The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 2009 **25:** 17–42

Taxonomic revision of the order Halichondrida (Porifera: Demospongiae) from northern Australia. Family Axinellidae

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ABSTRACT

Nine species in five genera of the family Axinellidae, including three new species, *Axinella loribellae* sp. nov. *A. sinoxea* sp. nov. and *Phakellia tropicalis* sp. nov., are recorded for the tropical northern Australian waters of Western Australia, the Northern Territory and the Queensland coast as part of a revision of the order Halichondrida (Porifera: Demospongiae) in this region. One species, *Dragmacidon durissimum* (Dendy, 1905), generally found in the Indian Ocean, represents a new record for Australia. Taxonomic descriptions and discussion of those species are presented here. The position of *Reniochalina* within the Axinellidae is also discussed based on new evidence found in this and other studies.

KEYWORDS: Sponge, Porifera, Halichondrida, Axinellidae, northern Australia, new species, taxonomy.

INTRODUCTION

The northern marine region of Australia, or the Northern Province as defined by the Interim Marine and Coastal Regionalisation of Australia (IMCRA, version 3.3, www.environment.gov.au/coasts/mpa/imcra/index.html) includes tropical waters off the Northern Territory (from the Admiralty Gulf in the west) and the Queensland coasts (western coast of Cape York to Torres Strait in the east). The continental shelf of this area is generally shallow (less than 70 m) and extensive, reaching approximately 400 km in width in the Timor Sea and adjoining the coast of New Guinea in the Arafura Sea and Torres Strait (Bunt 1987; Ferns 1999). The area is part of the central Indo-West Pacific, which is well known for its high species-richness, high levels of endemism and is considered to be centre of origin of many tropical marine species (Veron 1995).

Sponges are one of the most diverse and prevalent groups of marine invertebrates of northern Australia, but also one of the most poorly known in terms of proportions of known and new species, and levels of endemism. According to Hooper *et al.* (1997) the northern sponge fauna includes approximately 800 species, 60% of which remain undescribed. Further studies based on 'presence-absence' analyses of the diversity of tropical Australian sponges (Hooper *et al.* 2002) identified at least two 'hot spots' of biodiversity for the northern area, one in the region of Darwin and Cobourg Peninsula and the other in the Wessel Islands region. Only 30% of the sponge species included in that biodiversity study could be assigned to a known taxon indicating that a great percentage of the fauna of that region is not well known.

Taxonomic knowledge of northern Australian sponges is limited to a few studies. The first sponges collected from this area were described by Ridley (1884) and included 24 species, of which only 17 are currently recognised as valid species. Bergquist and Tizard (1967) later described 19 species from the rich intertidal area of Darwin Harbour. Since 1967, there have been 50 additional records to the fauna of northern Australia and only one revision of a particular group, i.e. the family Halichondriidae (Hooper *et al.* 1997 and references within). Recent descriptions of some species have also been included in major taxonomic revisions of the demosponge families Raspailiidae (Hooper 1991) and Microcionidae (Hooper 1996).

The order Halichondrida is presently represented in northern Australia by 41 nominal species (Hooper and Wiedenmayer 1994; Hooper *et al.* 1997), and a large number of specimens recently collected and deposited in the Museum and Art Gallery Northern Territory and the Queensland Museum (see abbreviations below). Data gathered from these collections clearly indicate that new species and records are represented in the area, and that species previously recorded also need to be revised using more sophisticated taxonomical tools.

The Halichondrida is a group with an uncertain classification and definition. As with many other sponge groups, it is defined by traditional morphological characters, such as growth form, surface characteristics and skeletal features. But in the Halichondrida, however, these characters are extremely simple, polymorphic and few, and as a consequence the discrimination of taxa within this group is ambiguous. Halichondrid sponges have diverse growth forms (e.g. encrusting, massive, ramose, tubular, flabellate).

The skeletons are plumoreticulate, dendritic or confused, construeted with three types of spicules (strongyles, styles and oxeas), or transitional forms, in any eombination and not funetionally loealised. The order ineludes five families (Axinellidae, Dictyonellidae, Heteroxyidae, Haliehondriidae and Bubaridae), and 45 genera, most of whieh remain poorly defined despite recent efforts to clarify and redefined the taxonomy of these families (Alvarez and Hooper 2002; Alvarez and Van Soest 2002; Hooper 2002a; Van Soest *et al.* 2002; Van Soest and Hooper 2002). Evidenee from molecular studies (Alvarez *et al.* 2000) indicates also that some of the genera are not monophyletic. Moreover, speeies alloeated to some genera (e.g. *Axinella*, *Acanthella*, *Phakellia*) have fuzzy boundaries and overlapping eharaeters and inelude numerous forms (or varieties/morphs). Similarly, some allegedly widely distributed speeies may represent eomplexes of eryptic speeies hiding under morphotypes that span a eontinuum, and whieh eannot be resolved easily using morphometric data alone.

The taxonomic confusion around the Halichondrida, has generated long-lasting debates at higher levels of sponge elassifieation. Further studies using larger groups of speeies, revisions at the regional level and different kinds of genetie and chemical approaches have been reeommended to refine the eurrent eoneept of this taxon (Van Soest and Hooper 2002).

The aim of this study is to revise the fauna of the Haliehondrida from northern Australia and the status of all the nominal halichondrid speeies in this region. The present paper represents the first part of this revision and includes the family Axinellidae. Revision of the remaining families represented in the area (i.e. Dietyonellidae, Halichondriidae and Heteroxyidae) will follow in separate papers.

MATERIALS AND METHODS

This revision ineludes material of the family Axinellidae reeorded for the tropieal northern Australian waters of the Western Australia, Northern Territory and Queensland eoast (from Admiralty Gulf in the west to Torres Strait in the east, approx. between the 125° E and 142° E meridians (Fig. 1). The area does not represent a true biogeographieal area and it was delimited based on the marine bioregions defined by IMCRA. This area also eorresponds with two of the eeoregions (i.e. Arafura Sea, Arnhem Coast to Gulf of Carpenteria) of the Sahul Shelf marine provinee as defined by Spalding *et al.* (2007).

All speeimens reeorded for the seleeted area and registered under Axinellidae at the Queensland Museum and the Museum and Art Gallery Northern Territory sponge eollections were examined and identifieations were verified. Speeimens and relevant type material from adjaeent areas including western Australia, the Ashmore, Cartier and Hibernia reefs on the Sahul Shelf, Lesser Sunda Islands, Aru Islands, the south eoast of Papua New Guinea and Great Barrier Reef were also examined if the speeies distribution was included in the studied area.

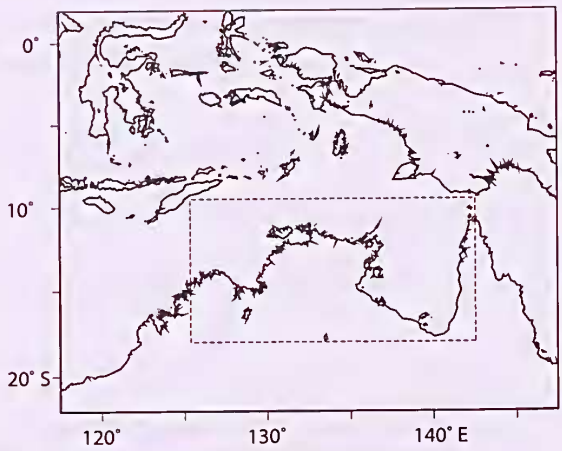

Fig. 1. Study area included in this taxonomic revision.

Complete locality and eollection data of material ineluded in this revision is indieated under the speeies deseription as usual, whereas non type voucher material deposited at the Queensland Museum and the Museum and Art Gallery Northern Territory, is listed in Appendix 1.

Specimens were prepared for light microscopy using the usual methods (e.g. Hooper 1996; Van Soest and Hooper 2005). Spicule measurements are in micrometres, based on 25 spicules (otherwise indicated in brackets), of each category and denoted as range (and mean ± 1 S.E.) of spicule length x spieule width. Measurements were made using a digital video camera attached to a light mieroscope in eombination with the software V++ Precision Digital Imaging System v 4.0 (© Digital Optics Ltd). Scanning Eleetron Mieroscope photographs were taken in a JEOL JSM 5610LV. The higher systematie arrangement follows elassifieation in the current version of World Porifera Database (Van Soest *et al.* 2008).

Terminology used here follows Boury-Esnault and Rützler (1997) and Alvarez and Hooper (2002).

ABBREVIATIONS

Abbreviations used in the paper are: AIMS, Australian Institute of Marine Seienees; BMNH, Natural History Museum, London (formerly British Museum Natural History); CRRF, Coral Reef Researeh Foundation, Palau; GBR, Great Barrier Reef, NTM, Museum and Art Gallery Northern Territory, Darwin, Australia (formerly Northern Territory Museum); MONZ, Museum of New Zealand; NTM, Museum and Art Gallery Northern Territory (formerly Northern Territory Museum), Darwin; SMF, Senekenberg Researeh Institute and Natural History Museum, Frankfurt; QLD, Queensland, Australia; QM, Queensland Museum, Brisbane; WA, Western Australia,

Australia; ZMA, Zoologisch Museum, University of Amsterdam, Amsterdam.

Numbers prefixed with Q666C, 0CDN, 0M9H are the cross-reference sample number collected for the United States National Cancer Institute, under the 'Collection of shallow-water organisms' program, by the Australian Institute of Marine Sciences, CRRF and NTM (subcontracted through CRRF), respectively.

TAXONOMY

Order Halichondrida Gray, 1867
Family Axinellidae Carter, 1875

Nine species of Axinellidae, listed below, were recorded within the studied area; three of these being new species.

Axinella aruensis (Hentschel, 1912)
Axinella loribellae sp. nov
Axinella sinoxea sp. nov
Cymbastela stipitata (Bergquist and Tizard, 1967)
Cymbastela vespertina Hooper and Bergquist, 1992
Dragmacidon australe (Bergquist, 1970)
Dragmacidon durissimum (Dendy, 1905)
Phakellia tropicalis sp. nov.
Reniochalina stalagmitis Lendenfeld, 1888

Genus *Axinella* Schmidt, 1862

Gender feminine. Type species, by subsequent designation of De Laubenfels (1936), *Axinella polypoides* Schmidt, 1862. Recent, Adriatic Sea.

Axinella aruensis (Hentschel, 1912)

(Figs 2 A–F, 3, 4, Table 1)

Phakellia aruensis Hentschel, 1912: 420; Hooper *et al.* 1992 [in part]; Pulitzer-Finali 1993: 283.

Axinella aruensis. – Hooper and Wiedenmayer 1994:72; Alvarez *et al.* 2000 [form II, see below]; Alvarez, Krishan and Gibb 2007[form II]; Holmes and Blaneh 2007.

Material examined. The material examined for this species is separated according to the morphotypes described below. Holotype – SMF 953, E side, Aru I., Indonesia, 31 August 1908, coll. Merton, H.. Additional specimens – Lacepede Is, NW Shelf, WA: NTM Z.2284, Z.2304, Z.2331, Z.2345. Joseph Bonaparte Gulf: QM G301197, Cartier I.: QM G301092. Melville I. NT: NTM Z.615,

Table 1. Comparison of spicule dimensions among specimens and varieties of *Axinella aruensis*. Measurements in micrometres.

Specimen	Locality	Oxeas	Styles
Axinella aruensis			
SMF 953	Aru Is, Indonesia	257.1–423.9 (360.6±38.1)	249.1–382.2 (313.6±40.7) [12]
		x 13.8–21.4 (16.5±1.9)	x 14.1–21.7 (17.4±2.2) [12]
Z.2304	Lacepede Is, WA	245.5–337.6 (285.4±21)	213.2–271.4 (244.8±20.9) [9]
		x 8.6–17.2 (13±2.6)	x 11.9–15.7 (13.5±1.6) [9]
G301092	Cartier Is, WA	281.2–450.2 (360.7±39.9)	242.8–419 (301.1±36)
		x 10.3–19.4 (15.6±2.2)	x 12.6–20.3 (16.8±1.9)
Z.619	Melville I., NT	236.1–406 (302.4±39.4)	186–362.8 (267.2±43.3) [22]
		x 9.3–17.5 (13.9±2.3)	x 9.8–17.1 (14.1±1.9) [22]
Z.3141	Parry Shoals, NT	267.1–372.9 (307.1±23.3)	248.6–294.6 (270.4±18.8) [4]
		x 9.4–17.2 (13.6±2.3)	x 11.1–16.7 (13.9±2.3) [4]
Z.5053	Darwin Harbour, NT	297.6–498.6 (392.1±47)	263.6–417.2 (342.7±37.6)
		x 7.3–22.5 (16.5±3.7)	x 12–23.5 (17.1±2.9)
Z.4465	Wessel Is, NT	194.4–396.4 (299.5±48.6) [24]	204.6–331.7 (269.7±44.1) [15]
		x 5.6–17.4 (12±3.3)	x 8.6–18 (13.8±2.8) [15]
Axinella aruensis form I			
Z.5816	Bynoe Harbour, NT	305–451.7 (376.7±36.3)	283.1–406.6 (334.7±40.7) [6]
		x 13.1–25.9 (18.3±3.9)	x 14.7–19.6 (16.5±1.8) [6]
Z.3068	Parry Shoals, NT	187.1–318.2 (237.2±26.6)	167.2–222.5 (200±15.3)
		x 8.5–17.2 (13.2±2.4)	x 9.3–15.5 (13.2±1.7)
Z.5819	East Point, Darwin, NT	266.7–354.5 (312.1±23.3)	200.1–353.2 (260.7±34.1)
		x 13.1–18.8 (16.3±1.4)	x 10.3–22.8 (15.4±2.9)
Z.3946	Wessel Is, NT	274.8–392.8 (333±32.8)	248.6–363.3 (297±31) [10]
		x 8.3–16.4 (13.3±2.3)	x 11.5–18 (15.1±2.3) [10]
Axinella aruensis form II			
Z.4490	Stevens Rock, Darwin	209.1–278.6 (246.3±15.8)	163.6–231.4 (191.1±17.4)
		x 12.7–19.9 (15.1±1.8)	x 6.5–12.5 (9.8±1.6)
Z.5054	Wessel Is	173.8–247.4 (214.7±18.9)	166.4–262.3 (218.2±22.4)
		x 7.5–16.7 (10.3±1.9)	x 7.8–17.9 (13.9±2.4)

