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Myriophyllum (Haloragaceae) in Australasia. I. New Zealand: A Revision of the Genus and a Synopsis of the Family*

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Abstract

Orchard, A.E. *Myriophyllum* (Haloragaceae) in Australasia. I. New Zealand: a revision of the genus and a synopsis of the family. *Brunonia* **2**:247–87 (1979). The six species of *Myriophyllum* found in New Zealand are described and illustrated. The name *M. triphyllum* is proposed as a substitute for *M. elatinoides* of New Zealand authors and one new subspecies, *M. pedunculatum* subsp. *novae-zealandiae*, is described. A synopsis of the family Haloragaceae in New Zealand is provided.

Introduction

In previous papers, (Orchard 1975, 1977) I revised the species of *Haloragis* and four related genera included in Schindler's tribus Halorrhageae of Haloragaceae. At the same time I summarized the evidence that has gradually accumulated regarding the status of *Gunnera*. This seems now to overwhelmingly support the removal of *Gunnera* to its own family, with relationships far removed from Haloragaceae. As a result, the only genus of Haloragaceae in New Zealand remaining to be re-examined was *Myriophyllum*, and the purpose of the present paper is to complete the family revision for this country. As my earliest paper on *Haloragis* etc. (Orchard 1975) was written on a world-wide basis, the few New Zealand species of the included genera are difficult to locate among the much larger number of extra-New Zealand species. For this reason a synopsis and key to the whole family Haloragaceae, as found in New Zealand, is provided.

The nomenclature of some of the New Zealand species is influenced by the existence of putatively identical or related species elsewhere, particularly in South America and Australia. This paper treats the species only as they occur in New Zealand, although the literature cited is more widespread and the generic description attempts to cover all species. The Australian and South American relatives of the species included here will be discussed in two further papers currently in preparation.

Notes on Terminology

Hydathodes. In several species of *Myriophyllum*, small filiform, often dark coloured appendages up to about 2 mm long are found in various positions, particularly on the stems near the leaf axils, between the pinnae of the leaf, and sometimes in the flowers at the base of the petals. These structures, which are useful taxonomically but of unknown function, have been variously referred to in the

* This is the third in the series 'Taxonomic revisions in the family Haloragaceae'. Parts I and II appeared in 1975 and 1977 respectively (see Orchard 1975, 1977).

past as 'hydathodes', 'enations', 'myriophyllin glands', 'pseudo-stipules' or 'scales'. In this paper they are called hydathodes, as this seems to be the most frequently used term, but it is not intended to imply that they necessarily have an excretory function.

Primary bracts. In previous papers (Orchard 1975, 1977) I have called the foliar structures subtending the flowers 'primary bracts'. In genera like *Haloragis*, these structures often resemble the upper leaves in shape but are clearly distinct, particularly in their reduced size. In *Myriophyllum*, the homologous structures are in most cases the emergent leaves, which are usually distinctly different from the submerged leaves. There is usually no difference between sterile emergent leaves and emergent leaves subtending a flower, so the term 'primary bract' has been dispensed with in this paper. However it should be remembered that the 'fertile' emergent leaves of *Myriophyllum* are homologous with the 'primary bracts' of *Haloragis* and its allies.

Secondary bracts. As the term 'primary bracts' has been dropped it makes little sense to refer to 'secondary bracts'. These are therefore called 'bracteoles', a term used by several other authors.

MYRIOPHYLLUM

Annual or perennial, aquatic or littoral herbs. Stems weak, usually with a small central vascular supply, surrounded by radiating vertical plates of parenchyma alternating with air sacs. Glabrous, apart from 1 Australian species. Leaves usually whorled, sometimes opposite or alternate, usually bimorphic, with pectinately divided submerged leaves and ± entire emergent leaves, or rarely, leaves all similar, of one type or the other. Hydathodes often present near leaf axils.

Inflorescence a simple (rarely branched) spike with the flowers borne (usually) singly in the axils of the emergent leaves and surrounded by 2 bracteoles. Flowers rarely also found in axils of submerged leaves. Flowers unisexual or bisexual, plants monoecious or dioecious. In monoecious plants with unisexual flowers, the male flowers are usually borne above the females in the same inflorescence, with sometimes a few bisexual transitional flowers. Male flowers (2–)4-merous, sepals and petals usually present, stamens (1–)4 or 8, styles and ovary reduced or absent. Female flowers (2–)4-merous, sepals and petals usually reduced or absent, stamens absent, styles same in number as locules of ovary, usually clavate with capitate, fimbriate stigmas, ovary (2–)4-locular. Fruit dry, splitting at maturity into 1-seeded mericarps.

The genus is almost cosmopolitan although absent from most of Africa, the Middle East, north-eastern South America and much of southern Asia. It is sporadic in the tropics, where the few species tend to be alpine or subalpine. The distribution of the approximately 40 species is bimodal: the major centre of diversity is Australasia with about 25 species (18 endemic), particularly Australia (*c.* 20 species, 15 endemic), with a secondary centre in eastern North America (8 species, 6 endemic). In New Zealand, 6 species are recognized, 2 species and 1 subspecies being endemic, 1 species being introduced.

Key to the species of *Myriophyllum* in New Zealand

1. Leaves bimorphic, the submerged leaves pectinately divided, the emergent leaves ± entire (sometimes serrate or shortly toothed, never pectinate)
   2. Emergent leaves ovate, fruit ± globular ..... 3. *M. triphyllum*
   2. Emergent leaves linear to terete, fruit ± cylindrical ..... 4. *M. propinquum*
1. Leaves all of one type, either all pectinate/pinnatifid or all entire
   3. Leaves all pectinate/pinnatifid
      4. Leaves in whorls of (2-)3-4; relatively small plants of mud or shallow water with stems 1-2 mm diam.
         5. Leaves with well defined petiole 1-2 mm long; fruits ± cylindrical; plants usually green .....4. *M. propinquum*
         5. Leaves sessile (petiole less than 0.2 mm long); fruits (if present) ± globular; plants often bronze .....3. *M. triphyllum* (stranded form)
      4. Leaves in whorls of 5-8; robust plants of deeper water with stems to 5 mm diam.
         6. Leaves rounded at tip in outline; numerous hydathodes at base of leaves; bracteoles trifid; female flowers only (male flowers and fruits never present in New Zealand specimens) .....1. *M. aquaticum*
         6. Leaves acute at tip in outline; few hydathodes (up to 5) at base of leaves; bracteoles pinnate/digitate; flowers hermaphrodite, fruit set readily .....2. *M. robustum*
   3. Leaves all entire
      7. Female flowers and fruits lacking sepals
         8. Fruit ± cylindrical, green to olive; leaves linear or terete .....4. *M. propinquum*
         8. Fruit depressed globular, usually deep purple; leaves obovoid (rarely ± terete) .....6. *M. votschii*
      7. Female flowers and fruits with sepals (sometimes caducous in old fruits) .....5. *M. pedunculatum* subsp. *novae-zelandiae*

1. ***Myriophyllum aquaticum*** (Vellozo) Verdcourt, Kew Bull. 23 (1973) 36; Boutique and Verdcourt, Halorag. in Fl. Trop. E. Africa (1973) 7-9; Guillarmod, S. Afr. J. Sci 73 (1977) 89-90; Guillarmod, Eastern Cape Nat. 61 (1977) 14-17; Chicken, Watsonia 11 (1977) 375.

   Enydria aquatica Vellozo, Fl. Flumin. (1825) 57 & icones 1 (1831) t. 150 [*Typus:* 'Offendi rivulo quodam ad fluvium Taguahy confluentum sub aquis' [Brazil], Vellozo. *n.v. Lectotypus*: Vellozo, Fl. Flumin. icones 1 (1831) t. 150.]

   Myriophyllum brasiliense Cambess. in St. Hil. et al., Fl. Bras. Merid. 2 (1830) 252 [*Typus*: 'In paludibus prope Jondiahi haud longe ab urbe S. Pauli. Florebat Octobri.' MPU, *n.v.*] Walpers, Rep. 2 (1843) 98; Kanitz in Martius, Fl. Brasil. 13 (1882) 380; Schindler, Pflrch 23 (1905) 88-89; Heyne, Nutt. Pl. Ned. Ind. 3 (1917) 391; Standley, Field Mus. Nat. Hist. Bot. 18 (1938) 851; Cabrera, Man. Fl. Alred. Buenos Aires (1953) 342; Curtis, Stud. Fl. Tas. 1 (1956) 190; Mason, Fl. Marshes Calif. (1957) 615; Gleason, New Britt. Brown Illust. Fl. 2 (1958) 600; Strausbaugh & Core, W. Virginia Univ. Bull. 58 (1958) 670-71; Hitchcock et al., Vasc. Pl. Pacific NW. 3 (1961) 502-3; Backer & Bakhuizen, Fl. Java 1 (1963) 266; Standley & Williams, Fieldiana, Bot. 24 (1963) 568; Neal, Gard. Hawaii (1965) 651; Angely, Fl. Anal. Parana (1965) 519; Aston, Muelleria 1 (1967) 171; Sculthorpe, Biol. Aq. Vasc. Pl. (1967) 8 et al.; Steyermark, Fl. Missouri (1968) 1110; Cook, Fl. Europ. 2 (1968) 312; Meijden, Blumea 17 (1969) 310; Praglowski, Grana 10 (1970) 208; Correll & Johnston, Man. Vasc. Fl. Texas (1970) 1138; Soukup, Biota 9 (1971) 8; Meijden & Caspers, Fl. Males. 7 (1971) 253; Beadle, Stud., Fl.

NE N.S. Wales 2 (1972) 223 ('braziliense'); Beadle et al., Fl. Sydney Reg. (1972) 208; Willis, Hdbk. Pl. Vict. 2 (1972) 471; Aston, Aq. Pl. Aust. (1973) 82–3; St. John, Pac. Trop. Bot. Gdn. Mem. 1 (1973) 257.

Myriophyllum proserpinacoides Gillies ex Hook. & Arn., Bot. Misc. 3 (1833) 313 [*Typus*: 'Ditches at Buenos Ayres, *Dr. Gillies*; *Tweedie*. Andes of Chili (first and second ranges), *Cuming* (*N.* 164).' *Lectotypus* (Mora): *L. Gillies s.n.*, Ditches at Buenos Ayres (K!). *Syntypi: Cuming 164*, Andes of Chili (K!); *Tweedie s.n.*, La Plata B. Ayres (K!).] Walpers, Rep. 2 (1843) 98 ('proserpinoides'); Kanitz in Martius, Fl. Brasil. 13 (1882) 380; Reiche, Estud. Crit. Fl. Chile 2 (1898) 270; Arechavaleta, Fl. Urug. 2 (1905) 16; Degener, Ill. guide Pl. Hawaii Nat. Pk. (1930) 240; Small, Man. S.E. Fl. (1933) 955; Praglowski, Grana 10 (1970) 212.

Figures: Vellozo, Fl. Flumin. icones 1 (1831) t. 150; Schindler, Pflrch. 23 (1905) fig. 25, 28K; Cabrera, Man. Fl. Alred. Buenos Aires (1953) fig. 126D, E; Mason, Fl. Marshes Calif. (1957) fig. 280; Gleason, New Britt. & Brown Illus. Fl. 2 (1958) 601; Hitchcock et al., Vasc. Pl. Pacific NW 3 (1961) 503; Sculthorpe, Biol. Aq. Vasc. Pl. (1967) fig. 1.2; Meijden & Caspers, Fl. Males. 7 (1971) 256 fig. 14a–c; Aston, Aq. Pl. Aust. (1973) fig. 30; Boutique & Verdcourt, Halorag. in Fl. Trop. E. Africa (1973) 8 fig. 3; Guillarmod, S. Afr. J. Sci. 73 (1977) 90 fig. 2.

Description

Stout aquatic or marsh-dwelling herb; stems to 2 m long, 4–5 mm diam. near base, glaucous, rooting freely from lower nodes, glabrous. Leaves all whorled, slightly dimorphic. Submerged leaves in whorls of (4–)5–6, oblanceolate in outline, rounded at apex, (1·7–)3·5–4·0 cm long, (0·4–)0·8–1·2 cm wide, pectinate, with 25–30 linear pinnae up to 0·7 cm long, the lower leaves usually decaying rapidly. Emergent leaves glaucous, in whorls of (4–)5–6, erect near apex, ± spreading in lower parts, narrowly oblanceolate in outline, rounded at apex, (1·5–)2·5–3·5 cm long, (0·4–)0·7–0·8 cm wide, pectinate, with (18–)24–36 pinnae in the upper $\frac{4}{5}$ (lower 5–7 mm of leaf rachis naked), pinnae linear-subulate, 4·5–5·5 mm long, 0·3 mm wide, tips very shortly apiculate, slightly incurved. Numerous hydathodes at base of emergent leaves.

Plant dioecious. Inflorescence an indeterminate spike with the flowers borne singly in the axils of the upper emergent leaves and subtended by 2 bracteoles. Leaves subtending flowers in whorls of 6, pectinate, ± identical to other emergent leaves in size and shape. Bracteoles subulate, 1·2–1·5 mm long, with (1–)2 short teeth in lower $\frac{1}{3}$, sometimes almost trifid.

Flowers (in New Zealand) only female, 4-merous, on pedicel *c.* 0·2–0·4 mm long. Sepals 4, white, deltoid, 0·4–0·5 mm long, 0·3 mm wide, denticulate with 1–several small teeth on each margin, smooth. Petals absent. Styles 4, clavate, 0·1–0·2 mm long, stigmas white, densely fimbriate. Ovary pyriform, 0·6–0·7 mm long, 0·6 mm wide, 4-ribbed longitudinally between sepals.

Male flowers and fruits not developed in New Zealand. (Figs 1 and 2).

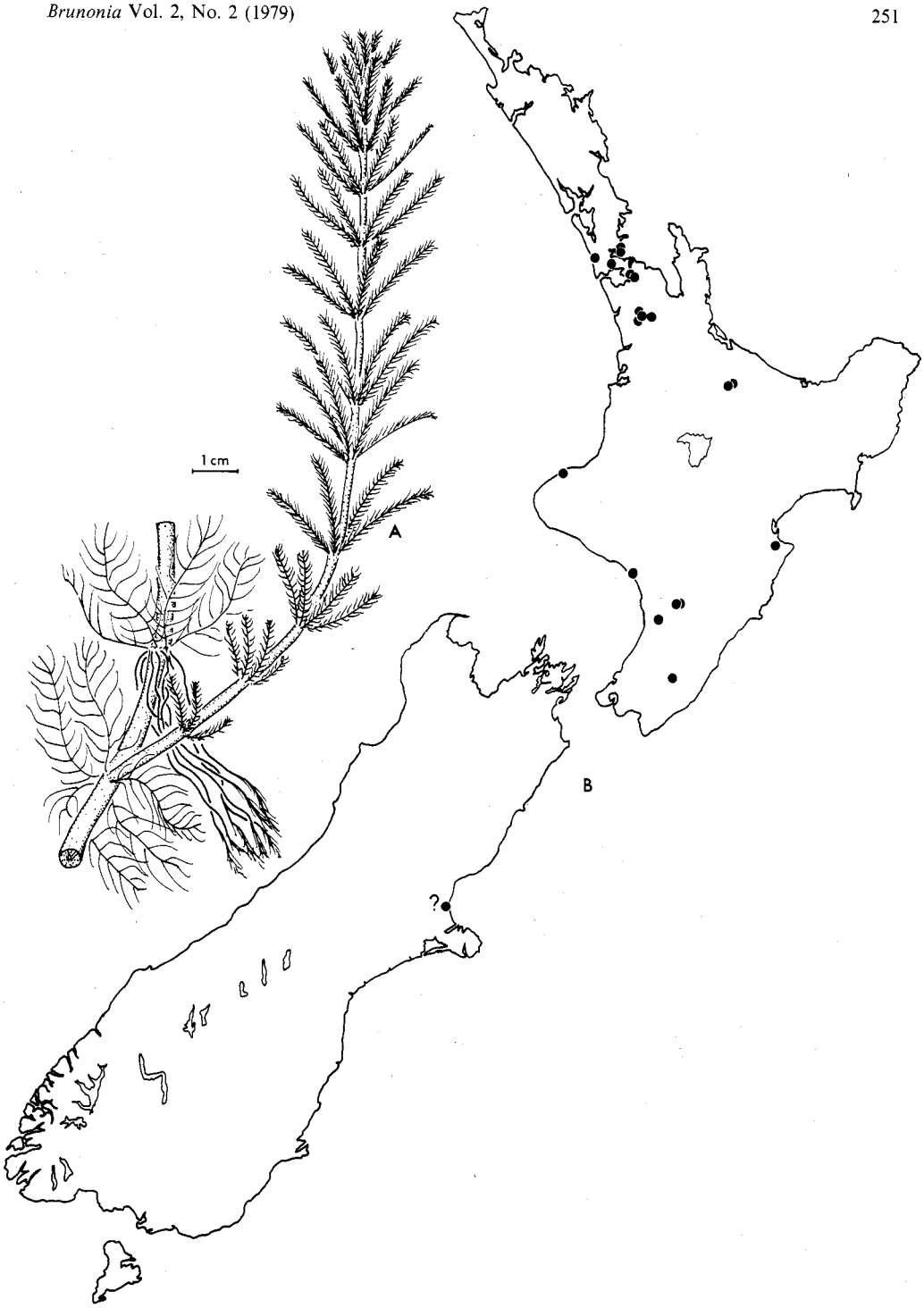

Fig. 1. *Myriophyllum aquaticum*. *A*, habit, showing short section of submerged stem and leaves and lateral emergent shoot with inflorescence. *B*, distribution within New Zealand. (*A*, *Orchard 4876*, AK).

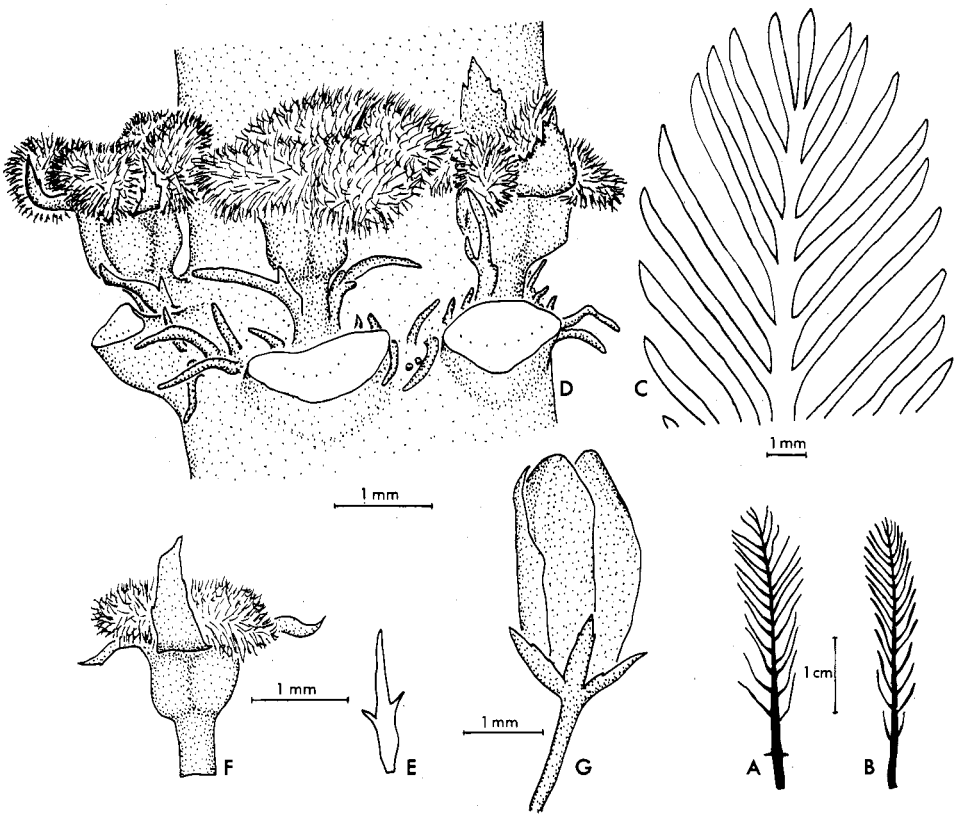

Fig. 2. *Myriophyllum aquaticum*. *A*, submerged leaf. *B*, emergent leaf. *C*, tip of emergent leaf. *D*, portion of inflorescence showing three female flowers, bracteoles and hydathodes (leaves cut away for clarity). *E*, bracteole. *F*, female flower. *G*, male flower. (*A*, *Orchard 4776*, AK; *B*, *C*, *Orchard 4774*, AK; *D–F*, *Hardacre s.n.*, AK 132830; *G*, *Müller s.n.*, Brazil, P).

