

## Review of the genus *Monotheca* (Hydrozoa: Leptolida) from Australia with description of a new species and a note on *Monothecella* Stechow, 1923

JEANETTE E. WATSON

Honorary Research Associate, Marine Biology Section, Museum Victoria GPO Box 666, Melbourne 3001, Victoria, Australia (hydroid@bigpond.com)

### Abstract

Watson, J.E. 2011. Review of the genus *Monotheca* (Hydrozoa: Leptolida) from Australia with description of a new species and a note on *Monothecella* Stechow, 1923. *Memoirs of Museum Victoria* 68: 71–91.

*Monotheca* Nutting, 1900 is a genus with few known species worldwide. It is an artificial genus, as some species of the Plumulariidae sometimes have one or two hydrocladial hydrothecae and are thus borderline between *Monotheca* and *Plumularia*. This review considers only Australian species with consistently monothecate hydrocladia; species with more than one hydrotheca on the hydrocladium are considered to belong to *Plumularia*. Ten species referable to *Monotheca* are reported from southeast Australia; three are synonymised here in other species, four are presently known to be endemic to Australia and one species, *Monotheca amphibola*, is described as new. The gonosome of *Monotheca togata* is described for the first time. *Monothecella* is synonymised in *Monotheca*. A key to the Australian species of *Monotheca* is given.

### Keywords

*Monotheca*, artificial genus, eight Australian species, key to species; *Monothecella* synonymised.

### Introduction

*Monotheca* Nutting, 1900 (type species *Monotheca margareta* Nutting, 1900) is an artificial genus; Vervoort and Watson (2003) list 10 species and Bouillon et al. (2006) list eight species worldwide. Other authors, such as Millard (1975) and Hirohito (1995), synonymised *Monotheca* in *Plumularia*. In their phylogeny, Leclère et al. (2007) demonstrated that *Monotheca* with monohydrothecate hydrocladia (*M. pulchella*, *M. margareta*, *M. obliqua*) form a distinct clade within the Plumulariidae.

Species of *Monotheca* reported from Australia are *Monotheca obliqua* (Johnston, 1847), *Monotheca australis* (Kirchenpauer, 1876), *Monotheca compressa* (Bale, 1882), *Monotheca hyalina* (Bale, 1882), *Monotheca pulchella* (Bale, 1882), *Monotheca spinulosa* (Bale, 1882), *Monotheca aurita* (Bale, 1888), *Monotheca flexuosa* (Bale, 1894), *Monotheca obesa* (Blackburn, 1938) and *Monotheca togata* (Watson, 1973). Four of these species — *M. hyalina*, *M. pulchella*, *M. spinulosa* and *M. togata* — are also reported from New Zealand (Vervoort and Watson 2003). A new species, *Monotheca amphibola* sp. nov., from seagrass habitat in southeast Australia, is described here. Some species assigned to *Monotheca* — for example, *Plumularia excavata* (Mulder and Trebilcock, 1910), *Plumularia crateriformis* (Mulder and Trebilcock, 1910), *Plumularia epibracteolosa* Watson, 1973 and *Plumularia meretricia* Watson, 1973 sometimes have two hydrothecae on the hydrocladium and are thus borderline between *Monotheca* and *Plumularia* as defined here. In this

review, only strictly monohydrothecate species are considered, and species that sometimes have more than one hydrotheca on the hydrocladium are referred to *Plumularia*.

Although several species of *Monotheca* from Australia discussed in this paper as presently known are endemic to Australia there are some exceptions. These include *M. obliqua* known from the *Posidonia oceanica* seagrass meadows of the Mediterranean Sea (Boero 1981a, Boero et al. 1985; Fresi et al. 1982, Bouillon et al. 2004), the eastern Atlantic (Calder 1997) and Japan (Hirohito 1983); *M. spinulosa* is known from South Africa, the South Atlantic (Millard 1975) and Japan (Yamada 1959, Hirohito 1995); and *M. flexuosa* (as *M. pulchella*, see later discussion) is reported from the Mediterranean Sea and South Africa (Millard 1975). A key to species of *Monotheca* is given.

With the exception of *Monotheca flexuosa*, which is an opportunistic species occurring on many substrates, all Australian species of *Monotheca* are epiphytic — *M. obliqua*, *M. spinulosa* and *M. hyalina* are associated with algae, while *M. australis*, *M. compressa*, *M. obesa* and *M. amphibola* sp. nov. occur on seagrasses. New Zealand species recorded as *M. hyalina* and *M. flexuosa* (see later discussion concerning their identity) are from algae.

### *Monothecella* Stechow, 1923.

Stechow (1923a) erected the genus *Monothecella* for three species (*Monotheca australis* Kirchenpauer, 1876; *Monotheca aurita* Bale, 1888; *Monotheca compressa* Bale, 1882), all of

which have a hydrocladial median inferior nematotheca on a stout immovable base. The term monothalamic is usually applied to this structure, assuming that the distal cup is openly contiguous with its supporting peduncle. Detailed examination of fresh, preserved and mounted material of this suite of species (synonymised in *M. australis*, see discussion later) clearly shows that the cup is seldom completely open, and there is usually a faint line of demarcation between the cup and its base. The term monothalamic is therefore abandoned in the present context and the nematothecae regarded as incipiently bithalamic. For this reason, the genus *Monotheccella* is untenable and is here synonymised in *Monothecca*.

### Material.

In the following account, a large amount of material collected over four decades by the author and others around Australia is examined. Material is held in the collections of Museum Victoria, Melbourne, Australia (NMV), the Australian Museum, Sydney (AM), the South Australian Museum (SAM), the Western Australian Museum (WAM), the National Museum of New Zealand (NMNZ) and in the author's personal collection.

Family **Plumulariidae** McCrady, 1859

### *Monothecca* Nutting, 1900

Colony small, caulus erect, monosiphonic, simple or sparingly branched, divided into internodes without hydrothecae. Hydrocladia alternate, consisting of two internodes, the distal one bearing a hydrotheca with one median inferior nematotheca and two superior lateral nematothecae seated on a distal enlargement or a bifurcation of the internode. Gonangia fixed sporosacs, usually borne on proximal part of the stem, ovate or sac shaped, without protective appendages.

### *Monothecca amphibola* sp. nov.

Fig. 1A–G

*Material examined.* NMV F147479, holotype, microslide (malinol mounted), fertile colony from leaves of the seagrass *Amphibolis antarctica*, 200 m offshore from Queenscliff, Victoria, depth 2 m, coll: J. Watson 23 March 2008. NMV F147481, remainder of holotype colony, alcohol preserved. Paratype, NMV F147480, microslide (malinol mounted), fertile colony on leaves of the seagrass *Amphibolis antarctica*, 200 m offshore from Queenscliff, Victoria, depth 2 m, coll: J. Watson 23 March 2008.

*Description from holotype and paratype.* Stems to 3.5 mm long, monosiphonic, arising at regular intervals from hydrorhiza running more or less straight up seagrass leaf; stolons wide, ribbon-like with a narrow perisarcal flange with numerous internal flexion joints. Proximal stem with four or five strong transverse joints, succeeding cauline internodes variable in length, longer on taller stems, perisarc smooth and thick with several strong, more or less equally spaced transverse internal septa, nodes broad V-shaped overlapping joints.

Hydrocladia alternate, distal on cauline internode, on a short, strong apophysis, directed almost perpendicularly

outward from stem, distal node of apophysis slightly oblique to transverse; proximal hydrocladial internode short, athecate, distal node strongly oblique.

Hydrothecate internode moderately long and deep with two distinct internal opposing septa; hydrotheca distal on internode, facing upward at an angle of c. 45° to hydrocladium; cup shaped, slightly broader than deep, adcauline wall weakly concave to straight, abcauline wall distinctly concave, margin circular, entire, rim not everted, perisarc thin, a large sinuous abcauline perisarcal flange passing from margin downwards to beyond base of hydrotheca; a smaller triangular adcauline flange passing from hydrothecal margin to hydrocladium.

Nematothecae small, bithalamic, one on cauline internode, about one-third distance up internode and on same side as hydrocladium, base moderately long, adpressed to internode, cup slightly adcaudally excavated, one axillar, on front of stem beside apophysis, cup slightly elliptical, one hydrocladial median inferior on hydrothecate internode, not moveable, base long, stout and bent, cup small, adcaudally excavated and adpressed to flange of internode, not quite reaching base of hydrotheca; twin laterals standing erect, distal on hydrocladium below hydrothecal flange but not reaching hydrothecal margin, cups slightly adcaudally shortened; stolonal nematothecae scattered along hydrorhiza, base long, slightly tapering, cup circular, shallow.

Male and female gonothecae often borne on opposite sides of same caulus, large, similar in shape, irregularly ovoid, borne on a pedicel inserted below proximal stem apophysis; some gonothecae recumbent to substrate, others standing out perpendicular to stem; walls of gonotheca smooth, no distinct operculum, a thin diagonal apical fold usually marking site of future rupture; female gonophore packed with many moderately large ova.

### *Monothecca amphibola*, measurements (µm)

Hydrorhiza, width	160–170
Stem internode	
length	272–360
width at node	36–40
Apophysis, adcauline length	32–56
diameter at distal node	40–52
Hydrocladium	
length adcauline athecate segment	32–36
basal length of thecate internode	176–200
Hydrotheca	
length, base to margin along axis	100–108
diameter at margin	116–128
Nematotheca	
cauline, length of base	40–50
cauline, depth of cup	28–20
cauline, diameter of cup	28–32
axillar, length of base	30–36
axillar, depth of cup	12–14
axillar, diameter of cup	28–34

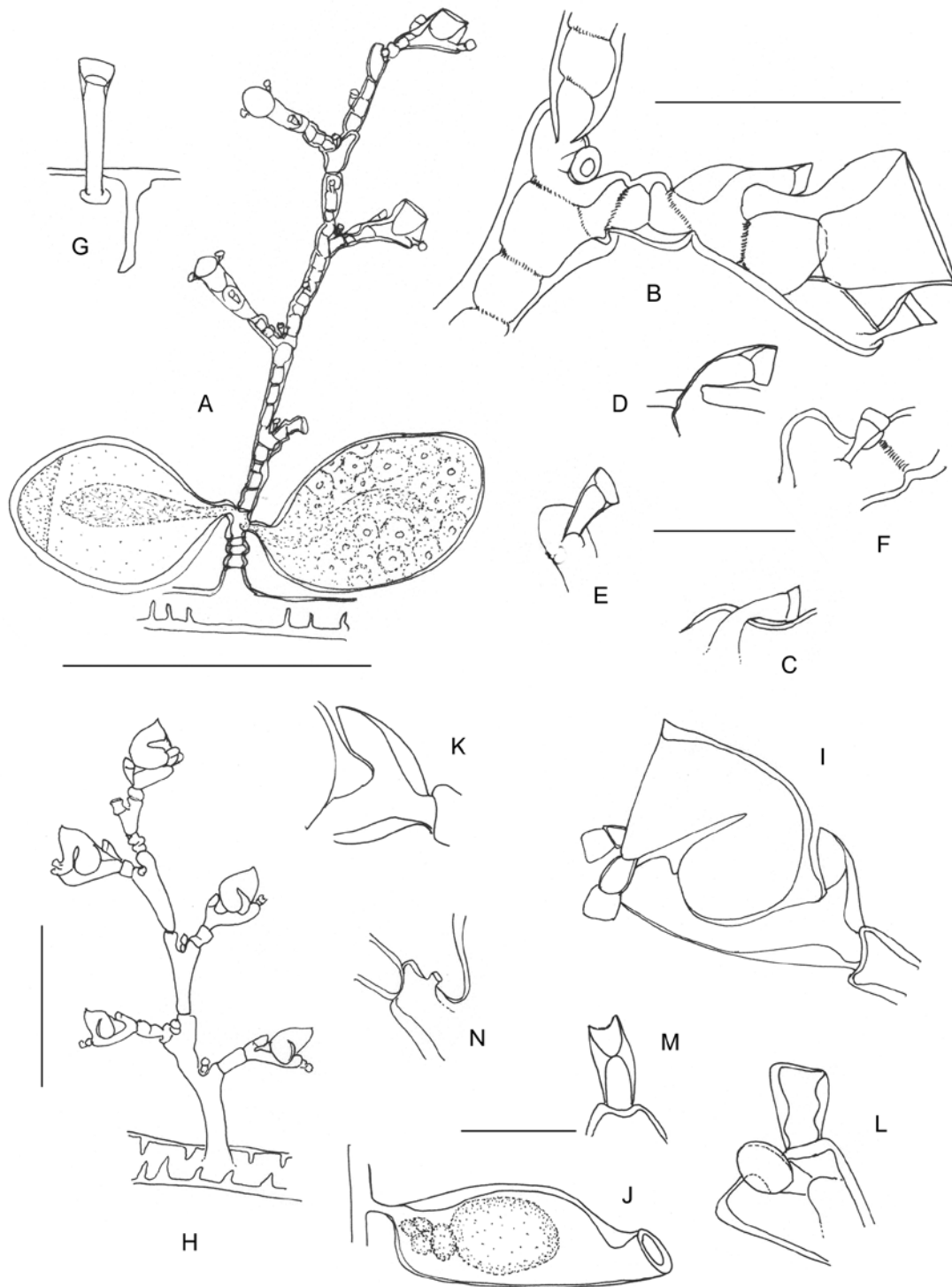


Figure 1. A–G, *Monotheca amphibola* sp. nov. (drawn from holotype and paratypes). A, fertile stem with male and female gonothecae; B, hydrocladium and hydrotheca; C, median inferior nematotheca; D, cauline nematotheca; E, one of twin lateral nematothecae; F, axillar nematotheca; G, hydrorhizal nematotheca. H–N, *Monotheca australis*. H, infertile stem; I, hydrocladium and hydrotheca; J, female gonotheca with developing larva; K, median inferior nematotheca. Note clear demarcation between cup and peduncle (I) and its absence (K); L, axillar nematotheca; M, one of twin lateral nematothecae; N, axillar hydrostatic pore (axillar nematotheca not shown). Scale bar: A, 1 mm; B, I, H, 0.2 mm; C–G, K–N, 0.1 mm; J, 0.5 mm.

median, length of base	34–40
median, depth of cup	12–16
median, diameter of cup	30–34
lateral, length of base	38–42
lateral, depth of cup	10–16
lateral, diameter of cup	36–40
hydrorhizal, length of base	98–100
hydrorhizal, depth of cup	30–32
hydrorhizal, diameter of cup	28–36

*Remarks.* The Mulder and Trebilcock collection in Museum Victoria contains five microslides (Canada Balsam-mounted) labelled '*Plumularia setaceoides* var. *crateriformis*, 1910'. Two of these slides are labelled 'type' by Mulder and Trebilcock (see Mulder and Trebilcock 1910, p. 118). The locality of the specimens is Bream Creek on the central Victorian coast. Unfortunately, the specimens are so badly fragmented that it is impossible to determine whether they were originally *Plumularia* or *Monothecha*. These, and a third slide from the same series (NMV F57987, F57988, F57989), were designated syntypes by Stranks (1993). I select the best of these (F57987) as lectotype of *Plumularia setaceoides* var. *crateriformis*.