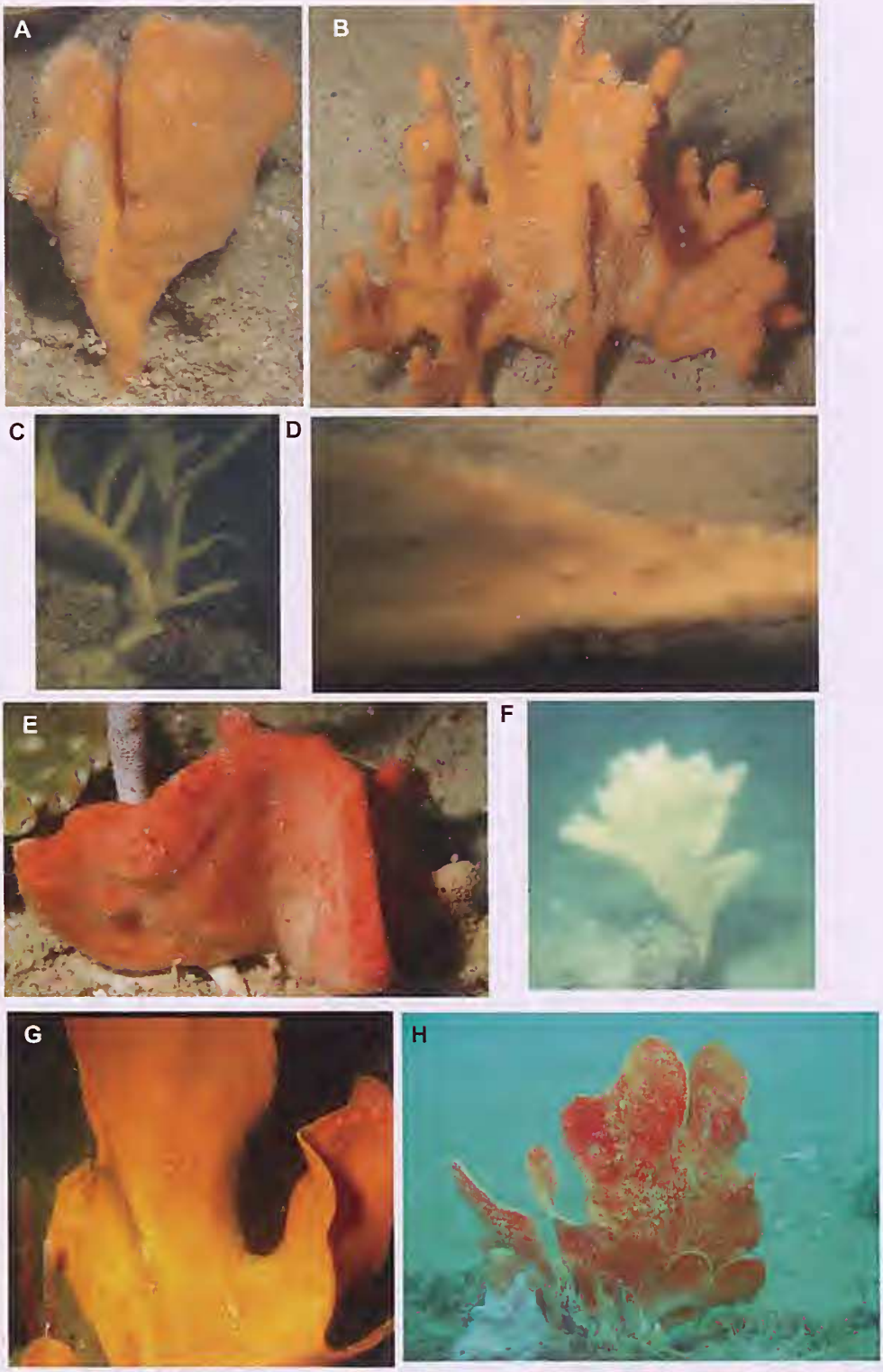

Fig. 2. *Axinella aruensis*: **A, B**, specimens at Raragala I., Wessel Is; **C**, specimen at South Shell I., Darwin Harbour; **D**, form I, Z.5816, Dawson Roek, Bynoe Harbour; **E**, form II, specimen at Raragala I, Wessel Is; **F**, *Axinella sinoxea* sp.nov., NTM Z.2719. *Axinella loribellae* sp. nov.; **G**, Holotype, NTM Z.4427; **H**, NTM Z.5662. Photos: **A–B**, P. Colin; **C–D, G**, B. Alvarez; **E**, D. DeMaria; **F**, J. Hooper; **H**, A. Ayling.

Z.619, Z.630, Z.632. Parry Shoals, Arafura sea, NT: QM G310136 (Q66C0514-X), NTM Z.3062 (Q66C87-0514-X), Z.3141.Bynoe Harbour, NT: NTM Z.5071 (0M9H2464-U). Darwin Harbour, NT: NTM Z.5053 (0M9H2168-X), Z.5057 (0M9H2665-O), Z.5058 (0M9H2675-Y), Z.5072 (0M9H2579-U), Z.5830. Cobourg Peninsula, NT: NTM Z.1363, Z.1388, Z.2511, Z.2526, Z.2529. English Company Is., NT: NTM Z.3956. Wessel Is, Gove Peninsula, NT: QM G3.609 (Q66C4762-R), G300768 (=Q66C4737P, QM G311873 and NTM Z.3945), Z.3922 (Q66C4687-L), Z.3935 (=Q66C4785-R, QM G300752), Z.3936 (Q66C4831-R), Z.4465 (0M9H2770-C), Z.5055 (0M9H2650-W). Papua New Guinea: QM G312913, G312935.

Axinella aruensis, form I, Bynoe Harbour, NT: NTM Z.5816, Z.5817, Z.5818. Darwin Harbour, NT: NTM Z.2156, Z.5819-Z.5823. Wessel Is, Gove Peninsula, NT: NTM Z.3925, Z.3946.

Axinella aruensis, form II. Darwin Harbour, NT: QM G303332, Z.1961, Z.2249, Z.2402, Z.2632, Z.4425 (0M9H2044-O), Z.4490, Z.4491, Z.5824-Z.5829, Z.5831, Z.5232. Parry Shoals, Arafura sea, NT: NTM Z.3137, Z.3068. Wessel Is, Gove Peninsula, NT: QM G300759 (Q66C-4831-R), NTM Z.5054 (0M9H2648-U). Yampy sound, WA, NTM Z.665.

Description. Three different morphotypes of this species with one corresponding to the holotype are recognisable among the material examined and they will be described below separately under the heading of 'forms'.

***Axinella aruensis*, typical form.** *Shape* (Fig. 2A–C). Thickly flabellated, on broad and short, or long and narrow, peduncle, uni or bi-planar, sometimes folded, with round margins projecting in most cases into short and broad extensions with square, round or pointed tips, or in long rounded to flat branches which tend to fuse laterally. Specimens up to 400 mm high.

Colour. Orange, pale yellow or yellowish brown alive. Dark brown in alcohol.

Oscula. Regularly distributed in one or both sides of fan, stellate, flush or with elevated rims, less than 5 mm diameter.

Surface. Evenly microconulose-conulose, nodulose, rough, marked with primary longitudinal choanosomal fibres.

Skeleton (Fig. 3A). Plumose, vaguely reticulated to halichondroid, very compact, with plumose columns up to 600 µm thick, diverging toward surface, ending in fan-shapped spicule brushes and projecting through ectosome. Axial skeleton differentiated only towards base of attachment or peduncle, halichondroid.

Spicules (Fig. 3B). Oxeas with blunt, pointed or telescoped tips; slightly bent and sometimes slightly sinuous, 195–498 x 5–22 µm. Styles, less frequent or rare, similar in size to oxeas (see Table 1) with blunt ends, enlarged or slightly narrow bases, straight or slightly bent. Transitional forms (e.g. styloids, strongyles) are common.

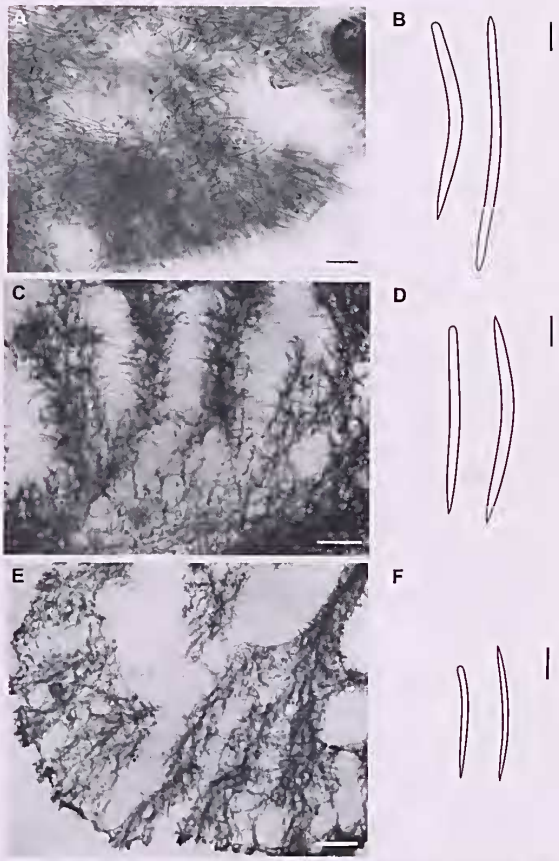

Fig. 3. *Axinella aruensis*: light microphotograph of skeleton and diagram of spicules: **A, B**, SMF 953, holotype; **C, D**, Z.5819 (form I); **E, F**, NTM Z.5054 (form II). Scale bars: **A**, 200 µm; **B, D, F**, 50 µm; **C, E**, 500 µm.

***Axinella aruensis*, form I.** *Shape* (Fig. 2D). Erect, fan-shaped or narrow long and flat digits with few simple ramifications, generally with square margins. Specimens up to 20 cm high and 10 cm wide.

Colour. Light orange, brown, beige or yellow. Same colour in alcohol.

Oscula. Regularly distributed, less than 5 mm diameter, with distinctive raised margins.

Surface. Minutely hispid, marked with choanosomal skeletal tracts in a regular reticulation or with radial grooves.

Skeleton (Fig. 3C). Plumose and slightly compressed at axial region, with thick plumo-echinated multispicular columns, up to 1 mm thick, and radiating outwards towards surface, anastomosing or connected irregularly by short and thick paucispicular or multispicular tracts, or by single spicules oriented in any direction. Main tracts end at surface in fan-shaped brushes with spicules projecting shortly through ectosome; light spongin embedding tracts.

Spicules (Fig. 3D, Table 1). Oxeas, 187–451 x 8–25 µm, with pointed or blunt ends, straight or bent; thinner forms are common. Styles less frequent or rare, slightly smaller,

including intermediate forms similar to styloids, anisoxeas or strongyles. Fused spicules are characteristically common.

***Axinella aruensis*, form II.** *Shape* (Fig. 2E). Thick fans or lamellae with round margins, folding in more than one perpendicular plane, or joining at angles from 45-90 degrees; or short single or digitate projections, stipitate, on short narrow peduncles or on broad base. Generally small with individuals reaching up to 13 cm high.

Colour. Bright or light orange alive. Light beige in alcohol.

Oscula. Stellate with minute drainage canals, sometimes located at margin of fans or evenly distributed in both sides of fan, 3-5 mm in diameter.

Surface. Pierced uniformly with minute ostia. Microconulose; minutely hispid, firm but some has mucous consistency after collection. Marked by regular choanosomal reticulation.

Skeleton (Fig. 3E). Thick and dense plumo-echinated multispicular tracts up to 600 µm wide, forming regular, nearly radial reticulation which is marked on surface. Main columns end at surface in fan-shaped brushes, with spicules projecting shortly through ectosome. Axial skeleton not differentiated.

Spicules (Fig. 3F, Table 1). Oxeas and styles in nearly equal proportions, 174-279 x 7-20µm. Styles are dominant and slightly smaller than oxeas.

Remarks. Although some features allowed distinction of two additional morphotypes within this species, the limits among them are not clear and some individuals could be considered intermediate forms. *Axinella aruensis sensu stricto* is distinguished from its two other forms by shape and colour, generally observed to be thickly flabellate and orange when alive, by the change of colour in alcohol (it turns brown) and by the dominance of oxeas in relation to styles. Form I differs slightly in shape from *A. aruensis*; the colour in life is always beige or pale yellow and does not change in alcohol; oxeas are also dominant and styles are relatively more common. Form II is always beige in alcohol and styles are dominant relative to oxeas. Some other features of shape and surface consistency and texture are also distinctive within this form.

Some data included in Hooper *et al.* (1992) indicate there are some differences in the biochemistry between populations (i.e. North West Shelf versus Darwin Harbour) of this species, however the published results do not seem to be related to the forms distinguished here.

Alvarez *et al.* (2007) detected up to 29% of intra-genomic polymorphism within the Internal Transcribe Spacer (ITS) of the rDNA in individuals of *Axinella aruensis* from Darwin Harbour. These levels of intra-genomic variation are so far the highest reported for Porifera and correspond in most cases to hybrid species reported for other groups, including corals of the genus *Acropora*. Thus, it is possible that the forms here distinguished to document the variability present within species are the result of a hybridisation processes with sympatric species or populations. Future population genetic studies will help to determine whether the variability observed across these forms are significant to justify their recognition as different species or as hybrids.

Axinella aruensis is very similar in shape, skeletal architecture and spicule composition and dimensions to some *Axinella* species recorded from the Indian Ocean (e.g. *A. donnani* (Bowerbank, 1873); *A. manus* Dendy, 1905 and *A. symmetrica* (Dendy, 1905, as *Phakellia*)). Skeletal reticulation of the Indian Ocean species, in particular *A. donnani*, is much more regular, with thicker primary lines. Interesting also is the change in colouration, from orange to brown after few hours of collection, reported for *A. donnani* (Bowerbank, 1873), a characteristic also seen in *A. aruensis*. A detailed revision of the Indian Ocean species complemented with population genetic studies is essential to define their limits and phylogenetic relationships with the northern Australian populations of *A. aruensis* and its forms.

Distribution. *Axinella aruensis* and its forms appear to occur sympatrically and are common throughout northern Australia (Fig. 4). The type locality is the Aru Is, Indonesia, but the species is also known from other Indonesian localities (Alvarez and de Voogd, unpublished data) and from Papua New Guinea. It is found in subtidal areas from 5 to 76 m. Pulitzer-Finali's (1993) record for East Africa, is dubious and requires confirmation.

Axinella loribellae sp. nov

(Figs 2G–H; 5)

Material examined. Holotype – NTM Z.4427 (0M9H2041-L), Stevens Rock, Weed Reef, Darwin Harbour, 12°29.2001′S, 130°47.1′E, NT, 5–19 m depth, 8 May 2002, coll. B. Alvarez and party. Paratypes – NTM Z.5834 Stevens Rock, Weed Reef, Darwin Harbour, Northern Territory, Australia, 12°29.1667′S, 130°47.19′E, 17 m depth, 8 May 2006, coll. B. Alvarez.

Additional specimens. Melville I., NT, NTM Z.631. Darwin Harbour, NT: QM G303388, NTM Z.822, Z.868, Z.5662. Wessel Is, NT: NTM Z.3938, Z.5059 (0M9H2771-F).

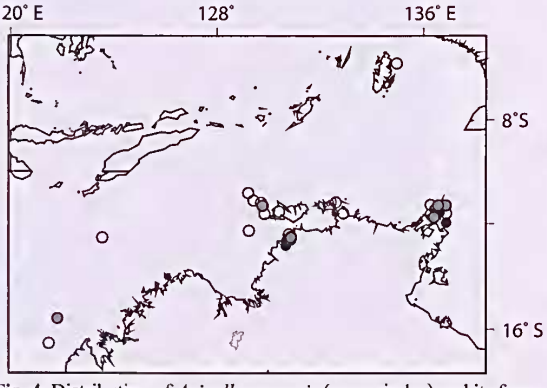

Fig. 4. Distribution of *Axinella aruensis* (open circles) and its forms (I, black circles; II, grey circles) based on confirmed records from QM and NTM.

