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The moss-back alga (Cladophorophyceae, Chlorophyta) on two species of freshwater turtles in the Kimberleys

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Abstract

The range of the Australian freshwater alga *Basicladia ramulosa* Ducker is extended, both in its turtle hosts (*Chelodina burrungandjii* Thomson et al.; *Emydura australis* (Grey)) and in geography, to tropical northern Western Australia. Along with further morphological observations, sporangia are described for the first time in this taxon.

Introduction

Moss-back turtles (Fig. 1) have fascinated biologists for many years. While the carapace of a potentially amphibious turtle would be a challenging habitat for most aquatic organisms, it is perhaps surprising there are only a handful of attached algae reported from such sites. Edgren et al. (1953) detailed the range of host turtles then known in North America and the range of epizoic algae that included *Rhizoclonium* and *Cladophora*. Two further genera in the Cladophoraceae are the only macroalgae widely reported on turtle carapaces: the prostrate, spreading, endozoic (and possibly disease causing) *Dermatophyton radicans* Peter, and species of the heterotrichous genus *Basicladia*, responsible for the name 'moss-back'.

In the United States, *Basicladia* is considered a small epizoic genus on turtles and water snails, of three to four taxa (John 2003). Hamilton (1948) described sexual reproduction in North American species of *Basicladia* involving the fusion of biflagellate zooids as is commonly the case in the Cladophoraceae. From unialgal cultures and field experiments, Proctor (1958) provides a natural history of *Basicladia* in North America and contends that *Basicladia* will establish on various substrates if a source of inoculum, a moss-back turtle, is present. Ernst and Norris (1978) added further to the understanding of *B. crassa* and its association with its host. *B. chelonum* is reported by Sherwood et al. (2003) to have been collected on rock in Ho'omaluhia Botanical Garden in Hawai'i but was brought in with imported freshwater turtles.

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In Australia, one species, *Basicladia ramulosa* Ducker, has been described and reported from Victoria and Queensland (Ducker 1958). The purposes of this note are to report its occurrence in northern Western Australia and inland New South Wales (a distribution pattern that almost certainly reflects lack of collecting rather than anything else), to expand the description given by Ducker (1958) to include reproductive structures and make further comments on both prostrate and erect anatomy, and report further host animals. *Cladophora kosterae* van den Hoek, a free living taxon morphologically close to *Basicladia*, has been reported from New South Wales (Skinner & Entwisle 2004).

Methods

Collections were air dried or preserved in 70% ethanol. Slides were stained with aniline blue and mounted in 40% Karo. Examination was done with a Leitz Laborlux D microscope and drawing tube; photomicrographs were taken with a Nikon Coolpix 4500 digital camera and enhanced using Adobe Photoshop. Collections and slides are maintained at NSW.

Description

Basicladia ramulosa Ducker, *Hydrobiologia* 10: 165 (1958)

Type: Victoria: Stratford, on *Chelodina longicollis* (Shaw), *Ducker* s.n., 11 Dec 1956 (MEL? – see notes below, K) *n.v*.

Thallus heterotrichous, consisting of a basal cushion (endozoic) and branched erect axes (epizoic) (Fig. 2), on the carapaces of freshwater turtles (Fig. 1). *Basal system* one or more layers of isodiametric (18–25 µm diam.) or irregular tubular (11–18 µm diam.) cells in and on the substrate (Fig. 3). *Erect axes* filamentous, uniseriate becoming secondarily bi/triseriate by adhesion of lower cells reinforced by downward growth of rhizoids (Figs 4, 5), becoming uniseriate again in upper axis, 34–61 µm diam., or, with buttressing by adhesion, to 91 µm diam., terminal cell truncate, 14–25 µm diam. Branching bifurcate or trifurcate, becoming pseudodichotomous, usually above the lower 3 or 4 cells; laterals with very acute adaxial angle, arising below the endwall (occasionally up to ⅓ below endwall), 17–28 µm diam.; terminal cells truncate 14–16 µm diam. (Fig. 6). *Sporangia* intercalary, thin-walled, 17–32 µm diam., 55–116 (–145) µm long, development acropetal until upper 10–20 cells of branch all sporangia; opening round, projecting, sub-terminally lateral, terminal in apical cell (Fig. 7). Zooids 24–64 per sporangium, 6 × 6–9 µm, uniform, flagella 2.

