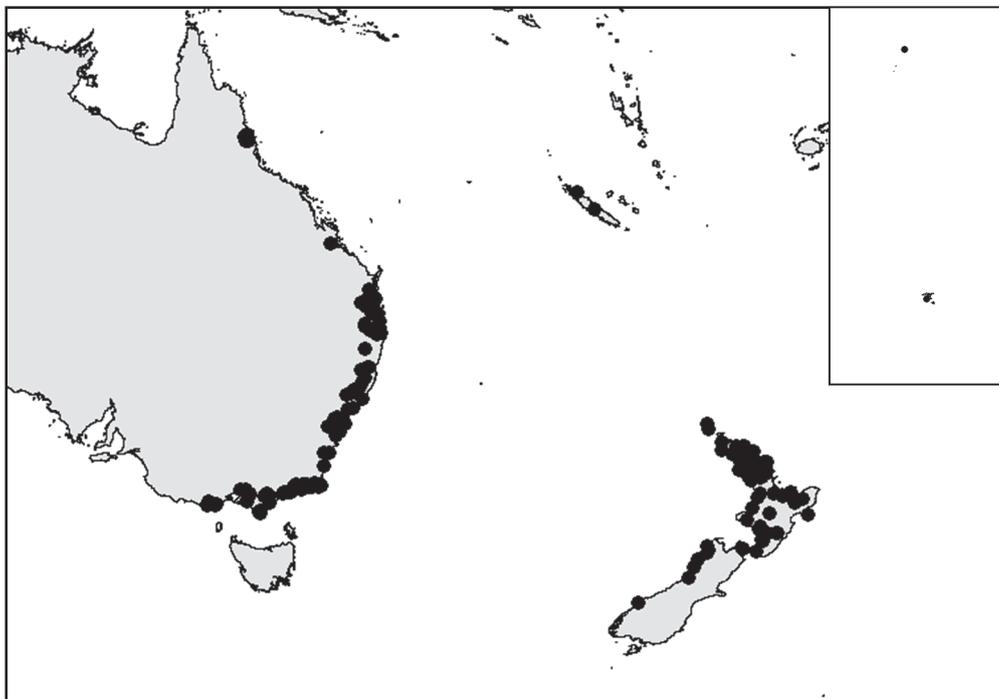


FIGURE 12. The distribution of specimens of *C. muelleri* based on data held on AVH (inset: Chatham and Kermadec Islands)

Habitats and Ecology:—Throughout its range, *Callitriche muelleri* typically grows on bare wet mud, loam or sand, often extending over adjacent stones, gravel or even leaf litter, as well as on thin soil over paving in habitats subject to seasonal inundation (Jeanes 1999) and occasionally in shallow water (Stanley and Ross 1986). It has been recorded growing with a wide range of species such as *Blechnum nudum*, *Callitriche stagnalis*, *Carex appressa* R.Br. (1820: 242), *Centella asiatica* (von Linné) Urb. (1879: 287), *Cyperus brevifolius* (Rottb.) Hassk. (1844: 24), *Isotoma fluviatilis* (R. Br.) F. Muell. ex Benth. (1868: 136), *Juncus procera* E.Mey. (1828: 367), *Leptospermum continentale* Joy Thomps. (1989: 417), *Lobelia purpurascens* R.Br. (1810: 563), *Melaleuca squarrosa* Sm. (1802: 300), *Persicaria praetermissa* (Hook. f.) H. Hara (1966: 73), *Schoenoplectus mucronatus* (von Linné) Palla, (1888: 299) and *Typha orientalis* C.Presl. (1851: 239) in Australia and with *Carex dissita* Sol. ex Hook.f. (1853: 284), *C. solandri* Hook.f. (1853: 284), *C. virgata* Sol. ex Hook.f. (1853: 282), *Hydrocotyle novae-zelandiae* DC. (1830: 67) and *Uncinia uncinata* Kük. (1909: 62) in New Zealand. It is most frequently recorded in a range of forest types including rainforest, wet sclerophyll forest or notophyll rainforest, as well as *Melaleuca* sp. woodland and humid scrub, while in New Zealand it has been recorded from *Podocarpus dacrydioides* A.Rich. (1832: 358) floodplain forest. 8–1128 m elevation.

Conservation Status:—This species is classed as Least Concern (IUCN 2012) as it is widespread with stable populations and does not face any major threats. It is classed as Not Threatened, Secure Overseas in New Zealand (de Lange *et al.* 2018).

Additional material studied:—AUSTRALIA: NEW SOUTH WALES. Blue Mountains, *s.d.*, *L. Atkinson s.n.* (MEL 2247295, STU 15649); Blue Mountains, *s.d.*, *Woolfs s.n.* (MEL 2247298); 1843, *Leichhardt s.n.* (MEL 2247296); Port Jackson District, 1888, *R. Fitzgerald s.n.* (NSW 33808); Port Jackson District, November 1897, *J.H. Campfield s.n.* (NSW 33806); Thirroul, January 1917, *A.H.S. Lucas s.n.* (NSW 33811); Myall River, September 1924, *H.M.R. Rupp, s.n.* (NSW 77650); Upper Williams River, 13 January 1934, *L. Fraser & J. Vickery s.n.* (NSW 33805); Albion Park, 21 March 1946, *E.G. McBarron 1576* (NSW 33810); W of Wauchope, 4 October 1951, *A. Garden s.n.* (NSW 17255); Whian State Forest, 12 April 1960, *J.G. Tracey & W. Jones, 25755* (BRI AQ334983); Gloucester, 3 August 1964, *B. Briggs s.n.* (NSW 65391); Gloucester Fall, 18 April 1965, *B.G. Briggs s.n.* (NSW 75458); Ellenborough River, 400 m, 17 November 1965, *E.F. Constable 6335* (NSW 79233); Kioloa State Forest, 11 October 1966, *L.G. Adams 1589* (CANB 160042); Mt. Dromedary, 25 January 1970, *N.T. Burbidge 7817* (CANB 236762, CANB 251531); Toonumber State Forest, 750 m, 2 September 1972, *R. Coveney 4421* (NSW 373522); Wilson's River headwaters, 18 May 1976, *J. Thompson 2581* (NSW 373521); Mount Royal, 29 May 1990, *E.J. Jefferson 14* (CANB 00402713); Whian State Forest, 25 September 1994, *A.R. Bean 7930* (BRI AQ632689, NSW 673950); Chichester River, 31 March 1996, *S.W.L. Jacobs 7966* (NSW 406095); Unumgar State Forest, 13 May 1998, *A.R. Bean 13227* (BRI AQ670599, NSW 506888); SE of Tyalgum, 24 January 1999, *A.R. Bean 14561* (BRI AQ676285, NSW 508664); Oakes State Forest, 30 January 1999, *A.R. Bean 14596* (BRI AQ676401); 16 April 2000, *A.R. Bean 16227* (BRI AQ679178); Bilambil, 11 August 2004, *A.R. Bean 22748* (BRI AQ781495); Kingsgate Forest Preserve, 27 December 2005, *A.R. Bean 24540* (BRI AQ734808); Gap Creek, Watagan Mts, 3 January 2006, *I.R. Thompson 878 & W. Cherry* (MEL 2299679); Murray Scrub Road, Richmond Range, 7 October 2006, *S.P. Phillips 1616 & B.A. Phillips* (BRI AQ699444); Doyles River State Forest, 706 m, 21 December 2007, *A.R. Bean 27219* (BRI AQ786535); Raspberry Gully Reserve, Lake Macquarie LGA, 18 December 2011, *S. Lewer s.n.* (NSW 899658); Bungabee Nature Reserve, 29 December 2011, *A.R. Bean 31433* (BRI AQ823479). QUEENSLAND. Archer's Station, 28 August 1843, *Leichhardt s.n.* (NSW 33813); Brisbane River, July 1855, *Mueller s.n.* (MEL 2247293); Brisbane, 5 November 1887, *J.H. Simmonds s.n.* (BRI AQ27079); Brisbane, April 1888, *J.H. Simmonds s.n.* (BRI AQ27080); Burnett River, August 1889, *J. Keys s.n.* (MEL 2247292); Bulli, 9 March 1891, *J.H. Maiden s.n.* (NSW 673951); Atherton, August 1901, *E. Betche 44* (NSW 33807); Sidling Creek, Petrie, December 1930, *S.T. Blake s.n.* (BRI AQ027083); Sidling Creek, July 1931, *S.T. Blake 2515* (BRI AQ027078); Oxenford, 150 ft., 17 August 1930, *C.E. Hubbard 3673* (GH); Sidling Creek, October 1931, *S.T. Blake 2810* (BRI AQ027082); Coomera River, 26 August 1961, *S.T. Blake 21592* (BRI AQ413221); White Water Creek, 20 April 1973, *P. Sharpe 00345* (BRI AQ11668); Conondale Range State Forest, 22 October 1982, *W.J. McDonald 3633 & J.B. Williams* (BRI AQ439003); Maxwells Road Forest Reserve, 17 January 1984, *A. Nunnink 542* (NSW 673952); Kiamba, 23 June 1990, *P.R. Sharpe 4950 & A.R. Bean*, (BRI AQ502504); Bli Bli, 18 February 1993, *A.R. Bean 5779* (BRI AQ564770), 20 April 1993, *D. Halford Q1674* (BRI AQ566136); Jimna, 580 m, 18 May 1993, *A.R. Bean 6056* (BRI AQ567492); Corella Creek State Forest, 5 October 1993, *A.R. Bean 6705* (BRI AQ621416); State Forest 185 Danbulla, 16 July 1994, *P.I. Forster PIF15606*, *G. Sankowsky & M.C. Tucker* (BRI AQ631918, MEL 241082), 1 April 1995, *A.R. Bean 8524* (BRI AQ634914); Carnarvon NP, 19 March 2001, *R.J. Fensham 4798* (BRI AQ557099); Mt. Mee State Forest, 3 March 2002, *A.R. Bean 15843* (BRI AQ554718); Guanaba, 23 July 2002, *D. Halford Q7076 & W. McDonald* (BRI AQ559390); Gambubal State Forest, 23 November 2003, *A.R. Bean 21193* (BRI AQ763510); Northbrook Parkway, D'Aguilar Range, 27 July 2005, *S.P. Phillips 1325 & B.A. Phillips* (BRI AQ766837); The Crater,