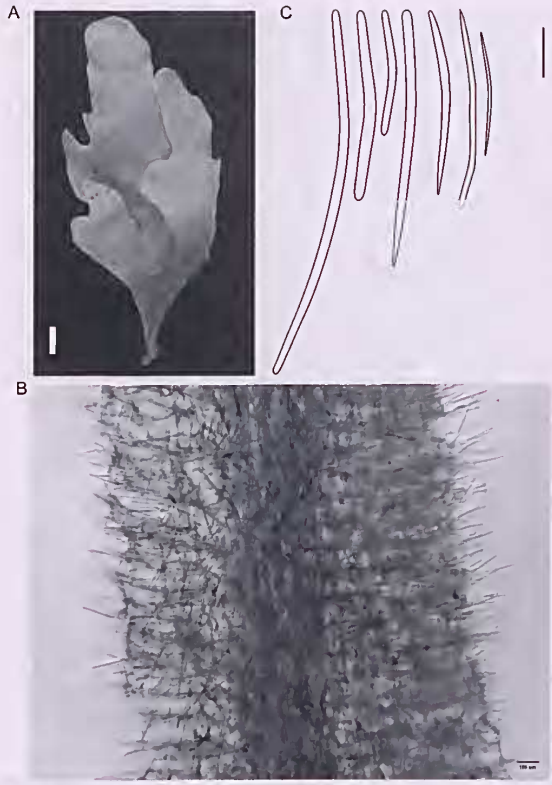

Fig. 5. *Axinella loribellae* sp. nov.: **A,** Paratype, NTM Z.5834; **B,** light microphotograph of skeleton; **C,** diagram of spicules. Scale bars: **A,** 2 cm; **B,** 100 µm; **C,** 50 µm.

Description. Shape (Figs 2G–H, 5A). Fan-shaped; thin lamellae, 1–5 mm thick, single or bifurcated, sometimes convoluted with rounded margins and indentations on short stalks or broad base. Specimens are 300 mm high and up to 400 mm wide.

Colour. Burnt orange alive, brown in alcohol.

Oscula. Small, 2–5 mm diameter, with stellate drainage canals, evenly distributed.

Consistency. Flexible, easy to tear, rubbery.

Surface. Smooth, velvety, marked irregularly with ribs.

Skeleton (Fig. 5B). Plumose, differentiated in extra-axial and axial region. Axial skeleton compressed with wavy longitudinal paucispicular-multispicular tracts, lightly embedded in collagenous spongin, interwoven, and radiating towards the extra-axial region. Extra-axial region a close-set reticulation of plumose paucispicular tracts oriented perpendicular to surface and laterally close, connected by single spicules or uni-paucispicular tracts up to 2 spicules long, cemented with thin and clear spongin, to each other and ending in brushes of spicules that protrude shortly through ectosome.

Spicules (Fig. 5C; Table 2). Styles slightly bent; strongyles straight, slightly sinuous, bent in middle; oxeas fusiform, straight. Transitional shapes between monoactins and diactins are common. All types in a wide range of sizes and thickness. Dominant types vary among specimens (see below).

Remarks. A great variability in the shape and size of spicules was observed among specimens of this species. Styles and strongyles of 190–270 by 7–13 µm, are the dominant types, however they were absent in some of the examined specimens (i.e. NTM Z.631 and NTM Z.3938). Apart from these differences in spicule composition and dimensions, no other characters seem to vary among specimens examined here, and consequently they are considered at this stage to belong to a single species. Further genetic studies may help to confirm whether or not variability in spicule dimensions and composition is indicative of sibling species differentiation.

The new species differs from *Axinella aruensis* and its related species from the Indian Ocean (see above) mainly in shape (thinly instead of thickly flabellate); in skeletal architecture (clearly differentiated into axial and extra-axial skeleton with thinner extra-axial spicular tracts and more regular reticulation when compared to the thicker multispicular columns present in *A. aruensis*) and in spicule composition (with common transitional shapes between oxeas and styles not observed in *A. aruensis*).

Axinella ceylonensis (Dendy, 1905, as *Phakellia*) from the Gulf of Manaar is similar to *A. loribellae* in shape (although shortly stipitate) and in thickness of the lamellae. Both species share the variability observed in the size and shape of oxeas and styles. The two species differ in skeletal and surface characteristics. The skeleton of *A. ceylonensis* is not differentiated in axial and extra-axial region but described as plumose, with columns radiating outwards into small surface conules. No other species in the study area or in the Indian Ocean is similar to this new species. Indeed, most nominal species of *Axinella* reported for the Indian Ocean, do not agree with the current diagnosis of the genus and need to be re-examined. Some of these are massive forms with styles and trichodragmata in the skeleton and might belong in the axinellid genus *Dragmacidon* (e.g. *Axinella*

Table 2. Comparison of spicule dimensions among specimens of *Axinella loribellae* sp. nov. Measurements in micrometres.

Specimen	Locality	Styles	Strongyles	Oxeas
Z.4427 (Holotype)	Darwin Harbour	196.3–352.9 (274.6±47.7) x 8.33–18.3 (13.5±2.7)	103.6–396.3 (190.1±74.0) x 6.01–13.09 (10.3±1.9)	148.5–440.2 (226.8±63.6) x 4.8–12.9 (8.7±2.1)
Z.5059	Wessel Is	159.7–365.4 (250.6±50.4) x 5.8–14.43 (10.0±2.1)	93.7–531.8 (243.1±128.6) x 5.8–13.3 (8.8±2.3)	100.8–302.2 (208.5±50.1) x 3.7–11.4 (6.5±2.1)
Z.631	Melville Is	187.6–307.9 (228.9±29.0) x 4.3–11.3 (7.3±1.8)	– –	142.8–351.6 (217.8±44.1) x 3.5–13.2 (7.1±2.7)

bidderi Burton, 1959 and *A. massalis* Burton, 1959). Some others are *Stylissa*-like, or other dictyonellid genera, with the surface marked by ridges or conules and with a dense and irregular skeleton of multispicular tracts of styles (e.g. *Axinella bubarinoides* Dendy, 1922; *A. dragmaxioides* Burton, 1959 [?]; *A. flabelloreticulata* (Burton, 1959); *A. labyrinthica* Dendy, 1889; *A. minor* Thomas, 1981; *A. proliferans* Ridley, 1884; *A. tenuidigitata* Dendy, 1905; *A. ventilabrum* Burton, 1959), or closer to halichondrid genera (e.g. *Axinella halichondrioides* Dendy, 1905, which is encrusting and has only oxeas) or to the raspailiid genus *Ceratopsion* (i.e. *Axinella lamellata* Dendy, 1905, with a dermal and tangential layer of small oxeas).

Distribution. *Axinella loribellae* seems to be restricted to northern Australia between Darwin Harbour and the Wessel Is. It is found between 11–32 m depth.

Etymology. Named after Lori Bell, Coral Reef Research Foundation, Palau, for her considerable contribution to the knowledge of Indo-Pacific sponge diversity and distribution. It is intended as a noun in apposition.

Axinella sinoxea sp. nov.

(Figs 2F, 6A–D)

Material examined. HOLOTYPE – NTM Z.940, East Point, Darwin Harbour, NT, 12°24.05′S,130°48.01′E, 12 m depth, 13 September 1982, coll. Hooper, J.N.A. PARATYPES – Z.5833, East Point, Darwin Harbour, NT, 12° 24.484′S, 130° 48.471′E, 11 m depth, 7 June 2007, coll. B. Alvarez.

Additional specimens. NW Shelf, WA: NTM Z.2310, Z.2322. Darwin Harbour, NT: NTM Z.2246, Z.2719.

Description. *Shape* (Figs 2F, 6A). Single or multiple fans, 4–6 mm thick, 8–14 cm long and up to 30 cm wide, on common stalk, 3–5 cm long and 7–10 mm in diameter; erect, uniplanar with digitate to irregular margins or bifurcate tips.

Colour. Orange, pale yellow or beige with light pink tinge alive; brown-grey in alcohol.

Oscula. Regularly distributed in one or both sides of fan, round to elongated or irregularly shaped, some stellate, with slightly elevated rims, less than 1 mm diameter.

Consistency. Soft, floppy, flexible, slightly compressible.

Surface. Smooth but slightly rough to touch; pierced regularly by minute pores, microhispid due to projections of brushes of choanosomal spicules. Encrusted irregularly with detritus in some specimens.

Skeleton (Figs 6B-C). Plumoreticulated, with ascending multispicular tracts connected regularly by single spicules or unispicular tracts, 1 or 2 spicules long, ending in brushes at surface; slightly compressed in axial region. Spicule tracts bound only slightly with clear collagenous spongin.

Spicules (Fig. 6D; Table 3). Styles robust, bent, or less often, straight, enlarged in the middle section, 159–245 x 7–17 µm; thinner category, 97–201 x 2–6 µm also present. Long thin raphids abundant. Smaller oxeas and thick and short strongyles, very rare.

Remarks. This species conforms in most of its characteristics with the current concept of *Axinella.* The absence or low frequencies of oxeas observed in the examined specimens are also seen in other Caribbean species of the genus (e.g. *Axinella waltonsmithi* (de Laubenfels, 1953) and *A. pomponiae* Alvarez, Van Soest and Rützler, 1998), which might be considered a common feature among *Axinella* species.

The new species resembles *Axinella aruensis* in gross morphology and as such can be easily mistaken for it in the field; both are fan-shaped on a common stalk and both have a similar surface pierced with minute ostia and microconulose. But *A. sinoxea* is clearly different from *A. aruensis* in skeletal architecture and spicule composition, having a regular plumoreticulated skeleton of ascending tracts and long thin raphids in the skeleton. As is the case with *A. loribellae*, no other species recorded in the study area or in the Indian Ocean was found to be related to *A. sinoxea*.

Distribution. Common in the vicinity of East Point Sponge Gardens, Darwin Harbour, but also found in deeper waters (down to 40 m) of Western Australia.

Etymology. Latin, *sine-* without; *sinoxea* referring to the lack of proper oxeas characteristic of the species. It is intended as a noun in apposition.

Remarks on *Axinella.* *Axinella* is a widespread genus of sponges with approximately 100 accepted species (Van Soest *et al.* 2008), many of which, however, need to be verified against the current definition of the genus (Alvarez and Hooper 2002). Ongoing revisions of species of *Axinella* and related genera by one of the authors (BA) are undertaken on a regional basis with the purpose to verify the identity of the reported species and the monophyly of the genus, which is currently proven as polyphyletic based on molecular studies (Alvarez *et al.* 2000; Erpenbeck *et al.* 2005).

Three species of *Axinella* (*A. aruensis*, *A. loribellae*, *A. sinoxea*) are reported in this work. No other species of the genus, as far as we know, have been reported within the area of northern Australia that is the subject of this present study. *Axinella echidnaea* reported by Ridley 1884 is accepted as *Reniochalina stalagmitis* (see below).

Table 3. Comparison of spicule dimensions among specimens of *Axinella sinoxea* sp. nov. Measurements in micrometres.

Specimen	Locality	Thick styles	Thin styles	Raphids
Z.940 (Holotype)	East Point, NT	184.5–245.1 (223.7±12.92) x 7.35–17.4 (13.11±2.49)	97.77–201.3 (179.64±22.84) [23] x 2.48–5.6 (3.8±1) [23]	192.9–249.6 (227.2±14.9) x 0.8–3.0 (2.0±0.6)
Z.2310	NW Lacepede Is WA	153.4–197.6 (183.4±10.2) x 7.8–12.2 (10.2±1)	131.3–191.2 (152.1±14.8) x 2.2–6.4 (4.4±1.)	131.9–258.6 (201.5±35.1) x 0.37–2.69 (1.6±0.5)

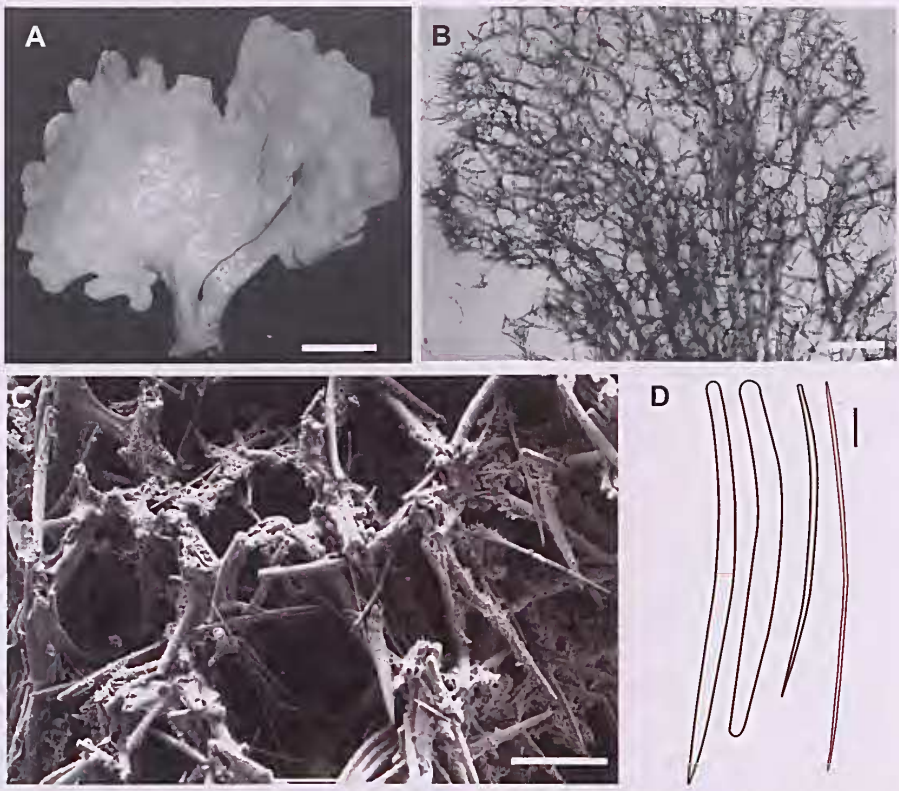

Fig. 6. *Axinella sinoxea* sp. nov. NTM Z.940: **A,** photograph of the holotype; **B,** light microphotograph of the skeleton; **C,** SEM, raphids in choanosomal skeleton; **D**, scale bars: **A,** 5 cm; **B,** 500 µm; **C**, 100 µm; **D**, 20 µm.

In the present study area, the genus *Axinella* seems to be less speciose than in other taxonomically revised regions: seven species in the Western Central Atlantic (Alvarez *et al.* 1998); six (recorded) species and nine possible new species (Kelly *et al.* 2009); at least five species in Indonesia (Alvarez and De Voogd, unpublished data). Unfortunately little is known about the biology of these species to explain why the genus might be more diverse in some areas than others. Many more putative *Axinella* species are known for the GBR (pers. obs.), but these remain unresolved pending future studies.

Distinction of *Axinella* species continues to be subjective and is based on a combination of characters as discussed by Alvarez *et al* (1998). Variability and plasticity of all the morphological characters that characterise the species are seen in all the species described above. The morphological variability of *A. aruensis*, for example, is remarkable and suggestions from molecular data (Alvarez *et al.* 2007) that it may be due to hybridisation should be further explored.

Genus *Cymbastela* Hooper & Bergquist, 1992

Gender feminine. Type species, by original designation, *Pseudaxinyssa stipitata* Bergquist and Tizard, 1967. Recent, Darwin Harbour, Arafura Sea.