Distribution

M. aquaticum is native to South America (Brazil, Argentina, Uruguay, Peru, Chile and Paraguay) but is almost cosmopolitan as an adventive in temperate and tropical regions of the world. It has been reported as an adventive from Nicaragua and Mexico in Central America; the southern, eastern and western United States in North America; England, Austria and France in Europe; South Africa and Rhodesia in southern Africa; and in Java, Japan, Hawaii and the eastern States of Australia, as well as New Zealand. In many countries it is cultivated as an ornamental plant for indoor and outdoor aquaria, and most adventive populations stem from this source. In Java, the young shoots are eaten as a vegetable.

The first record of *M. aquaticum* in New Zealand as an adventive plant is a specimen collected by V. D. Zotov from Boundary Road, Palmerston North on 21 November 1929. For the next 20 years, the only collections made were in the Palmerston North–Awapuni district, and all of these early records were originally confused with the native *M. robustum*. The difference between the two species

was first recognized about 1968–1970, and *M. aquaticum* was then found to be present in scattered localities throughout the North Island, particularly in the Auckland-Waikato region. In the South Island, only 1 rather doubtful record exists. This is a plant with submerged leaves only, collected at Kaiapoi by R. Mason in March 1968. Although it is impossible to be certain, I believe this plant to be *M. aquaticum* rather than the only other species growing to this size in New Zealand, *M. robustum*.

Ecology

As mentioned above, *M. aquaticum* closely resembles *M. robustum* and the two species were originally confused, but their habitat requirements are distinct. While *M. robustum* is usually found in relatively undisturbed sites, in peaty soils, *M. aquaticum* is usually in disturbed areas, often in muddy situations, although it is tolerant of a wide range of conditions and can be found on peat. The plant is usually found growing on waterlogged soil, and along the margins of lakes and slowly flowing rivers, where it roots near the bank in shallow water, and extends to deeper areas as large rafts of floating stems. As only female flowers are developed on plants outside of South America, reproduction is entirely vegetative. Adventitious roots form readily on floating clumps of *M. aquaticum*, and the fragile stems allow the clumps to break up readily and form new populations. Dumping of aquarium plants is probably the major source of introduction to new watersheds. Collectors' notes include 'locally abundant in ditch with *Glyceria* sp.' (*Bangerter 5127*), 'in newly drained portion of swamp, rooting on edge of ponds, stems forming floating rafts out into deeper water' (*Bartlett & Gardner AK 143099*), 'with *Nasturtium officinale* and *Aponogeton distachyus*' (*Goulding AK 120484*), 'uncommon, with *Ceratophyllum* & *Elodea* in up to 1 m of water' (*Orchard 4868*), 'abundant on damp mud left by receding water, forming turf with *Ludwigia*' (*Orchard 4876*). Flowering occurs from October to January (–May) but is erratic.

Specimens Examined

NORTH ISLAND: *Bangerter 5127*, Freyberg Park, Browns Bay, 13.xii.1973 (AD, AK).– *Bartlett s.n.*, Meremere, 10.vi.1977 (AK).– *Bartlett & Gardner s.n.*, east bank of Whangamarino River near Meremere, 29.x.1977 (AK).– *Esler 3081*, Western Springs, Auckland, 17.iv.1970 (CHR).– *Esler & Dickson 4339*, Bethell's Beach, 17.vii.1973 (CHR).– *Frith s.n.*, Western Springs, Auckland, 11.iv.1970 (CHR).– *Goulding s.n.*, Otara Creek, 2.v.1969 (AK).– *Goulding & Gurr 501*, Lake Pupuke, 25.x.1972 (AK).– *Gurr s.n.*, Lake Pupuke, 4.vi.1972 (AK, CHR).– *Hardacre s.n.*, cultivated, ex Western Springs, 8.i.1973 (AK).– *Mackie s.n.*, Otara Creek, 30.iv.1969 (AK).– *Manley s.n.*, Hastings, 16.iv.1970 (CHR).– *Manson s.n.*, Shannon, xi.1967 (CHR).– *Manson s.n.*, 6 m [10 km] from New Plymouth, 4.xii.1970 (CHR).– *Manson s.n.*, Lake Kaitoke, S. of Wanganui, 5.ii.1971 (CHR).– *Mason s.n.*, Racecourse Lagoon, Palmerston North, 11.iii.1948 (CHR).– *Mason 4358*, Palmerston North near greyhound track, 17.i.1956 (AD, CHR). – *Mason 10011*, Ohau Channel between Rotorua and Rotoiti, 28.i.1963 (CHR).– *Moar s.n.*, Racecourse Lagoon, Awapuni, 21.vii.1948 & 10.v.1949 (CHR).– *Orchard 4868*, Waikato River between Mercer and Meremere, 17.ii.1977 (AK).– *Orchard 4872*, northern end of Lake Waikare, 17.ii.1977 (AK).– *Orchard 4876*, northern side of Lake Whangape, 17.ii.1977 (AK).– *Orchard 4987, 4988*, Middlemore Hospital, Otahuhu, 16.vi.1977 (AK).– *Ridall s.n.*, between Rangiriri and Huntly, 25.ii.1969 (CHR, 2 sheets). – *Stevenson s.n.*, Carterton, iv.1970 (CHR).– *Sylvester s.n.*, Lake Pupuke, 3.xi.1976 (AK).– *Wilcox 1000*, Okere Bay, Lake Rotoiti, 21.i.1970 (NZFRI).– *Wright 1532*, Bethell's Beach, 18.xii.1976 (AK).– *Zotov s.n.*, Boundary Road, Palmerston North, 21.xi.1929 (CHR).

SOUTH ISLAND: *Mason 10751*, Kaiapoi, 23.iii.1968 (CHR).

Comments

Only female plants of this dioecious species are known outside its natural range in South America. Even there, male plants are by no means common, and fruits are apparently only very rarely formed. The only previous description of the fruit is in Schindler (1905), and the only illustration is in Gleason (1958). The particular specimens on which these accounts of the fruits were based were not cited, and I have seen only immature fruits on two collections. In both cases – *G. T. Hastings s.n.*, lake near Reuca, Chile, 2.ii.1901 (NY), and *L. Gillies s.n.*, ditches at Buenos Ayres, Argentina (K) – the fruits are not fully mature, although those of the latter are slightly more advanced than those of the former. The following is a composite description. Fruits borne on pedicel 0.7–0.8 mm long, 4-merous, cylindric-ovoid, 1·7 mm long, 1·3–1·4(–1·7) mm diam. Sepals at first persistent, erect, deltoid, 0·6 mm long, 0·3 mm wide, toothed towards tip, withering at maturity. Mericarps cylindric, 1·7 mm long, 0·6–0·7 mm diam., slightly wider towards base, apex oblique, with indistinct thickened rim, otherwise smooth, rounded on dorsal surface. The fruit on the Gillies specimen (or a duplicate) probably formed the basis for Schindler's description (1905). The fruit illustrated by Gleason (1958) is almost certainly not this species.

All specimens examined of *M. aquaticum*, with one exception, are strictly dioecious, bearing either male or female flowers. The sole exception is the Gillies specimen cited above, which consists of 2 stems, one with female flowers in the upper part, with fruits below, the other with male flowers above and 2 whorls of fruits below. This collection has the annotation 'Lectotype of *M. proserpinacoides* Gill. Det. L. E. Mora, Dec. 1970'. As far as I am aware, this choice of lectotype has not previously been published. The specimen chosen is the best available for the purpose.

The type specimen of *Enydria aquatica* Vellozo has not been located, and appears to be lost (Carauta 1969). However, the illustration appearing in Vellozo's Icones (t. 150) is clearly compatible with his description and is here chosen as lectotype.

Relationships

Within New Zealand, *M. aquaticum* seems to have no close relatives, as might be expected, but is often confused with *M. robustum*. The two species, if fertile, are easily distinguished. *M. robustum* has hermaphrodite flowers, with subtending pinnate/digitate bracteoles, and sets fruit readily, while *M. aquaticum* has female flowers only, with subtending trifid bracteoles, and never sets fruit. The flowers of *M. robustum* are pink in most of their parts; those of *M. aquaticum* are white. Sterile specimens with emergent leaves are also readily distinguished. In *M. robustum* the fully developed emergent leaves are spreading, with tips acute in outline, and with very few hydathodes at the base. In *M. aquaticum* the fully developed emergent leaves are held erect in the upper parts of the stem, have rounded tips, and numerous hydathodes at the base. Specimens consisting of submerged leaves only cannot be reliably determined.

2. ***Myriophyllum robustum*** Hook.f., Handbk. N.Z. Fl. (1867) 67 [*Typus*: 'Northern Island, *Colenso*'. *Lectotypus* (Moore): *Colenso 112*, N. Zealand, 1844 (K!).

Syntypi: *Colenso 110, 238, 245,* N. Zealand, 1844 (K!)] Featon, Art Alb. N.Z. Fl. (1889) 150; Kirk, Stud. Fl. N.Z. (1899) 151; Schindler, Pflrch 23 (1905) 86–87; Cheeseman, Man. N.Z. Fl. (1906) 151–2; Cheeseman, Illus. N.Z. Fl. 1 (1914) pl. 46; Cheeseman, Man. N.Z. Fl. 2 ed. (1925) 624–25; Moore in Allan, Fl. N.Z. 1 (1961) 253; Praglowski, Grana 10 (1970) 208.

Myriophyllum variaefolium var. β Hook.f., Fl. N.Z. 1 (1852) 64 [*Typus*: as for *M. robustum*].

Figure: Cheeseman, Illus. N.Z. Fl. 1 (1914) pl. 46.

Description

Stout aquatic or terrestrial herb; stems pink in upper parts, green below, to 30 cm tall, 5–6 mm diam. at base, rooting only at lower nodes, glabrous. Leaves all whorled, slightly dimorphic. Submerged leaves often decaying early and absent; if present, in whorls of 5–7, ovate in outline, rounded at tip, 5 cm long, 4 cm wide, pectinate with 24–30 filiform pinnae 1·5–2·5 cm long. Emergent leaves yellow-green to subglaucous, crowded towards tips of stems, spreading, in whorls of (4–)5–7, oblong in outline with acute tip, (1·5–)2·0–3·5 cm long, (0·4–)0·6–1·0 cm wide, becoming smaller near water level, pectinate, with 26–32 pinnae; pinnae linear, (2–)6–7 mm long, 0·3 mm wide, tips acute, usually incurved.

Inflorescence an indeterminate spike with the flowers borne singly in the axils of the upper emergent leaves and each subtended by two bracteoles. Fertile emergent leaves in whorls of 4–6, pectinate, equalling other leaves in size and shape. Bracteoles ovate to orbicular in outline, 0·7–0·8 mm long, 0·7–0·8 mm wide, 6–8-pinnatifid or -palmate, the pinnae cut $\frac{2}{3}$ of way to centre of lamina.

Flowers hermaphrodite, 4-merous. Sepals 4, green to pinkish, ovate to deltoid, 0·6–0·8 mm long, 0·5–0·6 mm wide, minutely denticulate on margin, smooth. Petals 4, yellowish-green, weakly hooded, not or only weakly keeled, 2·5–3·4 mm long, 1·1–1·2 mm wide, on unguiculum 0·5 mm long. Stamens 8; filaments 0·3 mm long, anthers yellow, linear-oblong, 1·7–2·3 mm long, 0·2–0·3 mm wide, antisepalous anthers *c.* 0·2 mm longer than antipetalous ones, 4-locular, very shortly apiculate. Styles 4, clavate, 1 mm long, stigmas capitate. Ovary pink, ovoid, *c.* 1·0 mm long, 0·7 mm wide, 4-ribbed opposite petals, 4-locular, with 1 ovule per locule.

Fruit 4-merous, on pedicel to 1 mm long, globular to slightly obturbinate, 1·5–2·0 mm long (excluding sepals), 2·0–2·5 mm wide, sepals persistent, deltoid, 0·6 mm long, 0·6 mm wide, styles persistent, reflexed; mericarps slightly flattened, dorsally rounded especially in upper part, often ± keeled in lower part, with a few small tubercles on keel. (Figs 3 and 4.)

Distribution

M. robustum is endemic to the two main islands of New Zealand. Its range formerly extended almost the length of the country, but is now very much reduced. The plant has not been collected north of Kaitaia, nor from Taranaki, the central plateau or East Cape peninsula in the North Island, and in the South Island is known only from the west coast, apart from two old records from Mt Arthur, Nelson, and Awatere, Marlborough.

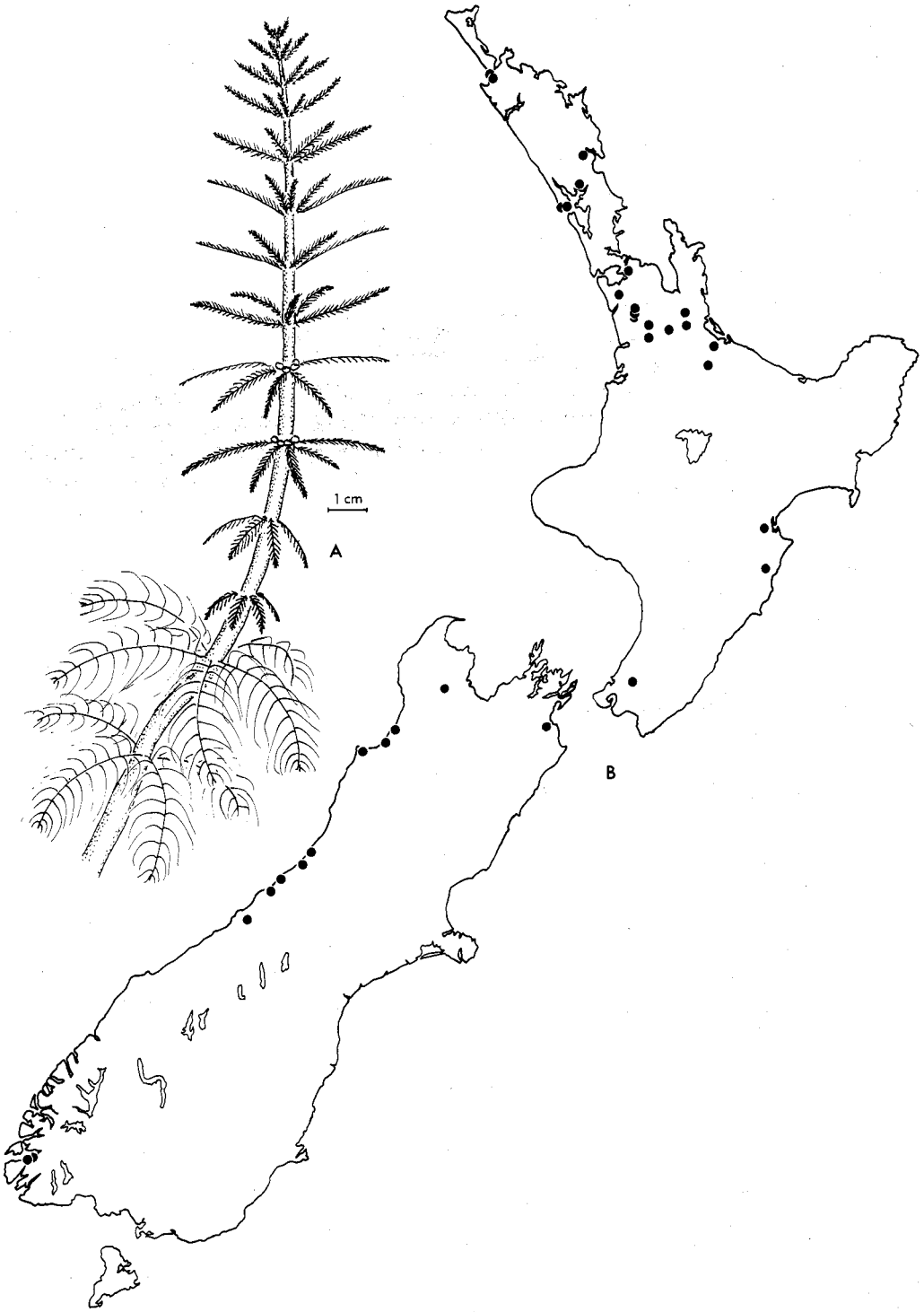

Fig. 3. *Myriophyllum robustum*. *A*, habit. *B*, distribution (*A, Carse s.n.*, AK 46551).

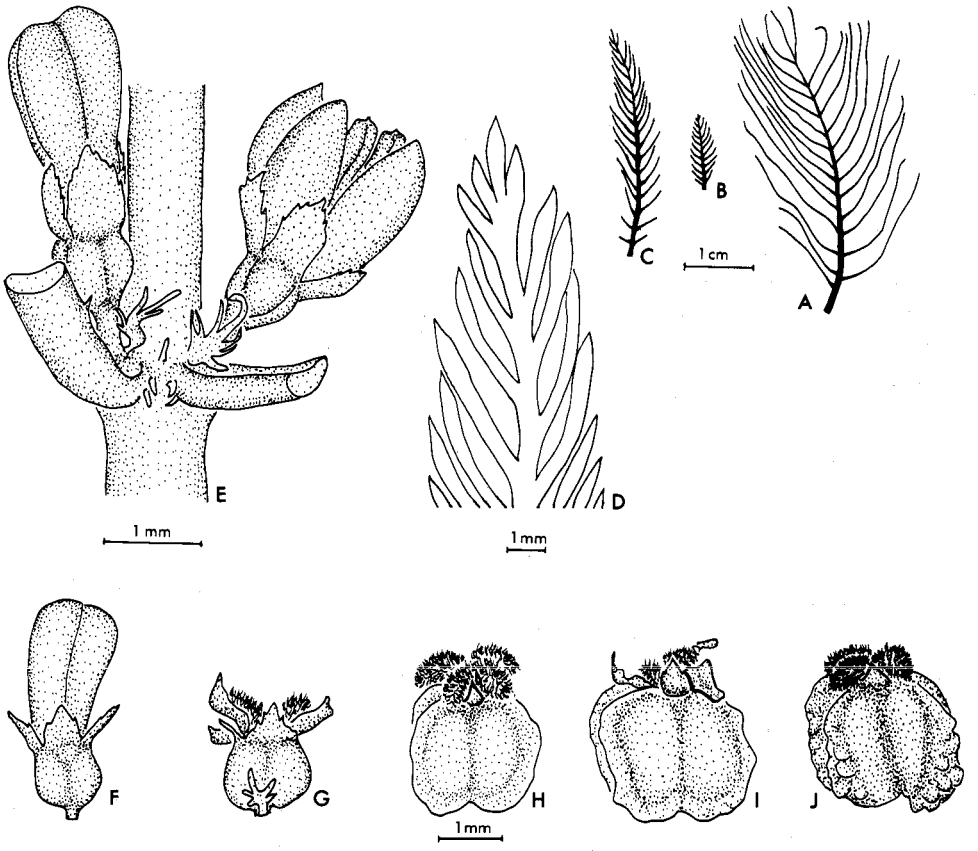

Fig. 4. *Myriophyllum robustum*. *A*, submerged leaf. *B*, transitional leaf. *C*, emergent leaf. *D*, tip of emergent leaf. *E*, portion of inflorescence showing two flowers, bracteoles and hydathodes (leaves cut away for clarity). *F*, unopened bud. *G*, flower and bracteole just after anthesis with petals withering. *H*, *I*, immature fruits. *J*, mature fruit. (*A*, *Lyttle s.n.*, OTA 34166; *B–G*, *Carse s.n.*, CHR 291255; *H–J*, *Carse s.n.*, CHR 291254).

Ecology

The preferred habitat for this species is peaty swamps, and their associated slowly flowing streams. In these situations, it is found in deep to shallow water. Unlike *M. aquaticum*, with which it is often confused, it does not form floating mats from the banks in deeper water, but roots on the bottom. Its chief centre of distribution is in the northern Wairoa and Thames–Waikato area, where Cheeseman (1914) described it as 'covering large stretches in swamps that are deeply covered with water in winter, but dry or nearly so in summer'. Collectors' notes include 'in newly drained portion of swamp, growing in ca. 30 cm of water on peaty soil' (*Bartlett & Gardner s.n.*), 'in muddy part of creek' (*Carse s.n.* CHR 291258), 'in lake in ca. 3 ft of water' (*Lyttle s.n.*), 'wet part of *Typha* swamp' (*Mason & Moar 2111*) and 'swamp in depression in dunes' (*Moar 610*). Apart from one undated Adams collection labelled 'Mt Arthur, Nelson', *M. robustum* is a lowland species,

found at altitudes up to 150 m. Flowering occurs from October to January, fruiting from about December to April.