4 July 2007, *B. Gray 9116* (BRI AQ738766, CANB 00723435); Mount Hypipamee National Park, Cook District, 22 August 2007, *F.A. Zich 616* (BRI AQ849030, CANB 724576, NSW 920753, CNS 130790); Main Range National Park, 7 September 2008, *S.P. Phillips 1856 & B.A. Phillips* (BRI AQ743626); Mt. Glorious, 11 July 2009, *S.P. Phillips 2034* (BRI AQ749243); Brisbane Valley Rail Trail, Blackbutt Creek, 10 July 2011, *S.P. Phillips 2179 & B.A. Phillips* (BRI AQ759196). VICTORIA. Snowy River, s.d., *H.B. Williamson s.n.* (MEL 2247304); Snowy River, s.d., *F. Mueller s.n.* (MEL 2247320); East Gippsland, s.d., *Menall s.n.* (MEL 2247313); Gellibrand River, s.d., *H.B. Williamson s.n.* (MEL 2247533); Gellibrand River, near Colac, s.d., *H.B. Williamson 14103* (MEL 2247317); Near Mt. Ellery, 1886, [illegible] *s.n.* (MEL 2247534); East Gippsland, 1887, *W.A. Sayer s.n.* (MEL 2247316); Tidal River Camp, 7 December 1975, *H.I. Aston 1891* (MEL 609857); Irrewillipe, April 1903, *H.B. Williamson s.n.* (MEL 2247521); Otway Ranges, April 1903, *H.B. Williamson s.n.* (MEL 2247314); Irrewillipe, April 1903, *H.B. Williamson s.n.* (MEL 2247319); Otway Range, April 1903, *H.B. Williamson s.n.* (MEL 2247310); Otway Forest, April 1903, *H.B. Williamson* (NSW 673953); tributary of Gellibrand River, 15 April 1903, *H.B. Williamson s.n.* (NSW 33812); Otway Ranges, 1904, *H.B. Williamson s.n.* (CANB 282975); Near Vereker Range, 19 October 1909, *P.R.H. St John & J.W.C. Audas s.n.* (MEL 2247311); Gippsland, Jan 1911, *H.B. Williamson s.n.* (MEL 2247318); Tonimbuk, 26 February 1936, *H.B. Williamson s.n.* (MEL 2247317); East Gippsland, ca. 1937, *F. Robbins s.n.* (MEL 2247308); Hotspur, December 1949, *A.C. Beaglehole 497* (MEL 2247524); Chapple Creek, western Otways, 26 November 1961, *J.H. Wills s.n.* (MEL 2247522); Wilson's Promontory, 21 November 1961, *M.E. Phillips 613350* (CANB 15438); Mt. Drummer, 17 February 1965, *J.H. Wills s.n.* (MEL 2247523); Webenduck Creek, 25 January 1969, *A.C. Beaglehole 31250* (MEL 2247315); Combienbar River, 8 April 1969, *N.A. Wakefield s.n.* (MEL 1511765); Mallacoota, 3 November 1969, *A.C. Beaglehole 31487 & Wills, J.H.* (MEL 2247305); Mallacoota Inlet National Park, 16 November 1969, *A.C. Beaglehole 31802* (MEL 2247531); Mallacoota Inlet National Park, 5 December 1969, *A.C. Beaglehole 32446 & E.W. Finck* (MEL 2247306); Alfred National Park, 17 December 1969, *A.C. Beaglehole 32588 & Finck, E.W.* (MEL 2247536); Mallacoota Inlet National Park, 29 December 1969, *A.C. Beaglehole 32906* (MEL 2247303); East Gippsland, 10 October 1970, *A.C. Beaglehole s.n.* (MEL 2247530); Major Creek, East Gippsland, 16 November 1970, *A.C. Beaglehole s.n.* (MEL 2247301); Snowy River, East Gippsland, 3 December 1970, *A.C. Beaglehole 35119* (MEL 2247307); Lake Victoria, East Gippsland, 3 April 1971, *A.C. Beaglehole & F.C. Barton s.n.* (MEL 2247532); Lake Tyers, 7 April 1971, *A.C. Beaglehole s.n.* (MEL 2247309); Toorloo Arm Reserve, 7 April 1971, *A.C. Beaglehole s.n.* (MEL 2247302); Western Port Bay, 16 May 1971, *A.C. Beaglehole 38307* (MEL 2247528); Healesville, Coranderk Bushland Reserve, 1 March 1977, *J.H. Wills s.n.* (MEL 2247299); Coranderk Bushland Reserve, 3 January 1980, *J.H. Willis s.n.* (MEL 574958); Cooagalah Hill, 25 May 1980, *S.J. Forbes 374* (MEL 595465); Gembrook Regional Park, 28 November 1982, *A.C. Beaglehole 72012* (MEL 626739); Mullungdung Flora and Fauna Reserve, 28 October 1983, *A.C. Beaglehole 74905* (MEL 654201); Mullungdung Flora and Fauna Reserve, 8 December 1983, *A.C. Beaglehole 75784* (MEL 1602794); Jones Creek Reference area, 200 m, 27 January 1984, *E.A. Chesterfield 68* (MEL 1545471); Heyfield State Forest, 17 October 1984, *A.C. Beaglehole 78390* (MEL 673050); Wallagaraugh River, 21 October 1991, *N.G. Walsh 3138* (MEL 2013384); "Malinns" on Bonang Hwy, *N.G. Walsh 6871*, 14 April 2009, *J. Walsh & E.J. Renowden s.n.* (MEL 2323838); Bunyip State Park, 30 December 2009, *J.A. Jeanes 2275, N.G. Walsh & J. Reid* (K, MEL 2325836). NEW CALEDONIA: Pouebo, 27 December 1962, *M. Mackee 9858* (K, P 03985991, NSW 935602); Toili, 25 August 1965, *H.S. Mackee 196 I3347* (P 03985989, P 03985990); Col d'Amieu, Toili, 400 m, 25 August 1965, *H.S. Mackee I3347* (P 03985989, P 03985990), Crete au N Isl H^{le}, Pouebo 500 m, 27 December 1962, *H.S. Mackee 9858* (K, NSW 935602, P! 03985991); NEW ZEALAND: 1967, *von F. Müller s.n.* (STU 15651); 26 December 1961, *L.B. Moore s.n.* (CHR 125545). CHATHAM ISLAND. Kaitirira, Chatham Island, 1863 and 1898, *T. Kirk s.n.*, (STU 12805). KERMADEC ISLAND. Raoul Island, 24 November 1966, *W.R. Sykes 282* (CHR 175965). NORTH ISLAND. Auckland, s.d., *J.K. 15* (MEL 2404666); Auckland, North Island, s.d., *T. Kirk 3* (US); Auckland, s.d., *T. Kirk s.n.* (STU 15650); Bay of Islands, s.d, *s.coll. s.n.* (GH); Great Barrier Island, s.d, *s.coll. s.n.* (NSW 935589); Beside Waiotahi River, south of Scenic Reserve, Waiotahi Valley, Opotiki District, 200 ft., s.d., *M. Heginbotham s.n.* (CHR 368176); Auckland Peninsula, s.d., *D. Petrie 1481* (NY); Bay of Islands, October 1874, *S. Berggren s.n.* (G); Auckland, 12 April 1949, *E.H. Walker 5428* (US); Waipoua Forest, North Auckland, 24 November 1949, *R. Mason and N.T. Moar 125* (MEL 2404665); South Auckland, 3 February 1950, *N.T. Moar 559* (CHR 69978); Warkworth, 19 March 1951, *L.B. Moore s.n.* (CHR 70353); Bay of Plenty, 11 December 1959, *R. Mason 7710* (CANB 00589574); Tiritiri Island, 20 December 1970, *A.E. Esler 3233* (CHR 362517); Russell State Forest, 29 November 1972, *A.E. Orchard 3712* (AD 97315205); Hawke's Bay, June 1976, *A.P. Druce s.n.* (CHR 283003); Manawatu River, October 1976, *A.P. Druce s.n.* (CHR 313040); Mauturu, 6 February 1981, *R.O. Gardner 2894* (CHR 446052); Levin, Koputaroa, 1 April 1986, *C.C. Ogle 1391* (CHR 421263); Lake Rotoiti, Wanganui, 1 February 1992, *C.C. Ogle 2219* (CHR 477055); Wanganui, Lake Wairua, 31 January 1999, *C.C. Ogle 3460* (CHR 518739); Wellington, 26 May 1959, *A.P. Druce s.n.* (CHR 111093);

Wellington, 26 May 1959, *A.P. Druce s.n.* (CHR 111093). SOUTH ISLAND. South Westland, Big Bay, Haast, 1 October 1945, *P.N. Johnson 204* (CHR 415741); Westport Domain, 25 January 1953, *R. Mason & N.T. Moar 1721* (NSW 935588); Westport, 24 January 1953, *R. Mason & N.T. Moar 1709* (MEL 2401984); Lower Kokatahi Valley, 13 February 1958, *R. Mason & N.T. Moar 5179* (AD 99025090, CHR 97629); Okarito Lagoon, 24 February 1958, *R. Mason & N.T. Moar 5563* (CHR 107249).

14. *Callitriche palustris* von Linné (1753: 969)

Type:—Herb. Linnaeus, Sheet No. 13.1, lowermost three specimens (Lectotype [designated by Lansdown & Jarvis 2004: 110]: LINN!)

14a. *Callitriche palustris* var. *palustris*

Description (after Lansdown 2008):—Stem and leaf scales present. Leaf bases connate. Lingulate leaves linear to narrowly expanded, 5.6–9.7 mm long × 0.5–1.2 mm wide; expanded submerged or floating leaves elliptic to more or less orbicular, 3.6–9.9(–10.3) mm long × 1.2–4.3(–4.5) mm wide, most leaves have at least part of a tertiary vein, petiole 1–3.5 mm long; the apical leaves forming a floating rosette; leaves of terrestrial plants narrowly elliptic, bluntly emarginate, more or less rigid. A ♀ flower in each of a pair of axils or ♂ and ♀ opposed by a solitary ♀, occasionally more than one ♀ with a single ♂. Bracts 0.5–1.2 mm long, translucent, whitish, falcate, persistent. Styles erect or slightly spreading, often poorly developed, 0.2–1.7 mm long. Filament erect, 0.2–2.7 mm long; anthers 0.2–0.5 mm long × 0.2–0.6 mm wide, quadrilocular; pollen yellow. Fruit not strumose, subsessile, higher than wide, black when mature, 0.9–1.4 mm long × 0.8–1.1 mm wide, wing mainly toward apex.

Illustrations:—Figures on pages 125 and 127 in Lansdown (2008); Figures 13(a–b) and 13A(a–b) in Mason (1959). Fig. 10d.

Recognition:—*C. palustris* can be distinguished from all other *Callitriche* species by the elongate fruit which are blackish when mature and winged only or more broadly at the apex, with a narrow rim at the base.

Distribution:—Non-native. Within the region, *Callitriche palustris* has been recorded in a few scattered localities in Victoria, Australia (Fig. 13). Its native range is circumboreal, from Europe east through Russia, the Caucasus, the Himalayas and Mongolia, to China, the Russian Far East, the Korean Peninsula and Japan. In North America, it occurs more or less throughout, apart from extreme northern Canada and the south-eastern United States.