Cymbastela stipitata (Bergquist and Tizard, 1967)

(Figs 7A–B)

Pseudaxinyssa stipitata Bergquist and Tizard, 1967:189; Hooper *et al.* 1992: 265.

Cymbastela stipitata. – Hooper and Bergquist 1992: 106; Hooper and Wiedenmayer 1994 : 75; Alvarez *et al.* 2000: 195; Alvarez and Hooper 2002: 733.

Material examined. Specimens as listed in Hooper and Bergquist (1992). Additional Specimens – Bynoe Harbour, NT: Z.5065 (0M9H2333-C). Darwin Harbour, NT: QM G303262, NTM Z.4078 (0CDN8001-H, Fig. 7A), Z.4104 (0CDN8026-J), Z.4131, Z.4435 (0M9H2008-Y), Z.5064 (0M9H2134-M), Z.5835, Z.5836, Wessel Is, NT: Z.5066 (0M9H2658-H), Z.5067 (0M9H2785-T).

Remarks. *Cymbastella stipitata*, was re-described extensively by Hooper and Bergquist (1992) and the type material re-examined by Alvarez and Hooper (2002). This is one of the most common sponges in the studied area. It is particularly abundant in the intertidal zone of Darwin Harbour, which becomes greatly exposed during the nocturnal king tides of the dry season (May–June) and the diurnal king tides during the wet season (September-November, Fig. 7B). It is found, but less commonly, in subtidal areas down to 19 m depth. New records indicated that its distribution within northern Australia extends from

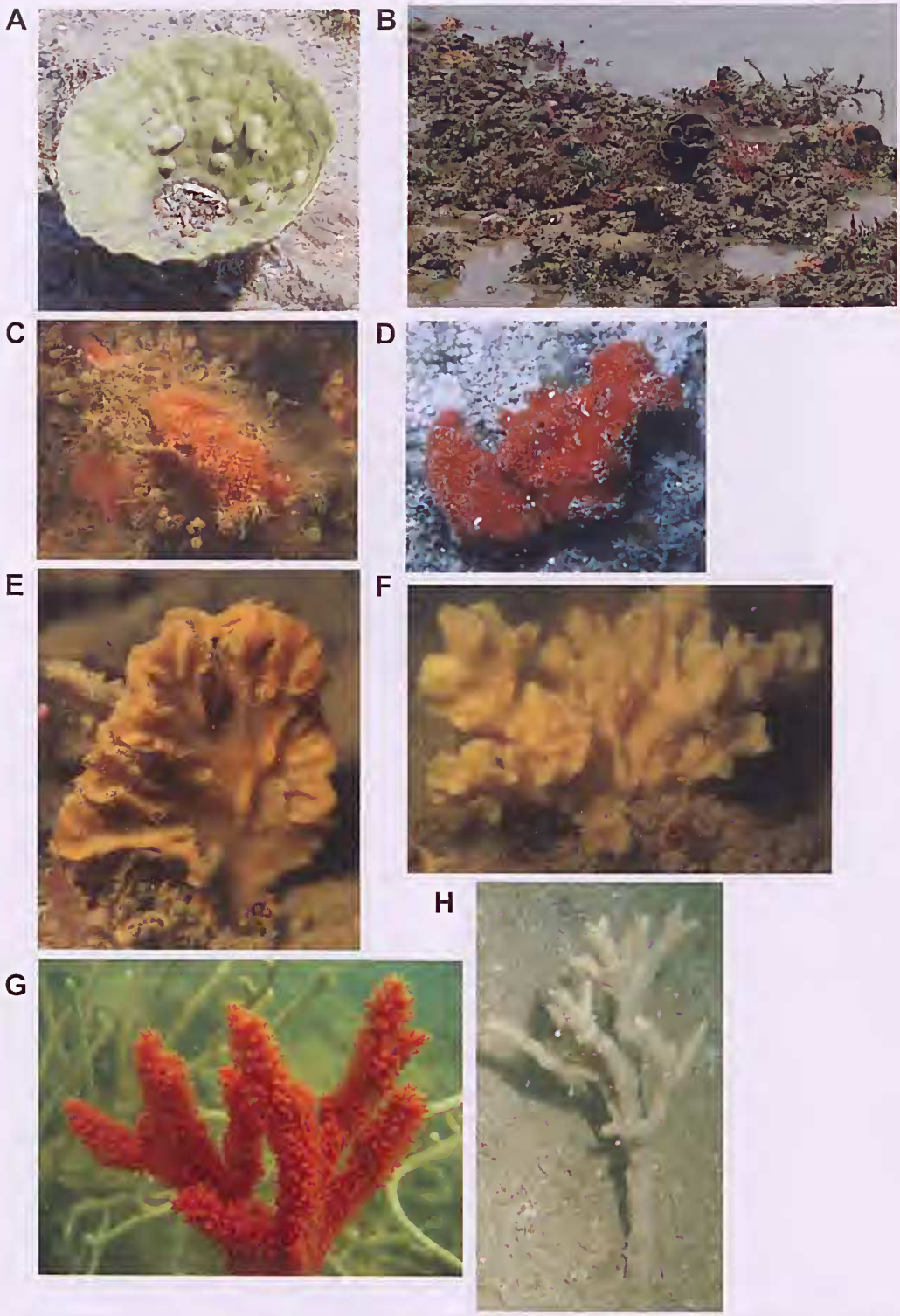

Fig. 7. *Cymbastela stiputata*: **A**, NTM Z.4078 (0CDN-8001-H); **B**, specimens exposed at the reef flat of East Arm, Darwin Harbour during the low tide of 20 September 2001. *Dragmacidon australe*: **C**, specimen at Channel I. Darwin Harbour; **D**, QM G304246, Lizard I, GBR, QLD. *Phakellia tropicalis* sp. nov.; **E**, Holotype (NTM Z.5847); **F**, Paratype (NTM Z.5845). *Reniochalina stalagmites*: **G**, specimen at East Point, Darwin; **H**, specimen at Cotton I., Wessel Is. Photos: **A**, **B**, **E**, **F**, B. Alvarez; **C**, H. Nguyen; **D**, J. Hooper; **G**, A. Ayling; **H**, P. Colin.

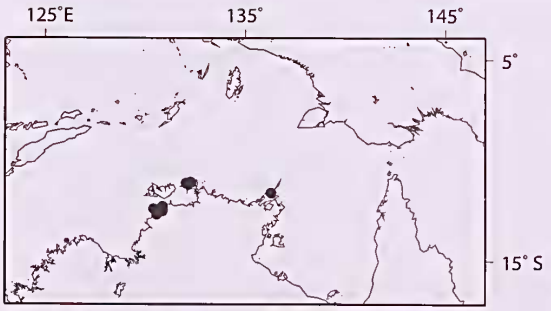

Fig. 8. Distribution of *Cymbastela stipitata*, based on confirmed records from QM and NTM.

Bynoe Harbour to the Wessel Is (Fig. 8), inferring it is a narrow range endemic within northern Australia.

***Cymbastela vespertina* Hooper and Bergquist, 1992**

Cymbastela vespertina Hooper and Bergquist, 1992: 110; Hooper and Wiedenmayer 1994: 75; Alvarez *et al.* 2000: 195; Alvarez and Hooper 2002: 733.

Pseudaxiyssa sp. nov. Hooper *et al.* 1992: 265.

Material examined. Specimens as listed in Hooper and Bergquist (1992).

Remarks. *Cymbastela vespertina* is a sibling species of *C. stipitata*. Separation of the two species based in morphology is difficult and very subjective. Biochemical and molecular evidence (Hooper *et al.* 1992; Alvarez *et al.* 2000) indicates the sympatric populations are heterogeneous. Future genetic population studies might reveal whether or not these populations can be reliably separated into different species, but based on current external gross morphological differences and skeletal characters the two taxa are maintained as distinct.

Remarks on *Cymbastela*. Two species of *Cymbastela* are present within the area of the present study (i.e. *C. stipitata* (Bergquist and Tizard, 1967) and *C. vespertina* Hooper and Bergquist, 1992). Other species of *Cymbastela* represented in other regions including Australia are: *C. cantharella* (Lévi, 1983), New Caledonia; *C. concentrica* (Lendenfeld, 1887), Queensland coast; *C. coralliophila* Hooper and Bergquist, 1992, GBR; *C. marshae* Hooper & Bergquist, 1992, Houman-Abrolhos, WA; *C. notiaina* Hooper and Bergquist, 1992, South Australia; and *C. tricalyciformis* (Bergquist, 1970) from New Zealand. Comprehensive descriptions of these species are given by the respective authors of the species.

Phylogenetic relationships of the genus with other axinellid species based on molecular characters indicate that the northern Australian species of *Cymbastela* are closely related to other members of Dictyonellidae, such as *Acanthella* (Alvarez *et al.* 2000; Erpenbeck *et al.* 2005). There is no doubt, however, that species of *Cymbastela* are related to the Axinellidae based on their morphology. Thus the phylogenetic relationships derived from these molecular analyses remain enigmatic at this stage.

Genus *Dragmacidon* Hallmann, 1917

Gender neuter. Type species, by original designation, *Thrinacophora agariciformis* Dendy, 1905. Recent, Gulf of Manaar, Indian Ocean.

***Dragmacidon australe* (Bergquist, 1970)**

(Figs 7 C–D, 9 A–B)

Pseudaxinella australis Bergquist, 1970: 20; Hooper and Lévi 1993: 1441; Hooper and Wiedenmayer 1994: 80; Alvarez *et al.* 2000: 196.

Dragmacidon australe. – Alvarez and Hooper 2002: 735; Kelly *et al.* 2009 (In press).

Material examined. HOLOTYPE – NMNZ Por. 26, Takatu Channel, Northland, New Zealand, 11 m. ADDITIONAL SPECIMENS – Cartier I, WA: QM G301089. Bynoe Harbour, NT: G303444. Darwin Harbour, NT: NTM Z.5068. Coral Sea, GBR, QLD: QM G300295, G304182, G304246, G304253, G320664, NTM Z.2727.

Description. *Shape* (Fig. 7 C–D). Thickly encrusting, following substrate, globular, bulbous or semispherical, approx. 100 mm in diameter by 20 mm thick.

Colour: Bright red, orange alive.

Consistency. Slightly compressible or stiff. Mucous surface.

Oscula. Irregularly distributed, less than 1 mm diameter, with slightly elevated rims surrounded by thin drainage channels in stellate arrangement.

Surface. Highly conulose; evenly pierced by pores 120–400 µm in diameter. Conules, approx. 1–3 mm long, single or grouped in reticulated pattern, unevenly echinated by spicules, 2–3 mm apart.

Skeleton (Fig. 9A). Plumoreticulate to halichondroid; formed by thick plumose or plumo-echinated multispicular tracts, up to 500 µm thick, ascending nearly perpendicularly from base and becoming thicker and bushy near surface; projecting through ectosome into surface conules. Main tracts connected by shorter and thinner plumose tracts, sometimes ill-defined, forming irregular reticulation of large round meshes.

Spicules (Fig. 9B; Table 4). Oxeas and styles in equal proportions, 176–510 x 7–21 µm (Table 4).

Remarks. The species was originally assigned to *Pseudaxinella* and transferred to *Dragmacidon* by Alvarez

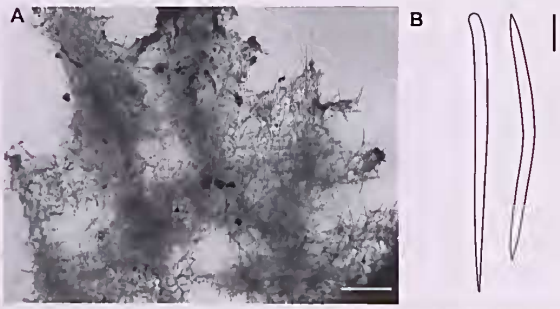

Fig. 9. *Dragmacidon australe*: **A**, light microphotograph of skeleton; **B**, diagram of spicules. Scale bars: **A**, 500 µm; **B**, 50 µm.

Table 4. Comparison of spicule dimensions among specimens of *Dragmacidon australe*. Measurements in micrometres.

Specimen	Locality	Styles	Oxeas
G303444	Bynoe Harbour	254.1–510.4 (349.1±78.8) x 7.3–20.9 (13.6±3)	286.2–434.5 (361.5±39.8) x 7.3–17.9 (13.4±2.4)
Z.5068	Darwin Harbour	176.4–397.3 (290.1±61.4) x 7–17.2 (13±2.8)	271.9–412.5 (340.7±31.9) x 9.5–18.9 (14.3±2.4)

and Hooper (2002) because it conformed more closely with the type species of that genus.

Hooper and Lévi (1993) compared specimens from the GBR with the holotype of *Dragmacidon australe* from New Zealand and with material from New Caledonia described as *D. debitusae* (Hooper and Lévi, 1993). Very subtle differences were found between the two species. The material from northern Australia reported here agrees with *D. australe* in the majority of its features and is therefore assigned to this species. This species is also very similar to *D. reticulatum* (Ridley and Dendy, 1886) from the central West Atlantic both in external morphology and spicule composition.

Distribution. *Dragmacidon australe* was first recorded for New Zealand and additional records from the GBR were reported in Hooper and Lévi (1993). The present revision extends the distribution range of this species into northern Australia. The species is not very common in this region with only isolated records registered through the extension of the studied area (Fig. 10) and thus is probably at the edge of its range. It is also found along more temperate areas of the Queensland coast (Hooper pers. obs.).

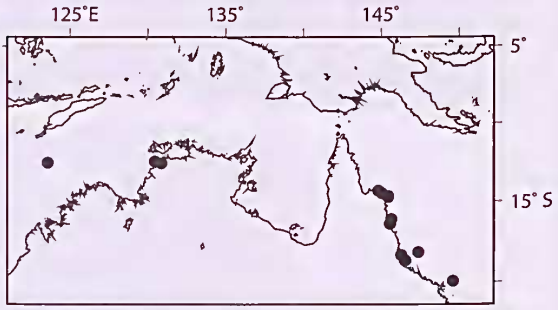

Fig. 10. Distribution of *Dragmacidon australe* in northern Australia, based on confirmed records from QM and NTM. Species distribution extends along the Queensland coast (Hooper pers. obs.) and New Zealand (type locality).

***Dragmacidon durissimum* (Dendy, 1905)**

(Figs 11 A–C)

Thrinacophora durissima Dendy, 1905:187.

Sigmaxinella durissima. – Dendy 1922: 113.

Axinella durissima. – Burton 1959: 259.

Pseudaxinella durissima. – Alvarez *et al.* 2000: 196.

Dragmacidon durissima. – Hallmann 1917: 639; Alvarez and Hooper 2002: 735.

Material examined. Ashmore Reef, WA: QM G300181.

Description. *Shape* (Fig. 11A). Hemispherical, cushion-shaped.

Colour. Orange alive, red on deck, beige in ethanol.

Oscula. Round, irregularly distributed at top, with slightly elevated rims.

Surface. Very rugose, composed of minute projections or conules, compact and close-knit; membranous skin stretched over conules.

Skeleton (Fig. 11B). Plumoreticulate. Multispicular, plumose or plumoechinated spicule tracts, ascending toward surface and connected by shorter and thinner ones, or loose spicules, forming irregular reticulation of oval to square meshes; projecting through ectosome in surface conules or projections.