Specimens Examined

NORTH ISLAND: *Adams s.n.*, Te Aroha (WELT, 2 sheets).- *Bartlett s.n.*, west bank of Waikato River opposite Meremere Power Station, 7.i.1978 (AK).- *Bartlett & Gardner s.n.*, east bank of the Whangamarino River near Meremere, 29.x.1977 (AK).- *Carse s.n.*, Kaitaia, 24.x.1897 (WELT).- *Carse s.n.*, Kaitaia, 7.xi.1897 (AK).- *Carse s.n.*, Maungatapere near Whangarei, 30.xi.1898 (AK, WELT, CHR). - *Carse, s.n.*, Mauku near Pukekohe, iii.1900 (WELT).- *Carse s.n.*, Mauku, 5.xi.1900, 2.xi.1901, xi.1907 (CHR, 3 sheets).- *Carse s.n.*, Hunahuna, west coast Manganui, 25.ix.1911 (CHR).- *Carse s.n.*, Pukemukumuku, near Tauhei, Piako Co., xi.1923, 26.xi.1925 (CHR, 2 sheets).- *Cheeseman s.n.*, swamps at Te Aroha (AK).- *Cheeseman s.n.*, Lake Waihi, i.1884 (AK, 2 sheets).- *Colenso 110, 112, 238, 245*, New Zealand, 1844 (K).- *Dieffenbach s.n.*, New Zealand (K).- *Kirk s.n.*, Waioho Creek, Auckland (WELT).- *Kirk s.n.*, Waikato (CHR, 2 sheets, OTA).- *Kirk s.n.*, Papatoetoe (AD, AK, WELT).- *Kirk s.n.*, Bay of Islands (WELT).- *Kirk s.n.*, lower Waikato (WELT).- *Kirk s.n.*, Tauranga (WELT).- *Kirk s.n.*, Papatoetoe, 6.ii.1866, i.1868 (WELT, 2 sheets).- *Kirk s.n.*, Mungaroa Swamp, 26.xii.1887 (WELT).- *Kirk 116*, Auckland (MEL).- *Mason 8414*, Horseshoe Lake, Patangata Co., 21.i.1961 (CHR). - *Mason & Moar 6145*, Waikato River opposite Meremere, 21.xi.1958 (CHR).- *Mason & Moar 6350, 6355*, Lake Wahi near Weaver's Crossing, 25.xi.1958 (CHR).- *Mason & Moar 6799*, Wahi Lake, 8.xii.1958 (CHR).- *Mason & Moar 6918*, smaller lake near Ohinewai, 10.xii.1958 (CHR).- *Matthews s.n.*, west coast, North Cape Peninsula, iii.1924 (CHR).- *Matthews s.n.*, Waituna Lake, Kaitaia, 1.iii.1924 (AK).- *Matthews s.n.*, west coast near Kaitaia, viii.1924 (WELT).- *Moar 610*, near Swan Lake, Pouto, 8.ii.1950 (CHR).-*Oliver s.n.*, Lake Kapupuarere, Pouto, 11.x.1928 (WELT).-*Petrie s.n.*, near Te Aroha, (WELT).- *Petrie s.n.*, Tirohia near Paeroa, xi.1907 (CHR, 2 sheets, WELT, 5 sheets).

SOUTH ISLAND: *Adams s.n.*, Mt Arthur, Nelson (AK).- *Dorizac s.n.*, Lake Forster, Dusky Sound, 21.ii.1963 (OTA, 2 sheets).- *Dorizac s.n.*, Dusky Sound, 3.i.1969 (CHR, 2 sheets).- *Johnson s.n.*, Lake Matheson, 23.ii.1970 (OTA).- *Kirk s.n.*, Awatere (WELT).- *Kirk s.n.*, Westport, 24.i.1898 (WELT).- *Lyttle s.n.*, Lake Forster, Dusky Sound, 13.ii.1969 (OTA).- *Mason & Moar 2111*, Birchfield, Buller Co., 30.i.1953 (CHR).- *Mason & Moar 5481*, Lake Matheson, 20.ii.1958 (CHR).- *Mason & Moar 5614*, north of Poerua River, 26.ii.1958 (CHR).- *Mason & Moar 5701*, Shearer's Swamp, south of Mikonui River, 1.iii.1958 (CHR).- *Parris s.n.*, Lake Matheson, 13.i.1967 (AK).- *Poole s.n.*, Blackwater Creek, Kongahu Swamp, 7.iii.1939 (CHR).- *Tipler s.n.*, Hokitika (WELT).- *Veitch s.n.*, near Ruatapu, south of Hokitika, iv.1968 (CHR).- *Wardle s.n.*, Lake Matheson, 2.v.1965 (CHR).

Comments

The type sheet of *M. robustum* consists of 4 Colenso collections numbered 110, 112, 238 and 245, and a Dieffenbach collection. The last-named, which is sterile, was not mentioned by Hooker (1867) and is thus excluded from being type material. Of the Colenso collections, No. 112 was effectively chosen as lectotype by Moore (1961). This specimen (in the lower left-hand corner of the sheet) is the only one bearing both flowers and fruits.

Cheeseman (1914) reported that the distribution of *M. robustum* was being severely reduced by draining and burning of the swamps and, with the continuation of these practices, it is now a very rare species. Attempts by several collectors to locate wild populations in previously recorded localities for this study turned up only two very small patches, both near Meremere. Other populations may still occur in the more inaccessible areas of the Waikato and on the West Coast of the South Island, but the species seems doomed to extinction unless conservation action is taken soon. Trials at the Auckland Institute and Museum and Auckland University indicate that it is easily grown, and its cultivation, perhaps as an

aquarium plant, should be encouraged. *M. robustum* is at least as attractive as the introduced *M. aquaticum* already used for this purpose.

Relationships

M. robustum seems to have no close affinities with any of the other New Zealand native species, nor with any of the Australian taxa. In New Zealand it was for many years confused with *M. aquaticum*, and it may be that its relationships lie here. For the distinguishing characteristics of the two species, see under *M. aquaticum*.

3. ***Myriophyllum triphyllum*** Orchard, sp. nov.

Myriophyllum elatinoides auct. Novae Zelandiae, non Gaudich.: Hook.f., Fl. N.Z. 1 (1852) 63–4 p.p.; Hook.f., Handbk. N.Z. Fl. (1867) 66 p.p.; Featon, Art Alb. N.Z. Fl. (1889) 150; Kirk, Stud. Fl. N.Z. (1899) 150–1; Schindler, Pflrch 23 (1905) 91–93 p.p.; Cheeseman, Man. N.Z. Fl. (1906) 151 et edn 2 (1925) 624; Moore in Allan, Fl. N.Z. 1 (1961) 253–254; Simpson & Burrows, N.Z. J. Bot. 16 (1978) 163–5.

Herba aquatica infirma, caulibus 50–100 cm longis, 1–2(–3) mm diametris, basibus radicantes praecipue. Folia dimorpha verticillata. Folia submersa (2–)3(–4) verticillata, ovata, (6–)10–15 mm longa, (5–)7–10(–15) mm lata, plusminusve sessilia, pectinata. Folia emersa 3(–4) verticillata, rarissimo alterna in parte superiora, anguste ovata ad obovata, (2·5–)5–6(–12) mm longa, (1·5–)2·0–2·5(–4·0) mm lata, integra vel folia inferiora incisa, obtusa, folia quam internodia breviora sub anthesi.

Inflorescentia spica terminalis, ramis lateralibus 2–4 interdum. Flores 4-meri, in axillis foliorum emersorum, flores superiores masculini, flores inferiores feminei.

Flores masculini 4-meri. Sepala 4, deltoidea, 0·5–0·6 mm longa, 0·4–0·5 mm lata, infirme 2–3-dentata. Petala 4, cucullata, 2·0–2·8 mm longa, 2·0 mm lata. Stamina 8; filamenta 0·1 mm longa, crescens post anthesin; antherae anguste oblongae, 1·8–2·4 mm longae, 0·4 mm latae, non apiculatae. Styli 4, clavati, 0·2 mm longi, vestigiales. Ovarium plusminusve cubiforme, 0·7 mm longum, 0·6 mm latum, vestigiale.

Flores feminei 4-meri. Sepala 4, deltoidea, 0·2 mm longa, 0·2 mm lata, minute serrata, vestigialia. Petala 4, vestigialia. Stamina 0. Styli 4, clavati, 0·5 mm longi, stigmata fimbriata. Ovarium plusminusve cubiforme, 1·0 mm longum, 0·8 mm latum.

Fructus plusminusve cubiformis, 1·3–1·4(–1·5) mm longus, 1·4–1·5 mm latus, stylis persistens et erectis, ubi maturis in mericarpia 4 findens. Mericarpia cylindrica, 1·4 mm longa, 0·8 mm lata, laevia et rotundata in pagina dorsali.

Typus: *A. E. Orchard 4916*, New Zealand. South Island. Springs County. Lower Selwyn Huts, Lake Ellesmere. In deep slowly flowing water. Emergent leaves deep reddish purple, submerged leaves dark green, 24.ii.1977. *Holotypus*: AK. *Isotypi*: AD, CANB, CHR, F, HO, MEL, MO, OTA, P, WELT.

Description

Weak aquatic herb; stems 50–100 cm long, rooting mainly at base, 1–2(–3) mm diam.; leaves dimorphic, verticillate. Submerged leaves in whorls of (2–)3(–4), ovate in outline, sessile (petiole 0·1–0·2 mm long), (6–)10–15 mm long, (5–)7–10(–15) mm wide, pectinate with 12–18 filiform pinnae 8 mm long. Leaves lacking hydathodes at base. Emergent leaves red-purple, in whorls of 3(–4), very rarely becoming alternate in upper part of inflorescence, narrowly ovate to obovate, (2·5–)5–6(–12) mm long, (1·5–)2·0–2·5(–4·0) mm wide, entire (or those of lower whorls incised), obtuse, shorter than internodes at flowering. Transition from submerged to emergent leaves abrupt (1–2 whorls).

Inflorescence an indeterminate spike, sometimes with 2–4 lateral inflorescences arising from axils of the upper whorl of submerged leaves. Flowers 4-merous, borne singly in axils of the emergent leaves, upper flowers male, lower ones female. Bracteoles cream, lanceolate, (1·0–)1·4–1·8(2·0) mm long, (0·2–)0·3–0·4 mm wide, entire or minutely 3–4 toothed, acute.

Male flowers. Sepals 4, cream, deltoid, 0·5–0·6 mm long, 0·4–0·5 mm wide, weakly 2–3-toothed. Petals 4, yellow to reddish, hooded, not or only very weakly keeled, 2·0–2·8 mm long, 2·0 mm wide. Stamens 8; filaments 0·1 mm long, lengthening after anthesis; anthers linear-oblong, 1·8–2·4 mm long, 0·4 mm wide, antisepalous anthers *c.* 0·3 mm longer than antipetalous ones, non-apiculate. Styles 4, clavate, *c.* 0·2 mm long, vestigial. Ovary ± cubiform, 0·7 mm long, 0·6 mm wide, lobed opposite petals, non-functional. Petals and stamens of lowermost whorl of male flowers sometimes smaller than in upper whorls.

Female flowers. Sepals 4, deltoid, 0·2 mm long, 0·2 mm wide, minutely serrate, vestigial. Petals 4, 0·5 mm long, vestigial. Stamens 0. Styles 4, clavate, 0·5 mm long, stigmas fimbriate, cream. Ovary ± cubiform, 1·0 mm long, 0·8 mm wide, 4-lobed opposite petals.

Fruit reddish-purple, ± cubiform, 1·3–1·4(–1·5) mm long, 1·4–1·5 mm wide, styles persistent and erect, fruit prominently 4-lobed opposite styles, splitting at maturity into 4 mericarps. Mericarps cylindrical, 1·4 mm long, 0·8 mm diam., smooth and rounded on dorsal surface, sometimes with a faint dorsal line, planar on faces where joined to other mericarps. (Figs 5 and 6.)

Distribution

M. triphyllum is found throughout New Zealand's two main islands, and from Stewart, Chatham, Auckland, Campbell and Macquarie Islands.

Ecology

This species is typically found in deeper water than most of the others dealt with here. It occurs in lakes and slowly flowing rivers and streams, from sea level to subalpine altitudes, rooting on the bottom with only the inflorescences emergent. In situations where seed has germinated in shallow water (*c.* 5 cm or less), or where mature plants have been stranded by a sudden drop in water level, the leaves on new growth assume a distinctive appearance, not found in deep water. In this 'stranded form', all the leaves, although occurring in an aerial environment,

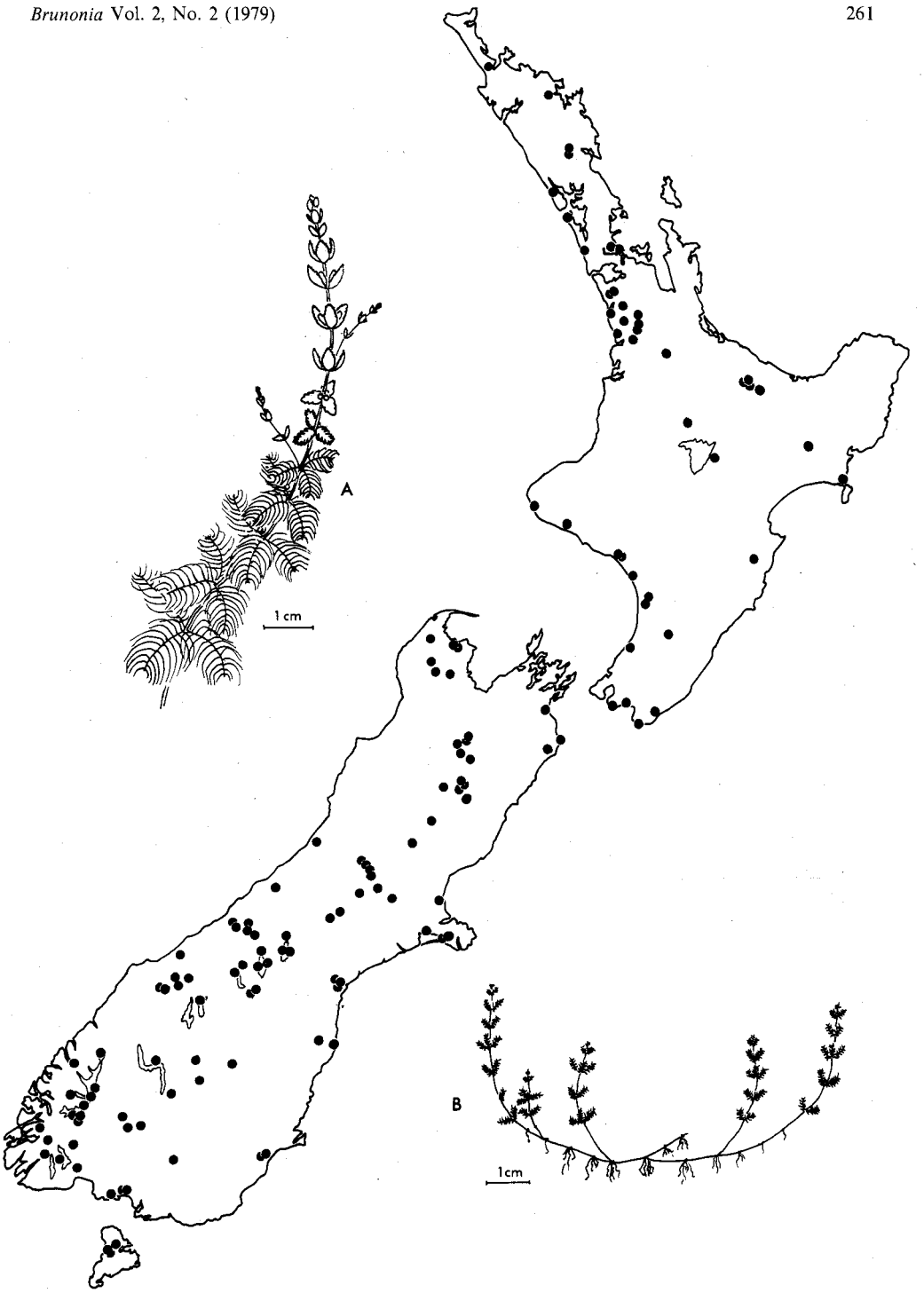

Fig. 5. *Myriophyllum triphyllum*. *A*, habit of normal deep-water form. *B*, habit of stranded form. *C*, distribution within New Zealand (Chatham, Auckland, Campbell and Macquarie Islands not shown). (*A, Orchard 4916*, AK; *B, Orchard 4887*, AK).

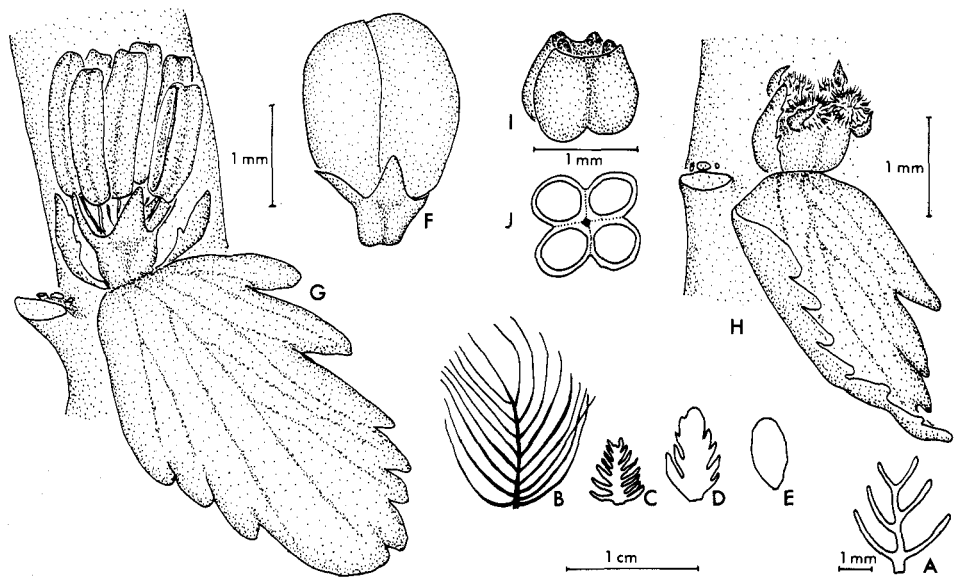

Fig. 6 *Myriophyllum triphyllum*. *A*, leaf of stranded form. *B*, submerged leaf of deep-water form. *C*, transitional leaf of deep-water form. *D, E*, lower and upper emergent leaves of deep-water form. *F*, male flower just before anthesis. *G*, male flower, after anthesis, in axils of emergent leaf and bracteoles. *H*, female flower, *in situ*. *I*, fruit. *J*, transverse section of fruit. (*A, Orchard 4887*, AK; *B–J, Orchard 4916*, AK).

are pectinately divided, *c*. 4–5 mm long and 3 mm wide, the lower ones sessile and arranged in whorls of 3, the upper ones petiolate and opposite. These plants, discussed in more detail under 'Comments' below, rarely flower.

Typical collectors' notes on deep water forms include 'slow flowing stream on flood plain' (*Allan s.n.*, CHR 11358), 'growing in deep hole just off shore' (*Clarke, Moore & Pearson s.n.*, CHR 174007) and 'belt in centre of steady flowing stream 2–4 ft [60–120 cm] deep' (*Macmillan & Mitchell s.n.*, CHR 211489). Notes on the stranded form include 'enclosed mudflat, in company with *Mimulus repens*' (*Allan s.n.*, CHR 90230), 'dry mud slope at edge of oxbow lagoon' (*Mason & Chapman 12436*) and 'damp hollows from which lake has recently retreated. Juvenile growth. Closely appressed to mud with *Tillaea* and *Potamogeton*' (*Moore s.n.*, CHR 159077).