Stechow (1925) raised the var. *crateriformis* to specific rank, recording the species from brown algae at 12–14 m depth in Warnbro Sound, Western Australia. Watson (2005) also reported *P. crateriformis* from algae at 16 m depth in the nearby Archipelago of the Recherche, Western Australia. *Plumularia nodosa* Stechow, 1924, also from Western Australia, is probably conspecific with *P. crateriformis*; however as neither species is referable to *Monothecha* as defined here, they are not considered any further.

Two of the three remaining Mulder and Trebilcock microslides are labelled '*Plumularia setaceoides* var. *crateriformis*, Bream Creek, January 1914' and are presumably those on which Mulder and Trebilcock (1915) based their augmented description of the var. *crateriformis*. The third slide is labelled '*Plumularia setaceoides* var. *crateriformis*, Torquay, February 1915'. The Bream Creek specimens have only one hydrotheca on the hydrocladium and are referable to *Monothecha*, whereas the Torquay specimen has more than one hydrocladial hydrotheca and thus belongs to *Plumularia*. The 1914 Bream Creek specimens are identical to *Monothecha amphibola* from Queenscliff.

The conspicuous anterior and posterior hydrothecal flanges of *Monothecha amphibola* resemble those in some of the smaller and more variable forms of the *Plumularia setaceoides* species group. These structures, together with the strong internal cauline segmentation and the wide, flat hydrorhiza with flexion joints are adaptations to strengthen the hydrocaulus in the high-energy *Amphibolis* seagrass habitat. The tall hydrorhizal nematothecae are probably for defence against the many grazing predators in the seagrass habitat. The smooth texture of the gonothecal wall is visible only in fresh material, as the gonothecae tend to crumple and become corrugated in mounting.

*Etymology.* The species is named for the seagrass *Amphibolis antarctica* upon which it grows.

### *Monothecha australis* (Kirchenpauer, 1876)

Fig. 1H–N

*Plumularia obliqua* var. *australis* Kirchenpauer, 1876: 49, pl. 6, fig. 10.— Von Lendenfeld, 1885a: 474.— Stranks, 1993: 8.

*Plumularia australis* Bale, 1884: 143, pl. 12, figs 7, 8.— Von Lendenfeld, 1885a: 475.— Bartlett, 1907: 42.— Mulder and Trebilcock, 1916: 77, pl. 10, figs 1–1b.— Bedot, 1921: 26.— Stechow, 1921: 260.— Blackburn, 1938: 316.— Blackburn, 1942: 108.— Watson, 1973: 189.— Staples and Watson, 1987: 218.— Watson, 1992: 220.

*Plumularia compressa* Bale, 1882: 31, pl. 15, fig. 5.— Bale, 1884: 142, pl. 12, figs 9, 10, pl. 19, figs 39, 40.— Von Lendenfeld, 1885a: 475.— Stranks, 1993: 9.

*Plumularia aurita* Bale, 1888: 784, pl. 19, figs 16–19.

*Monotheccella australis*— Stechow, 1923a: 13.— Stechow, 1923b: 221.— Leloup, 1932: 160.

*Monothecha australis*.— Watson, 2003: 252.

*Material examined.* The Kirchenpauer dry hydroid collection in Museum Victoria holds material (NMV F58239) labelled (presumably in Kirchenpauer's handwriting) '*Monopyxis australis* Port Phillip (Australien) on *Zostera* sp. c. 1865'.

*Material in author's collection:* i) from the seagrasses *Amphibolis antarctica* and *Amphibolis griffithi*; Torquay, Victoria, depth 3 m, 7 June 1970. Queenscliff, Victoria, depth 3 m, coll: J. Watson, 15 October 1986. Portland, Victoria, depth 3 m, 14 May 1969. Tipara Reef, Gulf St Vincent, South Australia, depth 5 m, coll: J. Watson, 24 November 1970. Starvation Bay, Western Australia, depth 2 m, coll: J. Watson, 11 January 1986. Point Peron, Western Australia, depth 3 m, coll: J. Watson, 26 January 1986. Whitfords Reef, Marmion, Western Australia, depth 4 m, coll: J. Watson, 6 February 1986. Cockburn Sound, Western Australia, depth 6 m, 12 October 1983. Starvation Bay, Western Australia, depth 6 m, coll: J. Watson, 13 January 1986. ii) from seagrasses *Posidonia australis* and *Posidonia sinuosa*; Gulf St Vincent, South Australia, depth 10 m, coll: J. Watson, 14 December 1968. Gulf St Vincent, South Australia, depth 12 m, 10 November 1968. Whitfords Reef, Marmion, Western Australia, depth 3 m, coll: J. Watson, 22 November 1983. Whitfords Reef, Marmion, Western Australia, depth 24 m, coll: J. Watson, 30 January 1986.

*Description (from mounted and preserved material).* Stems to 7 mm high, arising from a hydrorhiza reptant on seagrass leaf, stolons broad and flat with flexion joints. Stems monosiphonic, unbranched, sometimes with a short athecate basal internode, following internodes all of same length, cylindrical, smooth, widening to distal apophysis; node above apophysis transverse, narrow.

Hydrocladia alternate, in one plane, one distal on internode, given off below node on an upwardly directed apophysis with slightly oblique distal node. Hydrocladium with a short proximal athecate internode with thick walls and a strong, almost transverse distal node, hydrothecate internode considerably longer than athecate internode, base slightly convex, distal end blunt, ending below hydrothecal margin, no intranodal septa.

Hydrotheca seated in a concavity of internode, occupying almost entire internode, slightly laterally compressed, posterior quarter of abcauline wall strongly convex, then becoming straight to margin, base of hydrotheca divided into two segments by a strong intrathecal septum passing obliquely backwards into hydrotheca from margin, a small circular foramen in floor of hydrotheca, location variable from mid-

base to posterior of hydrotheca; margin perpendicular to or slightly oblique to hydrocladial axis, rim weakly to noticeably sinuous, margin slightly everted with thickened perisarc.

Nematothecae of two different shapes and sizes: one cauline similar to laterals in axil of hydrocladial apophysis, a small cylindrical hydrostatic pore (mamelon of former authors) on apophysis beside base of nematotheca; one hydrocladial median inferior on hydrothecate internode between base of hydrotheca and node, base robust, cup incipiently bithalamic, scoop shaped, sometimes without a line of demarcation between cup and base, closely adpressed to wall of hydrotheca, a distinct flange connecting abcauline wall with internode; twin lateral nematothecae bithalamic, directed outwards or downwards in front of hydrotheca, base large, cup excavated adcaudally to base.

One to three gonothecae borne on lower stem, male and female often on same stem; gonothecae large, turgid, inserted on a short, smooth pedicel below apophysis, standing out perpendicularly from stem or recumbent to substrate, abcauline (upper) wall inflated, adcauline wall straight to weakly convex, body narrowing distally to an upwardly bent cylindrical neck with a wide circular thickened aperture with broadly everted rim. Immature female gonophore with several ova, reduced to one large planula at maturity.

Perisarc of stems thick, translucent white when young, becoming pale-straw coloured with age; gonotheca brown, female gonophore cream.

***Monotheca australis*, measurements (µm)**

Hydrorhiza, width	~ 289
Stem	
length of internode	230–260
width at node	20–40
width at level of apophysis	90–149
Hydrocladium	
length of athecate internode	50–110
length of thecate internode	140–200
Hydrotheca	
diagonal length, margin to base	160–172
depth, margin to floor	90–180
diameter of rim	80–140
Nematotheca	
total length of median inferior	30–60
length of lateral including base	40–60
width of cup	20–50
width of axillar pore	14–20
Gonotheca	
length, including pedicel	650–1000
maximum width	200–350
diameter of neck	100–220
diameter of aperture	110–250

*Remarks.* The material in the dry Kirchenpauer collection of Museum Victoria is probably that on which Kirchenpauer (1876) described *Plumularia (Monopyxis) obliqua* var. *australis*. The specimen (NMV F58239) comprises many stems, some fertile, on dried leaves of the seagrass *Amphibolis antarctica*, formerly known as *Zostera*. Stranks (1993) nominated this material as possible syntype. Because of its unusual hydrocladial median inferior nematotheca, Bale (1884) raised Kirchenpauer's var. *australis* to specific rank as *Plumularia australis*. I designate F58239 as lectotype of *Monotheca australis* Kirchenpauer, 1876.

Compared with the height of the stems, the hydrorhizal stolons of *M. australis* are very wide, the strongly developed flexion joints permitting movement of the hydrorhiza on the *Amphibolis* leaves in strong water movement. Although the nematothecae are all essentially bithalamic, in some colonies the cup of the hydrocladial median inferior nematotheca is so adcaudally reduced that the line of demarcation between peduncle and cup is either very faint or altogether lost.

The small hydrostatic pore on the apophysis of the stem is obscured by the axillar nematotheca and is only visible in cleared specimens. The pore was described by Mulder and Trebilcock (1916) as similar in shape to a 'steamship ventilator'; in fresh material, however, it is cylindrical and likely to bend under pressure of a cover slip.

*Monotheca australis* is an obligate epiphyte of seagrasses, growing on *Amphibolis antarctica* in cool temperate south-eastern Australia and on *Posidonia australis* in warm temperate waters of southern and south-western Australia. In the rigorous *Amphibolis* habitat, the hydroid colonises the inner, sheltered leaves of the seagrass, while in the quieter *Posidonia* habitat it occurs on all but the outermost leaves of the plants. Colony size and cauline dimensions of *M. australis* on *Amphibolis* are usually smaller than those on *Posidonia*.

Boero (1981a, 1984) reported an increase in cauline length and loss of the intrathecal septum in *M. obliqua* from *Posidonia* seagrasses with increasing depth and decreasing water movement in the Mediterranean Sea. Because *M. australis* also grows on *Posidonia* in southern Australia, specimens from *Posidonia* habitat from 0–25 m depth were examined to investigate whether the same relationship exists among Australian *Monotheca* seagrass epiphytes. No such gradient was found; any tendency to loss of the intrathecal septum probably being lost in the more rigorous Australian *Posidonia* habitat.

*Type locality.* Port Phillip, Australia.

*Known distribution.* South-eastern and southern Australia to depth of 25 m.

*Status of Monotheca compressa* (Bale, 1882), *Monotheca aurita* (Bale, 1888) and *Monotheca obesa* (Blackburn, 1938). Bale (1882) described *Plumularia compressa* from fertile material collected by Mr T. B. Smeaton at Robe, South Australia. (The gonotheca was figured in 1884). The collection in Museum Victoria contains three microslides labelled by Bale '*Plumularia compressa* Bale, 1884'. These are presumably from Bale's 1882 collection and relabelled in 1884. The

specimens are probably from the shallow water seagrass *Posidonia australis* common at Robe. As Bale did not designate a holotype I designate a microslide NMV F59056 of a fertile colony as lectotype of *Monothecha compressa*.

Bale (1884, 1888, 1894) recognised the close relationship between *M. compressa* and *M. australis*, but nevertheless kept the two species separate — the main points of difference were length of stem, height and shape of the hydrotheca, position of the intrathecal septum and minor differences in shape of the neck of the gonotheca. Length of stem is an unreliable character as it may vary considerably between the same or different colonies according to environmental conditions and rate of growth. Height of the hydrotheca is quite variable over the range of material examined in the present study and is actually related to the degree of torsion around the intrathecal septum; shape of the base of the hydrotheca is also quite variable, some *australis* morphotypes being almost hemispherical in shape. The position of the foramen in the floor of the hydrotheca is also variable and depends on the degree of torsion of the hydrotheca around the intrathecal septum. It is more or less central in 75% of the *australis* morphotypes examined but is displaced towards the rear in the *compressa* form. Hydrothecae with a long, backwardly curved septum typical of Kirchenpauer's *australis* occur in colonies from the cool temperate *Amphibolis antarctica* habitat, the septum in these hydrothecae penetrating at least halfway into the hydrotheca, providing a pivotal point for torsion of the hydrotheca. In the warm temperate *Posidonia* habitat, the hydrothecae are taller and the septum is often directed forward as a rudimentary intrathecal ridge rather than a deep inflexion. Gonothecae vary in size and shape from almost cylindrical to turgid, and no relationship between sexual dimorphism, habitat or geographical distribution could be found to account for these variations.