Distribution: Western Australia, Northern Territory, Queensland, New South Wales and Victoria and probably throughout the continental mainland, on at least *Chelodina burrungandjii* Thomson et al. (2000), *C. longicollis* (Shaw) and *Emydura australis* (Grey). The presence of *C. burrungandjii* in the Kimberley is confirmed in Georges et al. (2002). As the *Chelodina* host is often nomadic, although moss-backs are less frequently encountered than clean backs, it is probable that *Basicladia ramulosa* may be encountered throughout the ranges of the three reported hosts: tropical northwestern Australia for *C. burrungandjii* and *Emydura australis*, and eastern and south-eastern Australia, especially the Murray-Darling system for *C. longicollis*. *Basicladia duckerae* has yet to be collected from other hosts (turtles, water snails) or found free-living.

It is very likely that the *Cladophora* referred to in Strøm (1921) is *Basicladia ramulosa* also. The locality given for the list of desmids found with the *Cladophora* is the Daly

Fig. 1. Moss-back *Chelodina longicollis*, Copeton Dam Rd, N.S.W. (Photo G.M. Towler)

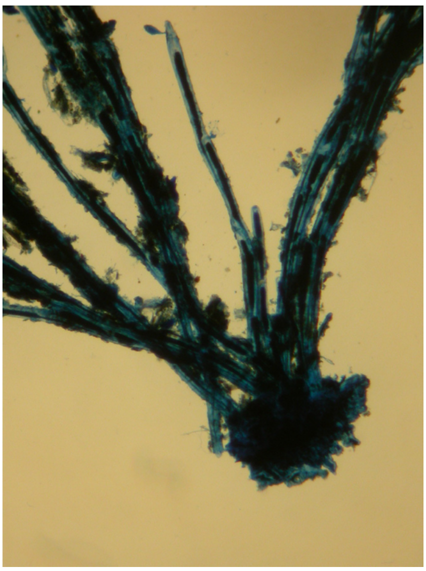

Fig. 2.

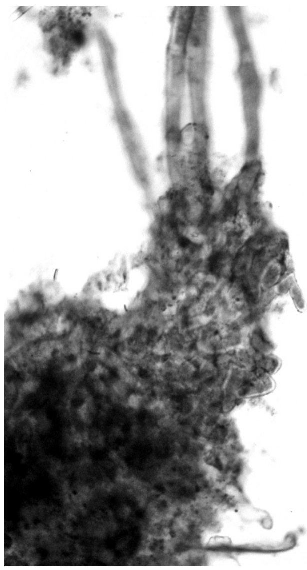

Fig. 3.

Fig. 2. Well developed multiseriate axes, *FitzSimmons A5*. Scale bar = 50 µm.

Fig. 3. Interlocking basal cells, *Skinner 0781, McPherson & Towler*. Scale bar = 20 µm.

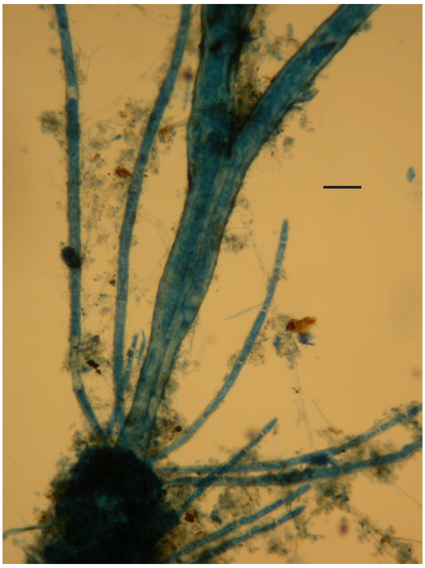

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 4. Biseriate base of erect axis, *Skinner 0781, McPherson & Towler*. Scale bar = 50 µm.

Fig. 5. Rhizoidal reinforcement of lower axis, *FitzSimmons A5*. Scale bar = 20 µm.

Fig. 6. Branching pattern showing narrow adaxial angle, *Skinner 0781, McPherson & Towler*. Scale bar = 20 µm.

Fig. 7. Sporangium with open pore and zooids in formation, *Skinner 0781, McPherson & Towler*. Scale bar = 20 µm.

River, and the host turtle is called *Chelodina oblonga* Gray, identified by Dahl (most likely *C. rugosa* Ogilby as *C. oblonga* is confined to south-western Western Australia).