In common with other species of the '*M. elatinoides*' complex, and unlike most other members of the genus, *M. triphyllum* appears to tolerate brackish conditions, as shown, for example by the collection *Mason & Chapman 12374* found 'submerged in tidal creek'. Flowering occurs from (October–) November to February and fruiting from about (December–) January to March.

Specimens Examined

NORTH ISLAND: *Anon. s.n.*, beyond Cape Tirakirae, Palliser Bay, 1912 (WELT).– *Adams s.n.*, Kerikeri (AK).– *Adams s.n.*, Rosy Bay, Lake Waikaremoana, 7.iii.1951 (CHR).– *Allan s.n.*, Rangitoto Island, lagoon beyond lighthouse (CHR).– *Aston s.n.*, Tarawera Mountains, i.1916 (WELT).– *Carse*

s.n., Wairua River, 9.xi.1899 (AK, CHR, 2 sheets).- *Carse s.n.*, Lower Waikato, xii.1900 (AK, CHR). - *Carse & Shannon s.n.*, Waikato River, Ngaruawahia, 15.i.1916 (CHR).- *Cranwell s.n.*, Waikato Heads, i.1932 (AK).- *Cranwell s.n.*, Okataina, i.1932 (AK).- *Druce s.n.*, 3 m [5 km] SE. of Opunake, i.1964 (CHR).- *Druce s.n.*, lagoon near Hawera, iii.1964 (CHR).- *Duguid s.n.*, Turakina Beach road, 27.x.1952 (CHR).- *Fish s.n.*, Lake Rotoehu, 18.i.1963 (CHR).- *Given s.n.*, Lake Taupo, ii.1939 (CHR). - *Gurr s.n.*, Lake Pupuke, 4.vi.1972 (AK).- *Hynes s.n.*, Muriwai Lake beyond Tarawera Road, 16.xi.1968 (AK, 2 sheets).- *Kirk s.n.*, Hawkes Bay (WELT).- *Kirk s.n.*, Rangiriri, Waikato (WELT).- *Kirk s.n.*, Waikato (CHR, 2 sheets, OTA).- *Kirk s.n.*, Pupuke Lake, 23.xii.1868 (WELT).- *Kirk s.n.*, Waikato River, Taupiri, 19.xii.1873 (WELT).- *Mason s.n.*, Lake Koputara, Manawatu 12.iii.1948 (CHR).- *Mason 561*, Palliser Bay, west end of Lake Onoke, 7.ii.1950 (CHR). - *Mason 4131*, Pauri Lake, S. of Wanganui, 10.i.1956 (CHR).- *Mason 4151*, Kaitoke Lake, S. of Wanganui, 10.i.1956 (CHR).- *Mason 4167*, Waikato Lake, Wukumaru, 11.i.1956 (CHR).- *Mason 8248*, Mangatainoka River at Pahiatua, 18.i.1961 (CHR).- *Mason 8658*, Rotopounamu N. of Mahia, 28.i.1961 (CHR).- *Mason 9590*, Lake Okataina, Rotorua Co., 17.i.1963 (CHR).- *Mason 10080*, Lake Pupuwharua near Kawerau, 30.i.1963 (CHR).- *Mason & Esler 11166*, Lake Rototuna, W. of Kaipara Harbour, 20.xi.1970 (CHR).- *Mason & Moar 6108*, Waikawau Creek, Raglan Co., 20.xi.1958 (CHR).- *Mason & Moar 6285*, Lake Whangape, 24.xi.1958 (CHR).- *Mason & Moar 6518*, Karapiro Lake, 28.xi.1958 (CHR).- *Mason & Moar 6734*, turnoff of Karakariki Road from road to Raglan, 5.xii.1958 (CHR). - *Moar s.n.*, Lake Little Pukepuke, Himitangi, 23.viii.1948 (CHR).- *Moar 443*, Muir's Lake, Waiuku, 23.i.1950 (CHR).- *Moar 469*, Thompson's Lake, Waiuku, 24.i.1950 (CHR).- *Moar 488*, small lake N. of R. Poheroa, Waiuku, 25.i.1950 (CHR).- *Moar 549*, L. Kawakatai, South Head, Kaipara Harbour, 1.ii.1950 (CHR).- *Morris Jones s.n.*, Lake Waikaremoana, i.1956 (CHR).- *Orchard 4863*, Lake Pupuke, 14.xii.1976 (AK).- *Orchard 4887, 4891*, Halletts Bay, Lake Taupo, 18.ii.1977 (AK).- *Oliver s.n.*, Otaki, 6.viii.1940 (WELT).- *Oliver s.n.*, Taupo, 19.iii.1946 (WELT, 2 sheets).- *Oliver s.n.*, Waikaremoana, 13.xii.1946 (WELT).-*Oliver s.n.*, Wanstead, 30.ix.1954 (WELT).- *Powell s.n.*, Lake Waiparera near Waiharara, 31.i.1950 (CHR).- *Sylvester s.n.*, Lake Pupuke, 5.vi.1974, 1.ix.1976, 3.xi.1976 (AK, 3 sheets). - *Tryon s.n.*, Patangata, Hawkes Bay (BRI).- *Zotov s.n.*, Palliser Bay, 2.i.1932 (CHR).

SOUTH ISLAND (selection only; 166 sheets examined): *Adams s.n.*, where Upper Hurunui R. flows into Lake Sumner, 20.i.1957 (CHR).- *Allan s.n.*, Saltwater Creek, Timaru, 16.iv.1939 (CHR).- *Berggren s.n.*, Lake Lyndon, 1874 (WELT).- *Buchanan 219*, Blue Lakes, Mt Cook National Park, i.1968 (CHR).- *Clarke, Moore & Pearson s.n.*, Lake Rubicon near Springfield, 14.xii.1966 (CHR).- *Enys s.n.*, Castle Hill Basin, Canterbury (WELT).- *Falla et al. s.n.*, Takahe Valley, xii.1949 (WELT).- *Given 67197*, Lake Mike between Long Burn and Dusky Sound, 14.i.1967 (CHR).- *Given 72162*, Wet Jacket Arm, ii.1972 (CHR).- *Hay s.n.*, Lake Peel, Mt Peel, 1.i.1951, 12.iv.1952 (CHR, 2 sheets).- *Johnson s.n.*, Lake Manapouri, 4.xii.1969, 21.xii.1969 (OTA, 2 sheets).- *Johnson s.n.*, Lake Te Anau, 13-21.v.1971 (OTA, 3 sheets).- *Macmillan & Chapman s.n.*, Lake Pukaki, 16-20.xii.1970 (CHR, 3 sheets).- *Mark s.n.*, Young Valley, Makaroa River, 2.ii.1969 (OTA).- *Mason s.n.*, Bealey River, Canterbury, 24.ii.1945 (CHR).- *Mason s.n.*, Arthur's Pass, 20.ii.1949 (CHR, MEL).- *Mason 3156*, Lake Elterwater, near Ward, 23.i.1955 (CHR).- *Mason 8076*, Hunter Valley, 29.xii.1960 (CHR).- *Mason 10409*, Lake Heron, 2.ii.1966 (CHR).- *Mason 11855*, Grebe River, 4.xii.1971 (CHR).- *Mason 11962*, Lagoon Point, Lake Te Anau, 9.xii.1971 (CHR).- *Mason & Chapman 12698*, Oreti River bridge at Mossburn, 22.ii.1973 (CHR). - *McMahon s.n.*, Starborough Creek, Awatere, xii.1903 (WELT).- *McNeur s.n.*, Earnscleugh, 2.i.1950 (CHR, 5 sheets).- *Melville 6076*, Lake Rotoiti, 18.i.1962 (CHR).- *Melville et al. 6243*, Maori Lakes, Ashburton Valley, 1.ii.1962 (CHR, 2 sheets).- *Oliver 39454*, Lake Wakatipu, 10.ii.1953 (WELT). - *Orchard 4899*, Edwards Pass, upper Clarence River, 23.ii.1977 (AK, HO).- *Orchard 4916, 4917*, Lower Selwyn Huts, Lake Ellesmere, 24.ii.1977 (AK, HO).- *Orchard 4918*, Lake Lyndon, 28.ii.1977 (AK). - *Petrie s.n.*, Tarras, 7.i.1911 (WELT).- *Simpson 2632*, Morgan's Flat, D'Urville River, 7.ii.1961 (CHR). - *Sykes 486/70*, near Cape Campbell, 29.x.1970 (CHR).- *Wardle s.n.*, moraine of Douglas Glacier, 2.iii.1970 (CHR). - *Willa s.n.*, Mason Bay, Stewart Island, 12.ii.1961 (WELT).- *Willa s.n.*, Freshwater River, Stewart Island, 20.ii.1961 (WELT).

CHATHAM ISLANDS: *Anon. s.n.*, Lake Marakapia, 25.i.1947 (CHR).- *Bell s.n.*, South East Island, xii.1961 (CHR).- *Findlay s.n.*, Kaiara, 21.i.1955 (CHR).- *Gilpin s.n.*, Chatham Island, 1942 (CHR).- *Martin s.n.*, Chatham Island, i.1924 (CHR).- *Moar 1590*, Lake Te Roto, 7.xi.1959 (CHR).- *Talbot s.n.*, Chatham Island, ii.1948 (CHR).- *Travers s.n.*, Chatham Islands (MEL, WELT, 3 sheets).

AUCKLAND ISLAND: *Knox & Bell s.n.*, stream to Tandy Saddle, Tandy Inlet, i.1963 (CHR).– *Turbott s.n.*, Lake Turbott, Adams Island, 19.ix.1944 (AK).– *Wise s.n.*, Lake Turbott, Adams Island, 27.i.1966 (CHR).

CAMPBELL ISLAND: *Godley s.n.*, Hooker Stream, 18.i.1961 (CHR).

MACQUARIE ISLAND: *Costin & Moore 8*, west coast, 12.xii.1958 (CANB).– *Taylor s.n.*, 1·5 km N. of Mt Waite, 29.xi.1950 (HO).– *Taylor s.n.*, *c.* 100 m west of Scobles Lake, 1.i.1951 (HO).

Comments

Three distinct forms of *M. triphyllum* can be recognized, although numerous intermediates exist. The first of these forms arises when seeds germinate in very shallow water (less than about 5 cm). In these circumstances, almost all of the leaves are above water level, but never adopt the emergent form. All remain pectinate, the lower ones arranged in whorls of three, the upper ones in twos, and all have distinct petioles. The plants of this form never grow more than about 10 cm tall, are usually deep olive to purplish in colour, and rarely flower. The few plants known with flowers and fruits have them in the axils of the undifferentiated upper leaves. Very similar forms arise when the normal deep-water forms of the species are stranded on mud by a sudden drop in water level early in the growing season. The normal leaves of these plants are soon lost by drying or rotting, but new shoots which arise from the stranded stems are of the above type (see *McNeur s.n.*, CHR 65649–54 for a range of specimens from stranded to deep-water forms).

The other two growth forms, already noted by Cheeseman (1906), are apparently related to altitude. The lowland or 'typical' form of *M. triphyllum* is a delicate plant with leaves nearly always in whorls of 3, thin stems, long internodes and lax inflorescences. At higher altitudes, plants are more robust, the leaves are often in whorls of 4, the stems are shorter and thicker with submerged leaves equalling or exceeding the internodes in length, and the inflorescence has the leaves more or less equalling the internodes at anthesis. Superficially, this high-altitude form closely approaches *M. quitense*, but is distinct in the size of its fruits, the shape of its bracteoles and the absence of hydathodes at the base of the petals. These two altitude-related variants could be worthy of recognition as formal varieties or forms, but I have decided not to adopt this course because of the relatively large number of intermediate specimens.

A collection by Thomson, Wairua River near Aponga, Whangarei, ii–iii.1900 (CHR) is possibly a hybrid between *M. triphyllum* and *M. propinquum*. It has variable emergent leaves, some almost linear and approaching those of *M. propinquum*. The submerged leaves are sessile and agree well with those of *M. triphyllum*. The long emergent spike of *c.* 20 whorls of leaves has no fruits set, and the flowers are apparently vestigial only.

Relationships

Until now, this plant has been known as *M. elatinoides* Gaudich. in New Zealand, being considered synonymous with similar plants in South America and Australia. The type of *M. elatinoides* Gaudich. came from the Falkland Islands ('Iles Malouines') and recent studies (Orchard, unpublished) have shown that this species is indistinguishable from *M. quitense* H.B.K, the name of which predates *M.*

elatinoides by 2 years. This precedence of the name *M. quitense* had already been pointed out by Fernald (1919), and Schindler (1905) had placed *M. quitense* in the synonymy of *M. elatinoides*. Despite this, both authors chose to use the later name. The name *M. elatinoides* is therefore no longer available for the New Zealand plants, but neither can they be referred to *M. quitense*. Present studies show that the South American and New Zealand plants can be distinguished on a number of characters, as set out in Table 1. As no other epithet is available for the New Zealand plants, they have been recognized as a new species, *M. triphyllum*.

Table 1. Comparison of *M. triphyllum* and *M. quitense*

M. triphyllum	*M. quitense*
Stems thin, 1-2(-3) mm diam.	Stems thick, 2-4 mm diam.
Leaves in whorls of (2-)3(-4)	Leaves in whorls of (3-)4
Submerged leaves ± sessile (petiole *c.* 0·1 mm)	Submerged leaves with petiole 0·5-1·0 mm long below pinnae
Submerged leaves usually shorter than internodes	Submerged leaves usually equalling or exceeding length of internodes
Inflorescence lax, emergent leaves (primary bracts) usually very much less than internodes at anthesis	Inflorescence compact, emergent leaves ± equalling internodes at anthesis
Bracteoles (secondary bracts) lanceolate, acute, (1·0-)1·4-1·8(-2·0) mm long	Bracteoles ovate, obtuse, 0·7-1·2 mm long
Flowers lacking hydathodes at base of petals	Flowers with small hydathodes at base of petals
Fruit 1·3-1·4(-1·5) mm long	Fruit (1·5-)1·7(-1·8) mm long

Although there is some overlap in the characters listed, in combination they provide an adequate means of distinguishing the two species. The most diagnostic factors are fruit size, bracteole shape and presence or absence of hydathodes near the base of the petals, but these characters, particularly the first, are often not available.

M. triphyllum is usually a very much more delicate plant than *M. quitense* and, as the name suggests, usually has at least some of its leaves in whorls of 3. However, variations from 2–4 leaves per whorl are known in many populations, and sometimes in the same plant. It is not unusual for a plant to have emergent leaves in whorls of 4 and submerged leaves in threes, or *vice versa.*

Australian plants at present treated under the name *M. elatinoides* differ in several respects from both *M. quitense* and *M. triphyllum*, but they will be discussed elsewhere. The relationships of *M. triphyllum* and *M. quitense* to each other are undoubtedly close, and much closer than either to the Australian '*M. elatinoides*'. Another close ally of the complex is *M. magdalenense* Fernald from Quebec, apparently known only from its type collection. Love (1961) reduced this species to varietal status under *M. exalbescens*, a species which has itself been reduced at various times to a variety or subspecies of *M. spicatum*. The exact status to be assigned to these northern hemisphere taxa is still under investigation by several workers, and will be discussed further in a forthcoming paper.

Fernald (1919) recorded '*M. elatinoides*' from Oregon on the basis of two collections from Des Chutes River (*Leiberg 465* and *Peck 5718*). These collections, and another specimen (*Peck 9704*) from the same general area are undoubtedly *M. quitense*.

A very high proportion of collections of this species, perhaps 50%, are sterile, and consist only of submerged leaves. Sterile collections of *Myriophyllum* can not, in general, be reliably determined, but among the New Zealand species, *M. triphyllum* can only be readily confused with *M. propinquum*. The submerged leaves of these two species can be distinguished by the length of the petiole (the rachis below the lower pinnae). The leaves of *M. triphyllum* are almost sessile (petiole *c.* 0·1 mm) while those of *M. propinquum* have a petiole of at least 1–2 mm.

Hooker (1852, 1867) reduced *M. propinquum* to synonymy under *M. elatinoides*. In all subsequent accounts, the two taxa have been considered as distinct.

4. ***Myriophyllum propinquum*** A. Cunningham, Ann. Nat. Hist. Ser. I, 3 (1839) 30 [*Typus*: 'New Zealand (Northern Island). Bogs at the Mission Station on the Keri Keri river, as also on the Hokianga river. – 1834, *R. Cunningham'. Holotypus*: *R. Cunningham 256, 532*, In bogs of the Keri Keri Hokianga etc. 1834 (K!).] Walpers, Rep. 2 (1843) 98: Raoul, Choix Pl. N.Z. (1846) 48; Schindler, Pflrch 23 (1905) 89 p.p.; Cheeseman, Man. N.Z. Fl. (1925) 624; Moore in Allan, Fl. N.Z. 1 (1961) 253; Moore & Edgar, Fl. N.Z. 2 (1970) 331; Meijden & Caspers, Fl. Males. 7 (1971) 252–3 p.p.

? *Myriophyllum propinquum* var. *α genuinum* Schindler, Pflrch 23 (1905) 89 p.p. [*Typus*: Not stated – see discussion under 'Comments' below].

Myriophyllum propinquum var. *β tenuifolium* Schindler, Pflrch 23 (1905) 90 [*Typus*: 'Neu-Seeland: Nordinsel (Berggren, Haast, Jelinek, Lesson, Reischek); Südinsel (Cockayne n. 5765, Colenso, Powerson in herb. Cheeseman n. 1717, Ralph n. 133)'. *Lectotypus*: None chosen – see below under 'Comments'. *Isosyntypi*: *Berggren s.n.*, Tauranga, xii.1874 (WELT 44940!, 44974!); *Cockayne 5765*, Malvern Hills, Canterbury, growing in very slowly running water, 21.xii.1901 (WELT 44975!); ?*Townson s.n.*, Marton (AK 5956!) – see note below, under 'Comments'.]

Myriophyllum variaefolium auct. Novae Zelandiae, non Hook.f. (1840): Hook.f., Fl. N.Z. 1 (1852) 64 (excl. var. *β*); Hook.f., Hdbk. N.Z. Fl. (1867) 66–67; Featon, Art Alb. N.Z. Fl. (1889) 150.

Myriophyllum intermedium auct. Novae Zelandiae, non DC.: Kirk, Stud. Fl. N.Z. (1899) 150; Cheeseman, Man N.Z. Fl. (1906) 151.

Myriophyllum verrucosum auct. Novae Zelandiae, non Lindley: Kirk, Stud. Fl. N.Z. (1899) 150; Praglowski, Grana 10 (1970) 210.

Description

Weak aquatic or semiaquatic or terrestrial herb (5–)10–25(–40) cm tall; stems weak, slender, 1·0–1·5(–3·0) mm diam., rooting at lower nodes; glabrous.