Habitats and Ecology:—There is very little information on the habitat in which *Callitriche palustris* occurs in the region. It is described as occurring in shallow, still water such as drains, ponds and dams, as well as on mud (Jeanes 1999, Bean 2007). In its native range, it typically occurs in a wide range of seasonally inundated habitats, including wet ruts on woodland rides, turloughs, lakes, river margins, and reservoirs, as well as occasionally in permanent water bodies. 0–2600 m elevation in its native range, there is no information on elevation in the region.

Conservation Status:—Least Concern (Lansdown 2016b).

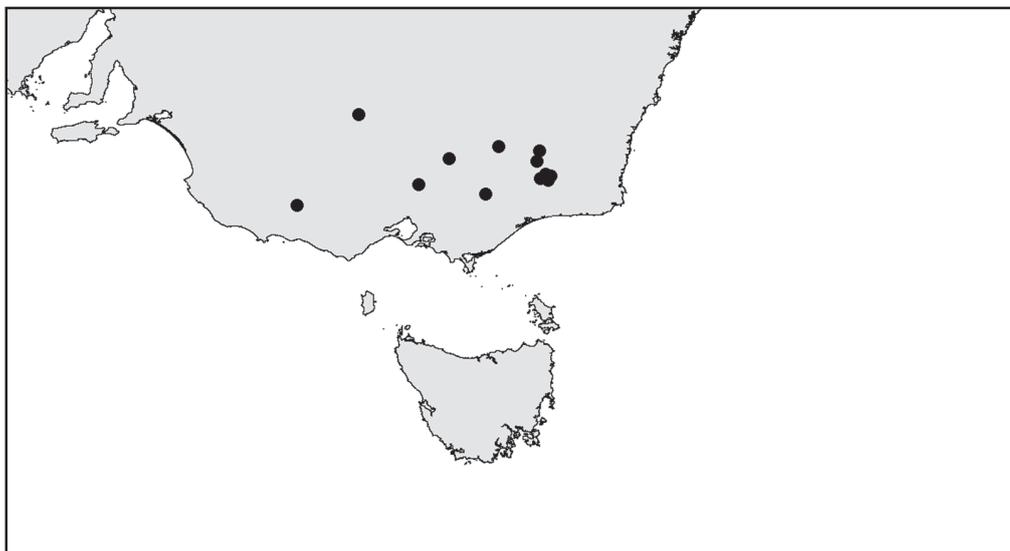


FIGURE 13. The distribution of confirmed specimens of *C. palustris* in Oceania and Australasia

15. *Callitriche papuana* Merrill & Perry (1941: 258).

Type:—INDONESIA. WEST PAPUA. Submerged (green) aquatic rooting in outer shallows of Lake Habbema, 3225m, Aug. 1938, *L.J. Brass* 9541 (Holotype: A; isotypes K 110073869!, L 950278395).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves very long and narrow, 0.7–22.0 mm long \times 0.4–0.5 mm wide; expanded submerged or floating leaves narrowly elliptic, 4.4–5.5 mm long \times 1.6–2.3 mm wide; venation simple or occasionally branched with veins between central and secondary veins, petiole 3.2–6.5 mm long; leaves of terrestrial plants unknown. Flowers solitary. Bracts strongly falcate, caducous, 1.5–1.8 mm long. Styles erect or sub-divergent 2.3–8.0 mm long. Filament erect 3.8–5.5 mm long; anthers, 0.5 mm long \times 0.6–0.7 mm wide, number of locules unknown; pollen yellow. Fruits sessile or very shortly pedicellate, as high as or slightly higher than wide, blackish when mature, 1.4–1.6 mm long \times 1.2–1.4 mm wide, narrowly winged throughout.

Illustrations:—Fig. 10e.

Recognition:—*C. papuana* can be distinguished from all other *Callitriche* species in the region by the fruit which are narrowly winged, higher than wide and blackish when mature, combined with the solitary flowers and large bracts. Fruits of *C. aucklandica* may be considered similar but are typically wider than high, while its vegetative parts are typically fleshy.

Distribution:—Native. *Callitriche papuana* is known from a few specimens collected in the highlands of New Guinea, from Lake Habbema in West Papua, to Mount Victoria near Port Moresby in New Guinea (Fig. 14).

Habitats and Ecology:—*C. papuana* has been described as occurring in water with pH between 6.50 and 7.50, including in the shallow, marginal waters of a lake surrounded by forest. Populations determined as *C. palustris*, but probably this species have been reported from pools, the outflow stream from a lake and a small bog lake at high altitude, with a thick growth of submerged *Isolepis fluitans* (von Linné) R.Br. (1810: 221) and *Spirogyra* Link (1820: 5), surrounded by fringe of *Carex gaudichaudiana* Kunth (1837: 417) fen which is surrounded in turn by *Carpha alpina* fen (Hoogland 1958, Wade and McVean 1969). 2225–4100 m elevation.

Conservation Status:—The information available is not adequate to assess the conservation status of the species and it is therefore classed as Data Deficient (IUCN 2012).

Notes:—*C. papuana* is extremely poorly known, with no records since 1980. As with many other *Callitriche* species in the region, there is a need for fieldwork to assess its current conservation status and collect accurate information on its distribution.

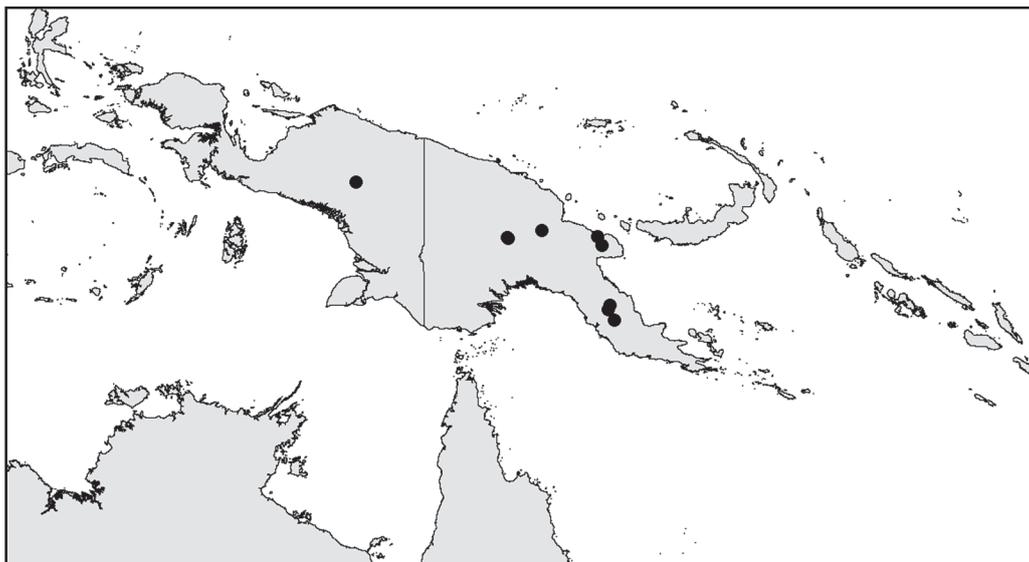


FIGURE 14. The distribution of confirmed specimens of *C. papuana*

Selected specimens examined:—INDONESIA: WEST PAPUA: Lake Habbema, 3225m alt., August 1938, *L.J. Brass* 9541 (K). PAPUA NEW GUINEA. Lake Aunde, 23 January 1976, *Verdcourt* 4909 (P 04214987); Salawaket 3 April 1937, *M.S. Clemens* 5733 (GH); Morobe, 6 April 1940, *M.S. Clemens* 41125 (GH); Mt. Wilhelm, 17 June 1959, *L.J. Brass* 29986 (CANB 102003, GH, NY, US); Murray Pass, Wharton Range, June–Sept. 1933, *L.J. Brass* 4774

(NY); Mt. Victoria, 5 July 1974, *J. Croft et al. LAE 61654* (BRI AQ329318); Mt. Edward, 20 June 1974, *J. Croft et al. LAE 61334* (BRI AQ329329); Lake Aunde, 15 September 1971, *N.M. Wace ANU13042* (CANB 765114.1, CANB 230517); Mt. Wilhelm, 1965, *M.M.J.v. Balgooy 186* (CANB 321839); Mt. Giluwe, 22 September 1961, *R. Pullen 2882* (CANB 98477); Kongdarumbun, 1 October 1964, *R.D. Hoogland 9971* (CANB 150082); Mt. Wilhelm, July 1969, *G. Hope ANU10804* (CANB 241288); Mt. Giluwe, 15 August 1972, *P.F. Stevens & D.B. Foreman LAE 52252* (CANB 282972); Mt. Wilhelm, 16 June 1967, *L.K. Wade ANU 7771* (CANB 173944).

16. *Callitriche peploides* Nuttall (1835: 141)

Type:—U.S.A. Arkansas: s.d., *T. Nuttall s.n.* (Lectotype [designated by Lansdown 2006: 115]: NY 248737!).

16a. *Callitriche peploides* var. *peploides*

≡ *Callitriche drummondii* Hegelmaier, Monogr. Callitriche 60. 1864.

Type:—U.S.A. Louisiana: Orleans Parish, New Orleans, [1832], *T. Drummond s.n.* (Lectotype [designated by Lansdown 2009: 367]: NY 248737!; isotypes: GH 48917, GH 48918).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves unknown; expanded submerged or floating leaves unknown; leaves of terrestrial plants spatulate-obovate, 1.4–2.3 mm long × 0.4–0.8 mm wide, 3-veined, petiole 0.8–1.2 mm long. Most pairs of axils contain both ♂ and ♀ flowers opposed by a solitary ♀. Bracts lacking. Styles erect or patent, persistent, 0.2 mm long. Filament erect, 0.2 mm long; anthers 1.0 mm long × 1.0 mm wide, number of locules unknown; pollen yellow. Fruit strumose, subsessile, wider than high, black when ripe, 0.5–0.6 mm long × 0.7–0.8 mm wide, unwinged.

Illustrations:—Plate 1171 7(a–d) in Fassett 1951, Fig. 10f.

Recognition:—*C. peploides* can be distinguished from other *Callitriche* species in the region by the very small, unwinged, strongly strumose fruit, combined with most leaf axils containing both ♀ and ♂ flowers.

Distribution:—Non-native. Within the region, *C. peploides* var. *peploides* is known from a specimen from Nukumaru, Taranaki, North Island, New Zealand, found during work for this article (CHR 625887) (Ogle *et al.* 2020). Its native range extends from South Carolina, Tennessee and southern Arkansas in the United States, south to Cuba and north-eastern Mexico (Fassett 1951). It is widely naturalised in Madagascar, Reunion Island and in Taiwan.

Habitats and Ecology:—In New Zealand, the plant was described as locally co-dominant with *Limosella lineata* Glück (1934: 555) in lake bed “turf”, submerged much of the year but exposed in summer. In its native range, *C. peploides* occurs in seasonally inundated hollows or areas which are damp for much of the year, such as the edges of trails in closed canopy woodland or open savannah-type grassland, muddy areas where trails and tracks cross streams, seepages and flushes, as well as flower beds which are regularly watered. 0–100 m elevation.