Bale (1888) described *Plumularia aurita* from Botany, New South Wales. A microslide (NMV F58776) in the collection of Museum Victoria is the only known material of the species and was nominated syntype by Stranks (1993). As this is the only known specimen, by monotypy it is the holotype of the species. Bale's description and figure of the hydrotheca of *M. aurita* shows no intrathecal ridge, yet examination of the microslide clearly shows a backwardly oblique ridge passing almost halfway into hydrotheca. The incipiently monothalamic hydrocladial median inferior nematotheca is the same as that of *M. australis*, and the single small gonotheca on the slide although somewhat damaged confirms the species as a morphotype of *M. australis*. Although Bale provided no ecological notes, the species was almost certainly collected from *Posidonia* seagrass in Botany Bay.

The holotype microslide of *Plumularia obesa* Blackburn, 1938, in the collection of Museum Victoria, consists of three small, infertile stems labelled 'holotype NMV F70661, *Plumularia obesa* Blackburn, 1938, Reevesby Island, South Australia, December, 1936'. No other mounted or preserved material is known to exist. Since the microslide specimen was not cleared of tissue before mounting many critical structures are obscured, making it difficult to accurately measure important features.

In his description of *Plumularia obesa*, Blackburn surprisingly compared the species with *Plumularia spinulosa* rather than comparing it with *Plumularia australis*, which he also recorded from the same locality. The hydrotheca of *Monothecha obesa* closely resembles the *compressa* form of *M. australis* from *Posidonia* seagrass, the major difference being the shorter and more robust hydrocaulus resembling Bale's *M. aurita*. Blackburn described and figured the nematothecae of *P. obesa* as bithalamic with slender bases; however, examination of the type shows that the hydrocladial median inferior nematothecae have sturdy bases similar to those of *P. australis*. The bases of the twin lateral nematothecae are not slender as figured by Blackburn, nor are the cauline nematothecae of the holotype similar to the laterals and the bases are not so slender as to be considered truly moveable. Apart from the much smaller and more robust hydrocaulus, and taller hydrothecae, *P. obesa* is indistinguishable from the extreme *compressa* form of *M. australis*. Although the gonosome of *P. obesa* is unknown, I am confident that the species is a morphological variant of *M. australis* and, accordingly, I include it in the synonymy of *M. australis*.

*Monothecha australis* is a highly variable species, the size of the colony and structural dimensions over the geographic range are closely related to substrate type and environmental conditions.

#### *Monothecha flexuosa* (Bale, 1894)

Fig. 2 A–G

*Plumularia flexuosa* Bale, 1894: 115, pl. 5, figs 6–10.— Bartlett, 1907: 42.— Shepherd and Watson, 1970: 140.— Watson, 1973: 187.— Watson, 1982: 106, fig. 4.11e.— Watson, 1992: 220.— Stranks, 1993: 10.

?*Plumularia flexuosa*.— Bedot, 1921: 27.— Blackburn, 1938: 315.  
*Monothecha flexuosa*.— Stechow, 1921: 260.— Stechow, 1925: 246.— Hirohito 1974: 37, fig. 17.— Watson, 1996: 78.— Watson, 2000: 48, fig. 37A, B.— Vervoort and Watson, 2003: 369.— Watson, 2003: 252.— Watson, 2005: 540.— Bouillon et al., 2006: 368.

*Monothecha pulchella*.— Medel and Vervoort, 1995: 58, fig. 25.— Medel and López-González, 1996: 202.— Watson and McInnes, 1999: 111.— Vervoort and Watson, 2003: 369, 373, fig. 90J–L.— Bouillon et al., 2004: 172, fig. 92G–K.

*Material examined*. Microslides in the Bale collection, Museum Victoria, labelled in Bale's handwriting are: NMV F58754, 'Catalogue number 206, *Plumularia flexuosa*, mouth of Snowy River, Dr Macgillivray, 1889' and three other slides, NMV F58755, all labelled '*Plumularia flexuosa*, Snowy River, Dr Macgillivray, 1892' (Bale's catalogue number 205).

*Material in author's collection*: Popes Eye reef, Port Phillip, fertile colonies on invertebrate and algal substrates, coll: J. Watson, depth 10 m, 20 September 2008. St Leonards pier, Port Phillip, depth 3 m, infertile colonies on red alga, coll: J. Watson, 10 August 2008. Clifton Springs, Port Phillip, jetty piles, depth 1.5 m, fertile colonies on algae, coll: J. Watson, 30 November 2005. Clifton Springs, Port Phillip, jetty piles, depth 1 m, fertile colonies on green alga *Caulerpa scalpelliformis*, coll: J. Watson, 16 September 2006. Clifton Springs, Port Phillip, jetty piles, depth 1.5 m, fertile colonies on green alga *Caulerpa scalpelliformis*, coll: J. Watson, 23 October 2008. Pearson Island, South Australia, infertile stems on red alga *Mychodea carcosa*, depth 37–45 m, coll: J. Watson, January 1969. Channel Island, Darwin, Northern Territory, depth 6 m, coll: J. Watson, July 2006.

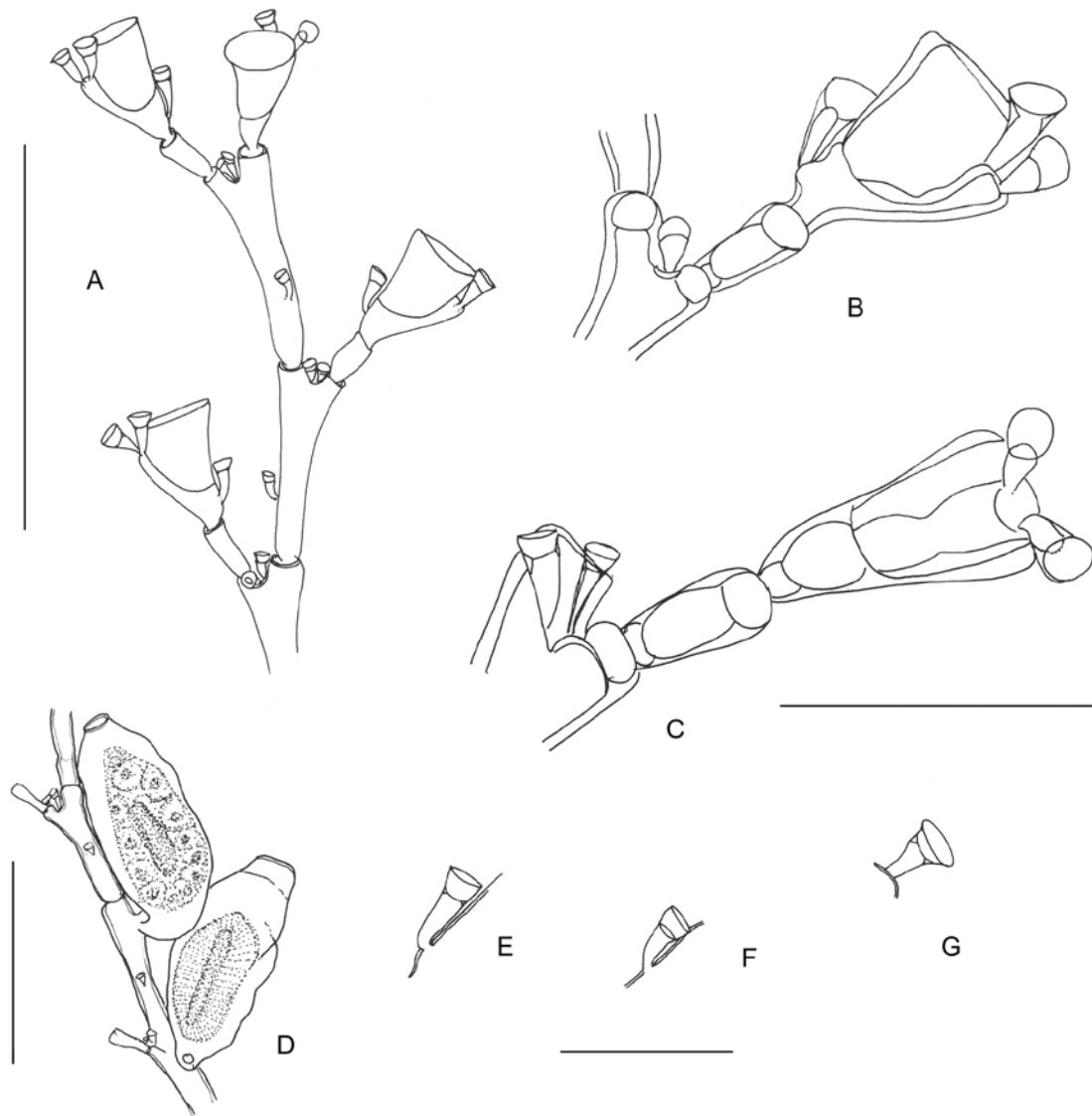


Figure 2. A–G, *Monothecha flexuosa*. A, part of stem; B, hydrocladium, lateral view; C, hydrocladium, ventral view; D, male and female gonothecae on same stem; E, median inferior nematotheca; F, cauline nematotheca; G, one of twin lateral nematothecae. Scale bar: A, D, 0.5 mm; B, C, 0.2 mm; E–G, 0.1 mm.

*Description.* Hydrorhiza of thin tubular stolons reptant on invertebrate substrate, sometimes intersecting in tangled knots, on algal substrate stolons often flattened with flexion joints. Caulus of same diameter as stolon, monosiphonic, flexuous, variable in length, up to 20 mm, base of stem smooth with a few irregular transverse joints; short stems unbranched, some longer stems with one or two orders of short side branches, stem internodes long.

Hydrocladia alternate, in one plane, borne on a strong apophysis below cauline node, apophysis curving smoothly away from internode, distal node transverse with rounded shoulder. Hydrocladial athecate internode long, cylindrical, straight to slightly curved, walls smooth, increasing slightly in

diameter distally; distal node transverse, deep, a transverse septum behind node, typically several transverse internal septa in internode.

Hydrothecate internode about same length as athecate internode, almost entirely occupied by hydrotheca, proximal node narrow, deep, inserted into shoulder of athecate internode; internode slightly distally inflated, terminating behind margin of hydrotheca, a faint intranodal septum sometimes in internode below hydrotheca. Hydrotheca cup shaped, adcauline wall convex, set deeply into internode, abcauline wall weakly concave, margin circular, transverse to hydrothecal axis, rim delicate, a slight thickening below margin.

Nematothecae all of same size and shape, bithalamic, moveable, fairly robust, base long, cup circular, slightly adcaudally shortened, three nematothecae on cauline internode, one on apophysis, the other axillar and one, variable in position, about one-third to mid-distance up internode, hydrocladial median inferior reaching one-quarter distance along hydrotheca, twin laterals extending well beyond rim of hydrotheca.

Gonothecae of both sexes borne thickly in a single row along lower stem or sparsely along branches. Male and female gonothecae the same shape, top-shaped when young, ovoid to barrel shaped at maturity, distally truncate, pedicel inserted beside apophysis of stem, upwardly bent, tapering into base of gonotheca; walls smooth to faintly undulated, aperture distal, transverse, circular, produced into a short thick neck of variable height closed by a low dome or shallow concavity. Male gonophore with rod-shaped spadix, mature female packed with large ova.

Cnidome:

- i) large microbasic euryteles capsule bean shaped 15–16 × 6  $\mu\text{m}$ , abundant in coenosarc and nematothecae; discharges sideways.
- ii) small ?isorhizas, capsule elongate, 5–7 × 2  $\mu\text{m}$ , tubule short; abundant in coenosarc and tentacles.

Perisarc of hydrocaulus and gonothecae fairly thin, thicker at base of stems. Colonies transparent white, basal stem region brown in older colonies, male gonophores white, often with a shining bluish tinge, mature ova in female gonophore yellow.

#### *Monothecha flexuosa*, measurements ( $\mu\text{m}$ )

Hydrorhiza, width	50–80
Stem	
internode length	344–400
diameter at node	36–44
length of apophysis (adcauline wall)	48–52
Hydrocladium	
length of athecate internode	116–128
width at distal node (shoulder)	50–58
length of thecate internode (measured along base)	164–200
Hydrotheca	
length of abcauline wall	132–148
length of adcauline wall	136–60
diameter of margin	140–152
Gonotheca	
length (excluding pedicel)	560–696
maximum diameter	280–320
Nematotheca	
length of base	45–55
diameter of cup	40–50

*Remarks.* All microslides of *Monothecha flexuosa* in the Bale collection of Museum Victoria are designated syntypes by Stranks (1993). I designate NMV F58754 as lectotype of *Monothecha flexuosa*.

The systematic importance of the presence, absence or position of the cauline nematotheca has been much discussed by authors (e.g. Medel and Vervoort, 1995). In many southern Australian specimens of *M. flexuosa*, cauline nematothecae are present in the proximal one-third to mid-cauline internode, suggesting precise position is of little or no diagnostic value for identification of the species.

Stems of *M. flexuosa* from sheltered habitat are usually much longer, and more flexuous and silky in appearance than those from more rigorous habitats. The longer stems may bear a single row of up to 15 female gonothecae whereas shorter stems have fewer gonothecae, usually near the base of the stem. No correlation with environmental conditions or habitat could be found to explain the presence, absence or length of the terminal neck of the gonotheca.

*M. flexuosa* is the most abundant and widespread species of *Monothecha* in Australia. In southern Australia, it is fertile from late spring to autumn (November to March) when colonies occur on many invertebrate substrates (mussels, ascidians, polychaete tubes), on some flabellate red algae and the green algae *Caulerpa scalpelliformis* and *Caulerpa remotifolia*.

An unusual endoparasitic association between *M. flexuosa* and the red alga *Mychodea carnosa* was reported by Watson (1973). The stolons of the hydroid penetrate the outer medulla of young *Mychodea* fronds, producing external hydrocauli at intervals. As the alga grows, its tissue is gradually broken down by the hydroid stolons so that eventually the alga is attached to the substrate only by the hydrorhiza of the hydroid. Hydrocauli emerging from the algal medulla differ somewhat from the normal epiphytic form, comprising one or two short cylindrical basal internodes bearing one or two large nematothecae, followed by normal hydrocauline internodes.

*Type locality.* Mouth of Snowy River, Victoria, Australia.