Leaves distinctly dimorphic. Submerged leaves in whorls of 3–4(–5), ovate to orbicular in outline, (0·6–)1·0–2·0(–2·5) cm long, 1·0–1·6(–2·5) cm wide, pectinate with 10–22 filiform pinnae 5–6(–20) mm long, with distinct petiole 1–2 mm

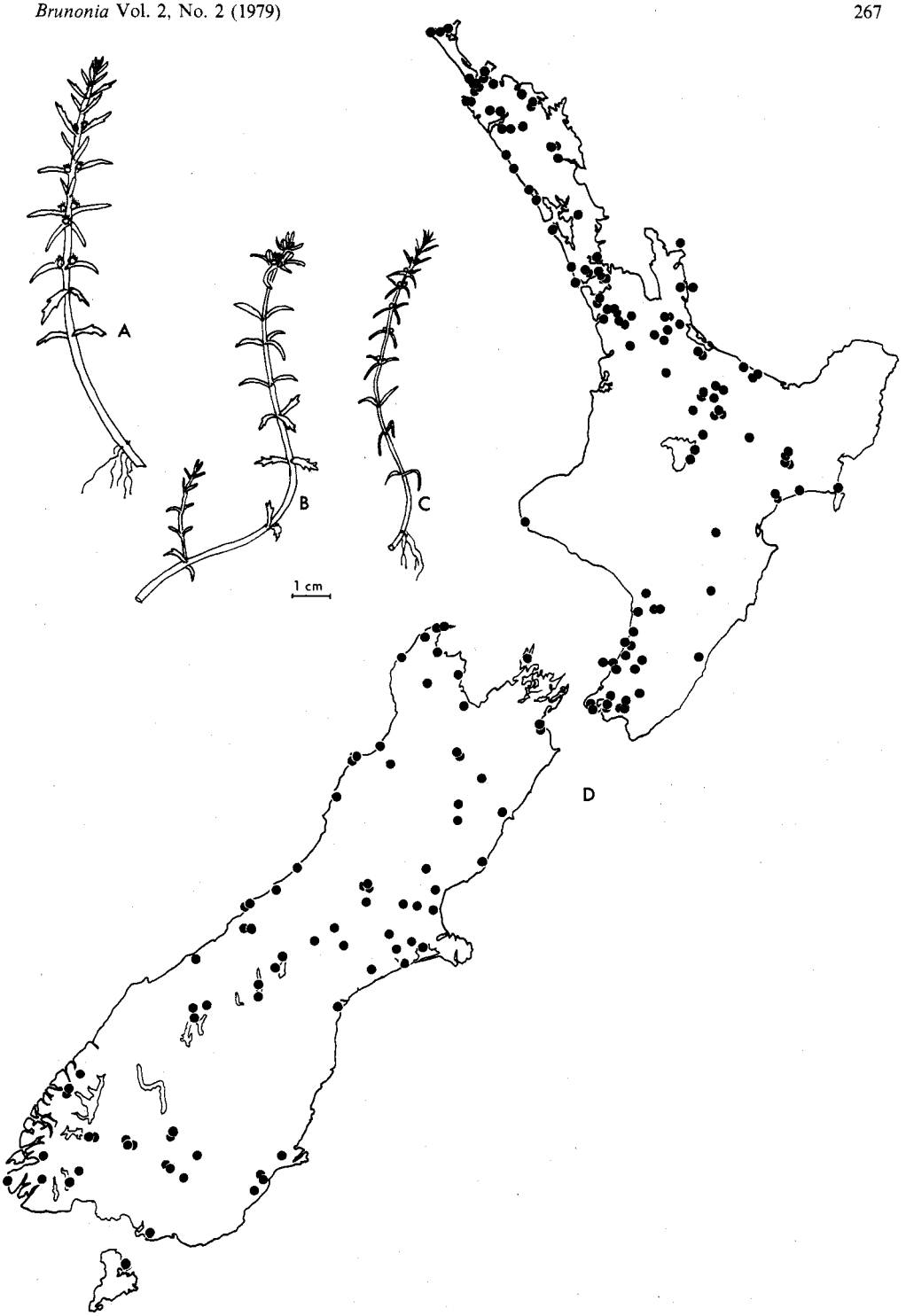

Fig. 7 *Myriophyllum propinquum*. *A–C*, habit of three different forms. *D*, distribution (Chatham Islands not shown). (*A, Orchard 4881*, AK; *B, Orchard 4882*, AK; *C, Orchard 4883*, AK).

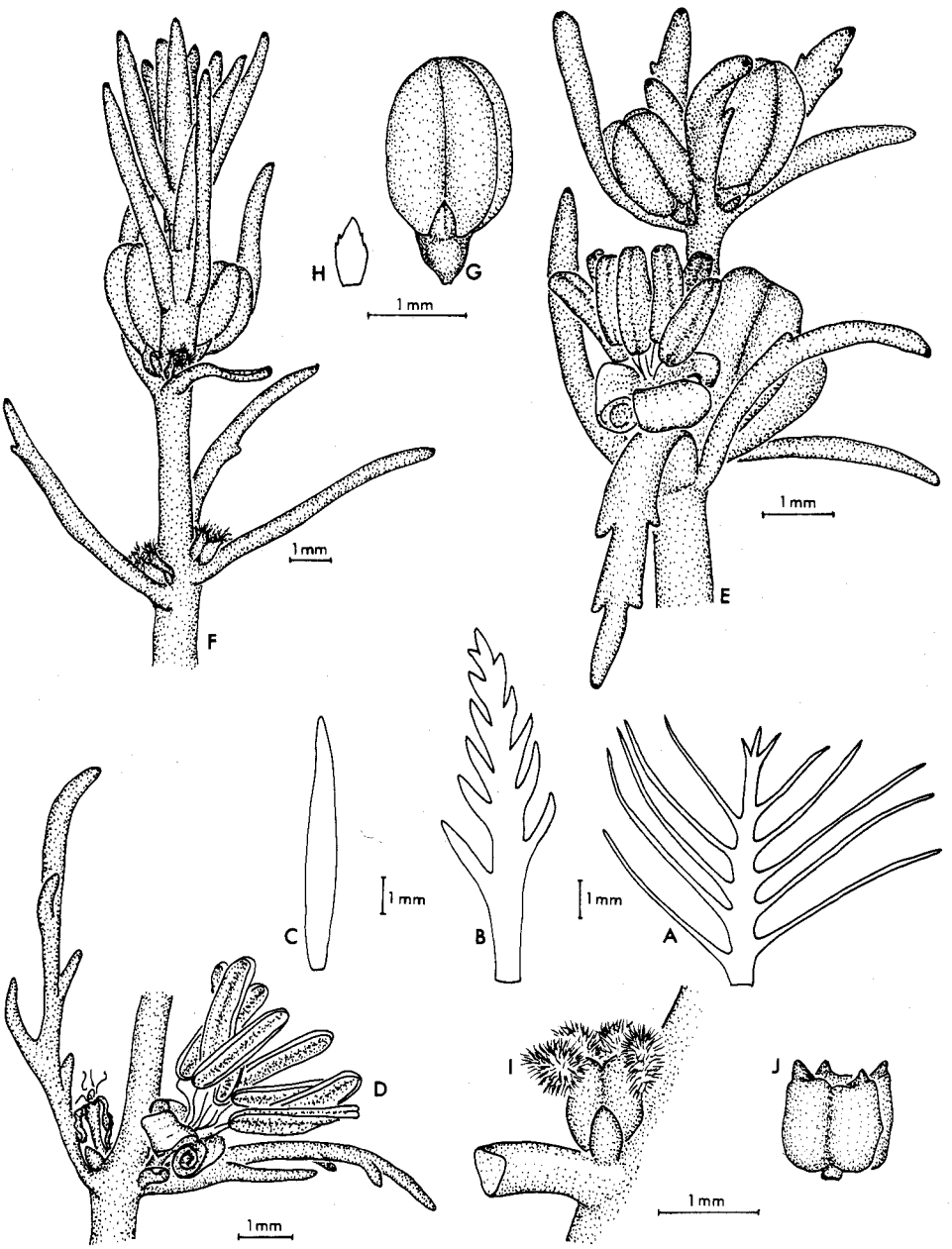

Fig. 8. *Myriophyllum propinquum*. *A*, submerged leaf. *B*, lower emergent leaf. *C*, upper emergent leaf. *D*, portion of inflorescence with two male flowers at late anthesis in axils of deeply dissected leaves. *E*, upper part of inflorescence with male flowers in axils of entire or toothed leaves. *F*, upper part of inflorescence with male and female flowers in axils of ± entire leaves. *G*, male flower just before anthesis. *H*, bracteole. *I*, female flower *in situ*. *J*, fruit (*A–C*, *I*, *Orchard 4923*, AK; *D*, *Orchard 3662*, AK; *E*, *Orchard 4882*, AK; *F*, *J*, *Orchard 4937*, AK; *G*, *H*, *Orchard 4930*, AK).

long. Emergent leaves in whorls of (2–)3–4(–5), linear, (2–)5–7(–12) mm long, 0·5–1·0(–1·5) mm wide, usually flattened but occasionally terete to filiform, spreading or slightly curved upwards, margin entire or sometimes weakly toothed. Rarely, all or most emergent leaves pinnatifid, 4–5 mm long, 1·5–3·5 mm wide with pinnae to 1·5 mm long. Transitional leaves usually 1–2(–4) whorls only.

Inflorescence an indeterminate spike with the unisexual flowers borne singly in axils of the emergent leaves. Each whorl contains flowers of 1 sex only, male in upper 1–8 whorls, female in lower 2–6 whorls, with usually 1–2 sterile whorls between. Occasionally all whorls (up to 20) contain female flowers only. All flowers subtended by 2 bracteoles. Bracteoles ovate, (0·4–)0·5–0·8 mm long, (0·2–)0·4–0·5 mm wide, slightly laciniate towards tip or entire.

Male flowers 4-merous, sessile or becoming shortly pedicellate. Sepals 4, ovate, 0·4–0·6 mm long, 0·3–0·4 mm wide, weakly toothed near apex. Petals 4, hooded, very weakly keeled, 1·8–2·7(–3·0) mm long, 1·4 mm wide, becoming reflexed and inrolled after anthesis. Stamens 8; filaments 1–2 mm long, elongating after anthesis; anthers yellow, linear-oblong, 1·7–2·4 mm long, 0·4–0·5 mm wide, antisepalous anthers *c.* 0·2 mm longer than antipetalous ones. Styles 0. Ovary vestigial.

Female flowers 4-merous, sessile. Sepals, petals and stamens 0. Styles 4, clavate, 0·2–0·3 mm long, stigmas occupying most of length of style, white, fimbriate. Ovary 4-merous, oblong, 0·7–0·8 mm long (excluding styles), 0·7 mm wide; carpels cylindrical, smooth, with styles on outermost corners.

Fruit pale yellow-brown, cylindrical, sessile, splitting at maturity into 4 mericarps. Mericarps 0·8–1·1 mm long, 0·4–0·5 mm diam., smooth apart from scattering of very small asperities on outer face, crowned by persistent base of style. (Figs 7 and 8)

Distribution

M. propinquum in New Zealand is found in North, South, Stewart and the Chatham Islands. Most plants from Australia and eastern Asia which have been referred to this species in the past differ in a number of respects and will be discussed elsewhere. The exceptions are a few plants from northern Tasmania which may be referable to *M. propinquum* s.str.

Ecology

M. propinquum extends from the lowlands to middle altitudes, usually in or adjacent to still waters, such as lakes, bogs and ditches. It is rarely found in running water, but will occur in backwaters, or on the boggy margins of fast-flowing streams. Although occasionally found in water up to about 1 m deep, *M. propinquum* usually occurs in shallower water, up to about 15 cm, and many forms thrive in completely terrestrial situations in soils which are not much more than just permanently damp. Edaphic conditions influence, to some extent, the form of the adult plant, and this is discussed further under 'Comments' below.

Typical collectors' notes include 'in newly drained portion of swamp, growing in mud or in up to 15 cm of water' (*Bartlett & Gardner s.n.*, AK 143100), 'wet sandy margin of small lake' (*Cheeseman s.n.*, AK 5961), 'Occasional in turf of

Ludwigia on damp mud left by receding water' (*Orchard 4878*), 'occasional on sand with sedges and *Ceratophyllum* in up to 5 cm of water' (*Orchard 4879*), 'in small lagoon near shore of lake, in grass/sedge community at edge of *Typha* clump' (*Orchard 4881*).

Flowering takes place from November to March (-May), and fruiting from February to May.

Specimens Examined

NORTH ISLAND (selection only, 188 examined): *Bartlett & Gardner s.n.*, east bank of Whangamarino River near Meremere, 29.x.1977 (AK).- *Berggren s.n.*, Tauranga, xii.1874 (WELT, 2 sheets).- *Bibby s.n.*, Lake Okareka, 28.iii.1950 (NZFRI).- *Carse s.n.*, Mangawhero Creek, Kaitaia, i.1898 (AK).- *Carse s.n.*, Waipapakauri, N. of Ahipara, 7.i.1902 (AK, CHR, WELT).- *Cheeseman s.n.*, Onehunga Springs near Auckland (AK).- *Court et al. s.n.*, Slipper Island off Tairua, 19.viii.1973 (AK).- *Cunningham 256, 532*, Keri Keri, Hokianga etc, 1834 (K).- *Druce s.n.*, near Wairoa, 19.xii.1948 (CHR).- *Druce s.n.*, Waikaremoana, i.1954 (CHR).- *Druce s.n.*, near Kopua, Maungaharuru Range, xii.1970 (CHR).- *Hynes s.n.*, Kohukohu, 10.xi.1961 (AK).- *Kirk s.n.*, Tauranga (AK, CHR, MEL, 2 sheets, WELT).- *Kirk s.n.*, Waikoko Creek, Auckland (OTA, WELT).- *Mason s.n.*, Otakairanga Swamp, Hikurangi, 4.xii.1949 (AK, MEL).- *Mason 8515*, N. of Whirimaki Bluff near Petone, 25.i.1961 (CHR).- *Mason 9724*, Lake Rotoiti, 21.i.1964 (CHR).- *Mason & Esler 11408*, Taharoa Lake, SW. of Kaihu, 23.xi.1970 (CHR).- *Mason & Esler 11439*, Lake Omapere, 24.xi.1970 (CHR).- *Mason & Moar 6136*, Waikato River above Tuakau Bridge, 21.xi.1958 (CHR).- *McMahon s.n.*, Kapiti Island, i.1922 (WELT).- *Millener s.n.*, Cape Maria van Diemen, 8.xii.1934 (CHR, OTA).- *Moar s.n.*, Lake Horowhenua, Levin, 3.iv.1949 (CHR).- *Moar s.n.*, Lake Pokeroa, Waiuku, 25.i.1950 (CHR, 2 sheets). - *Orchard 3662*, Waimangu Thermal Area, 23.x.1972 (AK, HO).- *Orchard 4123*, Whatipu Beach, 1.ii.1974 (AK, HO).- *Orchard 4873*, north end of Lake Waikare, 17.ii.1977 (AK, HO).- *Orchard 4878*, north side of Lake Whangape, 17.ii.1977 (AK, HO).- *Orchard 4879*, Lake Atiamuri, 17.ii.1977 (AK, HO).- *Orchard 4881, 4882, 4883*, Five Mile Beach, Lake Taupo, 18.ii.1977 (AK, HO).- *Orchard 4886, 4888, 4890*, Halletts Bay, Lake Taupo, 18.ii.1977 (AK, HO).- *Orchard 4896*, western shore of Lake Wairarapa, 20.ii.1977 (AK, HO).- *Orchard 4897*, Lake Pounui, 20.ii.1977 (AK, HO).- *Petrie s.n.*, lagoon of Mt St John, Auckland, 1899 (WELT).- *Petrie s.n.*, Mangaiti near Te Aroha, xii.1905 (WELT).- *Petrie s.n.*, Rotorua Lake, i.1920 (CHR, WELT).- *Raoul s.n.*, Baie des iles, 1843 (MEL).- *Reed s.n.*, South Head, Kaipara, 22.iv.1972 (AK).- *Simpson s.n.*, Matata near Whakatane, 26.xii.1950 18.ii.1965 (CHR, 3 sheets).- *Townson s.n.*, Marton (AK).- *Wilcox 885*, Lake Rotomahana, 5.v.1968 (NZFRI).- *Wright 267*, Great Mercury Island, 15.v.1975 (AK).- *Wright 962*, Kawerua, 9.i.1976 (AK).

SOUTH ISLAND (selection only, 129 examined): *Aitchison s.n.*, Outram, Dunedin, 11.iv.1954 (OTA).- *Allan s.n.*, Ashburton, xii.1919 (CHR).- *Allan s.n.*, Richard Burn, head of Long Sound, 28.i.1946 (CHR).- *Cockayne 5765*, Malvern Hills, 21.xii.1901 (WELT).- *Helms s.n.*, Greymouth (BRI).- *Hynes s.n.*, outlet Buller River from Lake Rotoiti, 3.ii.1965 (AK).- *Johnson s.n.*, Lake Hauroko, 25.x.1974 (CHR).- *Leask s.n.*, Rakeahua River, Half Moon Bay, Stewart Island, 30.iv.1970 (CHR).- *Mark s.n.*, Makarora Valley, Young Range, 9.ii.1969 (OTA).- *Mark s.n.*, Umbrella Mts, 15.xii.1971 (OTA).- *Mason 668*, Cass, 24.i.1951 (AD, CHR).- *Mason 686*, Lake Sarah, 24.i.1951 (CHR).- *Mason 710*, Lake Pearson, 25.i.1951 (CHR).- *Mason 3045, 3050*, Tuamarina Swamp, 18.i.1955 (AD, CHR). - *Mason 8158*, Cotter's Creek, Hunter Valley, 6.i.1961 (CHR).- *Mason 9254, 9257*, Lake Rotorua (Star Lake) W. of Kaikoura, 28.ii.1962 (CHR).- *Mason 10934, 10935*, Irishman Creek Station, Lake Pukaki, 3.iii.1970 (CHR).- *Mason & Chapman 12667*, Old Man Swamp, E. of Lake Manapouri, 22.ii.1973 (CHR). - *Mason & Chapman 12694, 12699, 12726-729*, Oreti River bridge at Mossburn, 23.ii.1973 (CHR). - *Mason & Moar 4937*, S. of Cape Farewell, 22.ii.1957 (AD, CHR).- *Orchard 4900*, Edwards Pass, upper Clarence River, 23.ii.1977 (AK, HO).- *Orchard 4923*, 3 km N. of Lake Lyndon, 28.ii.1977 (AK, HO).- *Orchard 4926, 4927*, Shanghai Bay, Lake Mahinapoua, 1.iii.1977 (AK, HO).- *Orchard 4930*, eastern side of Lake Ianthe, 1.iii.1977 (AK, HO).- *Orchard 4937*, 2 km W. of Carters Beach, Westport, 2.iii.1977 (AK, HO).- *Orchard 4940*, Tauranga Bay, W. of Westport, 2.iii.1977 (AK, HO).- *Poole s.n.*, Stillwater River valley, 28.ii.1949 (CHR).- *Scott s.n.*, head of Lake Tekapo, 20.xii.1958 (OTA).- *Wright 2455*, Farewell Spit, 25.v.1977 (AK).

CHATHAM ISLANDS: *Hamlin 660*, Lake Huro, Chatham Island, 29.i.1957 (CHR, WELT).

Comments

The type sheet of *M. propinquum* consists of 2 small plants glued down, and 4 stems in an attached packet. All have male and very young female flowers. The label indicates that the plants are from at least 2 separate collections (*R. Cunningham 256* and *532*) but there is no indication of which is which. Moore (1961) mentioned only 'A. (sic) Cunningham, No. 532' under 'Type' for this species. This is unsatisfactory as a lectotypification as there is no way to tie this number to a particular specimen. The whole sheet has therefore been treated as (holo)type. This causes no problems, as all plants are of the same form, that with ± all leaves pectinate or toothed (see below).

Schindler's *M. propinquum* var. *genuinum*, as with all his newly described taxa, was not formally typified. Instead, he cited a number of collections, one (Huegel) from New Zealand, the rest from Australia. If one takes the view that Schindler was describing a new taxon, in view of his use of the name 'var. genuinum Schindler nov. var.', then a lectotype must be chosen from amongst the above syntypes. Schindler distinguished his varieties on leaf characters only, var. *genuinum* having the apices of the leaves submucronate, while those of var. *tenuifolium* were described as subobtuse. This difference in the tips of the leaves is one of many distinguishing *M. propinquum* s.str. from Australian species until now included under this name, and indicates that Schindler intended his var. *genuinum* to refer to the Australian taxa. The thicker leaves which he ascribed to var. *genuinum* tends to confirm this. This lectotype should therefore be chosen from among the Australian collections, and the Huegel specimen should probably be excluded as a misidentification although, as I have not seen the specimen involved, I have not been able to check this. The choice of epithet in this case was unfortunate, as 'var. *genuinum*' could be taken to imply that Schindler considered this to be the typical (in a nomenclatural sense) variety, which would then be typified by Cunningham's specimens. Schindler may indeed have mistakenly believed this to be the case, but did not see the Cunningham material. However, in view of the protologues to the two varieties, and the provenence of the specimens cited in each, there seems no possibility of equating *M. propinquum* var. *genuinum* with var. *propinquum*. Choice of a lectotype has been deferred, and will be made in conjunction with the treatment of the Australian species of the group.

M. propinquum var. *tenuifolium*, the second of Schindler's varieties, was similarly lacking a holotype, but was based on 9 New Zealand collections. Again, Schindler considered this a 'nov. var.' and, as such, it would require lectotypification. As I have not seen any of the specimens on which Schindler based the taxon, I refrain from making the choice at this time, but a number of undoubted duplicates of the syntypes which have been examined are cited above as isosyntypes. The name of the collector of one of the syntypes, 'Powerson', seems to be a misreading of 'Townson'. Moore (1961) considered that *M. propinquum* var. *tenuifolium* could be equated with var. *propinquum* as it was recorded only from New Zealand specimens and 'would be expected to include Cunningham's type'. However, as Schindler did not cite the Cunningham collections in his protologue, they cannot be considered for lectotypification, and *M. propinquum* var. *tenuifolium* can only be a taxonomic synonym of var. *propinquum*, not a nomenclatural synonym.