Conservation Status:—*Callitriche peploides* subsp. *peploides* is classed as Least Concern (IUCN 2012) as it is widespread with stable populations and does not face any major threats.

Selected specimens examined:—CHINA: TAIWAN. Chingmei, Taipei City, 24 March 1991, 0–50m, *S.F. Huang 4470* (TAI 219662); Shih-ting Hsiang, Taipei Co., 10 December 1999, 300–450m, *J.-c. Wang & C.-h. Chen* (TNU 11338, TNU 041261); National Taiwan Normal Univ., 22 March 2000, *J.-c. Wang* (TNU 11348); Taipei City 25° 01' 50" N, 121° 34' 0" E, 9 February 2001, *S.-M. Ku 1156* (PPI). CUBA: S. Jolinis R., Matanzas, s.d., *F. Rugel 234* (BM); Plantae Cubensis, 1860–1864, *C. Wright 2547* (P 04214924). FRANCE: REUNION. Plaine des Palmistes, s.d., *de Cordemoy s.n.* (P 03900488). GUATEMALA: Alta Verapaz Prov., February 1908, *H. von Türkheim s.n.* (G). MADAGASCAR: Tananarive, June 1913, *H. Perrier de la Bâthie, 2249* (P 03900494); Nr. Tananarive, alt. 1250–1450m, 14 August 1924, *H. Perrier de la Bâthie, H.Humbert 2199* (P 03900496, P 03900497); Tananarive, April 1927 *H. Perrier de la Bâthie 18003* (P 03900489); Tananarive, 26 August 1928, *R. Decary 6756* (P [P03900491]); Tananarive, 1500m alt., 20 June 1932, *H. Perrier de la Bâthie 13207* (P 03900498); Tananarive, 1932, *H. Perrier de la Bâthie 17795* (P 03900490); Bassin Supérieur du Sambirano, alt. 1700m, November–December 1937, *H. Humbert 18667* (P 03900495); Tananarive, 7 September 1972, *H. Jacquemin 1.101* (P P03900492). MEXICO: 1956, *Botteri 834* (P 04214927). MICHOACAN. Temascaltepec, San Miguel, L. Lano, 5 December 1934, *G.B. Hinton 6854* (K). TAMAULIPAS. San Jose, 17 February 1939, *H. LeSueur 126* (GH). VERACRUZ. Orizaba, August 1954, *Botteri 834* (BM). NEW ZEALAND: NORTH ISLAND. Lake Waikato, Nukumaru, Waverley, Taranaki, NZMS 260: R22 630 513, 80 m, 10 March 2013, *C.C. Ogle 6180* (CHR 625887). UNITED STATES OF AMERICA: ALABAMA. Auburn, Lee Co.,

24 March 1897, *F.S. Earle & C.F. Baker s.n.* (MO 1913626). FLORIDA. Jacksonville, March, s.d., *A.H. Curtiss 2462a* (MO 1913629, P 04214920); Hibernia, March 1869, *W.M. Canby s.n.* (MO 1913627); Jacksonville, 5 March 1894, *A.H. Curtiss 4570* (P 04214926, P 04214922); Jacksonville, Florida, 13 March 1893, *A.H. Curtiss 4310* (MO 766874); Jacksonville, 13 April 1897, *J.R. Churchill s.n.* (MO 1060127). GEORGIA. Tebeauville, April 1869, *W.M. Canby s.n.* (MO 1913630). LOUISIANA. New Orleans, 1832, *T. Drummond 115* (BM). MISSISSIPPI. Picayune, 21 March 1972, *F.H. Sargent 10,514* (MO 2455814, BM); Russum, 2 April 1986, *A.E. Brant & A.F. O'Donnell 821* (MO 3526792). TEXAS. Galveston Island, May 1843, *F. Lindheimer s.n.* (MO 1913770); Houston, 1 April 1872, *E. Hall 544* (BM, MO 1913623, MO 1913524); Baton Rouge, 21 January 1874, *J.F. Joor s.n.* (MO 1913625); Houston, 27 March 1877, *J.F. Joor s.n.* (MO 1913621); House Mountain, Llano Co., May 1885, *R.J. Reverchon 1589* (MO 1913622, MO 3932421, P 04214921); Houston, 17 April 1900, *B.F. Bush 22* (MO 1913620); Columbia, 20 April 1900, *B.F. Bush 85* (MO 1913619); Hungerford, 9 March 1914, *E.J. Palmer 4893* (MO 753698); Jacksonville, Texas, 24 December 1922 *s.coll., s.n.* (P 04214919); Jackson Co., 25 December 1923, *J.A. Prushel 5014* (MO 897817); Stockdale, 24 March 1947, *R. McVaugh, 7641* (P 04214923); San Jacinto Co., 30 March 1935, *B.C. Tharp 47003* (MO 1303712); Smith's Point, Chambers Co., 8 October 1936, *B.C. Tharp 47006* (MO 1303713); Austin, 10 March 1937, *B.G. Tharp 47013* (MO 1303855); Silsbee, 19 April 1964, *D.S. Correll 29293* (MO 2620939); Magnolia, 17 April 1964, *D.S. Correll 29347* (MO 2620891). Brazoria Nat. Wildlife Refuge, 23 April 1970, *D.S. Correll, H.B. Correll & R. Fleetwood 38452-A* (MO 2375347); Brazoria Nat. Wildlife Refuge, 23 April 1970, *D.S. Correll 38462, H.B. Correll & R. Fleetwood* (MO 2379848).

17. *Callitriche petriei* Mason (1959: 315).

Type:—NEW ZEALAND. NORTH ISLAND. Ngaruawahia, Waikato R., 4 February 1906, *Petrie, D. s.n.* (Holotype: WELT51443, isotype WELT51444).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves, parallel-sided, 0.6–0.7 mm long × 5.7–6.8 mm wide, expanded submerged or floating leaves elliptic, 0.5–1.2 mm long × 1.5–2 mm wide, 3-veined; petiole 1.2–1.4 mm long; leaves of terrestrial plants broadly ovate, 1.2–1.4 mm long × 1.5–2.0 mm wide, petiole 0.5–1.2 mm long. Dioecious, flowers solitary, usually in one of a pair of axils on alternate sides of the stem. Bracts lacking. Styles erect, ± persistent, 1.7–2.2 mm long. Filament erect, 2.2–4.9 mm long; anthers 0.4 mm long × 0.5 mm wide, number of loculae unknown; pollen yellow. Fruit not strumose, sessile or on pedicel to 0.5 mm, wider than high, greyish-brown when mature, 0.6–0.7 mm long × 0.7–0.9 mm wide, unwinged.

Illustrations:—Mason 1959, Fig. 10g.

Recognition:—*C. petriei* is the only *Callitriche* which is dioecious, however a number of other species appear to initially only produce female flowers and it may be necessary to be cautious in recognising plants based on this character unless they have very abundant flowers. The unwinged pale or golden-brown fruit will distinguish this species from all other *Callitriche* species in the region apart from *C. chathamensis* from which it can be distinguished by the smaller fruit.

Distribution:—Native. *C. petriei* is endemic to New Zealand, where it occurs on North and South Islands (Fig. 15a). On the North Island, it is scarce north of Auckland according to Mason (1959).

Habitats and Ecology:—*Callitriche petriei* occurs on damp mud and soil, in lake margin turf communities, on the margins of lakes and streams, in swamps and temporary pools, as well as occasionally in standing water of ponds and lakes, where it may grow permanently submerged (Mason 1959, Johnson and Rogers 2003). It is frequent in lowland indigenous riparian forest dominated by *Dacrycarpus dacrydioides* (P. de Lange pers. comm.) and can tolerate shade from non-native *Salix* species. It has been recorded with species such as *Eleocharis acuta* R.Br. (1810: 224), *Galium palustre* M.Bieb. (1808: 103), *Hydrocotyle sulcata* C.J. Webb & P.N. Johnson (1982: 165), *Lobelia angulata* G.Forst. (1786: 58), *Myriophyllum propinquum* A.Cunn. (1839: 30), *Nertera depressa* Gaertn. (1788: 124–125), *Dacrycarpus dacrydioides*, *Persicaria strigosa* (R.Br.) H.Gross (1913: 308), *Potamogeton ochreateus* Raoul (1844: 117) and *Viola lyallii* Hook.f., (1864: 16). 15–150 m elevation.

Conservation Status:—*Callitriche petriei* is classed as Least Concern (IUCN 2012) as it is widespread with stable populations and does not face any major threats. It is classed as Not Threatened in New Zealand (de Lange *et al.* 2018).

Notes:—*Callitriche petriei* was combined with *C. chathamensis* by Mason (1959), however differences between the two, such as the monoecy, larger fruit and larger leaves of *C. chathamensis* are significant, and justify their recognition as separate species.

The information presented here is based on a very small number of specimens bearing fruit. Most material in herbaria is not flowering and whilst the habit can be distinctive (see Fig. 15b), there is a need for information to be collected based on fruiting and therefore rigorously confirmed, material.

Selected specimens examined:—NEW ZEALAND: Tinamea Saddle, 6 February 1961, *M.J.A. Simpson 2582 & J.B. Moss* (CHR 521063); 25 November 1970, *R. Mason & A.E. Esler 11473* (CHR 214376). NORTH ISLAND. Lake Moumahaki, Wanganui, 22 January 1989, *C.C. Ogle 1762* (CHR 464160), Lake Waikato, Taranaki: R22 630 513, Wellington Land District, 10 March 2013, *C.C. Ogle 6182* (CHR 625889); Lake Waikari, 10 December 1958, *R. Mason & N.T. No. 6911* (CHR 111315); Huntly, 25 November 1958, *R. Mason & N.T. Moar 6330* (CHR 109500); Lake Whangape, 15 m, 14 January 1990, *P.J. de Lange 178* (CHR 466165); Paiko River, Patetonga, s.d., *R. Mason 7463* (CHR 113280); Paiko River Patetonga, s.d., *R. Mason 7464* (CHR 113281); Lake Alice, 16 March 1956, *R. Mason 4090* (AD 108590, NSW! 935590); Roto Aira, February 1875, *S. Berggren s.n.* (G); Totara Reserve, Pohangina V., October 1973, [name illegible] (CHR 262315); Mangamahu, Wanganui, 16 October 1990, *C.C. Ogle 2036* (CHR 471380). SOUTH ISLAND. Lake Heron, Ashburton Co., Canterbury, 27 March 1962, *R. Mason 9374/1* (ANSP, PH); Riversdale, Mataura River S160/577760, 25 February 1973, *R. Mason & E.M. Chapman 12788* (CHR 243613); Otamita Stream Mandeville SI69 74-51-, 27 September 1973, *R. Mason & E.M. Chapman 12825* (CHR 243649); Lake Poteriteri, 55 m alt., 46° 4' S, 167° 6' E, s.d., *M.D. de Winton s.n.* (CHR 502290); Peel Forest, Canterbury, 13 February 1984, *B.P.J. Molloy & A.P. Druce s.n.* (CHR 607421).