*Known distribution.* Temperate and tropical Australia, New Zealand, Strait of Gibraltar. The species may prove to be cosmopolitan.

#### *Monothecha hyalina* (Bale, 1882)

Fig. 3A–I

*Plumularia hyalina* Bale, 1882: 41, pl. 15, fig. 9.— Bale, 1884: 141, pl. 12, figs 4, 5.— Bartlett, 1907: 422.— Bedot, 1921: 28.— Trebilcock, 1928: 24, pl. 6, fig. 6.— Watson, 1975: 170, fig. 29.— Stranks, 1993: 11.

*Monothecha hyalina*.— Stechow, 1921: 260.— Watson, 1996: 78.— Watson, 1997: 529.— Bouillon et al., 2006: 368.

Not *Plumularia hyalina*.— Ralph, 1961b: 41, fig. 5a, b.— Ralph, 1961c: 109.

Not *Monothecha hyalina*.— Vervoort and Watson, 2003: 371, fig. 90F–I.

*Material examined.* NMV F59052, microslide; NMV F59053, microslide, Bale collection, Museum Victoria, locality Queenscliff, Victoria.

*Material in author's collection:* Houtman Abrolhos Islands, Western Australia, infertile colony on *Sargassum* and red alga, depth 6–10 m, coll: J. Watson, 12 October 1986; Hopetoun, Western Australia, female colony on brown alga, depth 2 m, under ledge, coll: J. Watson, 13 January 1986. Boatswains Rocks, South Australia,



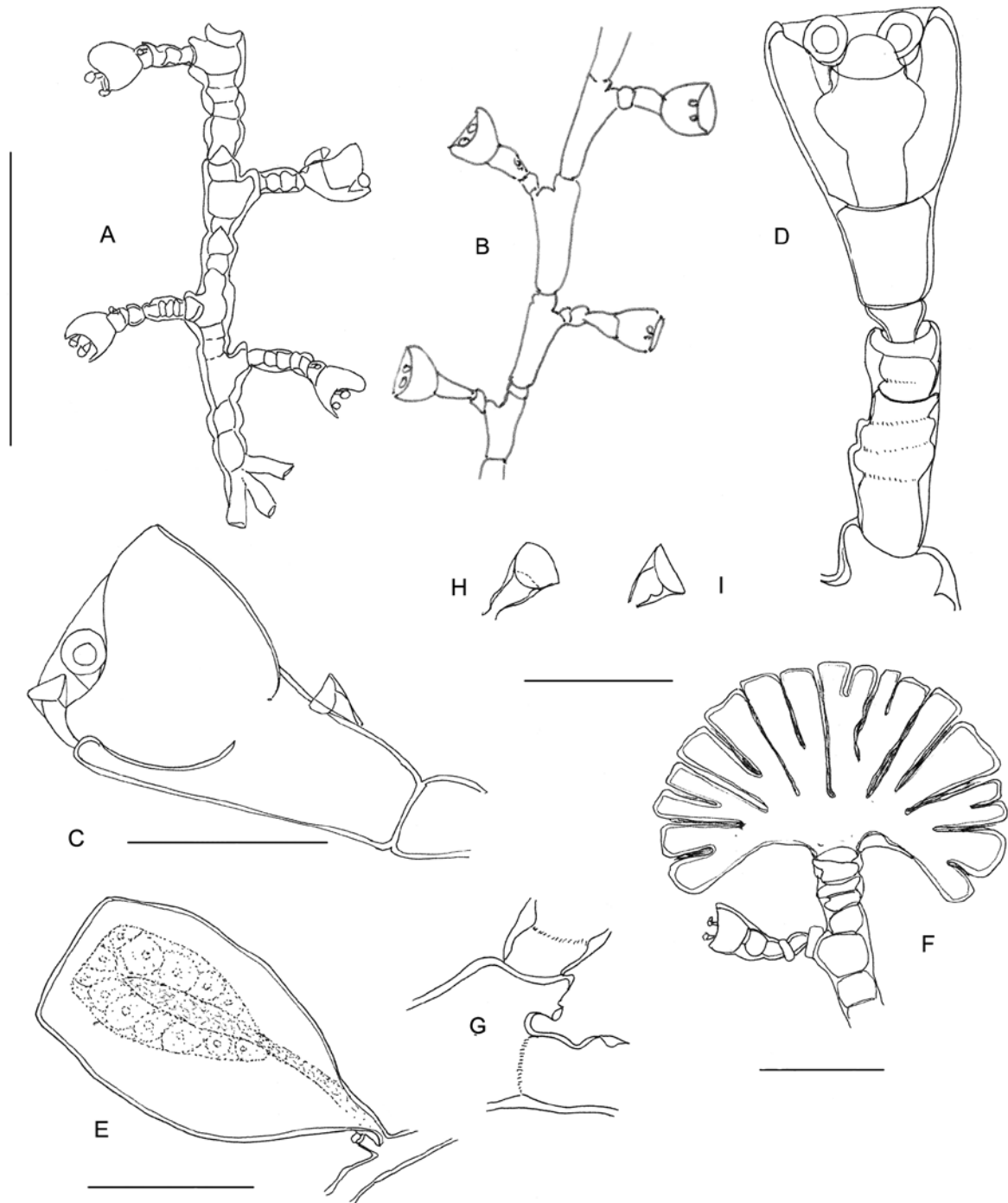


Figure 3. A–H, *Monotheca hyalina*. A, part of robust stem from cool temperate waters with intranodal septa; B, part of slender stem from temperate waters with no intranodal septa; C, hydrocladium and hydrotheca, lateral view; D, hydrocladium and hydrotheca, ventral view; E, gonotheca with female gonophore; F, apical stolonal plate; G, axillar hydrostatic pore; H, median inferior nematotheca; I, one of twin lateral nematothecae. Scale bar: A, B, 1 mm; C, D, 0.2 mm; E, 0.5 mm; G–I, 0.1 mm.

colony detached from substrate, coll: J. Watson, 27 January 1969. Fluted Cape, Bruny Island, Tasmania, female colony, depth 16 m, on red alga, coll: J. Watson, 10 February 1972. Lawrence Rocks, Portland, Victoria, infertile colony on red alga, depth 16 m, coll: J. Watson, 14 May 1969. Walkerville, Victoria, infertile colony detached from substrate, depth 3 m, coll: J. Watson, 1 March 1968. Nambucca Heads, New South Wales, infertile colony on coralline alga and ascidian, depth 13 m, coll: J. Watson, 11 January 1972.

*Description.* Hydrorhiza of tubular rugose stolons reptant on substrate; stolons usually with internal flexion joints. Stems 3–10 mm high, monosiphonic, straight to weakly sympodial, up to four short basal internodes with transverse joints above hydrorhiza. Succeeding stem internodes variable in length, longer ones typically on taller stems, smooth, expanding a little distally with a strong oblique V-shaped proximal node and a transverse distal node, usually an internal transverse septum below distal node at level of apophysis.

Shorter stems with one, rarely two, short proximal atecate internodes, stem thereafter hydrocladial; cauline internodes deeply and more or less irregularly septate with strong V-shaped proximal nodes and transverse distal nodes, and three or four strong transverse internal septa. Hydrocladia alternate, fairly long, given off in one plane from a short, strong apophysis distal on internode, apophysis curving smoothly out from internode, adcauline wall a shoulder with slightly oblique deep node, a cylindrical axillar hydrostatic pore on adcauline shoulder.

Atecate hydrocladial internode long, deeply inserted in shoulder of apophysis, with deep transverse distal node and several complete internal septa. Hydrothecate internode longer than atecate internode, terminating in a protuberance separating the twin lateral nematothecae, hydrotheca set deeply in internode, a large prehydrothecal chamber expanding from proximal node to floor of hydrotheca; hydrotheca deep bowl shaped, base convex with a large foramen connecting with prehydrothecal chamber; in lateral view abcauline wall convex, adcauline wall completely adnate to internode, in ventral view walls expanding in a smooth curve from base, narrowing just below margin, rim slightly thickened but not everted; margin hemispherical, wide in ventral view, abcauline side straight, adcauline side deeply concave, in lateral view, wall a broad sinous curve down to internode.

Three nematothecae on hydrothecate internode, hydrocladial median inferior about halfway along prehydrothecal chamber, small, bithalamic, moveable, adpressed to internode, base tapering, cup slightly adcaudally shortened, twin laterals of same shape as median, standing erect on each side of strong terminal protuberance of internode, tucked within hydrothecal margin, cup circular to slightly laterally compressed but not excavated; no cauline nematothecae.

Gonotheca large, one to several in a row on lower stem, conical, widening from a short indefinite pedicel inserted beside apophysis, walls of gonotheca smooth to obscurely undulated, truncated distally by a transverse, weakly concave aperture without operculum; female gonophore with 15–20 large ova.

Perisarc of slender stems thin, much thicker in shorter, robust stems.

Colour of live colonies where known, buff to yellow, gonophores yellow.

***Monotheca hyalina*, measurements ( $\mu\text{m}$ )**

	Slender group (warm temperate)	Robust group (cool temperate)
Hydrorhiza, width	112–120	88
Stem		
length of internode	456–640	304–400
width at node	80–120	80–112
distal width of apophysis	80–100	92–112
Hydrocladium		
length of atecate internode	80–220	80–120
length of hydrothecate internode	200–296	184–212
Hydrotheca		
length of abcauline wall	193–220	152–160
length of adcauline wall	160–186	80–116
width of margin front view	160–192	128–168
Nematotheca		
basal length of median inferior	35–42	16–26
diameter of cup	42–52	40–60
basal length of lateral	40–50	30–40
diameter of cup	40–46	44–50
Gonotheca		
length, including pedicel	960–1400	920
maximum width (margin)	720–900	680

*Remarks.* There is no known type material of *Monotheca hyalina*; a microslide NMV F59052 in the Museum Victoria Bale collection labelled in Bale's handwriting '*Plumularia hyalina* Queenscliff, February 1881' was nominated as probable syntype by Stranks (1993). I select this microslide as lectotype of *Monotheca hyalina*.

*Monotheca hyalina* is very variable in height of the stem, and slenderness and robustness of the hydrocaulus, in the presence or absence of intranodal septa and size of the hydrotheca. In some specimens, the prehydrothecal chamber is so reduced that the hydrocladial median inferior nematotheca extends one-third the length of the hydrotheca.

Specimens from warm-temperate southern Australian

waters are distinguished by their slender, flexuous stems with longer internodes, while those from the cool-temperate waters have sturdier stems with shorter internodes and smaller hydrothecae. Dimensions of these two groups are compared in the above table.

Despite the considerable structural and dimensional differences between the two morphological extremes, intergradation does occur, hence *M. hyalina* is recognised as a single but somewhat variable species. It is often difficult to obtain a good lateral view of the hydrotheca as they tend to twist forward in microslide preparations. *M. hyalina* is an algal epiphyte; some specimens from Tasmania have a large apical stolonal plate to securely anchor stems in a rigorous oceanic environment.

Examination of New Zealand material and a review of descriptions of Ralph (1961b) and Vervoort and Watson (2003) suggests that the New Zealand material is not *M. hyalina* because: i) the hydrotheca is pitcher-shaped with a short, concave free adcauline wall, ii) there is a partial intranodal septum below the hydrotheca, iii) there is an axillar nematotheca in the apophysis of the stem, and iv) as the New Zealand specimens usually have more than one hydrotheca on the hydrocladium it is excluded from *Monotheca* as defined here. It is likely that the New Zealand material is an undescribed species of *Plumularia*. It is noteworthy that Leclère et al. (2007) in their molecular analysis demonstrate that *M. hyalina* from New Zealand is outside the group, thus supporting the conclusion that the New Zealand species is not *M. hyalina*.

**Type locality.** Queenscliff, Victoria, Australia.

**Known distribution.** Southern Australia.

### *Monotheca obliqua* (Johnston, 1847)

Fig. 4 A–E

*Plumularia obliqua* Johnston, 1847: 106, pl. 28, fig. 1.— Bale, 1884: 138, pl. 12, figs 1–3.— Bartlett, 1907: 43.— Mulder and Trebilcock, 1910: 116.— Mulder and Trebilcock, 1916: 76, pl. 11, figs 1–1e.— Jäderholm, 1919: 22, pl. 5, fig. 6.— Stechow, 1919: 113.— Bedot, 1921: 28.— Billard, 1927: 342.— Broch, 1933: 31, fig.— Leloup, 1934: 15.— Billard, 1936: 9.— Blackburn, 1938: 315.— Blackburn, 1942: 108.— Hodgson, 1950: 39, fig. 68.— Rossi, 1950: 23, fig. 4b.— Pennycuik 1959: 180.— Watson, 1973: 189.— Millard and Bouillon, 1974: 9, 34, fig. 8A–D.— Millard, 1975: 396, fig. 125A–B.— Garcia-Corrales, Aguirre Inchaurre and Gonzalez Mora, 1978: 56, fig. 25.— Millard, 1978: 196 et seq.— Watson, 1979: 234.— Boero, 1981a: 197.— Hirohito, 1983: 69.— Boero, 1984: 103, fig. 8.— Boero et al., 1985: 29.— Gili and García-Rubies, 1985: 48, fig. 5B.— Isasi and Saiz, 1986: 70.— Roca, 1987: 151.— Gili, Vervoort and Pagès, 1989: 89, fig. 17A.— Boero and Bouillon, 1989: 39, fig. 1. García Rubies, 1992: 265.— Park, 1992: 294. Cornelius, 1995: 142, fig. 33.— Bouillon et al., 1995: 61.— Hirohito, 1995: 275, fig. 94d–f.— Watson and McInnes, 1999: 111.— Bouillon et al., 2006: 368.