The name *M. variaefolium* (excluding var. β) was misapplied to *M. propinquum* by Hooker (1852, 1867). *M. variaefolium* is based on specimens from Tasmania and New South Wales. *M. variaefolium* var. β was later raised to species rank as *M. robustum* Hook.f.

The name *M. intermedium* was misapplied to *M. propinquum* by Kirk (1899) and Cheeseman (1906), following Clarke (1878), who reduced *M. variaefolium* (wrongly) to synonymy under *M. intermedium*. *M. intermedium* is now (Meijden 1969) considered a synonym of *M. indicum*, a species confined to Sri Lanka and southern India.

Kirk (1899) identified sterile specimens collected by himself and by Dr. Berggren from Tauranga as *M. verrucosum* Lindl. These plants are undoubtedly *M. propinquum*. *M. verrucosum* is endemic to the drier regions of Australia.

M. propinquum is extremely variable, especially in the development of the pectinate submerged leaves. Many collections are known in which all the leaves are entire and untoothed, while others have all leaves pectinate to pinnatifid, including those ('primary bracts') in the inflorescence. Both types of plant can be found in the same population. The control of the degree of toothing or dissection of the leaves seems to be at least partly edaphic.

A population showing a wide range of forms was studied at Hallett's Bay, Lake Taupo (*Orchard 4886–4890*). The plants were growing in a loose pumice gravel in a wet hollow adjacent to the lake. Clumps, probably originally derived from single plants, were internally constant in morphology, but differed widely from one to the next in the degree of leaf division. They were growing on damp to waterlogged gravel or in water of up to 20 cm in depth. When extremes were transplanted to an artifical pond in Auckland, and kept in waterlogged but completely emergent conditions for a number of weeks, all new growth on all types of plants was of a pinnatifid type.

However, some of the variation is genetically fixed. Plants collected by A.E. Wright from Farewell Spit, which had all leaves opposite and entire, were grown for several months in varying depths of water, from fully emergent to completely submerged, without any change being effected in the shapes of the new leaves.

The development of true submerged-type, filiformly pectinate leaves is apparently quite rare, and inundation of actively growing plants which have already formed emergent type leaves does not give rise to filiformly pectinate foliage, but rather to a thicker, more or less pinnatisect form. True submerged-type leaves are perhaps formed only on young plants inundated from germination. True submerged leaves have a length : breadth ratio of about 1:1; the intermediate or pseudosubmerged leaves formed by late inundation have a ratio of about 2:1.

This species also shows a well marked sexual bimorphism. Within many populations there are plants bearing only female flowers, usually in 20 or more whorls, and in these plants the leaves are usually completely entire. Within the same populations are other plants with the normal 3–6 whorls of female flowers at the base of the inflorescence, with usually a sterile whorl or two above, then 1–8 whorls of male flowers at the tip. Other populations seem to consist of only the bisexual plants. The differentiation in this case seems to be genetically fixed.

The above notes on variation in vegetative morphology represent only a first

approximation of the causes and effects. Much more experimental work is needed to fully understand this aspect of the species.

Relationships

Until now, *M. propinquum* has been considered to include plants in Australia originally described, in part, as *M. variaefolium*, as well as those in New Zealand. Meijden (1969) and Meijden and Caspers (1971) also included *M. ussuriense* of eastern Asia within the limits of *M. propinquum*.

'*M. propinquum*' in Australia probably consists of several taxa, one of which is *M. variaefolium*, one (from northern Tasmania) may be *M. propinquum* s.str., the others are unnamed as yet. All differ from *M. propinquum* in a number of characters, including their fruit shape, more robust stems, and submucronate leaves borne in whorls of 6 or more. *M. ussuriense* more closely resembles *M. propinquum*, but differs mainly in the shape and size of its bracteoles and smaller flowers, which are often hermaphrodite. Despite these differences, there seems little doubt that the relationships of *M. propinquum* lie with the various species above, sharing with them not only a morphological similarity but also their growth forms and habitat preferences.

M. propinquum is not easily confused with other New Zealand species, with one exception. Although the plants usually have their leaves in whorls of 3–4 (only extremely rarely in fives), depauperate plants are known with only 2 leaves per whorl, and these leaves are usually entire. These depauperate forms can be reliably distinguished from the more robust forms of *M. pedunculatum* only by their female flowers and fruits. The female flowers of *M. pedunculatum* bear tiny deltoid sepals (often caducous in older fruits) which are completely absent in *M. propinquum*. The mericarps of *M. pedunculatum* are ± globose and attenuate at the apex; those of *M. propinquum* are cylindrical.

5. ***Myriophyllum pedunculatum*** Hooker f. in Hook. Lond. J. Bot. 6 (1847) 474 [*Typus*: 'Margins of rivers and pools, abundant. [Tasmania]'. *Lectotypus*: None chosen, see below. *Syntypi*: (*Gunn*) *1959*, Arthurs Lakes, 17.i.1845 (K!); (*Gunn*) *2020*, margin of Derwent – under water, 15.ii.1840 (K!); (*Gunn*) *2020*, Pine River, Marlboro', 5.i.1841 (K!)] Hooker f., Fl. Tas. 1 (1856) 122–3; Bentham, Fl. Aust. 2 (1864) 489; Hooker f., Hdbk N.Z. Fl. (1867) 67; Mueller, Fragm. 8 (1874) 162; Mueller, Key Syst. Vict. Pl. 2 (1885) 23, 1 (1887–8) 260; Mueller, Sec. Census 1 (1889) 86; Featon, Art Alb. N.Z. Fl. (1889) 150–151; Tate, Fl. S. Aust. (1890) 101, 234; Kirk, Stud. Fl. N.Z. (1899) 151; Rodway, Tasm. Fl. (1903) 50; Schindler, Pflrch 23 (1905) 85; Cheeseman, Man. N.Z. Fl. (1906) 152; *idem.* edn 2 (1925) 625; Maiden & Betche, Census N.S.W. Pl. (1916) 159; Black, Fl. S. Aust. (1926) 432; *idem.* edn 2 (1952) 646; Ewart, Fl. Vict. (1930) 885–6; Curtis, Stud. Fl. Tas. 1 (1956) 190–1; Moore in Allan, Fl. N.Z. 1 (1961) 252; Meijden, Blumea 14 (1966) 245; Meijden, Blumea 17 (1969) 310; Praglowski, Grana 10 (1970) 206; Burbidge & Gray, Fl. A.C.T. (1970) 280; Meijden & Caspers, Fl. Males. 7 (1971) 251–252; Beadle *et al.*, Fl. Syd. Reg. (1972) 208; Willis, Hdbk Pl. Vict. 2 (1972) 471; Aston, Aq. Pl. Aust. (1973) 91–93; Beadle, Stud. Fl. N.E.

N.S.W. 2 (1972) 223 (excl. fig. 101c); Curtis & Morris, Stud. Fl. Tasm. edn 2 1 (1975) 194.

Myriophyllum simplicifolium F. Mueller ex Hooker.f., Fl. Tasm. 1 (1856) 122 – nom. illeg.

? Myriophyllum longibracteolatum Schindler, Pflrch 23 (1905) 84–85 [*Typus*: 'Neu-Süd-Wales. Mt Wilson (Gregson in Nat. Herb. of N.S.W. n. 30). – Herb. Berlin'. *Holotypus*: B, probably destroyed. *Isotypi*: J. Gregson, Mt Wilson, boggy holes, -xii.1901, NSW 103217! MEL 62560! MEL 62561!] Maiden & Betche, Proc. Linn. Soc. N.S.W. 31 (1906) 394; Maiden & Betche, Census N.S.W. Pl. (1916) 159.

Description

Two subspecies can be recognized in *M. pedunculatum*, only one of which occurs in New Zealand. They can be distinguished as follows.

1. Mature fruits strongly verrucose; stigmas of female flowers dark red. [Tas., Vic., N.S.W. and P.N.G.] ..... subsp. *pedunculatum*
1. Mature fruits smooth or only very weakly striate; stigmas of female flowers white to pale pink [N.Z., Chatham Is.] ..... subsp. *novae-zelandiae*

5a. ***Myriophyllum pedunculatum*** Hook.f. subsp. ***novae-zelandiae*** Orchard, subsp. nov.

Planta valde similaris subsp. *pedunculato*, sed in fructu laevi et stigmatibus albis ad roseola differt. *Typus*: *T. F. Cheeseman s.n.*, pools near the base of Ngauruhoe, 4000 ft, -.i.1907, AK 5957.

Perennial mat-forming herb, aquatic to terrestrial, stems green, erect or prostrate, 2–10(–15) cm long, rooting at lower nodes, usually ± unbranched apart from rhizomatous portions at base.

Leaves all entire, linear, 2–6 mm long, 0.5 mm wide, decussate, tip blunt to acute, sometimes almost acuminate, usually with a ± well defined midrib. Hydathodes 0–2.

Inflorescence a terminal spike with the flowers borne singly in axils of the upper leaves which are indistinguishable from the other leaves. Each flower subtended by 2 bracteoles which are deltoid, 0·6–0·7(–1·3) mm long, 0·2–0·3 mm wide, acuminate. Flowers unisexual, males and females often borne on separate stems, but if together, then males borne in upper axils, females below.

Male flowers 4-merous, sessile or on pedicel up to 1 cm long. Sepals 4, (ob)lanceolate to narrowly (ob)ovate, 0·9–1·4 mm long, 0·3–0·5 mm wide, acute or obtuse, sometimes shortly mucronate, margins entire or minutely denticulate, Petals 4, red, hooded, weakly keeled, 1·3–1·7(–2·5) mm long, 0·8 mm wide, reflexed at anthesis. Stamens 8; filaments short, lengthening to 2·5 mm at anthesis; anthers linear-oblong, 0·9–1·1(–1·6) mm long, 0·4 mm wide, 4-locular, shortly apiculate. Styles and ovary 0.

Female flowers 4-merous, on pedicel 0·2–0·5(–1·0) mm long. Sepals 4, deltoid, 0·2 mm long, 0·2 mm wide. Petals 0. Stamens 0. Styles 4, alternating with sepals, 0·4 mm long, stigmas fimbriate, white, sometimes grading to pale pink. Ovary obpyriform, 0·6 mm long, 0·5 mm wide, channelled opposite sepals, 4-locular.

Fruit sessile or shortly pedunculate, red-purple, ovoid to obpyriform, 1·0–1·5

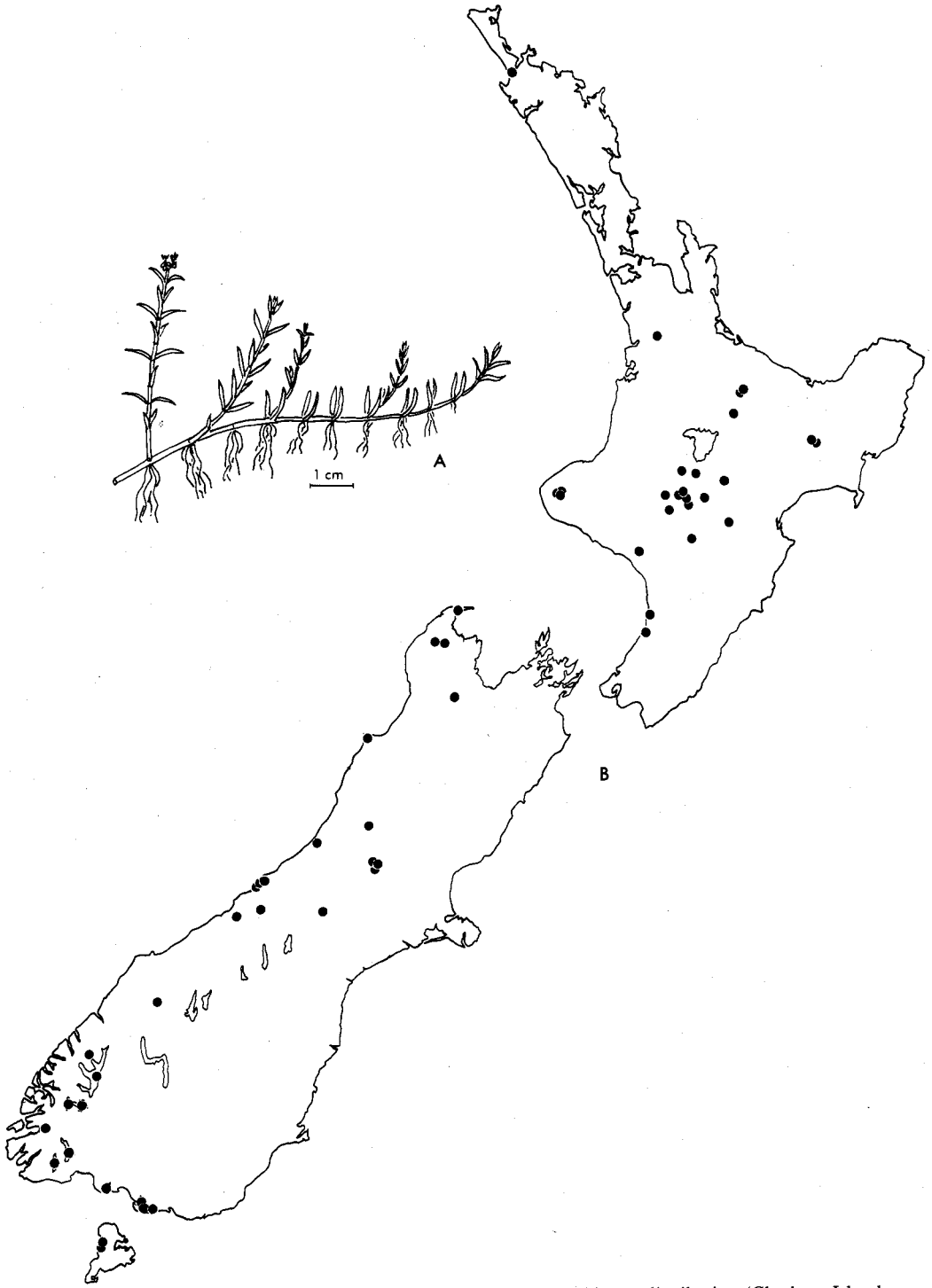

Fig. 9. *Myriophyllum pedunculatum* subsp. *novae-zelandiae*. *A*, habit. *B*, distribution (Chatham Islands not shown). (*A, Orchard 4928*, AK).

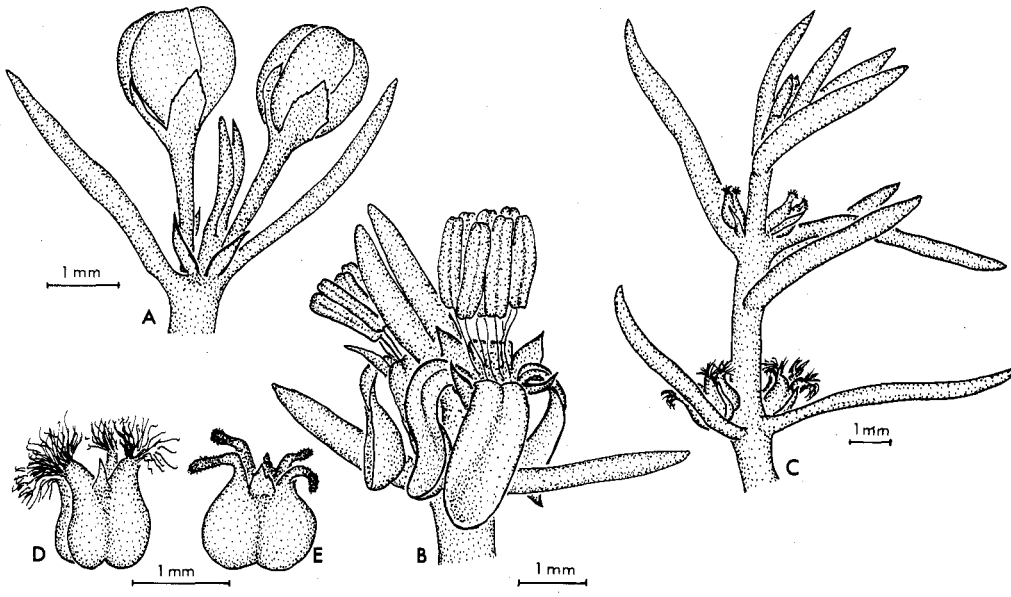

Fig. 10 *Myriophyllum pedunculatum* subsp. *novae-zelandiae*. *A*, tip of inflorescence showing pedicellate male flowers just before anthesis. *B*, the same, at anthesis. *C*, tip of inflorescence bearing female flowers. *D*, female flower. *E*, fruit. (*A*, *Mason s.n.*, CHR 70341; *B–D*, *Orchard 4928*, AK; *E*, *Healy 55/67*, CHR).

mm long, 1·1–1·2 mm wide, deeply channelled opposite sepals, smooth to weakly striated, not verrucose; sepals usually persistent, membranous, 0·2 by 0·2 mm; styles persistent, becoming reflexed. Fruit splitting at maturity into 4 single-seeded mericarps. Mericarps ± globular with attenuate neck formed from persistent style. (Figs 9 and 10).

Distribution

Myriophyllum pedunculatum extends from New Zealand to Tasmania, Victoria, New South Wales and the highlands of Papua New Guinea. Subspecies *novae-zelandiae* is confined to New Zealand, where it is found in the North Island (throughout, but rare except on the volcanic plateau and Mt Egmont), South Island (on the Alps, and on the west and south coasts), Stewart Island (west coast) and the Chatham Islands.

Ecology

This plant is usually found in boggy conditions in open situations from sea level to 1500 m altitude, either completely emergent or in only a few centimetres of water. Collectors' note include 'forming a dense carpet in the very wettest portion of the *Gleichenia* plant formation' (*Cockayne 5672*); 'forming a dense carpet on certain parts of *Sphagnum* bog' (*Cockayne 5762*); 'common creeping delicate herb along edge of tarn' (*Mark s.n.*, OTA 22172); 'completely submerged' (*Mason & Moar 265*); 'boggy area in manuka, flowers sweetly scented' (*Simpson s.n.*, CHR

167698–9). The distribution of the unisexual flowers ranges from monoecious, with both male and female in the same spike, through monoecious with male and female in separate spikes on the same plant, to fully dioecious. Flowering takes place from about (October–) December to March (–April), and fruiting from January to May.

Specimens Examined

NORTH ISLAND: *Anon. s.n.*, Kaimaniwas (WELT).– *Anon. s.n.*, Waimarino Forest, 14.xii.1927 (WELT).– *Beaton s.n.*, Clay Patch, Lake Waikareiti, 21.i.1978 (Waikato Univ. Herb.).– *Burstall s.n.*, Lake Rotopounamu, ix.1966 (CHR).– *Carse s.n.*, Lake Ngatu, Waipapakauri, 1878 (CHR).– *Carse s.n.*, Waimarino Plain, i.1921 (WELT).– *Carse s.n.*, Erua, 3.i.1921 (CHR).– *Cheeseman s.n.*, Lake Waihi, 1884, (AK, 2 sheets, CHR).– *Cheeseman s.n.*, base of Ngauruhoe, i.1907 (AK).– *Cheeseman s.n.*, camping ground, base of Ngauruhoe, i.1907 (AK).– *Cook s.n.*, Mt Ruapehu near Blyth Hut (CHR).– *Cooper, Mason & Moar s.n.*, Lake Ngatu, 29.xi.1949 (AK).– *Druce s.n.*, Makirikiri, NW. Ruahines, 4.i.1948, xii.1973 (CHR).– *Druce s.n.*, Holly Flat, Mt Egmont, 11.xii.1948 (CHR).– *Druce s.n.*, between Egmont and Pouakai Range, i.1960, 3.ii.1962 (CHR).– *Druce s.n.*, NNE. of Waikareiti, ii.1968 (CHR).– *Druce s.n.*, Hikurangi Range, ii.1968 (CHR).– *Druce s.n.*, Mangaturuturu Valley, Ruapehu, iv.1972 (CHR).– *Druce s.n.*, Moawhango River, Kaimanawa Mts, i.1973 (CHR, 2 sheets).– *Druce s.n.*, Mt Tihia, SW. of Lake Taupo, iv.1974 (CHR).– *Duguid s.n.*, mouth of Ohau River, 24.x.1950 (CHR, MEL).– *Harris s.n.*, Ngamatea Swamp, Rangitikei, 12.i.1949 (CHR).– *Hodgkins s.n.*, Lake Tama, National Park, 31.xii.1931 (AK).– *Hynes s.n.*, between Ruapehu and Hauhangatahi, i.1952 (AK).– *Kirk s.n.*, Rotokakahi (WELT).– *Kirk s.n.*, Lake Tikitapu, ii.1872 (AK, WELT).– *Lush s.n.*, Ohau River, 20.iii.1949 (WELT).– *Mason 2486*, Moawhango River, 4.iv.1953 (CHR).– *Mason & Moar 265*, Lake Ngatu, 29.xi.1949 (CHR).– *Matthews & Carse Mla*, Lake Ngatu, xii.1913 (WELT).– *Melville et al. 6781*, Blythe Hut, Ruapehu, 17.iii.1962 (CHR).– *Moore s.n.*, Reporoa Bog, 2.i.1959 (CHR).– *Moore & Cranwell s.n.*, Erua, 10.i.1933 (AK, 4 sheets).– *Morris Jones s.n.*, N. of Lake Waikareiti, xii.1954 (CHR). – *Ogle s.n.*, N. of Waikune prison farm, 13.xii.1962 (CHR).– *Oliver s.n.*, Whakapapaiti Stream, Mt Ruapehu, 23.i.1954 (WELT).– *Wilcox 189*, Pureora, ii.1960 (NZFRI).– *Wood s.n.*, Ruapani, 2.i.1969 (AK).– *Zotov s.n.*, Himatangi, 10.iii.1931 (CHR).– *Zotov s.n.*, Reporoa bog, 31.xii.1943 (CHR).