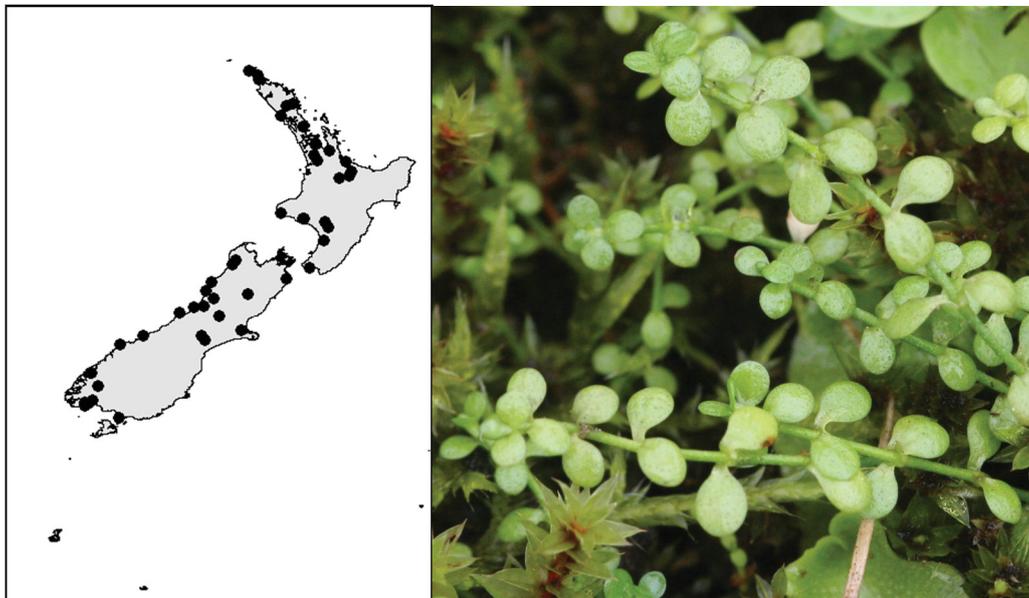


FIGURE 15. a) The distribution of confirmed specimens of *C. petriei* (left) and b) *C. petriei* in cultivation, Auckland, New Zealand, 2011 © R.V. Lansdown

18. *Callitriche platycarpa* Kützing (1831: 38).

Type:—Magdeburg, Germany, rec. 1865, *W. F. R. Suringar s.n.* (lectotype [designated by Schotsman (1967: 68)]: L 91017293!).

Description (after Lansdown 2008):—Stem and leaf scales present. Leaf bases connate. Lingulate leaves ± parallel-sided or tapering from base, often sinuous, 10.4–28.5 mm long × 0.1–2. mm wide; expanded submerged or floating leaves elongate-spathulate to elliptic, 11.1–15.9 mm long × 2–3.8 mm wide, 3-veined often with one or two short processes arising from the secondary veins; petiole (0.3–)1.1–5.5 mm long; the apical leaves forming a floating rosette; leaves of terrestrial plants 1.5–3.8 mm long × 0.5–1.8(–2.3) mm wide, narrowly elliptic. Flowers solitary. Bracts translucent, appearing whitish, falcate, persistent 0.3–2.6 mm long. Styles erect and slightly curved, 0.5–6.5(–7.8) mm long. Filament initially erect, ultimately recurved ≤ 8.3 mm long; anthers (0.5–)0.6–0.8 mm long × 0.6–1 mm wide, quadricellular; pollen yellow. Fruit not strumose, subsessile, ± as wide as high, pale brown when mature, 1.3–1.7 mm long × 1.4–1.8 mm wide, narrowly winged throughout.

Illustrations:—Figures on pages 114–115 in Lansdown 2008. Fig. 10h.

Recognition:—*C. platycarpa* can be distinguished from other *Callitriche* species in the region except *C. stagnalis* by the large, winged, pale brownish-grey fruit. It can only reliably be distinguished from *C. stagnalis* by the pollen of which most in each anther is bluntly triangular, as opposed to ellipsoid in *C. stagnalis*. *C. platycarpa* often produces linear, submerged leaves which are very rare in *C. stagnalis*, while the fruit of *C. platycarpa* are typically more narrowly-winged than in *C. stagnalis* and more greyish, but these characters are not diagnostic.

Distribution:—Non-native. Within the region. *Callitriche platycarpa* has been reported from a single site in New Zealand. In its native range it is mainly found in western Europe. It occurs throughout Britain and Ireland and throughout France, extending north into southern Sweden and east to the Czech Republic.

Habitats and Ecology:—There is no information on the habitat in which it was reported from New Zealand. In its native range *Callitriche platycarpa* typically occurs in lowland ditches, canals, streams, ponds and river backwaters. 0–520 m elevation in its native range, Palmerston North is at around 50 m elevation.

Conservation Status:—Least Concern (LC) (Lansdown 2011).

Notes:—Within the region *Callitriche platycarpa* is represented by three specimens in CHR determined as this species by R. Mason, two of which represent material cultivated from the first gathering which was collected from North Island, Palmerston North, October 1973, *Forde, M.B. s.n.* (CHR 279611, cultivated material CHR 279607 A, CHR 279607 B). Given the frequent problems with mis-identification of unfamiliar *Callitriche* species, even by specialists, this material needs to be confirmed by microscopic examination of pollen which is unique within the genus being tetrahedroid and appearing bluntly triangular in outline (Lansdown 2008: 115, Fig. 11).

19. *Callitriche sonderi* Hegelmaier (1867: 18, fig. 11–14).

Type:—AUSTRALIA. VICTORIA. “in paludibus prope Station peak Austr. felix. s. dat., *F. Mueller s.n.* (holotype: STU 83918; isotype: MEL 2289177).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves unknown, expanded submerged or floating leaves unknown, leaves of terrestrial plants linear-obovate, 0.8–1.7 mm long × 0.4–0.7 mm wide, 3-nerved, sometimes with 2 short free veins arising from the midrib, petiole 0.8–1.0 mm long. Most axils contain one ♂ and one ♀ flower. Bracts narrowly triangular to linear 0.2–0.3 mm long. Styles erect, persistent, 0.1–0.3 mm long. Filament arising from peduncle, erect, 0.4–1 mm long; anthers trilobular, 0.1–0.5 mm long; pollen yellow. Fruit distinctly strumose, sessile, wider than high, dark brown when mature, 0.5–0.6 mm long × 0.7–0.8 mm wide, narrowly winged throughout.

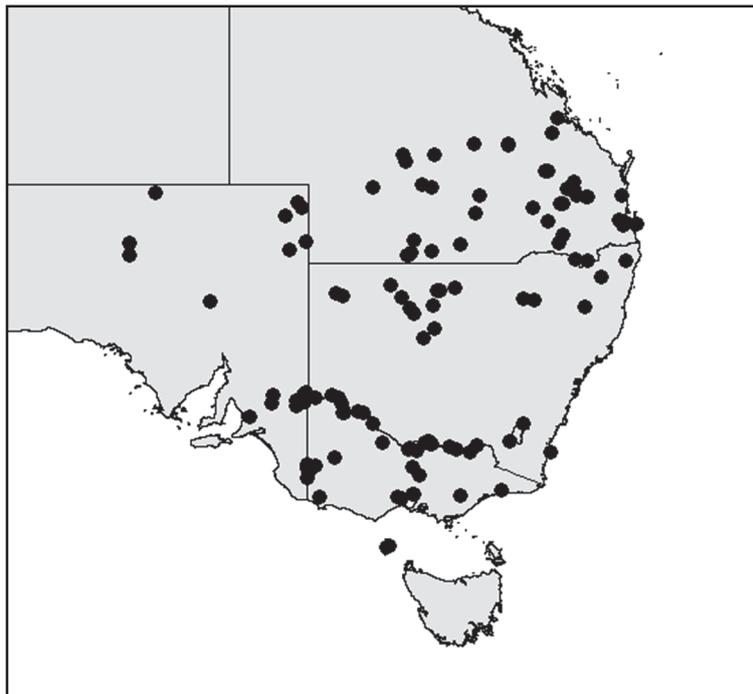


FIGURE 16. The distribution of records of *C. sonderi* based on records held by AVH

Illustrations:—Figures 2(a–d) and 2A(a–b) in Mason (1959); figures 1A–C in Orchard (1980); plates 2(A–D) and 3(1–2) in Schotsman (1985c). Fig. 10i.

Recognition:—*C. sonderi* can be distinguished from all other *Callitriche* species in the region by the small fruit which when mature are narrowly-winged, blackish, ± isodiametric or wider than high and clearly flat with a prominent struma. It most closely resembles *C. capricorni* which differs in the convex face of the fruit which are not strumose.

Distribution:—*C. sonderi* is endemic to Australia south of latitude 25°S (Mason 1959), where it is widespread in southern Queensland, much of New South Wales and Victoria (Bean 2007) (Fig. 16). It has also been recorded from South Australia but only from Cordillo Downs in the far northeast and from the floodplains of the River Murray near Loxton and Berri (Orchard 1980). In Tasmania it is known only from the Sea Elephant River, King Island.

Habitats and Ecology:—*Callitriche sonderi* typically grows on clays ranging from grey to orange or red-brown, as well as silt, sandy soils and less often on bare sand or on rich, organic black soils. It is most frequent on the draw-down zone or margins of lakes, lagoons, rivers, creeks, billabongs, reservoirs and other wetlands, as well as on seepages, floodplains, river bars, shallow pans on bedrock, swamps, damp areas beside roads and on bare soil in woodland where humidity remains high. It often occurs within or adjacent to woodland, typically dominated by species such as *Eucalyptus camaldulensis*, *E. crebra* F.Muell. (1858: 87) and *E. tereticornis* Sm. (1795: 41) more or less throughout its range, with *Acacia stenophylla* A.Cunn. ex Benth. (1842: 366), *Eucalyptus coolabah* Blakely & Jacobs (1934: 245) and *Melaleuca trichostachya* Lindl. (1848: 277) more often in the north, *Angophora floribunda* Sweet (1830: 248), *Eucalyptus chloroclada* (Blakely) L.A.S.Johnson & K.D.Hill (1988: 508), *E. conica* Deane & Maiden (1900: 612), *E. largiflorens* F.Muell. (1855: 34) and *Muehlenbeckia florulenta* in inland areas, *Callitris glaucophylla* Joy Thomps. & L.A.S.Johnson (1986: 731) in the south and with *Melaleuca ericifolia* Sm. (1797: 276) in Tasmania. It has been recorded with a range of species, varying from wetland plants such as *Alternanthera denticulata* R.Br. (1810: 417), *Ammannia multiflora* Roxb. (1820: 447), *Diplachne fusca* (von Linné) P.Beauv. ex Roem. & Schult. (1817: 615), *Elatine gratioloides* A.Cunn. (1839: 26), *Eleocharis pusilla* R.Br. (1810: 225), *Limosella australis* R.Br. (1810: 443), *Marsilea hirsuta* R.Br. (1810: 167), *Myriophyllum simulans* Orchard (1985: 203), *M. verrucosum* Lindl. (1848: 384), *Nymphoides crenata* Kuntze (1891: 429), *Pseudoraphis spinescens* (R.Br.) Vickery (1952: 69), *Ranunculus rivularis* Spreng. (1807: 43) and *Triglochin calcitrapum* Hook. (1844b: 731) and plants more typical of areas which are at most damp, such as *Centipeda minima* (von Linné) A.Braun & Asch. (1867: 6), *Glinus oppositifolius* Aug. DC. (1901: 559), *Goodenia gracilis* R.Br. (1810: 575), *Gratiola pedunculata* R.Br. (1810: 435), *Persicaria prostrata* (R.Br.) Soják (1974: 154), *Poa annua* von Linné (1753: 68), *Sclerolaena intricata* (R.H.Anderson) A.J.Scott (1978: 113), *Sphaeromorphaea australis* (Less.) Kitam. (1937: 80), *Stellaria media* and *Stemodia florulenta* W.R.Barker (1990: 90) as well as with *Callitriche deflexa* in the Royal Botanic Gardens, Melbourne. 10–1218 m elevation.