*Monotheca obliqua*.— Stechow, 1923b: 17.— Leloup, 1932: 160.— Yamada, 1959: 78.— Rho and Park, 1986: 99.— Ryland and Gibbons, 1991: 538, fig. 9.— El Beshbeeshy, 1995: 404.— Medel and López-González, 1996: 202.— Watson, 1973: 529.— Watson and McInnes, 1999: 111.— Vervoort and Watson, 2003: 369.— Watson, 2005: 541, fig. 15.— Bouillon et al., 2006: 368.

*Plumularia (Monotheca) obliqua*.— Stechow and Uchida, 1931: 565.

*Plumularia obliqua australis*.— Stranks, 1993: 8.

**Material examined.** NMV F101686, infertile colony, New Island, Archipelago of the Recherche, Western Australia, depth 20 m on red alga, coll: J. Watson, February 2003. WAM Z29970, fertile colony, New Island, Archipelago of the Recherche, Western Australia, depth 20 m, on brown alga, coll: J. Watson, February 2003.

**Material in author's collection:** fertile colony, Popes Eye reef, Port Phillip, Victoria, on stem of *Macrorhynchia whiteleggei*, depth 6 m, coll: J. Watson, 7 November 2009. Infertile colony, Popes Eye reef, Port Phillip, Victoria, depth, 3 m, on thallus of *Sargassum* sp., coll: J. Watson 29 December 2009.

**Description.** Hydrorhiza reptant on substrate, tubular, somewhat rugose. Stems to 7 mm long, monosiphonic, straight to sympodial, internodes moderately long, widening to distal node; node transverse to slightly oblique, often a distinct shoulder in perisarc and an internal septum above, sometimes one to three strong internal septa in proximal part of internode. Apophysis of stem short, upwardly directed, situated well below node, widening to a strong distal shoulder.

Hydrocladia alternate, short, in one plane, distal on internode, athecate internode with one to three internal septa, distal node transverse. Hydrothecate internode almost completely occupied by hydrotheca, internode with one or two faint septa below hydrotheca, sometimes a short, faint septum passing into hydrotheca from distal septum; internode distally inflated, pushing base of hydrotheca upward, prehydrothecal chamber short, triangular with internal triangular septum.

Hydrotheca scoop shaped, abcauline and adcauline walls smoothly convex, margin cut obliquely back to internode, rim slightly everted, a thickening behind rim.

Cauline and hydrocladial median inferior nematothecae similar in shape and size, bithalamic, moveable, base moderately long, cup fairly wide, cauline nematotheca about one-third distance up internode on side opposite hydrocladium, standing out from internode, base connecting with a large foramen of internode, hydrocladial median inferior nematotheca adpressed to prehydrothecal chamber, just reaching floor of hydrotheca; twin laterals directed outwards from an indentation in distal protuberance of internode, base short, stout, cup deeply adcaudally excavated; a nematotheca in axil beside apophysis; a dome-shaped axillar hydrostatic pore with small terminal aperture, sometimes also a small secondary pore on adcauline shoulder of apophysis.

Male and female gonothecae borne on the same colony but not on same stems, of same shape and size, large, conical, circular in section, perisarc fairly thick with tendency to proximal rugosity, typically one borne on a short, thin pedicel beside an apophysis near base of stem; aperture transversely truncate, occupying entire width of gonotheca, closed by a sheet of tissue. Female gonophore containing many large ova.

Perisarc of stems pale brown basally, becoming colourless distally, gonotheca pale brown, gonophores flesh-coloured.

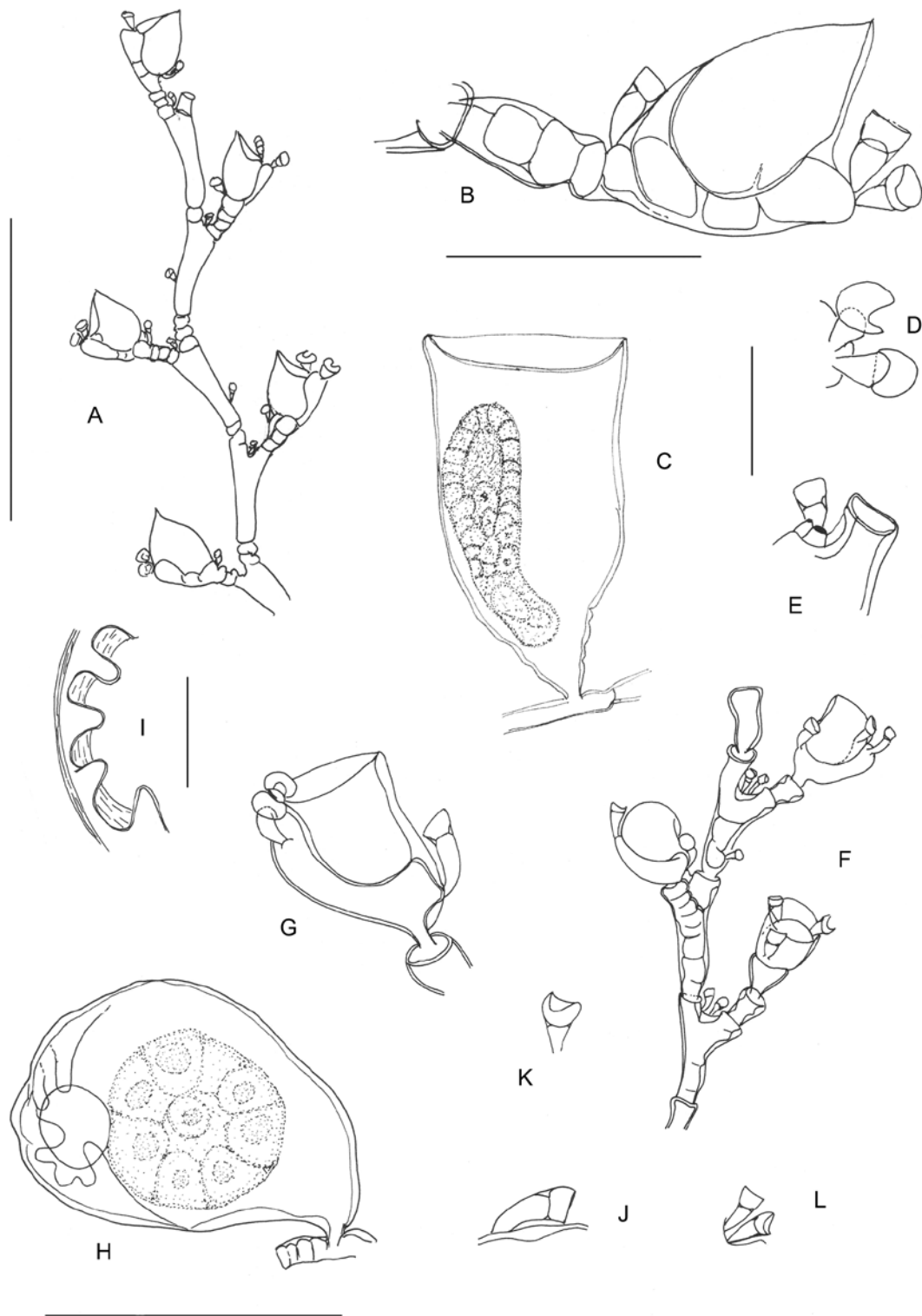


Figure 4. A–E, *Monothecha obliqua*. A, part of stem; B, hydrocladium and hydrotheca; C, female gonotheca; D, twin lateral nematothecae; E, axillar nematotheca and hydrostatic pore. Scale bar: A, C, 1 mm; B, 0.2 mm; D, E, 0.1 mm. F–L, *Monothecha pulchella*. F, part of stem; G, hydrocladium and hydrotheca; H, female gonotheca with ova; I, anterior view of gonothecal aperture with internal lobate submarginal cusps. J, median inferior hydrocladial nematotheca. K, one of twin lateral nematothecae. L, axillar nematothecae. Scale bar: A, C, 1 mm.; B, 0.2 mm; F, H, 0.5 mm; D–E, I–L, 0.1 mm.

***Monotheca obliqua*, measurements ( $\mu\text{m}$ )**

Hydrorhiza, width	70–88
Stem	
length of internode	200–320
width at distal node	40–60
Apophysis	
length of adcauline wall	26–58
width at distal shoulder (node)	40–70
Hydrocladium	
length of athecate internode	56–80
width at distal node	42–60
length of thecate internode	160–104
Hydrotheca	
length of abcauline wall	140–200
length of of adcauline wall	80–148
depth, floor to margin tip	180–200
width at rim	160–180
Nematotheca	
total length of lateral	52–60
diameter of cup	42–48
length of median	48–52
diameter of cup	26–28
Gonotheca	
length, including pedicel	1240–1580
width at margin	640–1100

*Remarks.* *Monotheca obliqua* is a well-known species with worldwide distribution. Mulder and Trebilcock (1910, 1916) briefly described material collected from Bream Creek on the Bass Strait coast and Corio Bay in Port Phillip, commenting on the slenderness of the base of the median inferior nematotheca, the small axillar hydrostatic pore and the abcauline flange connecting the base (prehydrothecal chamber) of the hydrotheca to the internode.

Although widely distributed across the south and east of the continent, *M. obliqua* is not a common species in Australia.

*Type locality.* British Isles.

*Known distribution.* Cosmopolitan; southern Australia to Queensland.

***Monotheca pulchella* (Bale, 1882)**

Fig. 4 F–L

*Plumularia pulchella* Bale, 1882: 30, pl. 15, figs 6, 6a.— Bartlett, 1907: 43.— Stranks, 1993: 13. — Watson, 1994: 67.

Not *Plumularia pulchella*. — Bedot, 1921: 28.— Trebilcock, 1928: 24. — Totton, 1930: 221, fig. 58 a–d.— Hodgson, 1950: 41, fig. 71.— Ralph, 1961b: 39, fig. 5 c–e.— Blanco, 1973: 73, figs 1–3.— Millard, 1975: 398, fig. 125 C–D.— Izquierdo et al., 1986: 54, fig. 5.— Genzano, 1990: 50, figs. 16–17.— Medel and Vervoort, 1995: 58, fig. 25.— Vervoort and Watson, 2003: 369, 373, fig. 90J–L.— Bouillon, et al., 2004: 172, fig. 92G–K.

?*Plumularia pulchella*.— Blackburn, 1942: 108.— Day et al., 1952: 404.— Millard, 1957: 232.— Millard, 1962: 300.— Pennycuik, 1959: 180.— Ralph, 1961b: 109.— Millard, 1966: 493.— Berrisford, 1969: 394.— Day et al., 1970: 14.— Millard, 1978: 196.— Millard, 1980: 133.— Medel and López-González, 1996: 202.

*Monotheca pulchella*.— Stechow, 1921: 260.— Watson and McInnes, 1999: 111.

*Material examined.* NMV F59054, Bale collection, Museum Victoria, one microslide, labelled in Bale's handwriting '*Plumularia pulchella* Bale, Queenscliff, November, 1878'.

*Material in author's collection:* microslide and preserved material, Knobbies Island, Western Port, on brown alga, coll: J. Watson, depth 10 m, 27 January 1985.

*Description.* Hydrorhiza flat and ribbon-like with flexion joints. Stems monosiphonic, straight to weakly sympodial, basal athecate region with several transverse nodes often with one or two nematothecae, succeeding cauline internodes variable in length, cylindrical, robust, nodes deep, transverse to oblique, internode typically with several internal septa imparting a wrinkled appearance to stem.

Hydrocladia alternate, usually in one plane, but sometimes one or two forwardly displaced, halfway to one-third distance up internode, apophysis of stem upwardly directed away from internode, long, stout, with a broad transverse distal shoulder, usually an internal septum behind shoulder; hydrocladium short, athecate internode variable in length, proximal end narrow, inserted into shoulder of apophysis. Hydrothecate internode variable in length, almost entirely occupied by hydrotheca, proximal end of internode a narrow neck inserted into athecate node; distal end terminating in a protuberance behind hydrothecal margin.

Hydrotheca cup shaped, adcauline wall convex, immersed in internode, abcauline wall weakly concave and thickened; margin circular, transverse.

Nematothecae bithalamic, moveable, cauline and hydrocladial median inferior of same size and shape, base long and conical, cup deep, rim circular, slightly adcaudally shortened; a nematotheca one-third distance up cauline internode and two axillar; hydrocladial median inferior seated on a prominence of internode, just reaching base of hydrotheca, twin laterals seated almost at end of internode, base fairly short, cup adcaudally excavated.

Male and female gonothecae borne on same stem. Sexes of same shape, kidney shaped to ovoid, inserted on a smooth, short, bent pedicel at base of apophysis, pedicel expanding and merging into body of gonotheca; walls of gonotheca thick, smooth to faintly rugose, aperture distal, circular, displaced to one side, rim slightly thickened, a submarginal row of large, irregularly shaped inwardly directed lobate cusps, usually one or two larger than the others. Mature female gonophore containing a large ovum.

***Monotheca pulchella*, measurements ( $\mu\text{m}$ )**

Stem	
internode length	204–400
diameter at node	48–60
length of apophysis (adcauline wall)	52–64
Hydrocladium	
length of athecate internode	52–128
width at distal node (shoulder)	50–58
basal length of hydrothecate internode	164–200
Hydrotheca	
length of abcauline wall	100–148
diameter of margin	116–152
Gonotheca	
length (excluding bent pedicel)	560–696
maximum width	280–344
Nematotheca	
length of base	40–55
diameter of cup	32–50

**Remarks.** Stranks (1993) considered microslide NMV F59054 a probable syntype of *Monotheca pulchella*. I select this microslide as lectotype of *Monotheca pulchella*.

The submarginal lobate cusps mentioned by Bale are clearly visible in the gonotheca of the type. On present evidence, *M. pulchella* is associated only with brown algae. This is in contrast to *M. flexuosa*, which is a common opportunistic species occurring on a wide variety of red and green algal and invertebrate substrates.

The hydroid reported as *Plumularia pulchella* by Izquierdo et al. (1986) from the Canary Islands is probably *Monotheca margareta* (see discussion in Calder, 1997), further supporting the contention that *M. pulchella* is endemic to Australia.