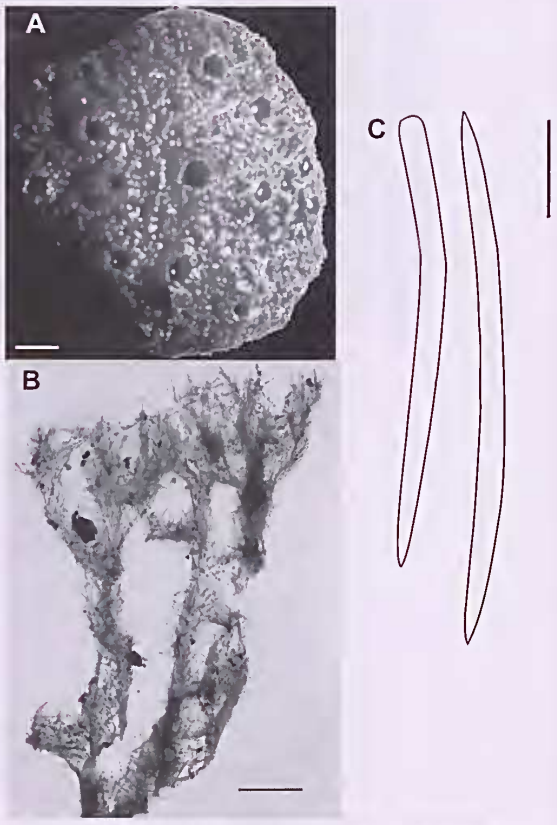

Fig. 11. *Dragmacidon durissimum*: **A**, QM G300181; **B**, light microphotograph of skeleton; **C**, diagram of spicules. Scale bars: **A**, 1 cm; **B**, 500 μm, **C**, 50 μm.

Spicules (Fig. 11C). Styles 203.1–312.5 µm (251.8±33.4) by 11.7–16.4 µm (13.7±1.2). Oxeas in equal proportions, 229.8–312.7 µm (283.2±18) by 7.4–19 µm (13.4±3.1). Triehodragmata short and thiek, 15–20 by 5–10 µm.

Distribution. Indian Oeean, ineluding Seyehelles Is, Amirante, Providenec, Saya de Malha (Dendy 1905; Dendy 1922; Burton 1959), Maldive Is (Alvarez and de Voogd, unpublished data) and Ashmore Reef, Australia.

Remarks. The material examined here agrees in all its characteristies with *Dragmacidon durissimum*, an Indian Oeean speeies never previously reeorded in Australia. Only one speeimen from WA was found among the eolleetions examined in this revision. More isolated populations might be present along thc WA coast, given that the species is widely distributed throughout the Indian Ocean.

The species was included originally in *Thrinacophora* due the presenee of triehodragmata, later transferred to *Sigmaxinella* by Dendy (1922), and subsequently to *Axinella* by Burton (1959) without suffieient justifieation. Hallman (1917) ereeted *Dragmacidon* for *D. agariciformis* (Dendy, 1905), *D. durissimum*, *D. clathriformis* (Lendenfeld, 1888) and *D. incrustans* (Whitelegge, 1897). All these species are very similar in habitat, spieule composition and all inelude triehodragmata. They elosely resemble to the West African speeies *D. lunaecharta* (Ridley and Dendy, 1886). Also similar are the Western Atlantie speeies *D. reticulatum* (Ridley and Dendy, 1886) and *D. australe* (see above), but they laek triehodragmata.

Remarks on *Dragmacidon*. An additional speeies of *Dragmacidon* (deseribed as *Pseudaxinella* sp. in Alvarez *et al.* 2000: 196) remains undeseribed as no additional material has yet been found to fully eharaeterise the speeies. The existing material is a fragment of a thin asymmetric lamella, found detaehed from original substrate that does not agree with the eharaeteristieally thiekly enerusting shape of *Dragmacidon* species.

Genus *Phakellia* Bowerbank, 1862

Gender feminine. Type speeies, by original designation, *Spongia ventilabrum* Linnaeus, 1767. Recent, Lervig, Norway, North Sea.

Phakellia tropicalis sp. nov

(Figs 7 E–F, 12 A–B)

Phakellia sp. Alvarez *et al.*, 2000: 195; Holmes and Blaneh 2007: 761; Alvarez *et al.* 2007: 1600.

Material examined. Holotype – NTM. Z.5847 (Fig. 7E), Stevens Roek, West Arm, Darwin Harbour, 12°29.1667′S, 130°47.19′E, NT, 9 m depth, 8 May 2006, eoll. Alvarez, B. Paratypes – NTM Z.5845 (Fig. 7F), Stevens Roek, West Arm, Darwin Harbour, 12°29.1667′S, 130°47.19′E, NT, 9 m depth, 8 May 2006, coll. B. Alvarez. Additional Specimens – Bynoe Harbour, NT:, NTM Z.4198, Z.4486, Z.4488. Darwin Harbour, NT: NTM Z.866, Z.877, Z.1948, Z.4197, Z.4428, Z.5665, Z.5839–Z.5842, Z.5844, Z.5848, QM G303365, G303383. Wessel Is: NTM Z.4463.

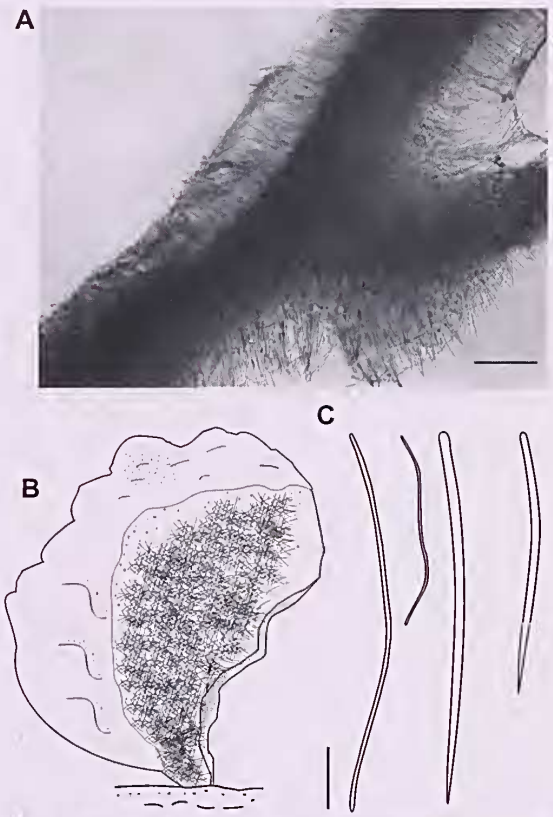

Fig. 12. *Phakellia tropicalis* sp nov.: **A**, light mierophotograph of skeleton in eross seetion; **B**, sehematie drawing of skeleton; **C**, diagram of spieules. Seale bars: **A**, 500 µm; **B**, 100 µm.

Papua New Guinea: QM G312926, G312937. Malaysia: NTM Z.5843.

Description. *Shape* (Fig. 7E–F). Small convoluted thin fans, up to 250 mm high and 300 mm wide, on short and thin pedunele, flexible, less than 5 mm thick, arranged in multiple planes, with fluted or planar flanges, ragged or erenulated margins.

Colour. Bright orange, beige-orange, or yellow-brown (Darwin and Bynoe Harbour specimens) alive.

Oscula. Star-shape oseula, minute.

Surface. Velvety, felty, with choanosomal spieules projeeting shortly; marked with fine network of exeurrent ehannels ending in oseula and reinforeed elose to the pedunele by thiek ehoanosomal axes or 'veins'.

Skeleton (Fig. 12A, B). A eore of interwoven spieules, oeeupying most of speeimen's thiekness, laterally eompressed, eehinated by a dense palisade of single spieules, sometimes aggregated in loose brushes, protruding through surfaee.

Spicules (Fig. 12C). Strongyles wavy, 222–800 in length by 3–8 µm thick and styles 231–703 in length by 6–16 µm thick (Table 5).

Remarks. (see Carvalho *et al.* 2007 for extensive review of *Phakellia* species.)

The species is atypical of *Phakellia*, although it agrees with the diagnosis given by Alvarez and Hooper (2002) in most aspects. It is fan-shaped, with styles projecting through the ectosome, and includes the typical spicule composition of the genus. However the reticulation of thiek 'veins' or thick axes observed in most species of *Phakellia*, seems to be either incomplete or obscured by the habit of the species here described.

The skeleton of this species (especially when seen in cross section, as in Fig. 12A) resembles some species of *Acanthella* (Dictyonellidae), a genus often confused with *Phakellia*. *Phakellia tropicalis* however, laeks two of the main diagnostic features of *Acanthella* – the cartilaginous to membranous surface and the cavernous structure of the choanosomal skeleton, with sheets of aspiculous collagen joining the primary axes in the skeleton. Instead, the surface of *P. tropicalis* is velvety, felty, with choanosomal spicules projecting shortly through the surface, a character shared with other axinellid genera such as *Axinella* and *Cymbastela,* and the skeleton is formed by a core of interwoven strongyles with a regular and dense palisade of erect styles that occupies most of the thickness of the sponge.

A phylogenetic analyses based on morphological characters by Alvarez *et al.* (2000) showed this species to be closely related to other species of *Acanthella* (i.e. *A acuta*, *A. cavernosa* and *A. pulcherrima*). In the same study, however, an analysis based on 28S rDNA sequences with the same set of species, indicated that *P. tropicalis* was closely related to typical axinellid genera such as *Axinella* and *Dragmacidon* supporting its allocation to Axinellidae instead of Dictyonellidae.

Furthermore, the skeletal architecture of *P. tropicalis* corresponds with the basic plan observed in species of *Bubaris* Gray, 1867, a genus of the family Bubaridae and currently used in the strict sense to include encrusting forms (Alvarez and Van Soest 2002). Thus, one could interpret the new species as an 'erect *Bubaris*' and be tempted to allocate it to that genus. It is possible that species with erect forms originally described under *Bubaris*, but transferred to *Acanthella* and *Phakellia* in order to preserve the revised concept of Bubaridae by Alvarez and Van Soest (2002), might be related to the new species. If that is the case, those species could be grouped under a new genus following a revised version of Hentschel's (1923) concept of Bubaridae, which accepted sponges of erect forms, where the core of interwoven strongyles echinated by styles is placed in the centre (or in the axis) instead of at the base, as in the encrusting forms. However, it would be premature to erect a new genus here based on the characteristic of one single species and without re-examining species currently hidden under *Acanthella* or *Phakellia* which might also share such characteristics and could justify the creation of the new genus. In the absence of such evidence, we assign the new species provisionally to *Phakellia* and propose to expand the definition of Alvarez and Hooper (2002) (and modified by Carvalho *et al.* 2007) as: Axinellidae of planar habit, with skeleton formed by multiple axes or a single core of sinuous megascleres (frequently strongyles), echinated either by single spicules or by secondary tracts of a second class of megascleres (frequently styles).

Phakellia tropicalis is the only species of *Phakellia* recorded in this study and as far as we know the first one recorded from warm waters and shallow depths. Note that some species currently accepted under *Phakellia* from similar habitats are likely to be misidentifications (see Carvalho *et al.* 2007 for an extensive review of *Phakellia* species). Other species of *Phakellia* recorded from northern Australia and adjacent areas are currently accepted under *Acanthella* (Van Soest *et al.* 2008) or *Axinella* (i.e. *Phakellia aruensis* Hentschel, 1912, see above). Yet other species described under *Phakellia* in the Indian Ocean are not typical of the genus: *P. ceylonensis* Dendy, 1905: 192 is an *Axinella* (see above); *P. crassistylifera* Dendy, 1905: 192 is likely to belong in *Stylissa* and *Phakellia ridleyi* Dendy, 1887: 159 is currently accepted as a species of *Phakettia.*

Distribution. This species is found along the NT coast and is very common in both Darwin and Bynoe harbours. It is also recorded for Papua New Guinea and Malaysia. It is found between 5–20 m depth

Etymology. Referring to its tropical habitat. It is intended as a noun in apposition.

Genus *Reniochalina* Lendenfeld, 1888

Gender feminine. Type species, by subsequent designation of Hallmann (1914), *Reniochalina stalagmitis* Lendenfeld, 1888. Recent, Western Australia.

Reniochalina stalagmitis Lendenfeld, 1888

(Figs 7G–H, 13A–F, 14 A–E, 15)

Reniochalina stalagmitis Lendenfeld, 1888: 82; Whitelegge 1902: 283; Hallmann 1914: 346; Hooper and Wiedenmayer 1994: 81; Hooper and Lévi 1993: 1404; Alvarez, *et al.* 2000: 197; Alvarez and Hooper 2002: 746; Holmes and Blanch 2007.

Axinella echidnaea. – Ridley 1884: 462; Kieschnick 1896: 533; Hentschel 1912: 419 [misidentification; not Ridley and Dendy 1887: 183]

Reniochalina lamella Lendenfeld, 1888: 83; Whitelegge 1902: 283; Hallmann 1914: 346.

Axiamon folium Hallmann, 1914: 441 [objective synonym, see Wiedenmayer (1989: 49) and Hooper and Lévi (1993: 1403)]

Material examined. TYPE MATERIAL – *Reniochalina stalagmitis*: Lectotype, BMNH 1887.4.27.122, Western Australia, Fig. 13A; paralectotype, AM G9004, wet, West Australia, Fig. 13B [also holotype of *Axiamon folium*]. *Reniochalina lamella*: AM B5478, syntype, wet, no locality data [also paratype of *A. folium*]. ADDITIONAL SPECIMENS – Ridley's (1884) material: BMNH 1882.2.23.261, Prince of Wales Channel, Torres strait, North Queensland, coll. HMS *Alert*; BMNH 1881.10.21.259, Thursday I., Torres strait, North Queensland, coll. HMS *Alert*. Hentschel's

Table 5. Comparison of spicule dimensions among specimens of *Phakellia tropicalis*. Measurements in micrometres.

Specimen	Locality	Strongyles	Styles
Z.5847	Holotype, Stevens Rock	284.1–651.2 (480.4±105.3) x 3.8–8.4 (5.7±1.2)	231.9–549.2 (385.7±82.5) x 7.3–430.9 (29.8±83.6)
Z.4488	Bynoe Harbour	222.8–670.7 (435.5±135) x 3.7–9.5 (7±1.6)	353.9–703.6 (484.6±102.2) x 9–16.4 (13.8±2)
Z.4463	Wessel Is	293.1–800 (553.4±134.6) x 4.4–8.4 (6.6±1.1)	273.6–658.2 (439.6±111.1) x 8.3–16 (11.2±2.2)
G312926	Papua New Guinea	277.8–696.3 (476.4±117.6) [24] x 4.2–8.4 (6.3±1.1)	239.6–490.6 (343.5±69.5) x 5.9–11.5 (8.7±1.8)

(1912) specimen, SMF 1687, Aru-Inseln, bei Pulu Bambu, Indonesia, 10 m depth, 3 April 1908, coll. H. Merton, dredge. NW Shelf, WA: NTM Z.2358, Z.2361, Z.2273, Z.724, Z.738. Ashmore reef, WA: QM G301093, G301112, G301139. NE Joseph Bonaparte Gulf, QM G301202. Fog Bay, NT, QM G303548. Bynoe Harbour, NT: NTM, Z.4462 (0M9H2388-N), Z.5074 (0M9H2451-H), Z.5853. Darwin Harbour, NT: QM G303329, G303362, G303374, G303579, NTM Z.227, Z.285, Z.474, Z.483, Z.815, Z.1107, Z.1989, Z.2686, Z.4448 (0M9H2005-V), Z.5854, Z.5855, Gunn Point, NT, QM G303535. Parry Shoals, NT, Z.525. Melville I., NT, NTM Z.608. Cobourg Peninsula, NT: NTM Z.67, Z.135, Z.537, Z.565, Z.1335, Z.2527. Groote Eylandt, NT, G313555. Wessel Is, Z.5075 (0M9H2647-T). Gulf of Carpenteria, NT, QM G300817. Torres Strait, QM G316882.