Conservation Status:—*Callitriche sonderi* is classed as Least Concern (IUCN) as it is widespread with stable populations and does not face any major threats. It is classed as Near Threatened in the states of South Australia (National Parks and Wildlife Act 1972) and Tasmania (Threatened Species Protection Act 1995: Rare species: June 2019 list).

Notes:—*C. capricorni* was reduced to synonymy under *C. sonderi*, however the differences between the two species are more than sufficient to justify their retention as separate species (see under *C. capricorni* above).

Selected specimens examined:—AUSTRALIA: NEW SOUTH WALES. Montagu Island, 31 October 1988, *P.C. Heyligers* 88202 (CANB 472117); Montague Island, 12 April 1973, *L.G. Adams* 3172 (CANB 381761); Louth, 21 September 1978, *C.W.E. Moore* 7921 (CANB 275618), 26 January 2007, *R.W. Pudie* 6328 (CANB 749092.1); Cunnabuncha Waterhole, 26 July 1997, *R.W. Purdie* 4484 (CANB 9711319.1); Gemmana, 10 September 1978, *C.W.E. Moore* 7771 (CANB 275619); Bourke, October 1883, *E. Betche s.n.* (MEL 2241800); Lake Cobham, September 1887, *W. Bäuerlen s.n.* (MEL 2241798); Lake Cobham, s.d., *W. Bäuerlen s.n.* (MEL 2241799); Waibar, 18 September 1891, *C.W.E. Moore* 8120 (CANB 336519); Kosciuszko National Park, 26 Jan 2006, *R.W. Purdie* 6328 (CANB 749092.1); Brewarrina, 21 August 1979, *K. Pajmans* 3200 (CANB 286089); Mulgowan Station, 27 September 1981, *H. Eichler* 22832 (CANB 747438); “Bundycoola” Cobar, 20 August 1973, *G.M. Cunningham* 853 (CANB 00729996). QUEENSLAND. Chinchilla, 13 June 1981, *M.G. Lithgow* 746 (BRI AQ348105); Rolleston, 3 September 1983, *H.I. Aston* 2477 (MEL 659248); Danbulla National Park, 25 January 2007, *K.R. McDonald* KRM60348, *B.G. Jamieson* & *S. Jamieson* (BRI AQ861758); Atherton, 21 April 2002, *A.R. Bean* 18783 (BRI AQ556328); Lake Victoria, 17 September 1999, *A.R. Bean* 15410 (BRI AQ677868, MEL 298615); Mitchell, 11 September 2005, *A.R. Bean* 23489 (BRI AQ725689); Warrego, 1973, *J.D. Pike s.n.* (BRI AQ13188); Rolleston, 3 September 1983, *H.I. Aston* 2477 (BRI AQ460187); Boondandilla State Forest, 6 September 1997, *A.R. Bean* 12386 (BRI AQ657506, CANB 529791, MEL 270252); Bollon, 156 m, 27 August 2006, *A.R. Bean* 25522 (BRI AQ617764); Texas Lagoon, 11 September 2001, *A.R. Bean* 17918 (BRI AQ551139); Enngonia, September 2004 *A.R. Bean* 23130 (BRI AQ613742); Enngonia, 17 September

2004, *A.R. Bean 23057* (BRI AQ613741); Langlo River, 20 September 2005, *D.A. Halford Q8593* (BRI AQ617086); Mungallala, 2 May 2002, *A.R. Bean 19022* (BRI AQ557741); Cunnamulla, 18 September 2004, *A.R. Bean 23150* (BRI AQ613740); The Glebe Station, 24 October 1996, *D. Halford Q3224* & *R. Dowling* (BRI AQ653901); Springsure, 13 September 1999, *A.R. Bean 15346* (BRI AQ67767); Cadarga, 5 September 1997, *A.R. Bean 12362* (BRI AQ657497, MEL 270249, NSW 468445); Idalia National Park, 6 July 2009, *R.J. Fensham 5953* (BRI AQ749996); Springsure, 13 September 1999, *A.R. Bean 15346* (BRI AQ677867); Lake Broadwater, 9 August 2008, *M.B. Thomas MBT3727* (BRI AQ840387). SOUTH AUSTRALIA. Murtho Park Homestead, 15 September 1979, *W.R. Barker 3978* & *R.M. Barker* (AD 97948329, MEL 268391); Mullinger's Swamp Conservation Park, 6 April 1996, *D.E. Murfet 2381* & *K.M. Alcock* (AD 171130); Comaum Forest, 25 December 2002, *D.E. Murfet 4286* (AD 141450); 1 January 1970, *K.M. Alcock s.n.* (AD 97041044); Blanchetown, 15 March 1997, *R.J. Bates 46586* (AD 99909009); Upper Murray Mallee, 11 April 1956, *H. Eichler s.n.* (AD 95708098); Murray, 15 May 1989, *R. Bates 18441* & *B. Spooner* (AD 98922291); Bunyip Reach, 14 September 1979, *J.S. Womersley 530* & *D.E. Symon* (AD 97950139); Morgan, 21 November 1964, *H. Eichler 18052* (AD 96649079); Nelwood Homestead, 12 September 1979, *W.R. Barker 3822* & *R.M. Barker* (AD 99308047); Katarapko Island, 15 March 1993, *R.J. Bates 31666* (AD 99423166); Pilby Creek, 20 August 2000, *M. Siebentritt 6* (AD 109430); Lake Eyre, 7 July 1997, *R. Bates 47432* (AD 99915133); Lake Eyre, 8 July 1997, *R. Bates 47834* (AD 99917252); Cooper Creek, 25 July 1987, *J. Reid 958* (AD 98734055); Mabel Creek Homestead, 20 September 1963, *H. Eichler 76712* (AD 96447034); Mount Willoughby Homestead, 28 September 1998, *R. Bates 5107B* (AD 101159); TASMANIA. Sea Elephant River, King Island, 7 January 1979, *D.I. Morris 7950* (MEL 1506952, HO 29222). VICTORIA. Royal Botanic Gardens, Melbourne, 9 May 2003, *V. Stajsic 3322* (MEL 2182997, NSW); Royal Botanic Gardens, 9 May 2003, *V. Stajsic 3321* (MEL 2182996, NSW); Royal Botanic Gardens, 12 May 2003, *V. Stajsic 3320* (MEL 2182995); Royal Botanic Gardens, 21 November 2002, *V. Stajsic 3122* (MEL 2162636); Neds Corner Station, 30 November 2011, *D.E. Albrecht 13944*, *V. Stajsic* & *A. Messina* (MEL 2356927); Crawford River Regional Park, 31 March 1985, *A.C. Beauglehole 79137* (MEL 717718); Echuca Regional Park, September 1985, *A.C. Beauglehole 80264* (MEL 717717); Hattah Lakes National Park, October 1948, *A.C. Beauglehole 1123* (MEL 2241802); Echuca Regional Park, 9 September 1985, *A.C. Beauglehole 80263* (MEL 2109973); Chiltern Box - Ironbark National Park, 5 August 2001, *N.G. Walsh 5359* (MEL 2193427); Lake Glenmaggie, 28 April 1985, *A.C. Beauglehole 79407* (MEL 717719); Edenhope, 11 March 1975, *A.C. Beauglehole 49703* (MEL 1506953); *Reader s.n.* (MEL 1518337); Kukuyn National Forest, 6 September 1941, *J.H. Willis s.n.* (MEL 2241778); Hattah-Kukuyn National Park, 3 October 1982, *D.C. Cheal s.n.* (MEL 615334); Kulkune National Forest, December 1941, *J.H. Willis* (MEL 2241803); Mildura, Sept. 1912, *J. M. M. ex Herb. H. B. Williamson s.n.* (MEL 2241805); Ryans Swamp, 25 March 2012, *V. Stajsic, 6291* & *J. Eichler* (MEL 2360544); Cobram Regional Park, 16 November 1985, *A.C. Beauglehole 82025* (MEL 2299319); Mullinger Swamp Wildlife Reserve, 13 March 1984, *A.C. Beauglehole 776504* (MEL 1602800); Redcliff, 18 January 1982, *J.H. Brone 105* (MEL 606573); Hattah Lakes National Park, 12 September 1969, *G.W. Anderson s.n.* (MEL 2241777); Barmah State Park, 28 September 1985, *A.C. Beauglehole 81287* (MEL 717638); Mount Black Flora Reserve, 3 May 1981, *A.C. Beauglehole 68918* (MEL 597287); Cobram Regional Park, 27 September 1985, *A.C. Beauglehole 81075* (MEL 2109975); Lower Darling River, 1888, *C.E. Holdinh s.n.* (MEL 2241801); Lake Moodemere, 19 December 1959, *J.H. Willis s.n.* (MEL 2241804); Mildura, Victoria, September 1912, *H.B. Williamson 832/16* (NSW 33819); Bourke, [name illegible], September 1883 (NSW 33817); Nathalia, 7 May 1969, *H.I. Aston 1763* (NSW 674133); Lake Powell, 3 May 1977, *A.C. Beauglehole 56088* (MEL 525300); Lake Hattah, September 19[?], *H.B. W[illiamson] 1442* (MEL 2241808, MEL 2241776); Snowy River area, 3 December 1970, *A.C. Beauglehole 35117* (MEL 2241775); Murray Mallee District, 34° 43' 33" S, 143° 07' 08" E, 10 September 2009, *J.N. McFarlane 3188* (MEL 2325794); Murray Mallee District, 34° 43' 33" S, 143° 07' 08" E, 10 September 2009, *J.N. McFarlane 3177* (MEL 232579).