**Type locality.** Queenscliff, Victoria, Australia.

**Known distribution.** Victorian coastal waters.

**Distinction between *Monotheca flexuosa* and *Monotheca pulchella*.** *Monotheca pulchella* (Bale, 1882) has often been confused by authors with *Monotheca flexuosa* (Bale, 1894). Although Bale clearly distinguished between the two species on the basis of *M. pulchella* having a robust septate stem, very short cauline internodes and hydrocladia midway along the internode, Totton (1930) reported infertile material from northern New Zealand as *M. pulchella*, presumably following Trebilcock (1928), who synonymised *M. flexuosa* in that species. Totton's opinion was based on i) the specimens being twice the size of those described by Bale (for *M. flexuosa*), some being half an inch in height (12 mm) and bearing 48 hydrocladia, ii) the trophosome of *M. flexuosa* falling well within the range of variation of *M. pulchella* and iii) there being only slight apparent differences in the gonosome. His figure (fig. 58, p. 221) is clearly that of *M. flexuosa*.

Later authors, such as Millard (1975) followed Totton but, with the exception of Millard, they did not provide figures of their specimens so the accuracy of their identifications cannot

be confirmed. Watson (1973) examined Bale's microslide specimens of both species in the collection of Museum Victoria, reporting the species to be markedly different and concluded that Totton was incorrect for the following reasons: i) height of the hydrocaulus is an unreliable character, ii) *M. flexuosa* has a more flexuous hydrocaulus than *M. pulchella* and iii) the gonothecae of the two species are markedly different. Medel and Vervoort (1995) misinterpreted Watson's (1973) note on the submarginal gonothecal cusps of *M. pulchella*, and their description and figure is clearly that of *M. flexuosa*. Infertile material on green algae reported from New Zealand by Vervoort and Watson (2003) is also *M. flexuosa*.

On present evidence, *M. pulchella* is endemic to southern Australia where it is associated only with brown algae.

***Monotheca spinulosa* (Bale, 1882)**

Fig. 5A–G

*Plumularia spinulosa* Bale, 1882: 30, pl. 15, fig. 8.— Bale, 1884: 139, pl. 12, figs 11–12.— Bale, 1888: 783, pl. 19, figs 11–13.— Von Lendenfeld, 1885a: 475.— Bartlett, 1907: 43.— Warren, 1908: 320.— Mulder and Trebilcock, 1910: 123, pl. 3, fig. 9, 9a.— Mulder and Trebilcock, 1916: 81, pl. 11, fig. 4.— Briggs, 1918: 34, 43.— Bedot, 1921: 29.— Blackburn, 1937: 368.— Blackburn, 1942: 116.— Pennycook, 1959: 180.— Ralph, 1961c: 109.— Millard, 1962: 301.— Millard, 1966: 494.— Berrisford, 1968: 394.— Day, et al., 1970: 14.— Watson, 1973: 188, figs 54, 55.— Millard, 1975: 401, fig. 125 E–J.— Millard, 1978: 196.— Watson, 1982: 107, fig. 4.11f–h.— Stranks 1993: 13.

*Monotheca spinulosa*.— Stechow, 1921: 260.— Stechow, 1923: 17.— Leloup, 1932: 160.— Millard, 1975: 401, fig. 125 E–J.— Millard, 1978: 196.— Hirohito, 1995: 278, fig. 96a–c.— Watson, 1996: 78.— Watson, 1997: 529.— Watson and McInnes, 1999: 111.— Watson 2003: 243, 252.— Vervoort and Watson, 2003: 369, 374.— Watson, 2005: 542.— Bouillon et al., 2006: 368.

*Plumularia spinulosa* var. *obtusa*.— Millard, 1957: 232.

*Monotheca spinulosa* var. *obtusa*.— Stechow, 1923d: 225.— Yamada, 1959: 78.

**Material examined.** NMV F59053, microslide, Queenscliff Victoria, Bale collection, Museum Victoria, nominated as probable syntype by Stranks (1993).

**Material in author's collection:** Stradbroke Island, south Queensland, on alga, depth 20 m, coll: J. Watson, 24 August 1975. Coniston Bay, Port Kembla, New South Wales, on bryozoan, depth 18 m, coll: J. Watson, September 1975. Gabo Island, Victoria, on ascidian *Herdmania grandis* and red algae under ledges, depth 12 m, coll: J. Watson, 15 February 1973. Port Phillip Heads, Victoria, on red alga, depth 10 m, coll: J. Watson, 9 January 1984. South (20 km) of Cape Bridgewater, Victoria, on red alga, depth 100 m, coll: V. Johnstone, from fishing trawl, 16 May 1969. Port Noarlunga, South Australia, on red alga, depth 10 m, coll: J. Watson, 10 February 1976. Abrolhos Islands, outer reef, Western Australia, on red alga, depth 15 m, coll: J. Watson, 17 October 1986. Karapuki Island, New Zealand, coll: D. A. Staples 14 September 1975 on red alga.

**Description.** Hydorrhizal stolons ribbon-like, flattened to substrate, outer flange with flexion joints in perisarc. Stems monosiphonic, to 5 mm high, basal stem region athecate, sometimes with two or three transverse nodes. Cauline internodes variable in length among colonies but typically moderately long and slender, straight to slightly curved, walls smooth, expanding slightly distally to apophysis, nodes

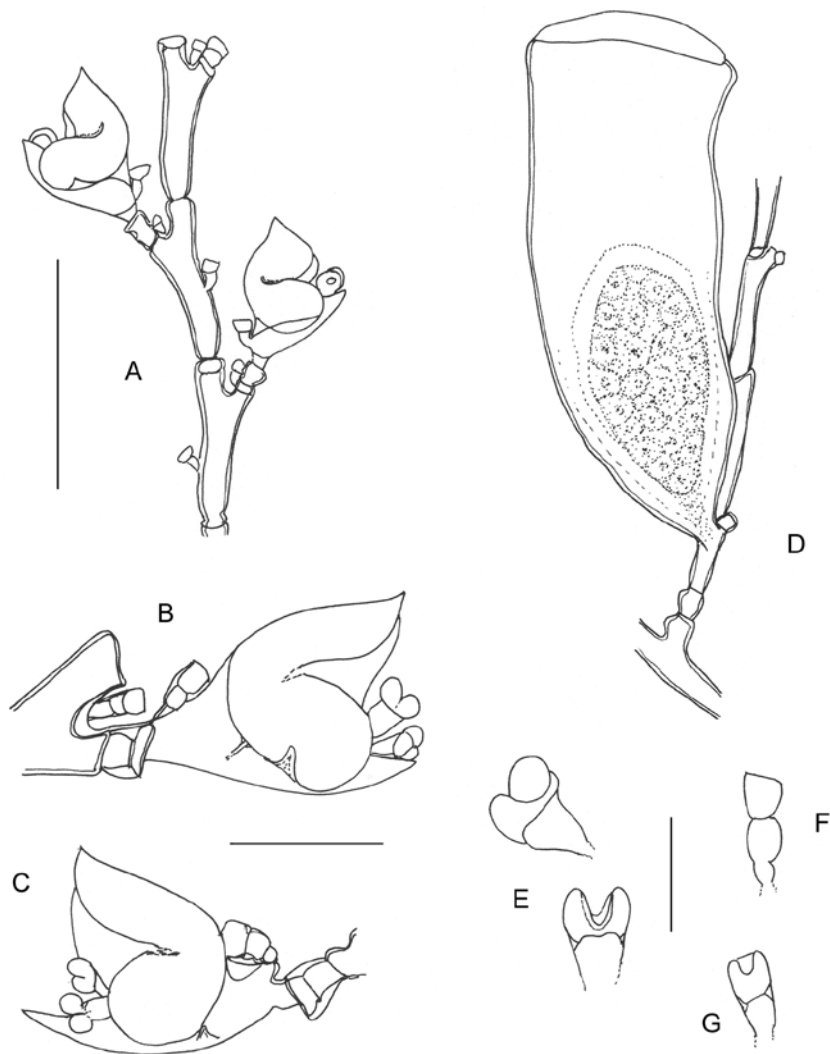


Figure 5. A–G, *Monotheca spinulosa*. A, part of stem; B, hydrocladium with short terminal spine; C, hydrocladium with long terminal spine; D, female gonotheca with ova; E, two views of twin lateral nematothecae; F, axillar nematotheca; G, median inferior nematotheca. Scale bar: A, 0.3 mm; B, C, 0.2 mm; D, 1 mm; E–H, 0.1 mm.

transverse to slightly oblique, deeply constricted, an internal transverse septum below node.

Hydrocladia alternate, distal on internode, in one plane, borne on an upwardly directed apophysis, abcauline wall of apophysis a smooth extension of internode, distal node a deep transverse shoulder with internal septum behind node, a minute mound-shaped hydrostatic pore in axil beside a nematotheca. Hydrocladium with a short proximal athecate internode, distal node transverse, deeply constricted with an internal septum, occasionally an identical secondary athecate internode between the athecate and hydrothecate internode. Hydrothecate internode narrow, short, ending in a distal spine of variable length, projecting beyond hydrotheca.

Hydrotheca occupying most of internode; internode expanding distally as a prehydrothecal chamber between node

and floor of hydrotheca, often a minute septum projecting backwards into chamber from floor of hydrotheca. Hydrotheca bonnet shaped, laterally compressed, adcauline wall rounded, set deep in internode, abcauline wall curved, proximally convex, straightening towards margin; margin delicate, deeply divided by a long V-shaped septum passing deeply backwards into hydrotheca, a minute triangular in septum in base of some hydrothecae. Hydranth with 12–14 tentacles.

Nematothecae bithalamic, moveable, all approximately of same size: one cauline, halfway along internode on opposite side to apophysis, one on internode in axil, one median inferior, base close to internode, twin laterals standing erect in front of hydrotheca, one at each side of distal spine, bases short, slightly inflated, cup deeply adcaudally excavated into a butterfly shape.

Male and female gonothecae large, one to several borne near base of stem, inserted on a short indistinct pedicel beside apophysis; body narrowly conical, facing upwards, walls smooth to weakly undulated, distally truncate, closed by a sheet of tissue, immature female gonophore with many ova.

Perisarc of stem and gonotheca moderately thick, thin on hydrothecal margin. Colonies colourless to white.

***Monothecha spinulosa*, measurements, ( $\mu\text{m}$ )**

Hydrorhiza, width	96–120
Stem	
internode length	228–320
diameter at node	30–50
length of apophysis (adcauline wall)	30–40
Hydrocladium	
length of athecate internode	32–56
width at distal node (shoulder)	40–60
length of base of thecate internode (excluding spine)	160–192
length of subhydrothecal chamber	199–200
length of terminal spine	18–64
Hydrotheca	
length of abcauline wall (measured diagonally from base)	156–200
width of margin	136–168
Gonotheca	
length (excluding pedicel)	1200–1560
maximum width (at margin)	640–740
Nematotheca	
length of base	22–32
diameter of cup	22–36

**Remarks.** A microslide (NMV F59053) in the Bale collection of Museum Victoria labelled '*Plumularia spinulosa* Bale 1882, Queenscliff' was nominated as a probable syntype by Stranks (1993). As this is the only known specimen, by monotypy it is the holotype of the species.

The position of the cauline nematotheca varies between colonies, typically being about halfway along the internode but sometimes only one-third the distance up from the proximal node. The position of the cauline apophysis is also somewhat variable, ranging from well below to close to the distal node. The axillar hydrostatic pore is very small and is only seen with careful searching.

Stechow (1923) erected the var. *obtusa* for morphotypes with a blunt terminal hydrocladial spine and Ralph (1961b) erected the var. *spinulosa* for material from New Zealand with a long terminal spine. Later studies, including the present one, suggest the length of the spine is very variable. Watson (2005) suggested it may be a response to environmental conditions and evidence from this study supports this conclusion, specimens with the longest spines being from deeper, less turbulent habitat.

*M. spinulosa* is a very small species with a preference for a substrate of flabellate red algae.

**Type locality.** Queenscliff, Victoria, Australia.

**Known distribution.** Temperate southern Australia to southeast Queensland, Lord Howe Island, New Zealand, Japan, South Africa, south Atlantic. Littoral to 100 m.

***Monothecha togata* (Watson, 1973)**

Fig. 6 A–I

*Plumularia togata* Watson, 1973: 191, figs 65–67.— Bouillon et al., 2006: 371.— Stranks, 1993: 14.

?*Monothecha togata*.— Vervoort and Watson, 2003: 374, fig. 91A–E.

**Material examined.** NMV F42060, holotype, microslide (malinol mounted), Pearson Island, South Australia, on red alga *Metagoniolithon charoides*, depth 33 m, coll: S. Shepherd 8 January 1969. Paratypes: microslides NMV F42061, F42062, F42063, F4G2064, F42065, F42066, F42105; SAMH40, Pearson Island on red alga *Metagoniolithon charoides*, coll: S. Shepherd, 8 January 1969.

**Description.** Hydrorhiza a network of broad, flat stolonal tubes with internal flexion joints. Stems short, to 4 mm long, monosiphonic, with one to three short basal internodes, nodes transverse, succeeding internodes moderately long and slender, expanding distally to a broad shoulder at apophysis, a strong transverse septum above and below node at level of apophysis, distal node V-shaped, sometimes a weak transverse septum about halfway up internode near level of cauline nematotheca.

Apophysis short, robust, just below distal cauline node, slightly frontal on stem, upwardly directed, abcauline wall a continuation of internode, adcauline wall set close to internode, distal end wide, thickened, node transverse, a weak oblique internal septum below node.

Hydrocladia alternate, one on cauline internode, slightly forwardly directed, athecate internode very short, corrugated, a strong transverse internal septum, distal node transverse. Hydrothecate internode much longer than athecate internode, inserted into shoulder of athecate internode with a slender V-shaped joint; internode downwardly curved below hydrotheca.