MEL have been unable to locate the type specimen; it isn't on Doris Sinkora's data base of algal specimens held in MEL and is possibly out on loan.

Specimens examined: Western Australia: Mornington Camp, Annie Creek, Fitzroy R. (17°30' 29''S, 126°06'42''E), on *Chelodina burrungandjii*; ibid, *FitzSimmons A1*, Jun 2004; ibid, *FitzSimmons Cb06*, 8 Jun 2006 (NSW); ibid, on *Emydura australis*, *FitzSimmons 3*, Jun 2005 (NSW); 'pump pool' on Drysdale R. (15°41'37''S, 126°22'03''E), on *Chelodina burrungandjii*, *FitzSimmons A3*; ibid, on *Emydura australis*, *FitzSimmons A4*, Jun 2004 (NSW); Miners Pool, Drysdale R. (15°40'55''S, 126°24'12''E), on *Chelodina burrungandjii*, *FitzSimmons A5/6*, Jun 2004 (NSW); Bell Creek, Isdell R. drainage (17°01'03''S, 125°13'39''E) on *Emydura australis*, *FitzSimmons 2*, Jun 2005 (NSW). **New South Wales**: floodway, Copeton Dam Rd, near Staggy Ck turnoff (29°50'08''S, 150°53'31''E), on back of snake-necked turtle, *Chelodina longicollis*, *Skinner 0781*, *McPherson & Towler*, Oct 2004 (NSW).

Other Australian records: Victoria: Stratford, on *C. longicollis*, *S.C. Ducker*, Dec 1956 (MEL?; K) (Ducker 1958). **Queensland:** Aspley, near Brisbane, *J.E. Coaldrake*, Apr. 1957 (MEL?) (Ducker 1958). **Northern Territory:** lagoons near Daly River, *Knut Dahl*, 1894 (UPS?) (Strøm 1921)

Morphological Observations

Prostrate system: from the sections she made of the prostrate system on and in the *stratum corneum*, Ducker (1958, p 162) concluded that the cells 'in general are round or somewhat angular, ranging from 15 µm to 30 µm in diameter'. The prostrate system in our material appeared filamentous but compacted with multilobed cells interlocking to form the basal cushion from which arose the erect axes (Fig. 3 - it is often difficult to obtain undamaged basal material, with sufficient clearance of cuticle and detritus for good lighting for microphotography and this was the best material available).

Erect axes: Ducker's (1958) descriptions and illustrations of basal cells of recently produced erect axes are verified by our observations. Older, more established bases of erect axes however appear to adhere, and so become multiseriate, becoming buttressed by the extension downwards of close fitting rhizoid-like growths from the cell or cells above (Figs 4, 5). Such multiseriate axes may involve the lower three or four cells in an axis. A similar, but much shorter, downward growth of cells at branches could be observed throughout the axis, except in the fresh growth towards the ends of axes. In some cases fusion between the walls of axial and lateral cells was observed, especially in older parts of the thallus (Figs 2, 4). While speculative, it is inviting to think that both the rhizoidal buttressing and the adhesions are responses to frequent changes in temperature and wetting associated with the turtles' lifestyle.

Reproductive structures: Ducker (1958) does not mention reproductive structures. While no zooids were observed in Western Australian material (the material arrived either dry or already preserved) some upper cells in young filaments were modified as sporangia, thin walled, L/D 1.5– 4, with a subterminal funnel-like pore. The New South Wales material had well developed moniliform sporangial series, with mature, discharging and empty sporangia.

Hoffmann and Tilden (1930) described the sporangia in *B. crassa* as short and almost as broad as long, with the pore in various positions. This form of sporangium differs from that described by Hoffmann and Tilden (1930) for *B. chelonum*, and by van den

Hoek (1963) for *C. kosterae* and *C. okamurai* (Ueda) van den Hoek, all of which have (sometimes multiple) lateral pores close to the middle of the sporangium. Hamilton (1948) found that the North American species released biflagellated gametes from sporangia in moniliform series, sometimes up to 18 in *B. crassa*, opening through a lateral pore. His illustration (Plate 1, figs 3–5) indicates that the pore in *B. chelonum* may be displaced towards the top of the sporangium rather than precisely central. The position and number of pores in sporangia needs further examination before it can be used reliably to discriminate between taxa.

Acknowledgments

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