20. *Callitriche stagnalis* Scopoli (1772: 251)

Type:—UNITED KINGDOM. CARDIGANSHIRE. (Lansdown 2006b: 108) Aberleri Fields, Borth, Cards 22/61209160, 20 July 1998, *A.O. Chater s.n.* (neotype [designated by Lansdown 2006b: 108]: NMW!).

Description (after Lansdown 2008):—Stem and leaf scales present. Leaf bases connate. Lingulate leaves very rare, usually lacking, expanded submerged or floating leaves variable, from broadly parallel-sided, through obovate-spathulate to almost circular, 2.7–21.7 mm long × 1.4–8.3 mm wide; venation simple or complex with numerous loops and anastomosing veins, petiole 0.7–6.5(–7.5) mm long; the apical leaves forming a floating rosette; leaves of terrestrial plants narrowly elliptic 2.6–4.4 mm long × 1.6–3.3 mm wide, petiole 0.8–2.1 mm long. Flowers usually

solitary. Bracts falcate, persistent 0.6–2.69 mm long. Styles erect, becoming recurved in fruit, ≤ 6 mm long. Filament erect, becoming recurved and continuing to grow after dehiscence, ≤ 16.2 mm long; anthers quadricellular, 0.3–0.9 mm diameter; pollen yellow. Fruit not strumose, sessile or occasionally very shortly-pedicellate, \pm as wide as high, greyish when mature, 1.1–1.8 mm long \times 1.1–2.0 mm wide, winged throughout.

Illustrations:—Figures 10(a–b) and 10A(a–e) in Mason (1959); Figures 1D–F in Orchard (1980); Figures on pages 81 and 83 in Lansdown (2008). Fig. 10j.

Recognition:—*C. stagnalis* can be distinguished from all other *Callitriche* species in the region except *C. platycarpa* by the large, pale, broadly-winged fruit which are greyish or pale brownish-grey when mature. It can only reliably be distinguished from *C. platycarpa* by the pollen which is ellipsoid, compared to the bluntly triangular pollen of *C. platycarpa*. *C. stagnalis* also rarely produces linear leaves, has a broader wing to the fruit and is typically more greyish than that of *C. platycarpa*, however these differences are not diagnostic.

Distribution:—Non-native. Within the region *Callitriche stagnalis* is widespread and abundant throughout much of Victoria and coastal areas into central Queensland, as well as in the west around Perth (Fig. 17). In New Zealand it has been recorded more or less throughout on the mainland, as well as on the Chatham Islands (de Lange *et al.* 2011). It is native to Europe, where it occurs from the Azores to Iceland and east to the western side of the Ural Mountains in Russia. It also occurs as an alien in North America and South America, including the Falkland Islands (Lansdown and Hassemer 2021).

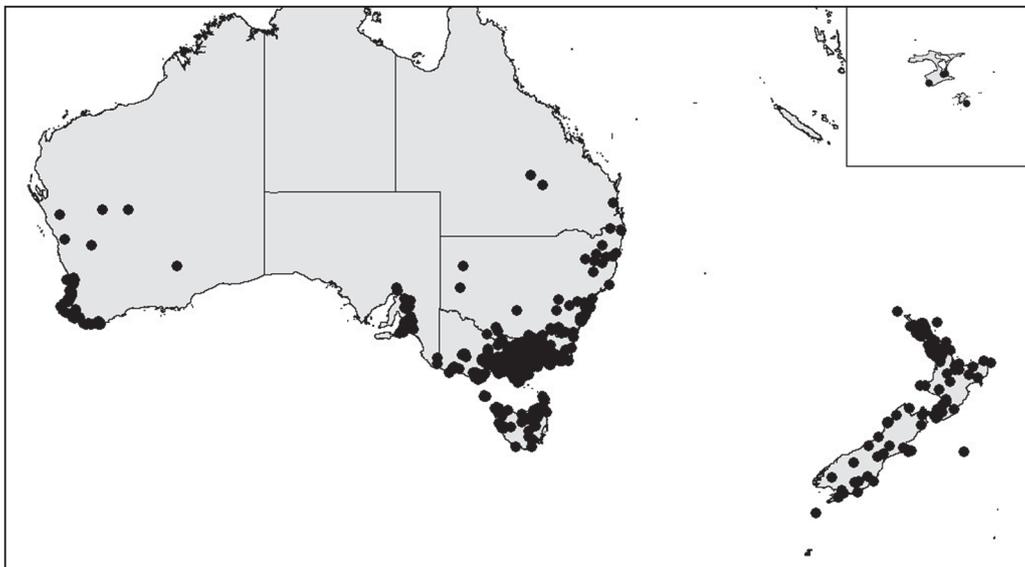


FIGURE 17. The distribution of records of *C. stagnalis* held by AVH (inset Chatham Islands)

Habitats and Ecology:—In the region, *Callitriche stagnalis* is the *Callitriche* species most frequently found growing in permanent water bodies, including rivers, streams, lakes and ponds. It has been described as the most common aquatic species of the genus in wet areas modified by human activity, such as ponds, lakes, ditches and drains (Mason 1959, Stanley and Ross 1986, Webb *et al.* 1988, Jeanes 1999, Bean 2007). Within its native range, it occurs in poached ephemeral pools on woodland rides, heathland, wet corners of pasture, seepages, flushes, lake and river margins, and the margins of ditches. 0–1600 m elevation in its native range. There is no information available on elevation in the region.

Conservation Status:—Least Concern (Lansdown 2014b).

21. *Callitriche umbonata* Hegelmaier (1867: 20, fig. 1–10).

Type:—AUSTRALIA. TASMANIA. Tasmania. South Esk, 1848–1857, *C.N. Stuart s.n.* (lectotype [designated by Bean 2007: 550]: STU; isolectotypes MEL 2289182B & 2289185).

Description:—Stem and leaf scales present. Leaf bases connate. Lingulate leaves \pm parallel-sided or tapering slightly from base, 5–10 mm long \times 0.4–0.5 mm wide; expanded submerged or floating leaves \pm orbicular to obovate, (4–)6–8

mm long \times 1.5–2.0 mm wide, 3 to 5-veined, usually with a number of short free veins, with a broad petiole 0.5–5 mm long; leaves of terrestrial plants unknown. Flowers solitary. Bracts broad, falcate, ca. 0.7 mm long. Styles spreading, caducous, (0.6–)1.0–2.0 mm long. Filament $<$ 3.5 mm long; anthers 0.1 mm long \times 0.1 mm wide, number of locules unknown; pollen yellow. Fruit strumose, sessile, slightly higher than wide, dark brown when mature, 1.1–1.5 mm long \times 1.0–1.2 mm wide, broadly winged throughout.

Illustrations:—Figures 5(a–c) and 5A(a) in Mason (1959); Figures 1G–I in Orchard (1980). Fig. 10k.

Recognition:—*C. umbonata* can be distinguished from all other *Callitriche* species in the region by the fruit which when mature are blackish, higher than wide and broadly winged, combined with the solitary flowers. It most closely resembles *C. cyclocarpa* from which it can be distinguished by the fruit which are typically higher than wide in *C. umbonata* and the venation is typically complex in *C. cyclocarpa* but relatively simple in *C. umbonata*.

Distribution:—Native. *Callitriche umbonata* is endemic to Australia where it is scattered in southern New South Wales, throughout much of inland Victoria and eastern Tasmania (Mason 1959), with a few records from South Australia (Willis 1972, Curtis and Morris 1975, Orchard 1980, Jeanes 1999, Bean 2007) (Fig. 18).

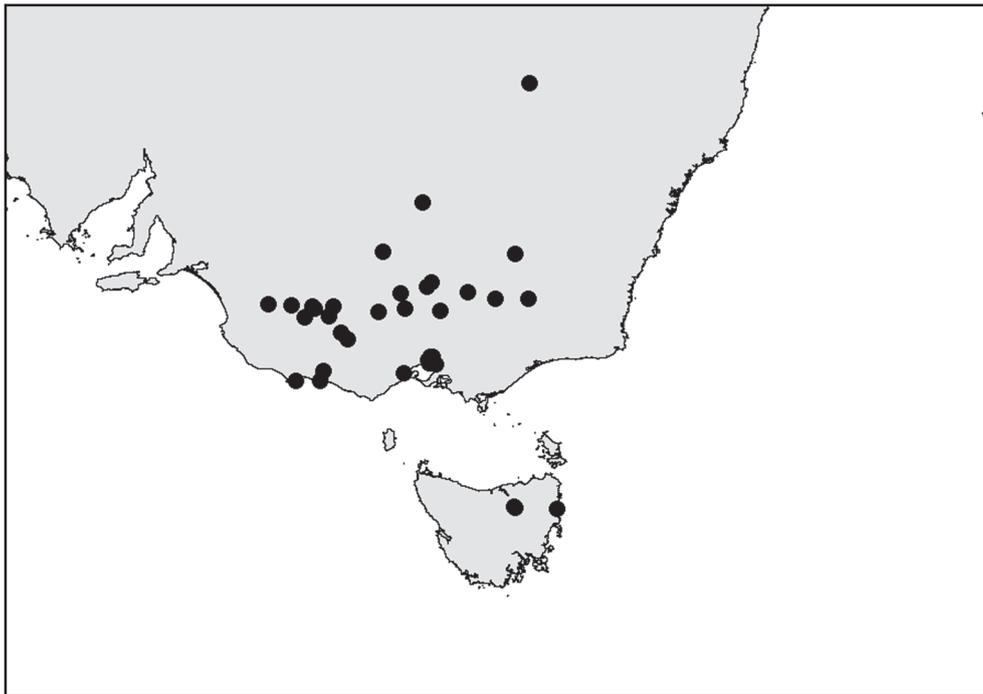


FIGURE 18. The distribution of confirmed specimens records of *C. umbonata*

Habitats and Ecology:—*Callitriche umbonata* occurs in rock pools, ice melt pools, shallow streams, billabongs, creeks, roadside pools, swamps and gilgai, often on clay or on black soils, as well as on the margins of larger water bodies including lakes and rivers. It has been recorded from *Acacia harpophylla* F.Muell. ex Benth. (1864: 389) and *Eucalyptus camaldulensis* forest, growing with species such as *Agrostis avenacea* var. *perennis* Vickery (1941: 114), *Alternanthera denticulata* R.Br. (1810: 417), *Amphibromus neesii* Steud. (1854: 328), *A. nervosus* (Hook.f.) Baill. (1894: 203), *Calandrinia eremaea*, *Cardamine moirensis* I.Thomps. (1996: 167), *Carex tereticaulis* F.Muell. (1874: 256), *Centipeda cunninghamii* (DC.) A.Braun & Asch. (1867: 6), *Crassula helmsii* (Kirk) Cockayne (1907: 349), *Damasonium minus*, *Dianella longifolia* R.Br. (1810: 280), *Elatine gratioloides*, *Eleocharis acuta*, *E. pusilla*, *Euchiton sphaericus* (Willd.) Anderb. (1991: 167), *Gratiola pedunculata* R.Br. (1810: 435), *Juncus flavidus* L.A.S.Johnson in J.M.Black (1978: 325), *J. holoschoenus* R.Br. (1810: 259), *Lilaeopsis* sp., *Limosella australis*, *Marsilea drummondii* A.Braun (1852: 721), *Myriophyllum crispatum* Orchard (1985: 210), *Nitella* sp., *Potamogeton cheesemanii*, *Ranunculus pumilio* R.Br. ex DC. (1817: 271) var. *pumilio*, *Triglochin dubia* R.Br. (1810: 343), *T. turriifera* Ewart (1906: 43) and *Wahlenbergia* species (Cook *et al.* 2009, specimens in CANB, HO, MEL, NSW). In Tasmania it has been recorded from wet sandy soil among rocks in a river, above the water but clearly subject to frequent inundation. 10–1800 m elevation.