Hydrotheca cowl shaped (lateral view), scoop shaped (anterior view), with a distinctly peaked adcauline margin (i.e. opposite base of hydrotheca), prehydrothecal chamber short, inflated, upper (adcauline) wall strongly convex, sometimes a faint septum passing from internode into base, hydrothecal margin hemispherical to triangular (anterior view), in lateral view adcauline wall extending in a peak over margin; rim thickened and outrolled.

Nematothecae bithalamic, moveable, all similar in shape but differing slightly in length of base, cup robust, wide and fairly shallow, adcaudally excavated almost to base; one cauline, about halfway along internode on same side as apophysis, one axillar beside apophysis, one median inferior on hump of prehydrothecal chamber, just reaching base of hydrotheca, twin laterals standing close together at either side of a low distal protuberance of internode, bases short, sides facing inwards to hydrothecal margin; in lateral view, nematothecae appear to be almost inside hydrothecal margin.

Male gonotheca large, inserted on a short, straight pedicel



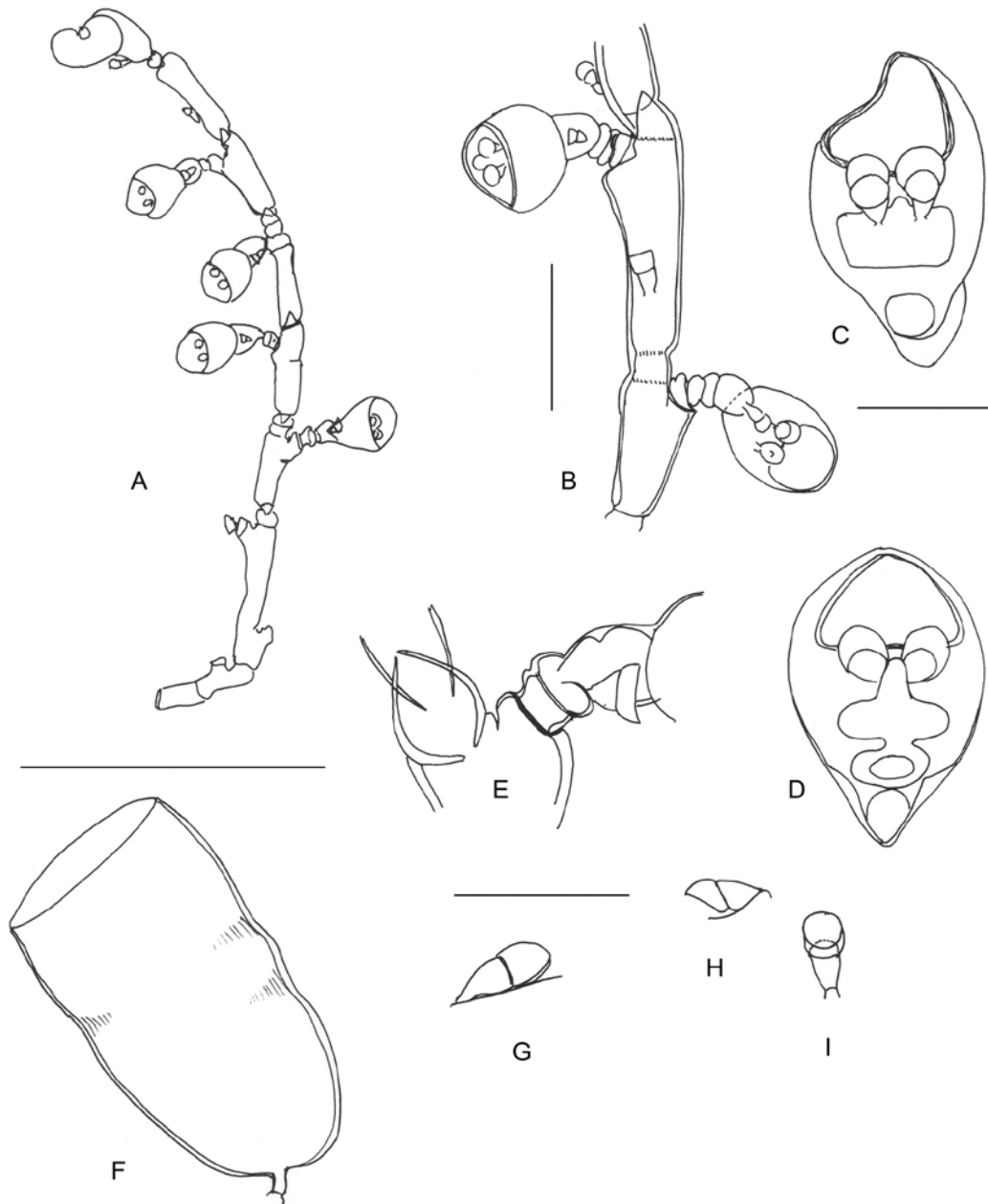


Figure 6. A–I, *Monotheca togata*. A, stem; B, part of stem showing internodes; C, slightly oblique ventral view of hydrotheca; D, full ventral view of hydrotheca, both views showing twin lateral nematocystae; E, apophysis of stem with proximal hydrocladium; F, gonotheca; G, cauline nematocyst; H, median inferior nematocyst; I, one of twin lateral nematocystae. Scale bar: A, F, 1 mm; B, 0.3 mm; C–I, 0.1 mm.

beside apophysis on first stem internode, body barrel shaped, distally truncated, walls smooth to weakly undulated, aperture terminal, transverse, closed by a sheet of tissue. Female gonotheca unknown.

***Monothecha togata*, measurements ( $\mu\text{m}$ )**

Hydrorhiza, width	72–80
Stem	
length of cauline internode	300–360
width at subnodal septum	76–80
length of apophysis (adcauline)	40–50
Hydrocladium	
length of subhydrothecal chamber adcauline	100–130
length of athecate internode	30–40
width at distal shoulder	44–64
length of hydrothecate internode (along base)	180–220
Hydrotheca	
depth, floor to highest point on margin	192–224
width across margin (frontal view)	186–200
Nematotheca	
length of base of cauline	36–52
width of cup	26–40
length of base of median inferior	28–32
width of cup	48–52
width of cup of lateral	30–44
Gonotheca	
length of pedicel	35–40
length excluding pedicel	1040–1260
distal diameter	600

**Remarks.** The cauline and axillar nematothecae are often absent. The frontal position of the cauline apophysis causes the hydrocladia and hydrothecae to twist forward during microslide mounting, which tends to obscure some structures.

This is first description of the gonotheca of *Monothecha togata*. The species is closely related to *M. hyalina* in size of stems and the cowl-shaped hydrotheca with a hemispherical margin. The distinctive adcauline apertural peak of *M. togata* distinguishes it from *M. hyalina*.

*Monothecha togata* (NMNZ BS834), was reported from East Cape and Ranfurly Bank, New Zealand, by Vervoort and Watson (2003). However, the material differs from the Australian species in having i) no axial hydrostatic pore, ii) a much smaller hydrocladial median inferior nematotheca, and iii) shorter cauline and hydrothecate internodes. In contrast to the epiphytic Australian species, the New Zealand material is epizootic on *Synthecium suentricosum* and *Halopteris campanula*. These structural and substrate preferences may indicate the New Zealand material is a different species, but until more is known, the material is here doubtfully referred to *M. togata*.

**Type locality.** Pearson Island, Great Australian Bight.

**Known distribution.** Southern Australia to Western Australia, ?New Zealand.

**Key to species of *Monothecha* in Australia**

- 1 Hydrotheca cup or bowl shaped ..... 3
- hydrotheca not this shape ..... 2
- 2 Hydrotheca scoop, cowl or hood shaped ..... 6
- 3 Hydrotheca with conspicuous abcauline flange .....  
..... *Monothecha amphibola*
- hydrotheca with inconspicuous abcauline flange or no flange ..... 4
- 4 Hydrocaulus flexuous, gonotheca barrel shaped with distal aperture ..... *Monothecha flexuosa*
- hydrocaulus robust, gonotheca not barrel shaped ..... 5
- 5 Aperture of gonotheca oblique with submarginal lobes .....  
..... *Monothecha pulchella*
- 6 Hydrotheca with adcauline intrathecal septum ..... 7
- hydrotheca without intrathecal septum ..... 9
- 7 Intrathecal septum inconspicuous ..... *Monothecha obliqua*
- intrathecal septum well developed ..... 8
- 8 Hydrocladium with terminal spine .....  
..... *Monothecha spinulosa*
- hydrocladium without terminal spine .....  
..... *Monothecha australis*
- 9 Hydrotheca subhemisphaerical, margin hooded ..... 10
- 10 Hydrotheca with distinct adcauline marginal peak .....  
..... *Monothecha togata*
- 11 Hydrothecal margin without adcauline peak .....  
..... *Monothecha hyalina*

**Acknowledgements**

I thank the many colleagues who generously spent time underwater with me over the years and the much appreciated helpful criticism of the reviewers of the manuscript.

**References**

- Anonymous 2004. Catalogues of the collections in the Showa Memorial Institute, National Science Museum, Tokyo. No. 2: 1–139.
- Bale, W. M. 1882. On the Hydroids of south-eastern Australia, with descriptions of supposed new species, and notes on the genus *Aglaophenia*. *Journal of the Microscopical Society of Victoria* 2: 15–48, pls 12–15.
- Bale, W. M. 1884. *Catalogue of the Australian hydroid zoophytes*. Australian Museum, Sydney. Pp. 198, pls 1–19.
- Bale, W. M. 1888. Some new and rare hydroids in the Australian Museum. *Proceedings of the Linnean Society of New South Wales*: 745–799.

- Bale, W. M. 1894. Further notes on Australian hydroids, with descriptions of some new species. *Proceedings of the Royal Society of Victoria* (n.s.) 6: 93–117, pls 3–6.
- Bartlett, G. C. 1907. Notes on hydroid zoophytes. *Geelong Naturalist* 3: 35–45, 60–66.
- Bedot, M. 1921. Notes systématiques sur les plumularides. Ire partie. *Revue Suisse de Zoologie* 28: 311–356.
- Berrisford, C. D. 1968. Biology and zoogeography of the VEMA Seamount: a report on the first biological collection made on the summit. *Transactions of the Royal Society of South Africa* 38(4): 387–398.
- Billard, A. 1927. Les Hydroïdes de la côte atlantique de France. *Compte Rendu du Congrès des Sociétés Savantes de Paris et des Départements. Sections des Sciences, 1926*: 326–346.
- Billard, A. 1936. Les fonds de pêche près d'Alexandre.VI. Hydroïdes. *Notes et Memoires du Ministère de Commerce et de l'Industrie d'Egypte* 73: 1–11.
- Blackburn, M. 1937. Notes on Australian Hydrozoa, with descriptions of two new species. *Proceedings of the Royal Society of Victoria* 50: 170–181.
- Blackburn, M. 1938. Hydrozoa. The Sir Joseph Banks Islands. Reports of the expedition of the McCoy Society for field investigation and research, 3. *Proceedings of the Royal Society of Victoria* 50: 312–328.
- Blackburn, M. 1942. A systematic list of the Hydroïda of South Australia with a summary of their distribution in other seas. *Transactions of the Royal Society of South Australia* 66: 104–118.
- Blanco, O. M. 1973. Nuevos plumularidos para aguas Argentinas. *Neotropica. Notas Zoológicas Sudamericanas* 19: 73–78.
- Boero, F. 1981a. Systematics and ecology of the hydroid population of two *Posidonia oceanica* meadows. *Publicazione della Stazione Zoologica Napoli. Marine Ecology* 2: 181–197.
- Boero, F. 1984. The ecology of marine hydroids and effects of environmental factors: a review. *Publicazione della Stazione Zoologica Napoli. Marine Ecology* 5: 93–118.
- Boero, F., Chessa, L., Chimez, C. and Fresi, E. 1985. The zonation of epiphytic hydroids on the leaves of some *Posidonia oceanica* (L.) Delile beds in the central Mediterranean. *Publicazione della Stazione Zoologica Napoli. Marine Ecology* 6: 27–33.
- Gili, J.-M., W. Vervoort and Pagès, F. 1989. Hydroids from the west African coast: Guinea Bissau, Namibia and South Africa. *Scientia Marina* 53(1): 67–112.
- Bouillon, J., Massin, C. and Kresevic, R. 1995. Hydroidomedusae de l'Institut Royal des Sciences naturelles de Belgique. *Documents de Travail de l'Institut Royal des Sciences Naturelles de Belgique* 78: 3–106.
- Bouillon, J., Medel, M. D., Pagès, F., Gili, J.-M., Boero, F. and Gravili, C. 2004. Fauna of the Mediterranean. Hydrozoa. *Scientia Marina* 68(2): 5–438.
- Bouillon, J., Gravili, C., Pagès, F., Gili, J.-M. and Boero, F. 2006. An introduction to Hydrozoa. *Mémoires du Museum National d'Histoire Naturelle* 194: 1–591.
- Briggs, E.A. 1918. Descriptions of two new hydroids and a revision of the hydroid-fauna of Lord Howe Island. *Records of the Australian Museum* 12: 27–47, pls 5–6.
- Broch, H. 1933. Zur Kenntnis der Adriatischen Hydroïdenfauna von Split. Arten und Variationen. *Skrifter utgitt av det Norske Videnskaps-Akademi i Oslo. Mat.-Nat. Klasse* 1933(4): 1–115.
- Calder, D. R. 1997. Shallow-water hydroids of Bermuda: (Superfamily Plumularioidea). *Royal Ontario Museum Life Science Contributions* 161: 1–86.
- Cornelius, P.F.S. 1995. North-west European thecate hydroids and their medusae. Part 2. Sertulariidae to Campanulariidae. in: Barnes, R.S.K. and Crothers, J.H. (eds). *Synopses of the British fauna (new series)* 50: 1–386.
- Day, J. H., Millard, N. A. H. and Harrison, A. D. 1952. The ecology of South African estuaries. *Transactions of the Royal Society of South Africa* 33: 367–413.
- Day, J. H., Field, J. G. and Penrith, M. J. 1970. The benthic fauna and fishes of False Bay, South Africa. *Transactions of the Royal Society of South Africa* 39: 1–108.
- El Beshbeeshy, M. 1995. Systematische, Morphologische und Zoogeographische Untersuchungen an den Thekaten Hydroïden des Patagonischen Schelfs. Dissertation, Universität Hamburg. Pp 1–390.
- Fresi, E., Chimez, C. and Marchio, G. 1982. Zonazione di briozoi ed idrioidi epifiti in una prateria de *Posidonia oceanica* (L.) Delile. *Naturaliste Sicily*. 6: 499–508.
- García-Corrales, P., Aguirre Inchaurre, A. and Gonzalez Mora, D. 1978. Contribución al conocimiento de los hidrozoos de las costas españolas. Parte I: Halécidos, campanuláridos y plumularídeos. *Boletín del Instituto Español de Oceanografía* 4(253): 5–73.
- Genzano, G. N. 1990. Hidropólipos (Cnidaria) de Mar del Plata, Argentina. *Nerítica* 5(1): 50–52.
- Genzano, G. N. 1994. Organismos epizóicos de *Amphisbetia operculata* (L) (Cnidaria, Hydrozoa). *Iheringia, Zoologica* 76: 3–8.
- Hirohito 1974. Some hydroids of the Bonin Islands. *Publications of the Biological Laboratory, Imperial Household, Tokyo 1974*: 1–55, figs 1–20.
- Hirohito, 1983. Hydroids from Izu Oshima and Niijima. *Publications of the Biological Laboratory, Imperial Household, Tokyo (1983)* 6: 1–83, figs 1–41.
- Hirohito, 1995. The hydroids of Sagami Bay. II. *Publications of the Biological Laboratory, Imperial Household, Tokyo 1995*: 1–244, pls 1–13.
- Hodgson, M. M. 1950. A revision of the Tasmanian Hydroïda. *Papers and Proceedings of the Royal Society of Tasmania 1949*: 1–65.
- Isasi, I. and Saiz, J.I. 1986. Sistemática de Cnidarios del Abra de Bilbao. *Cuadernos de Investigaciones Biológicas* 9: 67–74.
- Izquierdo, M. S., García-Corrales, P. and Bacallado, J. J. 1986. Contribution to the study of the calypotblastid hydrozoans of the Canary Islands (Spain). II. Plumulariidae. *Boletín del Instituto Español de Oceanografía* 3(2): 49–66.
- Jäderholm, E. 1919. Zur Kenntnis der Hydroïdenfauna Japans. *Arkiv för Zoologi* 12(9): 1–34, pls 1–6.
- Johnston, G. 1847. A History of the British Hydroid Zoophytes. Van Voorst, London, 2<sup>nd</sup> edition. Vol. 1 : i-xvi, 1–488, figs 1–87; vol. 2 : pls 1–74.
- Kirchenpauer, G.H. 1876. Ueber der Hydroïdenfamilie Plumulariidae, einzelne Gruppe derselben und ihre Fruchtbehälter. II. *Plumularia* und *Nemertesia*. *Abhandlungen aus dem Gebiete der Naturwissenschaften, Hamburg* 6: 1–59, pls 1–8.
- Leclère, L., Schuchert, P. and Manuel, M. 2007. Phylogeny of the Plumularioidea (Hydrozoa, Leptothecata): evolution of colonial organisation and life cycle. *Zoologica Scripta* 36: 371–394.
- Leloup, E. 1932. Une collection d'hydropolypes appartenant à l'Indian Museum de Calcutta. *Records of the Indian Museum* 34: 131–170.
- Leloup, E. 1934. Note sur les hydropolypes de la rade de Villefranche-sur-Mer (France). *Bulletin du Muséum Royal d'Histoire Naturelle de Belgique* 10: 1–18.
- McCrary, J. 1859. Gymnophthalma of Charleston Harbor. *Proceedings of the Elliot Society of Natural History of Charleston, South-Carolina* 1: 105–221.