Description. *Shape* (Figs 7G–H, 13 A–B). Arborescent, branching or fan-shaped, generally stalked, and erect with specimens up to 60 cm high. Branches, flat to cylindrical, dichotomous or fused, 1–2 cm diameter, generally with pointed tips, dividing and anastomosing irregularly in different planes.

Colour: Two colour forms, orange-red and beige-yellow. Always brown in alcohol.

Oscula. Small, less than 5 mm diameter, with elevated rims thin, membranous and transparent, irregularly distributed through the branches.

Surface. Long surface processes or conules with projecting spicules, up to 5 mm long, evenly distributed and separated by more-or less longitudinal and parallel channels, 1 mm apart, 1 mm deep.

Skeleton (Fig. 13C–F). Specialised ectosomal skeleton absent; choanosomal skeleton differentiated into axial and extra-axial regions. Extra-axial skeleton reticulated with ascending spongin fibres, 50–100 µm interconnected at all angles by single spicules or short fibres, or anastomosing and forming oval to round meshes up to 200 µm in diameter; spongin fibres slightly developed and cored with paucispicular tracts of spicules, sometimes plumose; projecting into surface processes and becoming dense and disorganised at tips. Axial skeleton slightly condensed and reticulated as in extra-axial region.

Spicules (Fig. 14A–E; Table 6). Oxeas or anisoxeas, occasionally modified to styles, straight, bent or slightly sinuous; with tips surmounted by microspines, which might be rudimentary or absent; microspines at one end might be half the compared size to those at other end (175–450 x 6–20 µm). Thin, sinuous styles or oxeas with smooth or slightly spined ends, 156–288 x 3–6 µm (Fig. 14A–C), scattered through the choanosomal skeleton, rare in most examined specimens. Few long styles, projecting through ectosome, present in some specimens but extremely rare.

Remarks. The thin and sinuous styles (Fig. 14) were first mentioned by Hallmann (1914) in his description of *Axiamon folium*. The presence of these spicules was confirmed in all the specimens examined here and point out relationships of *Reniochalina* with other members of the family Raspailiidae (order Poecilosclerida). Long and slightly sinuous styles, most of which were broken, were also observed in the type material of *Axiamon folium* (AM G9004) and in some of the specimens examined. These were extremely rare and scattered throughout the extra-axial skeleton and projecting through the surface, indicating further affinities with raspailid taxa and challenging the position of the genus within Axinellidae (see below).

Distribution. *Reniochalina stalagmitis* is one of the most abundant sponge species of northern Australia. It is found from the intertidal to depths of 60 m. Its distribution extends well beyond the boundaries of the studied region (Fig. 15) with validated records from the northern region of WA (down to W Buccaneer Archipelago) and QLD (down to the Howick Is region). It also occurs in Indonesia.

Notes on *Reniochalina*. *Reniochalina* was defined by Alvarez and Hooper (2002) as 'Axinellidae with extra-axial spongin fibres projecting into surface processes and cored with paucispicular tracts of oxeas, anisoxeas and styles. Oxeas with tips surmounted by micro-spines'.

The genus was considered to be closely related to other axinellid genera (i.e. *Ptilocaulis* and *Phycopsis*) by Alvarez and Hooper (2002), based on the shared presence of conspicuous, long, filamentous surface processes and their skeletal features. The close affinities with *Ptilocaulis* were further confirmed by molecular phylogenetic analyses (Alvarez *et al.* 2000). Recent molecular studies (Erpenbeek *et al.* 2007; Holmes and Blanch 2007) also showed strong affinities of *Reniochalina stalagmitis* with the raspaillid species *Axechina raspailoides*. As previously indicated (Hooper 1991; Hooper 2002b), these species have similar growth forms and choanosomal skeletons, and it is now confirmed that they also share the presence of styles

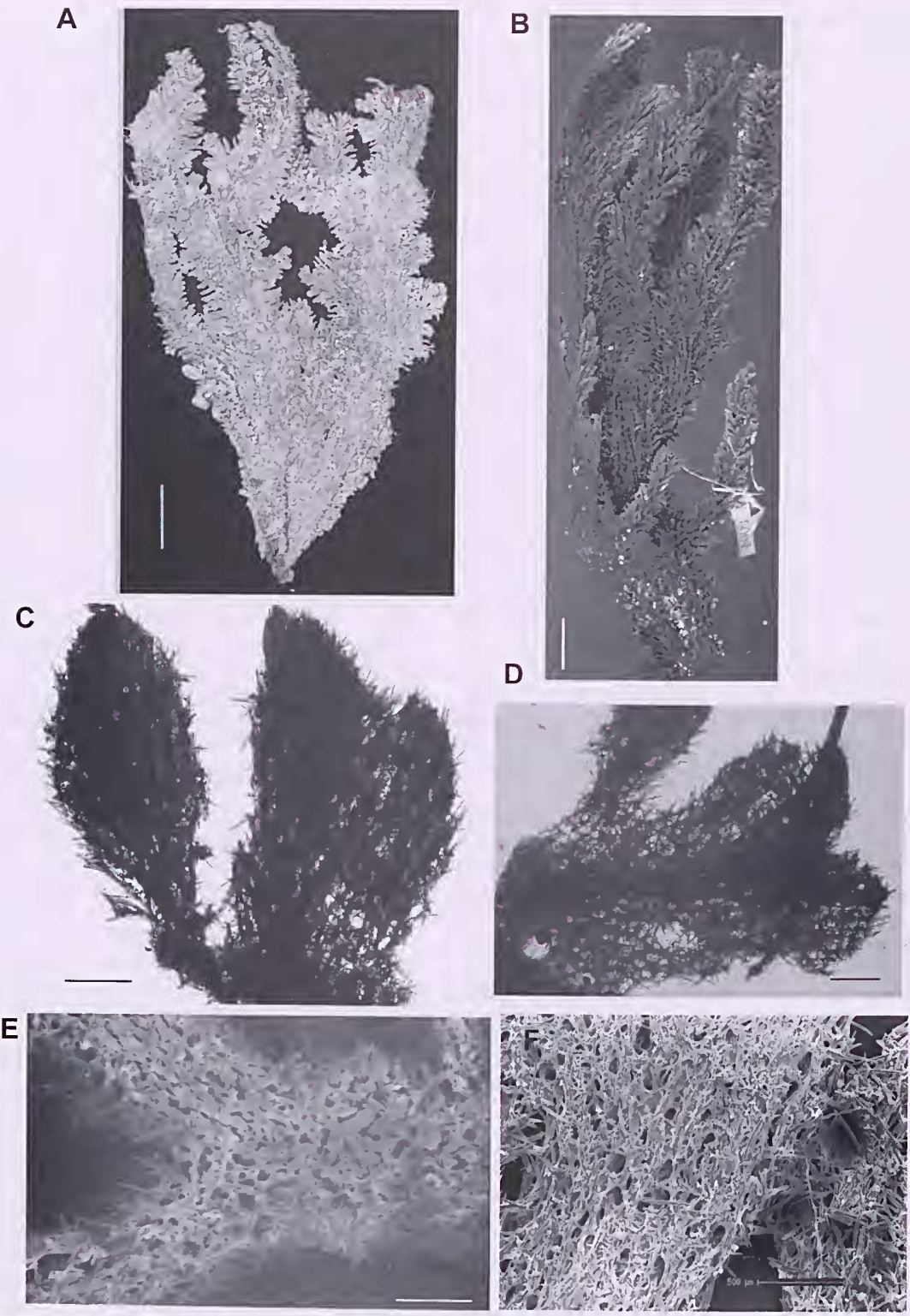

Fig. 13. *Reniochalina stalagmitis*: **A**, lectotype, BMNH 1887.4.27.122; **B**, paralectotype, AM G9004; **C**, lectotype, BMNH1887.4.27.122, light microphotograph of skeleton; and **D**, SEM of skeleton; **E**, paralectotype, AM G9004, light microphotograph of skeleton and **F**, SEM of skeleton. Scale bars: **A**, **B**, 2 cm; **C–F**, 500 μm.

with spined tips and identical shape (Fig. 14B, C), a fact overlooked by previous authors with the exception of Hallmann (1914).

Additional molecular analysis based on the CO1 fragment (Erpenbeck 2007) also indicated affinities of the Caribbean species *Ptilocaulis marquezi* (Duchassaing and Michelotti, 1864) with other raspailiid species (i.e. *Pandaros acanthifolium* (Duchassaing and Michelotti, 1864) and *Ecyoplasia ferox* (Duchassaing and Michelotti, 1864) suggesting strongly that both *Ptilocaulis* and *Reniochalina* are closely related to the Raspailiidae. These relationships however, remain unresolved as neither *Reniochalina* nor *Ptilocaulis* have the typical raspailiid ectosomal skeleton which is clearly present in *Axechina* and other raspailiid taxa. Unfortunately, the range of taxa sampled in the molecular analyses mentioned above was inadequate to conclude further on the affinities of the axinellid genera *Reniochalina* and *Ptilocaulis* (and likely *Phycopsis* too) with the family Raspailiidae. Therefore, if more evidence from molecular analyses becomes available to support the current results, these genera might be relocated to the Raspailiidae.

Other species of *Reniochalina* reported in the literature do not agree with the current definition of the genus and are referred here to more appropriate genera: *Reniochalina condylia* Hooper and Lévi, 1993, to *Dragmacidon*; *R. plumosa* Lévi and Lévi, 1983 to *Axinella* and, *R. sectilis* Wiedenmayer, 1989 to *Rhaphoxya* in Dictyonellidae. Additional species of *Reniochalina* including *Reniochalina* sp., reported in Alvarez *et al.* (2000), remain to be described from other areas of Australia (Hooper, pers. obs.). It is likely also that some species of *Reniochalina* are misidentified as species of *Ptilocaulis* (e.g. *P. rigidus* Carter, 1883:322).

DISCUSSION

The results of this revision indicate that the Axinellidae is represented in the area covered by this study by only five genera (i.e. *Axinella, Cymbastela, Dragmacidon, Phakellia* and *Reniochalina*) and nine species, three of which are new. Data gathered from NTM and QM collections during the initial stages of this revision indicated that the Axinellidae was represented in the area by a larger number of species. This observation turned out to be contrary to what was found after a thorough examination of recorded material. Many of the species thought to belong to the Axinellidae were in fact found to be members of other families and orders, particularly Raspailiidae (Poecilosclerida).This reflects that separation of species within this group is extremely subjective and could be erroneous if is taken in an isolated context. Examination of the taxonomic characters across a large number of specimens is critical to detect the variability and plasticity of morphological characters present in this group and to avoid incorrect splitting of taxa. It is possible that cryptic species or hybrid forms are hidden within the continuum of variability commonly observed in species of Axinellidae; but only results of population genetic studies can reveal such cryptic species, and indeed verify the occurrence of hybridisation among the Porifera, as has been demonstrated for the Cnidaria (e.g. Veron 1995, Van Oppen 2000 and references within).

The five remaining genera of the Axinellidae (i.e. *Auletta, Dragmaxia, Pipestela, Ptilocaulis* and *Phycopsis*) are curiously not represented in the studied material despite the fact that they do include tropical species.

Axinella loribellae, *Cymbastela stipitata* and *C. vespertina* are the only species of axinellids reported here with distributions restricted to northern Australia, reflecting some degree of endemism in the area. The latter sibling species pair represent western components of east-west coast species pairs of the genus *Cymbastela*, with *C. coralliophila* and *C. concentrica* of the east coast, presumed remnants of Pleistocene separation of northern Australian faunas during low strand sea levels (e.g. Hooper and Ekins 2004). *Axinella sinoxea* displays a similar distribution but can be found in deep waters of WA. The remaining species seem to have a more widespread distribution throughout Indonesia, Papua New Guinea and Malaysia. *Axinella arnensis* and *Reniochalina stalagmitis* are widely distributed in the northern region of Australia and Indonesia. *Dragmacidon australe* has a disjunct distribution with isolated records from New Zealand, GBR and northern

Table 6. Comparison of spicule dimensions among specimens of *Reniochalina stalagmitis*. Measurements in micrometres.

Specimen	Locality	Oxeas	Thin styles/oxeas
Lectotype BMNH1887.4.27.122	WA	190–315 (248.6±27.9) x 8–15.2 (12.1±2.4)	157.1–287.6 (240.2±35.3) [18] x 2.6–5.8 (4.5±0.9) [18]
AM G9004	WA	175–450 (243.9±61.8) x 7.9–20 (10.7±3)	211.7–268 (244±22.7) [9] x 2.6–5 (3.8±0.8) [9]
AM B5478	WA	197–376.6 (248.3±49.5) x 10.1–19 (14.4±1.9)	156.4–235 (203.7±25.3) [12] x 3.5–6.3 (4.9±0.8) [12]
G303362	Darwin	209.1–356.6 (253.3±43.4) x 9.2–17 (13±2.2)	206.5–232.6 (219.5±18.4) [2] x 3.9–4 (3.9±0) [2]
Z.4462	Bynoe Harbour	195.1–379.1 (293.5±39.1) x 7.1–18.2 (13.9±2.6)	158.2–244.4 (213.2±40.2) [4] x 2.6–5.2 (4.2±1.1) [4]
Z.5075	Wessel Is	199.6–380.2 (286.4±44.6) x 6.3–18 (12.4±2.8)	205.8x3.7 [1]