Conservation Status:—This species is classed as Least Concern (LC) as it is widespread with stable populations and does not face any major threats. It is classed as Vulnerable in South Australia (National Parks and Wildlife Act

1972) and Rare in both Tasmania (Threatened Species Protection Act 1995: Rare species: June 2019 list) and Victoria (Advisory List of Rare or Threatened Plants in Victoria: 2014).

Notes:—*C. cyclocarpa* was reduced to synonymy under *C. umbonata* (Bean 2007) however the differences between the two species are sufficient to justify their treatment as separate species (see under *C. cyclocarpa* above).

Selected specimens examined:—AUSTRALIA: NEW SOUTH WALES. Tumbarumba, October 1916, *J. Boorman s.n.* (NSW 33800); Albany, s.d., *J. Wilson s.n.* (MEL 528973); Booligal Wetland, October 2000, *P. Lloyd-Jones 0898:17* (NSW 495292); Inglewood, 18 October 1976, *A.C. Beauglehole 55250 & M. Needs* (MEL 717647). SOUTH AUSTRALIA. Wandilo, 10 October 1963, *D.N. Kraehenbuehl 976* (AD 96417161); Bangham Forest Reserve, October 1991, *R.J. Bates 26074* (AD 99146324); Mount Monster Conservation Park, 2 October 1994, *D.E. Murfet 2060 & R.L. Taplin* (AD 99605162); Comaam, 10 October 1965, *H. Eichler 18336* (AD 96649232); Muddy Flat NFR, 18 November 2010, *D.E. Murfet 7068 & D.J. Duval* (AD 243581); Mount Monster Conservation Park, 30 August 2007, *P.J. Ainsley No. 154 & T.S. Te*, (AD 223679). VICTORIA. In stagnis prope Melbourne, *Müller 52* (STU), Darebin Creek, *Müller s.n.* (K, STU), Swan River, 1867, *Drummond s.n.* (K); Mount Cobberas, 7 January 1992, *R. Bates 27241* (AD99205072); Mount Arapiles, 22 September 1968, *A.C. Beauglehole 28642* (MEL 2248512); Mt. Arapiles, 24 August 1896, *F.M. Reader s.n.* (MEL 2248519); Terrick State Forest, 2 September 1979, *A.C. Beauglehole 64474* (MEL 567195); Barrabool Flora and Fauna Reserve, 13 October 1986, *A.C. Beauglehole 59780* (MEL 717664); Barrabool Flora and Fauna Reserve, s.d., *A.C. Beauglehole 85775* (MEL 717663); The Range Flora Reserve, 24 October 1979, *A.C. Beauglehole 65369 & Donald History Group 186* (MEL 567175); Brighton, December 1909, *L. Roberts s.n.* (MEL 2248522); Port Fairy, 1894, *Williamson s.n.* (MEL 528972); Lucyvale Creek Reference Area, 2 November 1981, *A.C. Beauglehole 90501 & A.D.J. Pierre* (MEL 717651); Craigieburn Grasslands, 17 November 1989, *D. Frood 034/89* (MEL 1588546); Mt. Arapiles, 18 September 1952, *R. Melville 1024, P. Morris, A. Hicks and D. Williams s.d.* (MEL 2246478); Black Rock, October 1908, *A.J. Tadgell 181* (MEL 2246479); Black Range Scenic Reserve, 2 September 1983, *A.C. Beauglehole 74568* (MEL 663815); John Smith Reserve, 26 September 1969, *A.C. Beauglehole 31005* (MEL 2248514); Ninjip, 1890, *J.S.Eckert s.n.* (MEL 528971); Kamarooka State Park, 2 November 1981, *A.C. Beauglehole 69677* (MEL 597292); Kooyoorra Reference Area, 23 October 1981, *A.C. Beauglehole 69461* (MEL 597291); Horsham, 6 September 1961, *A.C. Beauglehole 6767* (MEL 2248511); Geelong, s.d., *B. Wilson s.n.* (MEL 2248515); Gaulbourne River, s.d., *Lewis s.n.* (MEL 2248517); Wimmera, 1890, *J.P. Eckert s.n.* (MEL 2248518); Tattiana County, s.d., *Walter s.n.* (MEL 2248521); [illegible] Wimmera, 1890, *Davis s.n.* (MEL 2248520); Chard Green, s.d., *Mueller s.n.* (MEL 2248516); Hawkesdale, Dec. 1898, *H.B. Williamson s.n.* (MEL 2247537); Holmes Plain, 27 December 1972, *A.C. Beauglehole 40748* (MEL 518344); Terrick National Park, 10 September 2013, *D.J. Murphy 623, F. Udovicic, J. Milne & C.L. Gallagher* (MEL 2376437); December 1898, *Walter s.n.* (NSW 33822); Melville Caves area, 11 September 1979, *A.C. Beauglehole 64858 & Maryborough F.N.C. 197* (MEL 567174); Hawkesdale, 1900, *H.B. Williamson s.n.* (MEL 2247538); [illegible], s.d., *St. Elroy Dalton s.n.* (MEL 1539096). TASMANIA. s.d., *s.coll. s.n.* (MEL 224851); Harridge Falls, 12 February 2014, *R. Skabo s.n.* (HO 575897); Tasmania (MEL 2248513); Jericho, 8 October 1970, *D.I. Morris s.n.* HO 34459).

Key to the taxa occurring in the region

Many of the species treated here are allopatric and identification could therefore theoretically be based in part on location. However, the number of non-native species known from or suspected to occur in this and other regions, combined with their distribution, show that the possibility of discovering a taxon new to a particular geographical area is high. This key is therefore designed to enable identification of any of the species suspected to occur in the region independent of locality. An indication of the known distribution of restricted-range species is given to aid decision-making. *C. muelleri* is the only species which can be reliably identified without flowers or fruit; it is the only species in the genus with toothed leaves.

- | | | |
|----|--|------------------------|
| 1. | Leaves with a single tooth on each margin..... | 13. <i>C. muelleri</i> |
| - | Leaves entire..... | 2 |
| 2. | Pollen colourless; style reflexed..... | 4. <i>C. brutia</i> |
| - | Pollen yellow; style erect or spreading..... | 3 |
| 3. | Fruit unwinged or only partially winged..... | 4 |
| - | Fruit winged throughout..... | 10 |

4.	Fruit winged at apex, occasionally with narrow wing tapering down the upper parts of the sides (<i>C. heterophylla</i> fruit may occasionally have a narrow wing at the apex of the fruit. In fresh material, it can be distinguished from <i>C. palustris</i> by the isodiametric fruit, those of <i>C. palustris</i> are longer than wide, however some herbarium material cannot reliably be determined) ...	14. <i>C. palustris</i>
-	Fruit unwinged.....	5
5.	Vegetative parts fleshy and almost succulent; lower leaves reduced to scarios scales	1. <i>C. antarctica</i>
-	Vegetative parts not fleshy; leaves either ± homophyllous or lower leaves lingulate, well-formed and green	6
6.	Fruit blackish when mature	7
-	Fruit pale or golden-brown when mature	9
7.	Fruit > 1 mm high and wide (known only from New Guinea).....	10. <i>C. fuliginea</i>
-	Fruit ≤1 mm high and wide	8
8.	Fruit strumose, wider than high; most axils with both ♀ and ♂ flowers	16. <i>C. peploides</i>
-	Fruit convex, not strumose, isodiametric; flowers usually solitary (reported in the region only from a single river in New Zealand and the Chatham Islands)	11. <i>C. heterophylla</i>
9.	Plant dioecious (mainland New Zealand).....	17. <i>C. petriei</i>
-	Plant monoecious (known only from the Chatham Islands)	6. <i>C. chathamensis</i>
10.	Mature fruit maroon, chestnut, grey, greyish-brown or golden-brown	11
-	Mature fruit blackish	14
11.	Wing very broad, c. ½ width of fruit; mature fruit maroon/chestnut in colour (known only from New Guinea)	8. <i>C. cycloptera</i>
-	Wing narrower, ≤ ¼ width of fruit; mature fruit grey, greyish or golden-brown	12
12.	Both ♀ and ♂ flowers in most axils; fruit <1 mm high and ≤1 mm wide (known only from Rapa and Tautourau Islands, French Polynesia)	12. <i>C. insularis</i>
-	Flowers solitary; fruit >1.1 mm high and wide	13
13.	Pollen ellipsoid; mature fruit greyish, broadly winged; lingulate leaves very rare.....	20. <i>C. stagnalis</i>
-	Pollen bluntly triangular mature fruit brownish; lingulate leaves frequent (reported but not confirmed from a single river in New Zealand).....	18. <i>C. platycarpa</i>
14.	Fruit higher than wide; flowers solitary	15
-	Fruit ± isodiametric or wider than high; both ♀ and ♂ flowers at least in upper axils	16
15.	Bracts ≥1.5 mm long; fruit not strumose; wing narrow (known only from New Guinea).....	15. <i>C. papuana</i>
-	Bracts ≤1 mm long; fruit strumose; wing broad (south-eastern Australia)	21. <i>C. umbonata</i>
16.	Anthers trilocular; fruit 0.5–0.6 mm high	17
-	Anthers quadrilocular; fruit >0.7 mm high.....	18
17.	Mature fruit face flat and strumose; wing narrow and poorly defined (eastern Australia)	19. <i>C. sonderi</i>
-	Mature fruit face convex, not strumose; wing well-defined (south-eastern Australia)	5. <i>C. capricorni</i>
18.	Fruit ± isodiametric (south-eastern Australia).....	7. <i>C. cyclocarpa</i>
-	Fruit wider than high	19
19.	Most or all fruit long-pedicellate.....	9. <i>C. deflexa</i>
-	Fruit sessile.....	20
20.	Leaves fleshy; flowers mainly solitary, occasionally both ♀ and ♂ flowers in one axil (known only from the Auckland Islands) ...	2. <i>C. aucklandica</i>
-	Leaves not fleshy; most axils with both ♀ and ♂ flowers (south-eastern Australia)	3. <i>C. brachycarpa</i>

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