- Medel, M. D. and López-González, P. J. 1996. Updated catalogue of the Iberian Peninsula and Balearic Islands, with remarks on zoogeography and affinities. *Scientia Marina* 60(1): 183–189.
- Medel, M. D. and Vervoort, W. 1995. Plumularian hydroids (Cnidaria: Hydrozoa) from the Strait of Gibraltar and nearby areas. *Zoologische Verhandelingen, Leiden*, 300: 11–72.
- Millard, N. A. H. 1957. The Hydrozoa of False Bay, South Africa. *Annals of the South African Museum* 43: 173–243.
- Millard, N.A.H. 1962. Hydrozoa of the south and west coasts of South Africa. Part I. The Plumulariidae. *Annals of the South African Museum* 46: 261–319.
- Millard, N.A.H. 1966. The Hydrozoa of the south and west coasts of South Africa. Part III. The Gymnoblastera and small families of the Calyptoblastea. *Annals of the South African Museum* 48: 427–487.
- Millard, N. A. H. 1975. Monograph on the Hydroida of southern Africa. *Annals of the South African Museum* 68: 1–513.
- Millard, N. A. H. 1978. The geographical distribution of southern African hydroids. *Annals of the South African Museum* 74: 159–200.
- Millard, N. A. H. 1980. Hydroida. The South African Museum's Meiring Naude cruises. Part II. *Annals of the South African Museum* 82: 129–153.
- Millard N.A.H. and Bouillon, J. 1974. A collection of hydroids from Moçambique, East Africa. *Annals of the South African Museum* 65: 1–40, figs 1–9.
- Mulder, J. F. and Trebilcock, R. E. 1910. Notes on Victorian hydroids with descriptions of new species. *Geelong Naturalist* 4(2): 115–120.
- Mulder J. F. and Trebilcock, R. E. 1915. Victorian Hydroida with description of new species. Part V. *Geelong Naturalist* 6(3): 51–59, pls 7–9.
- Mulder J. F. and Trebilcock, R. E. 1916. Notes on Victorian Hydroida. Part VI. *Geelong Naturalist* 6(4): 73–84, pls 10–11.
- Nutting, C.C. 1900. American hydroids. Part I. The Plumulariidae. *Special Bulletin of the United States Museum* 4(1): 1–285, pls 1–34.
- Park, J.H. 1992. Zoogeographical distribution of marine hydroids (Cnidaria: Hydrozoa: Hydroida). *Korean Journal of Systematic Zoology* 8(2): 279–300.
- Pennycuik, P. R. 1959. Faunistic records from Queensland. Part V. Marine and brackish water hydroids. *Papers of the Department of Zoology, University of Queensland* 1: 141–210.
- Ralph, P. M. 1961b. New Zealand thecate hydroids. Part IV. The family Plumulariidae. *Transactions of the Royal Society of New Zealand, Zoology* 1: 19–74.
- Ralph, P. M. 1961c. New Zealand thecate hydroids. Part V. The distribution of the New Zealand thecate hydroids. *Transactions of the Royal Society of New Zealand, Zoology* 1: 103–111.
- Rho, B. J. and Park, J. L., 1986. A systematic study on the marine hydroids in Korea. 8. On two new species belonging to the family Plumulariidae. *Korean Journal of Zoology* 217: 255–263.
- Roca, I., 1987. Hydroids on Posidonia in Majorcan waters. Pp 209–214 in: Bouillon, J., Cicogna, F., Cornelius P.F.S. (eds). *Modern trends in the systematics, ecology and evolution of hydroids and hydromedusae*. Clarendon Press, Oxford.
- Rossi, I. 1950. Celenterati de Golfe di Rapallo (Rivieri Ligure). *Bolletino dell'Instuto e Museo di Zoologia della Università di Torino* 2: 193–235.
- Ryland, J.S. and Gibbons, M.J., 1991. Intertidal and shallow water hydroids from Fiji. II. Plumulariidae and Aglaopheniidae. *Memoirs of the Queensland Museum* 30: 525–560.
- Shepherd, S.A. and Watson, J.E., 1970. The Sublittoral ecology of West Island, South Australia. 2. The association between hydroids and algal substrate. *Transactions of the Royal Society of South Australia* 94: 139–146, pl. 1.
- Staples, D. A. and Watson, J. E. 1987. Associations between pycnogonids and hydroids. Pp. 215–226 in: J. Bouillon, F. Boero, F. Cicogna and Cornelius, P. F. S. (eds), *Modern trends in the systematics, ecology and evolution of hydroids and hydromedusae*, Clarendon Press, Oxford.
- Stechow, E. 1919. Zur Kenntnis der Hydroidenfauna des Mittelmeeres, Amerikas und anderer Gebiete, nebst Angaben über einige Kirchenpauer'sche Typen von Plumulariden. *Zoologischer Jahrbücher, Abteilung für Systematik* 42: 1–172.
- Stechow, E. 1921. Neue Genera und Species von Hydrozoen und anderen Evertebraten. *Archiv für Naturgeschichte* 87: 248–265.
- Stechow, E. 1923a. Neue Hydroiden der Deutschen Tiefsee-Expedition, nebst Bemerkungen über einige andre Formen. *Zoologischer Anzeiger* 56: 1–20.
- Stechow, E. 1923b. Die Hydroidenfauna der japanischen Region. *Journal of the Imperial University of Tokyo* 44: 1–23.
- Stechow, E. 1923d. Zur Kenntnis der Hydroidenfauna des Mittelmeeres, Amerikas und anderer Gebiete. II. Teil. *Zoologischer Jahrbücher, Abteilung für Systematik* 47: 29–270.
- Stechow, E. 1924. Diagnosen neuer Hydroiden aus Australien. *Zoologischer Anzeiger* 59: 57–69.
- Stechow, E. 1925. Hydroiden von West- und Südwestaustralien nach den Sammlungen von Prof. Dr. Michaelsen und Prof. Dr. Hartmeyer. *Zoologische Jahrbücher, Abteilung für Systematik* 50: 191–270.
- Totton, A.K. 1930. Coelenterata. Part V. Hydroida. *Natural History Report. British Antarctic Terra Nova Expedition 1910, Zoology* 5(5): 131–252, pls 1–3.
- Stranks, T. N. 1993. Catalogue of recent cnidarian type specimens in the Museum of Victoria. *Occasional Papers from the Museum of Victoria* 6: 1–26.
- Trebilcock, R. E. T. 1928. Notes on New Zealand Hydroida. *Proceedings of the Royal Society of Victoria* n. ser. 41(1): 1–31.
- Vervoort, W. and Watson, J. E. 2003. Marine fauna of New Zealand. Leptothecata (Cnidaria: Hydrozoa) (Thecate Hydroids) *NIWA Biodiversity Memoir* 119: 1–538.
- Von Lendenfeld, R. 1885a. The Australian Hydromedusae. *Proceedings of the Linnaean Society of New South Wales* 9: 206–241, 345–353, 401–420, 467–492, 581–634. pls 6–8, 12–17, 20–29.
- Warren, E. 1908. On a collection of hydroids mostly from the Natal coast. *Annals of the Natal Museum* 1: 269–355.
- Watson, J. E. 1973. Hydroids. Pearson Island expedition 9. *Transactions of the Royal Society of South Australia* 97: 153–200.
- Watson, J. E. 1975. Hydroids of Bruny Island, southern Tasmania. *Transactions of the Royal Society of South Australia* 99: 157–176.
- Watson, J.E. 1979. Biota of a temperate shallow water reef. *Proceedings of the Linnaean Society of New South Wales* 103: 227–235.
- Watson, J.E. 1982. Hydroids (Class Hydrozoa). Pp 77–115 in: Shepherd, S.A. and Thomas I.M (eds) *Handbook of the flora and fauna of South Australia. Marine invertebrates of southern Australia 1*. Handbook Committee, South Australian Government, Adelaide.
- Watson, J. E. 1992. The hydroid community of *Amphibolis* seagrasses in south-eastern and south-western Australia. in: J. Bouillon, F. Boero, F. Cicogna, J.-M. Gili and Hughes, R. G. (eds), *Aspects of Hydrozoan Biology, Scientia Marina*. 56: 217–227.
- Watson, J. E. 1996. Distribution and biogeographic relationships of the hydroid fauna of the Australian west coast: a preliminary account. in: S. Piraino, F. Boero, J. Bouillon, P. F. S. Cornelius and Gili, J. M. (eds), *Advances in Hydrozoan Biology, Scientia Marina*. 60: 75–83.

- Watson, J. E. 1997. The hydroid fauna of the Houtman Abrolhos Islands, Western Australia. Pp. 503–546 in: F. E. Wells (ed.), *Proceedings of the Seventh International Marine Biological Workshop. The Marine Flora and Fauna of the Houtman Abrolhos Islands, Western Australia*, Western Australian Museum, Perth.
- Watson, J.E. 2000. Hydroids (Hydrozoa) from the Beagle Gulf and Darwin Harbour, northern Australia. *The Beagle, Records of the Museums and Art Galleries of the Northern Territory* 16: 1–82.
- Watson, J. E. 2003. Encounter 2002 expedition to the Isles of St Francis, South Australia: annotated list of shallow water hydroids with description of a new species of *Campanularia*. *Transactions of the Royal Society of South Australia* 127: 243–263.
- Watson, J. E. 2005. Hydroids of the Archipelago of the Recherche and Esperance, Western Australia: annotated list, redescription of species and description of new species. Pp 495–611 in: F.E. Wells, G.I Walker, and Kendrick, G.A. (eds). *The marine flora and fauna of Esperance, Western Australia*. Western Museum, Perth.
- Watson, J. E. and McInnes, D. E. 1999. Hydroids from Ricketts Point and Black Rock, Victoria. *The Victorian Naturalist* 116: 102–111.
- Yamada, M. 1959. Hydroid fauna of Japan and its adjacent waters. *Publications from the Akkeshi Marine Biological Station* 9: 1–101.