SOUTH ISLAND: *Allan s.n.*, Bluff Hill, 22.i.1946 (CHR).– *Allan s.n.*, Supper Cove, Dusky Sound, 11.ii.1946 (CHR).– *Attwood s.n.*, Mason's Bay, Stewart Island, 15–18.i.1940 (AK).– *Clarke s.n.*, Bell Hill Plains, Grey Co., 1.ii.1969 (CHR).– *Crosby Smith s.n.*, Lake Hauroto, iii.1910 (WELT).– *Druce s.n.*, Gouland Downs, i.1973 (CHR).– *Druce s.n.*, Luna Lake i.1974 (CHR).– *Fryer & Wardle s.n.*, Mt Cockayne, Craigieburn Range, 9.i.1968 (CHR).– *Healy 55/67*, Waituna Lagoon, 1.ii.1956 (CHR). – *Johnson s.n.*, Lake Manapouri, 4.xii.1969, 26.i.1970 (OTA, 2 sheets).– *Johnson s.n.*, Billy Burn, Lake Te Anau, 19.v.1971 (OTA).– *Johnson s.n.*, Waituna Lagoon, 10.i.1974 (CHR).– *Johnson s.n.*, Lake Hauroko, 24.x.1974 (CHR).– *Johnson s.n.*, head of Lake Hankinson, 14.xi.1974 (CHR).– *Kirk s.n.*, Lake Pearson (BRI, OTA).– *Kirk s.n.*, The Bluff (WELT).– *Kirk s.n.*, Lake Grassmere, i.1876 (WELT).– *Kirk s.n.*, near Woodend, 28.xi.1883 (WELT).– *Leask s.n.*, Mason Plain, Stewart Island, 21.i.1962 (WELT). – *Mackay s.n.*, Okarito, v.1931 (CHR).– *Mark s.n.*, Park Pass, Mt Aspiring Nat. Park, 19.ii.1968 (OTA).– *Mason & Chapman 12314*, NW. of Colac, 17.ii.1973 (CHR).– *Mason & Moar 1202, 1204*, Awarua Bay, 21.ii.1952 (CHR).– *Mason & Moar 1649, 1677*, Carter's Beach road, Buller Co., 24.i.1953 (CHR).– *Mason & Moar 5439*, near Jacobs River, 19.ii.1958 (CHR).– *Mason & Moar 5583*, Okarito Lagoon, 25.ii.1958 (CHR).– *McQueen s.n.*, Lake Poteriteri, i.1949 (WELT).– *Moore s.n.*, Bluff Hill, 4.i.1940 (CHR).– *Moore s.n.*, Mt Potts, 28.xii.1960 (CHR).– *Murdoch s.n.*, Mason Bay, Stewart Island, 1870, 1910–11 (CHR, WELT).– *Oliver s.n.*, Farewell Spit, 19.xii.1946 (WELT).– *Petrie s.n.*, Bluff (CHR, WELT).– *Rattenbury 708*, Boulder Lake, 8.ii.1955 (AK).– *Simpson s.n., 4793*, Farewell Spit, 27.x.1965 (CHR, 3 sheets).– *Talbot s.n.*, Gouland Downs, i.1954 (CHR).– *Thomson s.n.*, Bluff Hill, i.1880 (BRI).– *Veitch s.n.*, Awatuna Lagoon, iii.1968 (CHR).– *Wardle s.n.*, northern end of Okarito Lagoon, 26.ii.1970 (CHR).– *Wardle & Fletcher s.n.*, Five-mile, S. of Okarito, 29.xi.1972 (CHR).– *Wardle & Fryer s.n.*, northern end of Okarito Lagoon, 7.xi.1968 (CHR).– *Willa s.n.*, Mason Bay, Stewart Island, 21.i.1962, 25.ii.1962 (CHR).– *Wilson 2528*, Upper Sebastopol Terrace, Mt Cook Natl Park, 18.ii.1972 (CHR).– *Wright 2498*, Farewell Spit, 25.v.1977 (AK).

CHATHAM ISLANDS: *Anon 62*, Chatham Islands (MEL).- *Bell s.n.*, South East Island, Chatham Islands, xii. 1961 (CHR).- *Cockayne s.n., 5672, 5762*, Whangamarino Run, i.1901 (AK, WELT, 2 sheets). - *Findlay s.n.*, Kaiara, 20.i.1955 (CHR).- *Martin s.n.*, Chatham Island, i.1924 (CHR, WELT).- *Moar 1567*, above Te Awamanga River, 6.xi.1959 (CHR).- *Oliver s.n.*, Chatham Island, 9.xii.1909 (WELT). - *Travers s.n.*, Chatham Island (WELT).

Comments

In his original description, Hooker gave only '[Tasmania]. Margins of rivers and pools, abundant' as the source of his specimens. Later (1856) he cited *Gunn 1959, 2020* and *Mueller*, mountains of south-eastern Australia; elevation 6000 feet, as collectors of material that he had examined. In Kew herbarium (Herbarium Hookerianum) there is a sheet bearing 3 separate Gunn collections, plus a number of pencil sketches that clearly served as the basis for Plate XXIII B in Hooker's *Flora Tasmaniae* (1856). The Gunn collections are labelled, respectively, [Gunn] 1959, Arthurs Lake, 17.i.1845; [Gunn] 2020, Margin of Derwent – under water, 15.ii.1840; [Gunn] 2020, Pine River, Marlboro', 5.i.1841. It is not possible to say with certainty now which of the various plants mounted on the sheet belongs with particular labels. Two of the clumps of '*M. pedunculatum*' consist, 1 wholly, 1 in part, of a *Crassula* species, probably *Crassula helmsii*. There is also a small piece of *Myriophyllum amphibium*. With these exceptions, plus an admixture of a small sedge, the material on the sheet is monospecific, and clearly the plant described by Hooker as *M. pedunculatum*. Although, because of the mixed nature of the collections, a lectotype should be chosen, I feel that it would achieve little as none of the plants can be surely assigned to a particular label, and several were used by Hooker in drawing up his description (1847, 1856) and illustrations (1856). If a lectotype were needed, then the largest, and only fruiting specimen, that mounted on the bottom right hand corner of the sheet, would be best, but it is admixed with *Crassula* and a small sedge.

Hooker (1856) recognized two forms of *M. pedunculatum* to which he gave the designations 'Var α' and 'Var β', but no formal names. These 'varieties' differed in the shapes of their leaves and in whether or not the flowers were pedicellate or sessile. Although these taxa were based on Tasmanian specimens, they can be matched by parallel forms in the New Zealand flora, which seem to represent little more than adaptations to local growing conditions. In New Zealand plants, those found in marginal situations, such as drying mud etc., have the male flowers sessile, and the petals and stamens reduced in size. In more optimal situations where the plants are forming dense mats, the male flowers are distinctly pedicellate.

The name *M. simplicifolium* F. Muell. ex Hook.f. is illegitimate. It is a manuscript name applied to a number of sheets of Gunn collections by Mueller, and published as a synonym of *M. pedunculatum* by Hooker (1856).

In describing *M. votschii*, Schindler (1905) seems to have implied that all specimens collected and cited from the mainland of New Zealand (i.e. excluding the Chatham Islands) under the name *M. pedunculatum* up until that time, were to be placed in his new species. Cheeseman (1925) followed him in this. While the descriptions of *M. pedunculatum* given by Hooker (1867), Kirk (1899) and

Cheeseman (1906) and the specimens they cited may be referable to *M. votschii* in part, in the main the material they were describing was true *M. pedunculatum* (subsp. *novae-zelandiae*). Moore (1961) corrected this misapprehension.

Plants of *M. pedunculatum* subsp. *novae-zelandiae* from the Chatham Islands are in general much more robust than those from the New Zealand mainland, but agree with them very well in flower and fruit characters.

Relationships

The affinities of *M. pedunculatum* almost certainly lie with various Australian species, a number of which also have all of their leaves entire, and flowers and fruits very similar in shape and size to those of this plant. *M. amphibium* is particularly closely allied, and some of the alternate-leaved species such as *M. tillaeoides* and *M. drummondii* can probably also be counted amongst the allies of *M. pedunculatum*.

The status of *M. longibracteolatum* Schindler still needs investigation. Meijden (1969), Meijden & Caspers (1971) and Aston (1973) all placed it in synonymy under *M. pedunculatum*. Although, as these authors suggested, *M. longibracteolatum* may be just a deep water form of *M. pedunculatum*, it seems to warrant further study, as *M. pedunculatum* in deeper water in other localities does not assume such an attenuated, filiform appearance.

Similar comments apply to the trifid-leaved form of *M. pedunculatum* mentioned by the same authors. It seems to be very limited in its occurrence, and could well represent a distinct entity.

Within New Zealand, *M. pedunculatum* subsp. *novae-zelandiae* can be confused only with depauperate forms of *M. propinquum* or with *M. votschii*. To distinguish *M. pedunculatum* from *M. propinquum*, see under the latter. *M. pedunculatum* is easily distinguished from *M. votschii* by the presence of sepals on the flowers and fruits, by the shape of the fruit and by the shape of the leaves, which are linear in *M. pedunculatum* and (usually) obovoid to spathulate in *M. votschii*.

6. ***Myriophyllum votschii*** Schindler, Pflrch 23 (1905) 85 [Typus: 'Neu-Seeland: Nord Insel, nahe Auckland (Hooker f.), nahe Manukau-Hafen (Cheeseman n. 1721); Omatangi, Taupo (Berggren); Lyall's Bay (Hector).– Herb. Barb.– Boiss., Berlin, Deless., Petersb.' *Lectotypus*: none chosen – see below under 'Comments'. *Isosyntypi*: *Cheeseman s.n.*, N. of Manakau Heads on sandy coast, WELT 45009 p.p.!; *Cheeseman s.n.*, North Manakau Heads, –.xii.1882, AK 5967!; *Cheeseman s.n.*, Manakau Heads on wet sand, –.xii.1884, AK 5968 (2 sheets)!; *Cheeseman s.n.*, North Manakau Heads, –.xii.1884, AK 5969!] Cheeseman, Man. N.Z. Fl. edn 2 (1925) 625–6 p.p.; Moore in Allan, Fl. N.Z. 1(1961) 252; Praglowski, Grana 10 (1970) 206.

Description

Dioecious perennial terrestrial herb, stems prostrate (rarely erect, forming tight cushions to 7 cm high), branching freely, rooting at nodes, forming clumps to 10 cm in diameter, glabrous. Leaves all opposite, entire, obovoid, 1·8–3·5 mm long, (0·5–)0·7–1·1 mm wide, ± planar or slightly concave on upper surface,

convex below, spreading or slightly upward-curving, glabrous. Hydathodes absent. Rarely, in inundated plants, submerged leaves are formed, which are linear, 2 mm long, 0·2 mm wide.

Inflorescence a terminal spike with the unisexual flowers borne in the axils of opposite upper leaves indistinguishable from lower (sterile) leaves. Male and female flowers apparently borne on separate plants. Bracteoles linear, 0·5–0·7 mm long, 0·1–0·2 mm wide. Hydathodes 0.

Male flowers 4-merous, sessile, usually in axils of the uppermost pair of leaves only. Sepals 0. Petals 4, green at first, becoming white with a dark reddish spot at tip (rarely, completely dark red), hooded, non-unguiculate, 1·5–1·8 mm long, 0·7–1·0 mm wide, reflexed at anthesis. Stamens 8; filaments 0·2–0·3 mm long, elongating to 0·8–1·0 mm at anthesis; anthers yellow, oblong, 1·2–1·3 mm long, 0·4 mm wide, 4-celled, nonapiculate or very weakly apiculate. Styles 0. Ovary vestigial.

Female flowers 4-merous, sessile, in axils of upper 4–8 pairs of leaves. Sepals, petals and stamens 0. Styles 4, ± sessile, stigmas white, fimbriate, capitate. Ovary green, shortly cylindrical, 0·8 mm long, 0·6–0·8 mm wide, longitudinally channelled between styles, rounded opposite styles, otherwise smooth.

Fruit black, depressed-globular, 0·9–1·0 mm long, 1·1–1·4 mm diameter, suture between mericarps buff coloured; mericarps separating at maturity. Mericarps planar on inner faces, outer face convex, smooth or very weakly punctate, sometimes with a faint median longitudinal ridge. (Figs 11 and 12)

Distribution

Endemic to New Zealand, where it is found in the North Island (mainly west coast and Lake Taupo), South Island (nowhere common, but at isolated locations on west coast and shores of several larger lakes), and Chatham Island. Moore (1961) recorded *M. votschii* also from Stewart Island, but I have seen no specimens to confirm this.

Ecology

M. votschii is confined to open situations, usually on damp sand subject to fresh water seepage. Collectors' notes include 'running fresh water, on sand' (*Druce s.n.*, CHR 82459); 'littoral community, scattered through *Eleocharis acuta* sward' (*Macmillan & Chapman s.n.*, CHR 217788); 'damp sand subject to inundation' (*Mason & Chapman 12695*); 'prostrate clumps to 10 cm diam. in damp black sand' (*Orchard 4116*) and 'on otherwise bare sand flats in interdune hollows' (*Simpson 4588*). *M. votschii* seems to be mainly a plant of coastal sands but, at Lake Taupo and in the South Island, it is known from inland localities, and from altitudes of up to 450 m. Flowering takes place from November to February (–April), fruiting from January to March (–May).

Specimens Examined

NORTH ISLAND: *Anon. s.n.*, Wainuiomata (WELT).– *Carse s.n.*, Tanu Tanu,Tauroa, i.1908 (CHR, WELT).– *Carse s.n.*, Waihi, Mangonui Co., i.1913 (WELT).– *Carse s.n.*, Lake Rotokawa, Puheke, i.1915 (WELT).– *Carse s.n.*, Tanu Tanu Creek, i.1917 (CHR).– *Carse s.n.*, Whatipu, iv.1924

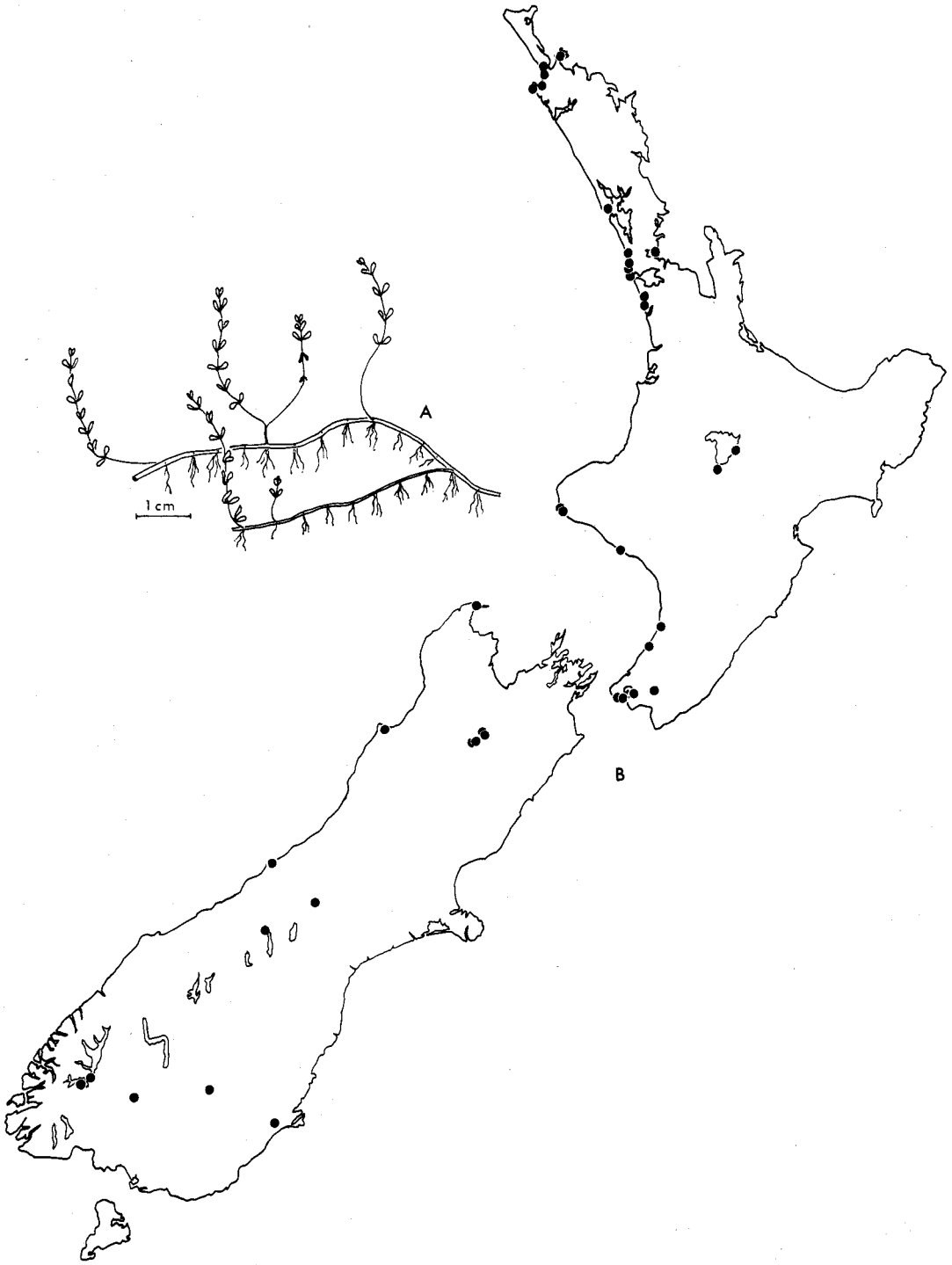

Fig. 11 *Myriophyllum votschii*. *A*, habit of part of plant, disentangled from dense cushion. *B*, distribution (Chatham Islands not shown). (*A, Wright 1680*, AK).