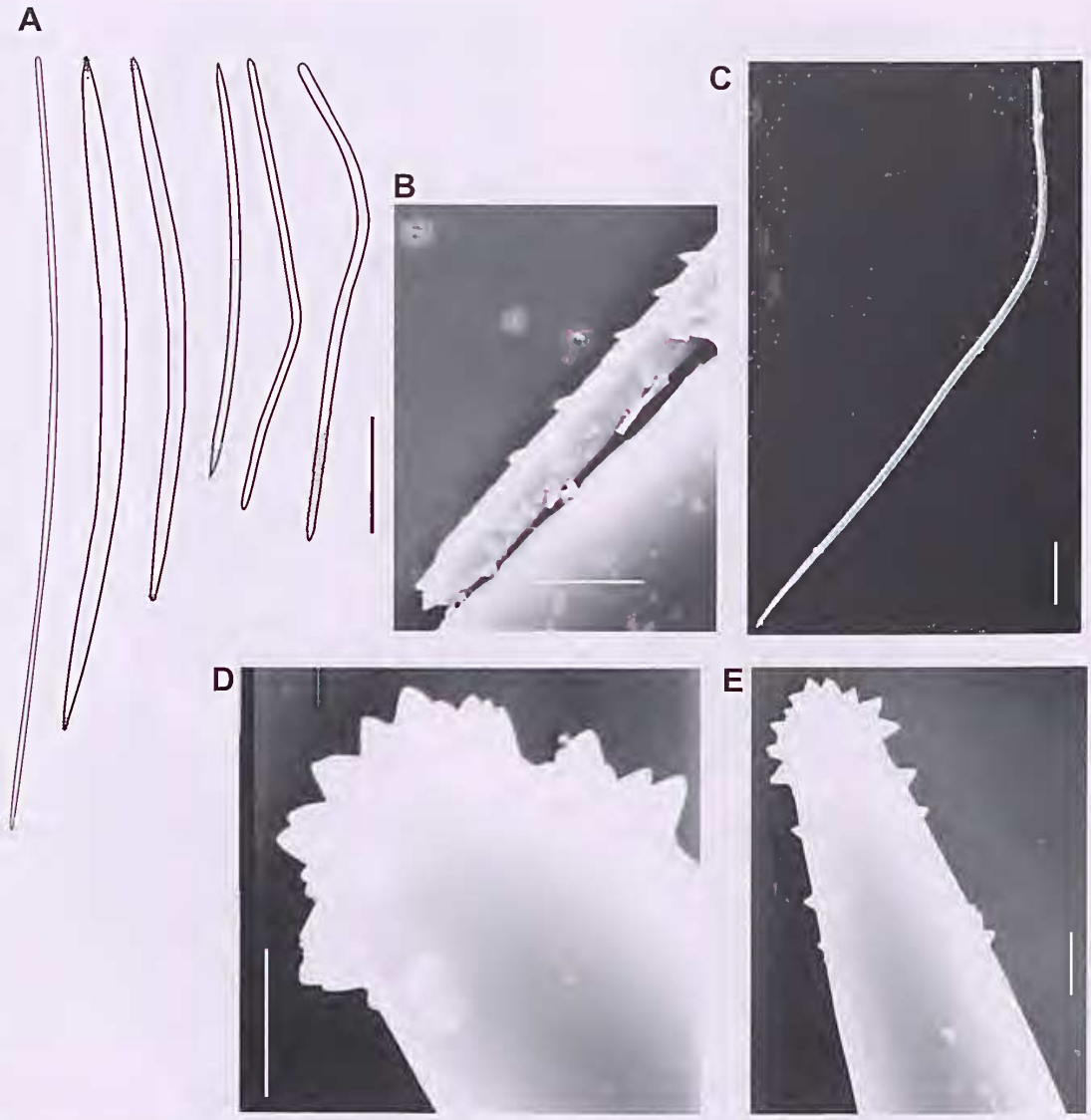

Fig. 14. *Reniochalina stalagmitis*: **A**, diagram of spicules; **B**, **C**, SEM of sinuous style with spined tip (AM G9004); **D**, **E**, tip of oxeas, (AM G9004). Scale bars: **A**, 50 μm; **B**, 5 μm; **C**, 20 μm; **D**, **E**, 2 μm.

Australia. *Dramacidon durissimum* is a species common from Indian Ocean but its distribution is now extended to the Ashmore Reef, WA of northern Australia.

The position of *Reniochalina* within the Axinellidae is now debatable. The presence of sinuous styles with spiny tips in *R. stalagmitis* and the recent evidence based on molecular data (see above) suggest strongly that the species is closely related to the raspailiid species *Axechina raspailioides* (Poecilosclerida) and challenges the position of *Reniochalina stalagmitis* within the family. The typical ectosomal skeleton present in raspailiid species and considered a synapomorphy for that family is absent in *R. stalagmitis*, thus no definitive conclusions can be made at this stage. New studies as suggested above are needed

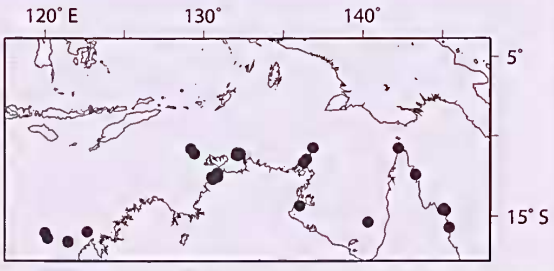

Fig. 15. Distribution of *Reniochalina stalagmitis* in northern Australia, based on confirmed records from QM and NTM. Species distribution extends along the Queensland coast (Hooper, unpublished data).

to decide whether *Reniochalina* should remain classified under the Axinellidae.

Phylogenetic relationships within the family Axinellidae and other related groups have been explored previously, using either morphological, molecular or chemical characters (Alvarez *et al.* 2000; Erpenbeck *et al.* 2002; Erpenbeck *et al.* 2005; Erpenbeck *et al.* 2006; Erpenbeck *et al.* 2007). The relationships shown in those studies remain inconclusive at this stage but suggest strongly that the Axinellidae is a polyphyletic taxon with uncertain affinities. The taxonomic revision of species of the Axinellidae and its sister groups is critical to support conclusions derived from those studies and is currently the focus of ongoing studies undertaken at regional basis (e.g. Indonesia, Eastern Australia, Central-West Pacific, Southern Australia and New Zealand).

ACKNOWLEDGEMENTS

This work was funded by an Australian Biological Research Studies (ABRS) research grant (Grant No 205-10) and by the 'Collection and Taxonomy of Shallow Water Marine Organisms' program for the US National Cancer Institute (Contract N02-CM-27003) subcontracted to NTM through CRRF.

We specially thank Michael Browne and Huy Nguyen, for their invaluable assistance during 2002–2004 NTM field collections; Dr Pat Colin (CRRF) and Don DeMaria, for their assistance and photographic work during NTM field collections in the 2004 Wessel Is; Terry Yumbuluy, Wessel Is, to allow collections in his home-land area; Merrick Erins (QM) for his assistance in interrogating the QM database and making specimens available for study; Ellie Hayward (Charles Darwin University) for her assistance with SEM preparations; Drs Rob W.M. Van Soest (ZMA), Richard Willan and especially Chris Glasby (NTM) for their continuous advice and suggestions during the preparation of this manuscript; and the two referees of this paper for their valuable suggestions.

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Accepted 21 October 2009

APPENDIX

Collection and locality data of material examined in the collections of QM and NTM.

QM material

G300181	Passage West 1., outer reef, Ashmore Reef, WA, 12°14′S, 122°56′E, 15.5 m, 27 Jul 1986, coll. Hooper, JNA
G300295	Snake Reef, Howick Group, GBR, QLD, 14°27′S, 145°1′E, 12.5 m, 14 Dec 1990, coll. Hooper, JNA
G300609	N side of Cumberland Strait, Wessel Is, Gove, NT, 11°28′S, 136°29′E, 13 m, 14 Nov 1990, coll. NCI, AIMS
G300759	Marinbar I, SE Cape Wessel, Wessel Is, NT, 11°1.13′S, 136°46.04′E, 20 m, 17 Nov 1990, coll. NCI, AIMS
G300768	Gugari Rip 100m NE, E Guluwuru I, Wessel Is, NT, 11°34′S, 136°22.12′E, 8 m, 13 Nov 1990, coll. NCI, AIMS
G300817	Duyfken Point, W Gulf of Carpentaria, QLD, 12°34′S, 141°0′E, 58 m, 26 Nov 1991, coll. Cook, SD. on CSIRO RV Southern Surveyor
G301089	Cartier I, outer reef slope, N side reef, WA, 12°31.07′S, 123°33.05′E, 14 m, 6 May 1992, coll. Hooper, JNA
G301092	Cartier I, outer reef slope, N side reef, WA, 12°31.07′S, 123°33.05′E, 22 m, 7 May 1992, coll. Hooper, JNA
G301093	Cartier I, outer reef slope, N side reef, WA, 12°31.07′S, 123°33.05′E, 22 m, 7 May 1992, coll. Hooper, JNA
G301112	Cartier I, outer reef slope, S side of reef, WA, 12°32.15′S, 123°33.12′E, 23 m, 8 May 1992, coll. Hooper, JNA
G301139	Hibernia Reef, entrance to lagoon, NE side reef, WA, 11°57.13′S, 123°22.06′E, 23 m, 10 May 1992, coll. Hooper, JNA
G301197	Flattop Bank, NE Joseph Bonaparte Gulf, NT, 12°16′S, 129°15′E, 32 m, 17 May 1992, coll. Hooper, JNA
G301202	Flattop Bank, NE Joseph Bonaparte Gulf, NT, 12°16′S, 129°15′E, 32 m, 17 May 1992, coll. Hooper, JNA
G303262	South Shell I., reef N of boat ramp, East Arm, Darwin Harbour, NT, 12°29.1334′S, 130°53.09′E, 0 m, 19 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303322	East Point Bommies, Darwin Harbour, NT, 12°24.08′S, 130°48.14′E, 10 m, 23 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303329	East Point Bommies, Darwin Harbour, NT, 12°24.08′S, 130°48.14′E, 10 m, 23 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303332	East Point Bommies, Darwin Harbour, NT, 12°24.0834′S, 130°48.14′E, 10 m, 23 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303362	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.17′S, 130°47.19′E, 19 m, 24 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303365	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.17′S, 130°47.19′E, 19 m, 24 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303374	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.17′S, 130°47.19′E, 19 m, 23 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303383	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.17′S, 130°47.19′E, 19 m, 24 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303388	Stevens Rock, West Arm, Darwin Harbour, 12°29.1667′S, 130°47.19′E, NT, 19 m depth, 24 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303444	Fish Reef, west side, Bynoe Harbour, NT, 12°26.01′S, 130°26.09′E, 11 m, 26 Sep 1993, coll. Hooper, JNA and Hobbs, LJ
G303535	Shoal Bay, W Gunn Point, NT, 12°9.15′S, 130°56.02′E, 14 m, 11 Oct 1993
G303548	Fog Bay, 1 nml E Point Blaze, NT, 12°54.15′S, 130°7.16′E, 7 m, 4 Oct 1993
G303579	Lee Point near Anglers Reef, Darwin Harbour, NT, 12°18.13′S, 130°52.14′E, 10 m, 11 Oct 1993
G304182	Granite Bluff, Lizard I., S headland Mermaid Cove, QLD, 14°39′S, 145°27′E, 18 m, 4 Apr 1994, coll. Hooper, JNA and party
G304246	Cobia Hole, Mrs Watson′s Bay, Lizard I., QLD, 14°39.03′S, 145°26.15′E, 18 m, 5 Apr 1994, coll. Hooper, JNA and party
G304253	Palfrey I., W side, Lizard I., QLD, 14°42.03′S, 145°26.09′E, 16 m, 6 Apr 1994, coll. Hooper, JNA and party
G310136	Parry Shoals 35nm W Bathurst I., NT, 11°7.03′S, 129°25.9′E, 16 m, 12 Aug 1987
G311873	100m NE Gugari Rip, East side Guluwuru IS, Wessel Is, NT, 11°20.4′S, 136°13.63′E, 8 m, 13 Nov 1990
G312926	12 mile sandbank, Kupiano, SE Papuan Lagoon, Papua New Guinea, 10°11.05′S, 148°10.14′E, 20 m, 15 Dec 1996, coll. Hooper, JNA
G312913	Coutance Islet, Kupiano, SE. Papuan Barrier Reef, Papua New Guinea, 10°14.0167′S, 148°6.14′E, 41 m, 14 Dec 1996, coll. Hooper, JNA
G312935	12 mile sandbank, Kupiano, SE Papuan Lagoon, Papua New Guinea, 10°11.0501′S, 148°10.14′E, 20 m, 15 Dec 1996, coll. Hooper, JNA
G312937	12 mile sandbank, Kupiano, SE Papuan Lagoon, Papua New Guinea, 10°11.05′S, 148°10.14′E, 20 m, 15 Dec 1996, coll. Hooper, JNA
G313555	S Groote Eylandt, NT, 14°27.1801′S, 136°14.29′E, 22.5 m, 12 Oct 1997, coll. Cook, SD. on CSIRO RV Southern Surveyor
G316882	Torres Strait, QLD, 10°46.8′S, 142°15′E, 16.4 m, 19 Jan 2004, coll. TSMap_GM_01_2004 Gwendoline May
G320664	Munro Reef, Coral Sea, QLD, 14°18.15′S, 144°48.82′E, 23 m, 2 Jul 2003, coll. Hooper, JNA and party

APPENDIX (continued)

Collection and locality data of material examined in the collections of QM and NTM.