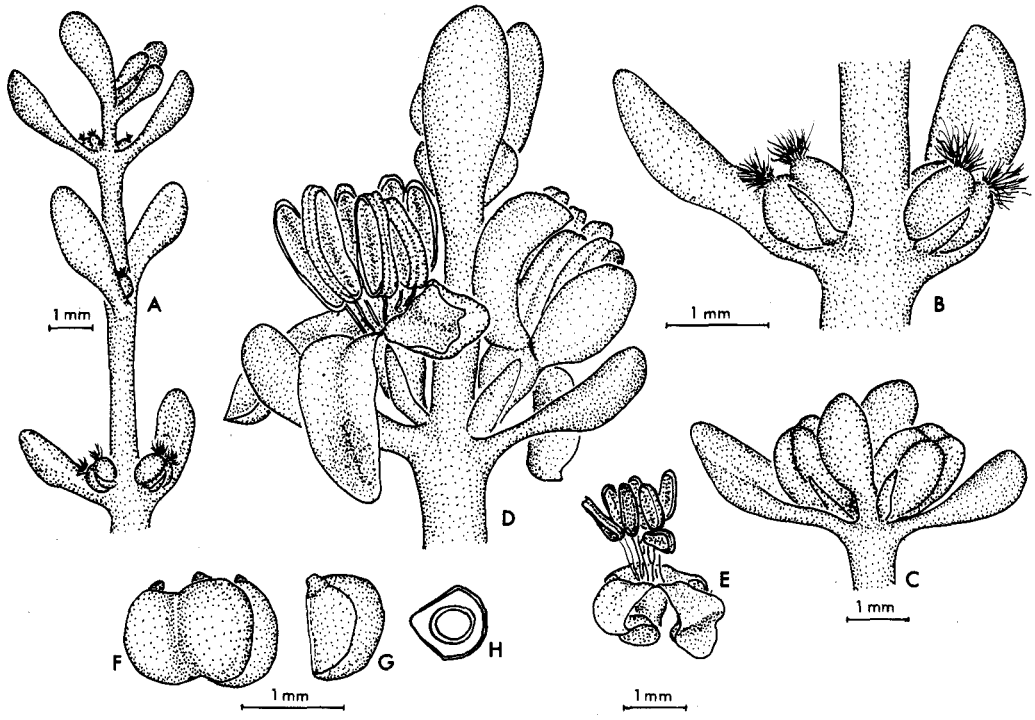

Fig. 12. *Myriophyllum votschii*. *A*, inflorescence of female flowers. *B*, details of female flowers in axils of leaves. *C*, tip of inflorescence with young male flowers. *D*, the same, flowers at anthesis. *E*, male flower. *F*, fruit. *G*, mericarp. *H*, transverse section of mericarp. (*A–E, Wright 1680*, AK; *F–H, Orchard 4116*, AK).

(CHR).- *Cheeseman s.n.*, near Reef Point (WELT).- *Cheeseman s.n.*, Waitakerei River, xii.1870 (AK).- *Cheeseman s.n.*, Lake Pupuke, i.1873 (WELT).- *Cheeseman s.n.*, Lake Takapuna, xii.1873 (AK).- *Cheeseman s.n.*, Manakau Heads, xii.1882, xii.1884 (AK, 4 sheets, WELT).- *Cheeseman s.n.*, Ahipara, i.1896 (AK).- *Cheeseman s.n.*, N. of Muriwai, i.1908 (AK).- *Cooper s.n.*, Lake Waipareira, 17.i.1967 (AK).- *Cooper, Mason & Moar s.n.*, top of Ahipara Hill, 28.xi.1949 (AK).- *Druce s.n.*, Bethells, iv.1943 (CHR).- *Druce s.n.*, near Lower Kahui Rd., Egmont coast, v.1964 (CHR).- *Druce s.n.*, Hallett's Bay, Lake Taupo, 4.iii.1970 (CHR).- *Druce s.n.*, Manihi Rd., Egmont coast, x.1972 (CHR).- *Kirk s.n.*, Lyall's Bay, Wellington (MEL, WELT).- *Kirk s.n.*, Miramar (CHR, OTA).- *Large s.n.*, W. of Waiuku (WELT).- *Lush s.n.*, dunes near Hokio, 10.xii.1949 (WELT).- *Mason 562*, Lake Wairarapa, 8.ii.1970 (AD, CHR).- *Mason 4008, 4016*, S. of Waikawa River mouth, 5.i.1956 (CHR).- *Mason 4343*, S. of Waitotara, 16.i.1956 (CHR).- *Mason & Moar 227*, Ahipara Gumland Road, 28.xi.1949 (CHR, 2 sheets, MEL).- *Mason & Moar 297*, Karikari Bay, 30.xi.1949 (CHR).- *Matthews s.n.*, beach beyond Reef Point, Ahipara, i.1915 (AK).- *Matthews & Carse s.n.*, Tauroa, i.1901 (AK, CHR).- *Matthews & Carse s.n.*, mouth of Tanu Tanu Creek, Tauroa, i.1915 (WELT).- *Matthews & Carse s.n.*, Waimimika Lagoon near Ahipara, i.1915 (WELT).- *Melville 5319*, Lake Waiparera, 11.xi.1961 (CHR).- *Moar 588*, Lake Kanono, Pouto, 9.ii.1950 (CHR).- *Oliver s.n.*, Pouto Point, 11.x.1928 (WELT).- *Orchard 4116*, Whatipu Beach, 1.ii.1974 (AK).- *Orchard 4889*, Hallett's Bay, Lake Taupo, 18.ii.1977 (AK).- *Orchard 4895*, western shore of Lake Wairarapa, 20.ii.1977 (AK, HO).- *Orchard 5003*, Muriwai Beach, 11.ii.1978 (AK, HO).- *Petrie s.n.*, Maioro near Waiuku, x.1896 (AK).- *Petrie s.n.*, coastal lagoons near Waiuku, 20.ii.1897 (WELT, 2 sheets).- *Petrie s.n.*, Kare Kare, 28.xi.1914 (WELT, 2 sheets).- *Petrie s.n.*, Tokaanu, Lake Taupo, ii.1924 (CHR).- *Powell s.n.*, Lake Waiparera, 31.i.1950 (CHR).- *Wright 1680*, Bethell's Beach, 26.i.1977 (AK).

SOUTH ISLAND: *Johnson s.n.*, Supply Bay, Lake Manapouri, xii.1973 (CHR, 2 sheets).- *Johnson s.n.*, Waiau Valley, Rainbow Reach, 7.i.1974 (CHR).- *Macmillan & Chapman s.n.*, Lake Pukaki,

20.xii.1970 (CHR).- *Mason 4410*, Lake Clearwater, 26.iii.1956 (CHR).- *Mason & Chapman 12695*, Oreti River Bridge at Mossburn, 23.ii.1973 (CHR).- *Mason & Moar 934*, Berwick-Henley road, 15.ii.1952 (CHR).- *Mason & Moar 1736*, Buller River bank behind Westport Domain, 25.i.1953 (CHR).- *Mason & Moar 4998, 5002*, Buller River at outlet from Lake Rotoiti, 26.ii.1957 (AD, CHR).- *Moore s.n.*, Lake Manapouri, 28.xii.1972 (CHR).- *Petrie s.n.*, Roxburgh (CHR, WELT).- *Simpson s.n.*, Farewell Spit, 27.x.1965 (CHR).- *Simpson 2542*, D'Urville River, Nelson Lakes Nat. Park, 31.i.1961 (CHR).- *Simpson 2549*, Sabine River, Nelson Lakes Nat. Park, 31.i.1969 (CHR).- *Simpson 4588, 4596, 4644*, Farewell Spit, 20-21.v.1965 (CHR, 3 sheets).- *Townson s.n.*, Westport (AK, 2 sheets, WELT).- *Townson s.n.*, SW. Nelson (WELT).- *Townson 186A*, Buller Valley (AK).- *Townson 747*, Granity Creek near Westport (AK).- *Wardle & Fryer s.n.*, northern end of Okarito Lagoon, 7.xi.1968 (CHR).- *Wright 2457*, Farewell Spit, 25.v.1977 (AK).

CHATHAM ISLANDS: *Anon. s.n.*, Chatham Island (WELT ex herb. Cockayne).

Comments

Schindler (1905) based his description of this species on 4 different collections, without specifying a type. As I have not seen Schindler's specimens, it has not been possible to nominate a lectotype, but the Cheeseman specimens listed above are almost certainly isosyntypes. In describing his new species, Schindler mistakenly assumed that all previous records of *M. pedunculatum* from the New Zealand mainland referred to *M. votschii*. He was followed in this by Cheeseman (1925), but not by Moore (1961), who correctly differentiated between the two species.

The leaves of *M. votschii* are basically monomorphic, being ± obovoid (spathulate when dried). Occasionally filiform, linear leaves are formed at the base of the plant, perhaps as a result of inundation. A few collections are known from the South Island in which all leaves are of this linear form. These are nearly all found to be plants from higher altitudes.

Relationships

The closest relative of *M. votschii* would seem to be *M. pygmaeum* of Papua New Guinea. Very similar plants, which may be identical with *M. pygmaeum*, have recently been found in New South Wales and the Australian Capital Territory, but their exact status requires further study. The major differences between *M. votschii* and *M. pygmaeum* are vegetative; the leaves of *M. votschii* are (usually) obovoid, lack a terminal thick mucro, and lack hydathodes, while those of *M. pygmaeum* are linear, have a terminal thick mucro, and hydathodes are present at the base. Among the few specimens of *M. votschii* with linear-subulate leaves, the lack of hydathodes and terminal thickenings of the leaves serve to keep them distinct from *M. pygmaeum*. *M. votschii* and *M. pygmaeum* also differ slightly in size and shape of flowers and bracteoles, and in *M. votschii* the male flowers are sessile, while in *M. pygmaeum* they are stalked.

Despite their similar superficial appearance, *M. votschii* is probably not closely allied to *M. pedunculatum* (see Meijden & Caspers 1971, p. 252). They are easily distinguished by the absence of sepals in *M. votschii*, the shapes of their fruits, and (usually) the shapes of their leaves.

Synopsis of the Family Haloragaceae in New Zealand

The Haloragaceae of New Zealand are a heterogeneous assortment of species, and nearly all have their affinities with species overseas (mainly in Australia) rather

than with each other. For this reason, the few New Zealand species of *Haloragis* and *Gonocarpus* were scattered throughout the revision of those genera (Orchard 1975) and were consequently difficult to locate. In the synopsis below, these species are listed with their synonymies, and simplified keys, applicable to the New Zealand taxa only, are provided.

Key to the genera of Haloragaceae in New Zealand

1. Fruits indehiscent; terrestrial plants, ± woody at least in the lower parts of stems.
   2. Flowers in groups of (1–)3–5 in axils of the upper leaves; fruits 4-locular; leaves usually greater than 1·5 cm long..... I. *Haloragis*
   2. Flowers strictly 1 per leaf axil; fruits (apparently) 1-locular; leaves usually less than 1·5 cm long. .....II. *Gonocarpus*
1. Fruits splitting at maturity into four 1-seeded mericarps; aquatic or subaquatic plants, never woody ..... III. *Myriophyllum*

I. *Haloragis*

Key to the species of *Haloragis* in New Zealand

1. Robust perennial herbs with simple taproot, stems sometimes rooting in lower parts; hairs minute, not hooked, or plants glabrous; fruits 4-angled, often with wings on angles ..... 1. *H. erecta*
   2. Leaves broadly lanceolate to ovate, (1·5–)2·5–4·5(–9·0) cm long, (0·5–)1·0–3·5 cm wide, thin, upper surface dark green, lower surface paler, margin 20–30(–45)-toothed, petiole (0·5–) 0·8–1·7(–3·0) cm long .....subsp. *erecta*
   2. Leaves orbicular to broadly ovate, 1·5–2·2 cm long, 1·0–1·5 cm wide, thick, both surfaces grey-green, upper surface drying shiny and cartilaginous, margin 10–15-toothed, petiole 0·2–0·4 cm long. ..... subsp. *cartilaginea*
1. Slender perennial herbs with deep stoloniferous rootstock; hairs hooked at tip; fruit 4-angled but never winged [Adventive] .....2. *H. aspera*

1a. ***Haloragis erecta*** (Banks ex Murr.) Oken subsp. ***erecta***
Cercodia erecta Banks ex Murr. (1780).– *Tetragonia ivaefolia* L.f. (1781).– *Haloragis ivaefolia* (L.f.) Salisbury (1796).– *Haloragis alata* Jacq. (1781–2).– *Haloragis tetragonia* L'Hérit. (1788).– *Haloragis cercodia* Dryand. (1789).– *Cercodia alternifolia* A. Cunn. (1839).– *Haloragis alternifolia* (A. Cunn.) Walp. (1842).– *Haloragis colensoi* Skottsb. (1922).

1b. ***Haloragis erecta*** (Banks ex Murr.) Oken subsp. ***cartilaginea*** (Cheeseman) Orchard
Haloragis cartilaginea Cheeseman (1897).– *Haloragis alata* Jacq. var. *cartilaginea* (Cheeseman) Cheeseman (1906).

2. ***Haloragis aspera*** Lindl.
Haloragis pinnatifida A. Gray (1854).– *Haloragis heterophylla* Brongn. var. *capreolicornis* Schindl. (1905).– *Haloragis heterophylla* Brongn. var. *glaucifolia* Schindl. (1905).– *Haloragis heterophylla* Brongn. var. *aspera* (Lindl.) Schindl. (1905).– *Haloragis heterophylla* Brongn. var. *rigida* Schindl. (1905).– *Haloragis heterophylla* Brongn. var. *pinnatifida* (A. Gray) Maid. & Betche (1916).

II. *Gonocarpus*

Key to the species of *Gonocarpus* in New Zealand

1. Stamens 4 (plus 4 staminodes); relatively large plants to 30 cm tall; fruits longer than 1·2 mm (excl. sepals) and cartilaginous
   2. Primary bracts opposite, at least in lower parts of inflorescence; fruit glabrous, ± unornamented apart from longitudinal ribs ..... 1. *G. montanus*
   2. Primary bracts all alternate; fruits scabrous, with 2–3 oblique calluses between ribs 3. *G. incanus*
1. Stamens 8; relatively small plants to 10 cm tall (rarely, up to 25 cm in *G. aggregatus*); fruits either less than 1 mm long, or if more than 1·2 mm long, then pericarp swollen
   3. Primary bracts decussate; fruit 1·5–2·0 mm long, pericarp swollen..... 2. *G. aggregatus*
   3. Primary bracts alternate; fruits 0·7–0·9 mm long, pericarp cartilaginous.....
   .....4. *G. micranthus* subsp. *micranthus*

1. ***Gonocarpus montanus*** (Hook.f.) Orchard
   Haloragis montana Hook.f. (1847).- *Haloragis depressa* (A. Cunn.) Walp. var. *montana* (Hook.f.) Hook.f. (1856).- *Haloragis tetragyna* (Labill.) Hook.f. var *diffusa* Hook.f. (1852).- *Haloragis aggregata* Buchan. var. *diffusa* (Hook.f.) Schindl. (1905).- *Haloragis diffusa* (Hook.f.) Cockayne (1909) (non *H. diffusa* Diels).- *Haloragis procumbens* Cheeseman (1909).
2. ***Gonocarpus aggregatus*** (Buchan.) Orchard
   Haloragis aggregata Buchan. (1872).- *Haloragis uniflora* Kirk (1877).- *Haloragis spicata* Petrie (1887).- *Haloragis bibracteolata* Col. (1890).- *Haloragis depressa* (A. Cunn.) Walp. var. *aggregata* (Buchan.) Kirk (1899).- *Haloragis uniflora* Kirk var. *genuina* Schindl. (1905), et var. *bibracteolata* (Col.) Schindl. (1905), et var. *spicata* (Petrie) Schindl. (1905).- *Haloragis depressa* (A. Cunn.) Walp. var. *spicata* (Petrie) Cheeseman (1925).
3. ***Gonocarpus incanus*** (A. Cunn.) Orchard
   Cercodia incana A. Cunn. (1839).- *Haloragis incana* (A. Cunn.) Walp. (1843).- *Haloragis tetragyna* (Labill.) Hook.f. var. *incana* (A. Cunn.) Kirk (1899).- *Haloragis aggregata* Buchan. var. *incana* (A. Cunn.) Schindl. (1905).
4. ***Gonocarpus micranthus*** Thunb. subsp. ***micranthus***
   Haloragis tenella Brongn. (1827-34).- *Haloragis micrantha* (Thunb.) R. Br. ex Sieb. & Zucc. (1835).- *Goniocarpus depressus* A. Cunn. (1839).- *Goniocarpus citriodorus* A. Cunn. (1839).- *Haloragis citriodora* (A. Cunn.) Walp. (1843).- *Haloragis depressa* (A. Cunn.) Walp. (1843).- *Goniocarpus rotundifolius* F. Muell. ex Hook.f. (1856).- *Haloragis minima* Col. (1885-86).

III. *Myriophyllum*

Key to the species of *Myriophyllum* in New Zealand See p. 249

1. ***Myriophyllum aquaticum*** (Vellozo) Verdc.
   Enydria aquatica Vellozo (1825).- *Myriophyllum brasiliense* Cambess. (1830).- *Myriophyllum proserpinacoides* Gillies ex Hook. & Arn. (1833).
2. ***Myriophyllum robustum*** Hook.f.
   Myriophyllum variaefolium Hook.f. var. β Hook.f. (1852).
3. ***Myriophyllum triphyllum*** Orchard
   Myriophyllum elatinoides auct. Novae Zelandiae, non Gaudich.
4. ***Myriophyllum propinquum*** A. Cunn.
   Myriophyllum propinquum A. Cunn. var. *tenuifolium* Schindl. (1905), ? et var. *genuinum* Schindl. (1905) p.p.
5. ***Myriophyllum pedunculatum*** Hook.f. subsp. ***novae-zelandiae*** Orchard
6. ***Myriophyllum votschii*** Schindl.

Genus Exclusus

Gunnera L. = Gunneraceae

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References

Aston, H. I. (1973). 'Aquatic Plants of Australia.' p.79–98. (Melbourne University Press.)

Carauta, J. P. P. (1969). A data efetiva de publicação da 'Flora Fluminensis'. *Velozia* **7**:26–33.

Cheeseman, T. F. (1906). 'Manual of the New Zealand Flora.' pp.150–152. (Government Printer: Wellington.)

Cheeseman, T. F. (1914). 'Illustrations of the New Zealand Flora.' Vol. 1. Pl. 46. (Government Printer: Wellington.)

Cheeseman, T. F. (1925). 'Manual of the New Zealand Flora.' 2 edn, pp. 624–626. (Government Printer: Wellington.)

Clarke, C. B. (1878). Halorageae. In Hooker, J. D., 'Flora of British India'. Vol. 2, pp. 433–434. (Reeve: London.)

Fernald, M. L. (1919). Two new Myriophyllums and a species new to the United States. *Rhodora* **21**:120–124.

Gleason, H. A. (1958). 'The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada.' Vol. 2, p. 600. (Lancaster Press for N.Y. Botanical Garden: New York.)

Hooker, J. D. (1852). 'The Botany of the Antarctic Voyage of H.M. Discovery Ships '*Erebus*' and '*Terror*' in the years 1839–1843. II. Flora Novae-Zelandiae.' Vol. 1, pp. 63–64. (Reeve: London.)

Hooker, J. D. (1856). ibid. 'III. Flora Tasmaniae'. Vol.1, pp. 122–123. (Reeve: London.)

Hooker, J. D. (1867). 'Handbook of the New Zealand Flora.' pp.66–67. (Reeve: London.)

Kirk, T. (1899). 'The Students' Flora of New Zealand.' pp. 149–151. (Government Printer: Wellington.)

Love, A. (1961). Some notes on *Myriophyllum spicatum*. *Rhodora* **63**:139–144.

Meijden, R. v.d. (1969). An annotated key to the south-east Asiatic, Malesian, Mascarene, and African species of *Myriophyllum* (Haloragaceae). *Blumea* **17**:303–311.

Meijden, R. v.d., & Caspers, N. (1971). Haloragaceae. *Flora Malesiana* **7**:239–263.

Moore, L. B. (1961). Haloragaceae, In Allan, H. H., 'Flora of New Zealand'. Vol. 1, pp. 252–254, 1017. (Government Printer: Wellington.)

Orchard, A. E. (1975). Taxonomic revisions in the family Haloragaceae. I. The genera *Haloragis, Haloragodendron, Glischrocaryon, Meziella* and *Gonocarpus*. *Bull. Auckland Inst. Mus.* **10**:1–299.

Orchard, A. E. (1977). Taxonomic revisions in the family Haloragaceae. II. Further notes on *Haloragis, Haloragodendron* and *Gonocarpus*. *Nuytsia* **2**:126–144.

Schindler, A. K. (1905). Halorrhagaceae. In Engler, H. G. A., 'Das Pflanzenreich'. Heft 23, pp. 77–105. (Engelmann: Leipzig.)

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Numerals in **bold** type represent main entries of accepted names. Numerals in *italics* represent main entries of synonyms. Numerals in roman type give pages on which discussion may be found.

Names in **bold** type are new taxa described in this account. Names in *italics* are synonyms.