NTM material

Z.67	Coral Bay, Port Essington, Cobourg Peninsula, NT, 11°11.50′S, 132°3.01′E, 17 Oct 1981, coll. Hooper, JNA & Alderslade, PN
Z.135	Sandy I. No.2, Cobourg Peninsula, NT, 11°5.50′S, 132°17′E, 10 m, 21 Oct 1981, coll. Hooper, JNA & Alderslade, PN
Z.227	Lee Point, Darwin, NT, 12°19.0167′S, 130°53′E, 14 Nov 1981, coll. Hooper, JNA
Z.285	Dudley Point Reef, East Point, Darwin, NT, 12°25.00′S, 130°48.01′E, 1 m, 18 Sep 1981, coll. Hooper, JNA & Murray, P
Z.474	Fannie Bay, Darwin, NT, 12°25.00′S, 130°50′E, 9 Feb 1982, coll. Hooper, JNA
Z.483	Fannie Bay, Darwin, NT, 12°25.00′S, 130°50′E, 9 Feb 1982, coll. Hooper, JNA
Z.525	Parry Shoals 35nm W Bathurst I., NT, 11°7.03′S, 129°25.9′E, 1 m, 30 Apr 1982, coll. Hooper, JNA & Alderslade, PN
Z.537	Port Bremer, Cobourg Peninsula, NT, 11°8.5′S, 132°18.8′E, 1 May 1982, coll. Hooper, JNA & Alderslade, PN
Z.565	Sandy I. No.2, Cobourg Peninsula, NT, 11°5′S, 132°16.51′E, 14 m, 2 May 1982, coll. Hooper, JNA
Z.608	Cootamundra Shoals, North of Melville I., NT, 10°49.07′S, 129°12.09′E, 31 m, 6 May 1982, coll. Thom, B & Lockyer, R
Z.615	Cootamundra Shoals,North of Melville I., NT, 10°50.22′S, 129°13.17′E, 22 m, 10 May 1982, coll. Lockyer, R
Z.619	Unnamed shoal N Melville I, NT, 11°38.23′S, 129°51.00′E, 24 m, 17 May 1982, coll. Thom, B & Lockyer, R
Z.630	Unnamed shoal N Melville I, NT, 11°32.58′S, 130°02.50′E, 18 m, 25 May 1982, coll. Lockyer, R
Z.631	Unnamed shoal N Melville I, NT, 11°32.58′S, 130°02.50′E, 18 m, 25 May 1982, coll. Lockyer, R
Z.632	Unnamed shoal N Melville I, NT, 11°32.57′S, 130°2.51′E, 18 m, 25 May 1982, coll. Lockyer, R
Z.665	NW Yampi Sound, NW Shelf, WA, 15°27.0334′S, 121°49.01′E, 76 m, 29 Apr 1982, coll. CSIRO R.V. Sprightly
Z.724	N Adele I.,Collier Bay, NW Shelf, WA, 15°58.02′S, 122°39.07′E, 59 m, 21 Apr 1982, coll. CSIRO R.V. Sprightly
Z.738	N Adele I.,Collier Bay, NW Shelf, WA, 15°58.02′S, 122°39.07′E, 59 m, 21 Apr 1982, coll. CSIRO R.V. Sprightly
Z.815	Channel I., Middle Arm, Darwin, NT, 12°32.02′S, 130°51.02′E, 11 m, 16 Jul 1982, coll. Scott Chidgey (Caldwell Connell Ass
Z.822	Channel I., Middle Arm, Darwin, NT, 12°33.08′S, 130°51.04′E, 20 m, 18 Jul 1982, coll. Scott Chidgey (Caldwell Connell Ass)
Z.866	Channel I., Middle Arm, Darwin, NT, 12°32.07′S, 130°52.04′E, 13 m, 20 Aug 1982, coll. Alderslade, PN.
Z.868	Channel I., Middle Arm, Darwin, NT, 12°32.07′S, 130°52.04′E, 13 m, 20 Aug 1982, coll. Alderslade, PN.
Z.877	Channel I., Middle Arm, Darwin, NT, 12°32.07′S, 130°52.04′E, 13 m, 20 Aug 1982, coll. Alderslade, PN.
Z.1107	Dudley Point Reef, East Point, Darwin, NT, 12°25.00′S, 130°48.01′E, 22 Dec 1982, coll. Hooper, JNA
Z.1335	Table Head, Port Essington, Cobourg Peninsula, NT, 11°13.5′S, 132°10.51′E, 11 May 1983, coll. Hooper, JNA
Z.1363	Coral Bay, Port Essington, Cobourg Peninsula, NT, 11°11.3′S, 132°3.71′E, .5–6 m, 16 May 1983, coll. Hooper, JNA
Z.1388	Coral Bay, Port Essington, Cobourg Peninsula, NT, 11°11.3′S, 132°3.71′E, 6 m, 17 May 1983, coll. Hooper, JNA
Z.1948	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.2′S, 130°47.1′E, 27 Apr 1984, coll. Hooper, JNA
Z.1961	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.2′S, 130°47.1′E, 27 Apr 1984, coll. Hooper, JNA
Z.1989	West side of Weed Reef, Darwin, NT, 12°29.2001′S, 130°47.1′E, m, 11 May 1984, coll. Hooper, JNA and party
Z.2156	Northern tip of Weed Reef, outer reef slope, Darwin Harbour, NT, 12°29.2′S, 130°37.61′E, 5 Oct 1984, coll. Hooper, JNA
Z.2246	Dudley Point Reef, East Point, Darwin, NT, 12°24.5′S, 130°48.01′E, 10 m, 12 Apr 1985, coll. Hood, C and party
Z.2249	Dudley Point Reef, East Point, Darwin, NT, 12°24.5′S, 130°48.01′E, 10 m, 12 Apr 1985, coll. Hood, C and party
Z.2273	NW Lacepede Is, NW Shelf, WA, 16°31.00′S, 121°28.01′E, 38–40 m, 17 Apr 1985, coll. Russell, BC (TRASH Fish project)
Z.2284	NW Lacepede Is, NW Shelf, WA, 16°31.00′S, 121°28.01′E, 38–40 m, 17 Apr 1985, coll. Russell, BC (TRASH Fish project)
Z.2304	NW Lacepede Is, NW Shelf, WA, 16°31.00′S, 121°28.01′E, 38–40 m, 17 Apr 1985, coll. Russell, BC (TRASH Fish project)
Z.2310	NW Lacepede Is, NW Shelf, WA, 16°31.00′S, 121°28.01′E, 38–40 m, 17 Apr 1985, coll. Russell, BC (TRASH Fish project)
Z.2322	NW Lacepede Is, NW Shelf, WA, 16°31.00′S, 121°28.01′E, 38–40 m, 17 Apr 1985, coll. Russell, BC (TRASH Fish project)
Z.2331	NW Lacepede Is, NW Shelf, WA, 16°31.00′S, 121°28.01′E, 38–40 m, 17 Apr 1985, coll. Russell, BC (TRASH Fish project)
Z.2345	NW Lacepede Is, NW Shelf, WA, 16°34′S, 121°27.01′E, 40–46 m, 17 Apr 1985, coll. Russell, BC
Z.2358	NW Lacepede Is, NW Shelf, WA, 16°34′S, 121°27.01′E, 40–46 m, 17 Apr 1985, coll. Russell, BC
Z.2361	NW Lacepede Is, NW Shelf, WA, 16°34′S, 121°27.01′E, 40–46 m, 17 Apr 1985, coll. Russell, BC
Z.2402	Dudley Point Reef, East Point, Darwin, NT, 12°24.5′S, 130°48.01′E, 8 m, 29 Jul 1985, coll. Hooper, JNA
Z.2511	Coral Bay, Port Essington, Cobourg Peninsula, NT, 11°11.3′S, 132°3.71′E, 15 Sep 1985, coll. Hooper, JNA

APPENDIX (continued)

Collection and locality data of material examined in the collections of QM and NTM.

NTM material

Z.2526	Orontes Reef,mouth of Port Essington,Cobourg Peninsula, NT, 11°3.60′S, 132°5.41′E, 18–20 m, 16 Sep 1985, coll. Hooper, JNA
Z.2527	Orontes Reef,mouth of Port Essington,Cobourg Peninsula, NT, 11°3.60′S, 132°5.41′E, 18–20 m, 16 Sep 1985, coll. Hooper, JNA
Z.2529	Orontes Reef,mouth of Port Essington,Cobourg Peninsula, NT, 11°3.60′S, 132°5.41′E, 17 Sep 1985, coll. Hooper, JNA
Z.2632	Dudley Point Reef, East Point, Darwin, NT, 12°24.5′S, 130°48.01′E, 3 Apr 1986, coll. Hooper, JNA and party
Z.2686	Dudley Point Reef, East Point, Darwin, NT, 12°24.5′S, 130°48.01′E, 3 Apr 1986, coll. Hooper, JNA and party
Z.2719	Dudley Point Reef, East Point, Darwin, NT, 12°24.5′S, 130°48.01′E, 3 Apr 1986, coll. Hooper, JNA and party
Z.2727	Myrmidon Reef,GBR, QLD, 18°10.00′S, 147°23′E, 15 m, 1 Jan 1985, coll. Wilkinson,CR
Z.3062	Parry Shoals, Arafura Sea, NT, 11°11.72′S, 129°43.26′E, 16 m, 12 Aug 1987, coll. Mussig, AM and NCI team
Z.3068	Parry Shoals, Arafura Sea, NT, 11°11.72′S, 129°43.26′E, 16 m, 12 Aug 1987, coll. Mussig, AM and NCI team
Z.3137	Parry Shoals, Arafura Sea, NT, 11°12.27′S, 129°42.71′E, 16 m, 14 Aug 1987, coll. Mussig, AM and NCI team
Z.3141	Parry Shoals, Arafura Sea, NT, 11°12′S, 129°43.01′E, 16 m, 14 Aug 1987, coll. Mussig, A.M. and NCI (AIMS)
Z.3922	Cumberland Strait, northern bay, Wessel Is, Gove Peninsula, NT, 11°27.5′S, 136°28.8′E, 20 m, 14 Nov 1990, coll. Hooper, JNA
Z.3925	Cumberland Strait, northern bay, Wessel Is, Gove Peninsula, NT, 11°27.5′S, 136°28.8′E, 20 m, 14 Nov 1990, coll. Hooper, JNA
Z.3935	N side of Cumberland Strait, Wessel Is, Gove Peninsula, NT, 11°27.60′S, 136°28.7′E, 32 m, 15 Nov 1990, coll. Hooper, JNA
Z.3936	N side of Cumberland Strait, Wessel Is, Gove Peninsula, NT, 11°27.60′S, 136°28.7′E, 32 m, 15 Nov 1990, coll. Hooper, JNA
Z.3938	N side of Cumberland Strait, Wessel Is, Gove Peninsula, NT, 11°27.60′S, 136°28.7′E, 32 m, 15 Nov 1990, coll. Hooper, JNA
Z.3946	S W headland, Rimbija I., Cape Wessel, Wessel Is, Gove Peninsula, NT, 11°0.5′S, 136°43.79′E, 15 m, 16 Nov 1990, coll. Hooper, JNA
Z.3956	N side Pugh Shoal, reef slope, NE of Truant I., English Company IS, Gove Peninsula, NT, 11°36.57′S, 136°53.39′E, 20 m, 18 Nov 1990, coll. Hooper, JNA
Z.4078	Near boat ramp, East Arm Port, Darwin, NT, 12°29.8′S, 130°53.5′E, coll. B. Glasby & party, by hand
Z.4104	Near boat ramp, East Arm Port, Darwin, NT, 12°29.8′S, 130°53.5′E, coll. B. Glasby & party, by hand
Z.4131	Near boat ramp, East Arm Port, Darwin, NT, 12°29.8′S, 130°53.5′E, coll. B. Glasby & party, by hand
Z.4197	"Town Hall" hole, SW Channel I., Middle Arm of Darwin Harbour, NT, 12°33.74′S, 130°51.67′E, 19.5 m, 9 Sep 2004, coll. Alvarez, B
Z.4198	Sand Island, Middle Arm, Darwin Harbour, NT, Australia, Australia, 12°35.291′S, 130°52.264′E, 7 m, 9 Sep 2004, coll. Alvarez, B
Z.4425	Stevens Rock, 1.25 km SE Talc Head, off Cox Peninsula, Darwin Harbour, NT, 12°29.09′S, 130°47.1′E, 5–19 m, 8 May 2002, coll. Alvarez, B and party
Z.4428	Stevens Rock, 1.25 km SE Talc Head, off Cox Peninsula, Darwin Harbour, NT, 12°29.09′S, 130°47.1′E, 5–19 m, 8 May 2002, coll. Alvarez, B and party
Z.4435	Channel Island, 100–400 m N of bridge, Middle Arm, Darwin Harbour, NT, Australia, Australia, 12°33.09′S, 130°52.43′E, 4–8 m, 6 May 2002, coll. Alvarez, B and party
Z.4448	Channel Island, 100–400 m N of bridge, Middle Arm, Darwin Harbour, NT, Australia, Australia, 12°33.09′S, 130°52.43′E, 4–8 m, 6 May 2002, coll. Alvarez, B and party
Z.4462	Dawson Rock, 3 km SSE Rankin Point, Bynoe Harbour, NT, 12°42.21′S, 130°35.46′E, 5–10 m, 26 May 2003, coll. Alvarez, B and party
Z.4463	Rimbija I., 2.8 km W of Cape Wessel, Wessel Is, eastern Arnhem Land, NT, 11°00.21′S, 136°43.84′E, 17–20 m, 1 Apr 2004, coll. Colin, P
Z.4465	Raragala I., bay on SW coast, Wessel Is, eastern Arnhem Land, NT, 11°38.57′S, 136°17.86′E, 11–20 m, 5 Apr 2004, coll. Alvarez B and party
Z.4486	Raft Point, Bynoe Harbour, NT, 12°37.69′S, 130°32.16′E, 5–8 m, 26 Jun 2003, coll. Alvarez, B and party
Z.4488	Dawson Rock, 3 km SSE Rankin Point, Bynoe Harbour, NT, 12°42.21′S, 130°35.46′E, 5 m, 1 Jun 2005, coll. Alvarez, B
Z.4490	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.17′S, 130°47.19′E, 5 m, 8 May 2006, coll. Alvarez, B
Z.4491	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.17′S, 130°47.19′E, 14 m, 8 May 2006, coll. Alvarez, B
Z.5053	South Shell I., East Arm, Darwin Harbour, NT, 12°29.87′S, 130°53.12′E, 4–11 m, 18 Aug 2002, coll. Alvarez, B and party
Z.5054	Raragala I., bay on SW coast, Wessel Is, eastern Arnhem Land, NT, 11°38.6′S, 136°17.84′E, 17–20 m, 30 Mar 2004, coll. Alvarez, B and party

APPENDIX (continued)

Collection and locality data of material examined in the collections of QM and NTM.

NTM material

Z.5055	Raragala I., bay on SW coast, Wessel Is, eastern Arnhem Land, NT, 11°38.6′S, 136°17.84′E, 17–20 m, 30 Mar 2004, coll. Alvarez, B and party
Z.5057	Raragala I., bay on SW coast, Wessel Is, eastern Arnhem Land, NT, 11°38.6′S, 136°17.84′E, 17–20 m, 30 Mar 2004, coll. Alvarez, B and party
Z.5058	Raragala I., 700 m off NE tip Wessel Is, eastern Arnhem Land, NT, 11°32.85′S, 136°21.28′E, 13–16 m, 31 Mar 2004, coll. Alvarez, B
Z.5059	Raragala I., bay on SW coast, Wessel Is, eastern Arnhem Land, NT, 11°38.55′S, 136°17.96′E, 25–30 m, 5 Apr 2004, coll. Alvarez, B and party
Z.5064	Weed Reef, entrance to West Arm, Darwin Harbour, NT, 12°29.25′S, 130°47.54′E, 9–15 m, 3 Aug 2002, coll. Alvarez, B and party
Z.5065	Dawson Rock, 3 km SSE Rankin Point, Bynoe Harbour, NT, 12°42.24′S, 130°35.56′E, 5–10 m, 23 May 2003, coll. Alvarez, B and party
Z.5066	Raragala I., bay on SW coast, Wessel Is, eastern Arnhem Land, NT, 11°38.6′S, 136°17.84′E, 17–20 m, 30 Mar 2004, coll. Alvarez, B and party
Z.5067	Raragala I., bay on SW coast, Wessel Is, eastern Arnhem Land, NT, 11°38.28′S, 136°17.52′E, 13–14 m, 5 Apr 2004, coll. Alvarez B. and party
Z.5068	"Town Hall" hole, SW Channel I., Middle Arm of Darwin Harbour, NT, 12°33.74′S, 130°51.67′E, 10–18 m, 17 Sep 2002, coll. Alvarez, B and party
Z.5071	Spencer Point, Indian I., Bynoe Harbour, NT, 12°35.35′S, 130°31.45′E, 6–8 m, 11 Jun 2003, coll. Alvarez, B and party
Z.5072	Weed Reef, entrance to West Arm, Darwin Harbour, NT, 12°29.25′S, 130°47.54′E, 9–12 m, 6 Sep 2003, coll. Alvarez, B
Z.5074	Spencer Point, Indian I., Bynoe Harbour, NT, 12°35.49′S, 130°31.29′E, 9–10 m, 11 Jun 2003, coll. Alvarez, B and party
Z.5075	Raragala I., bay on SW coast, Wessel Is, eastern Arnhem Land, NT, 11°38.6′S, 136°17.84′E, 17–20 m, 30 Mar 2004, coll. Alvarez, B and party
Z.5662	East Point, Darwin Harbour, NT, 12°24.16′S, 130°47.66′E, 11 m depth, 8 November 2008, coll. Ayling, A
Z.5665	East Point, Darwin Harbour, NT, 12°24.16′S, 130°47.66′E, 11 m depth, 8 November 2008, coll. Ayling, A
Z.5816	Dawson Rock, 3 km SSE Rankin Point, Bynoe Harbour, NT, 12°42.21′S, 130°35.46′E, 3–12 m, 1 Jun 2005, coll. Alvarez, B
Z.5817	Dawson Rock, 3 km SSE Rankin Point, Bynoe Harbour, NT, 12°42.21′S, 130°35.459′E, 6 m, 27 Apr 2007, coll. Alvarez, B
Z.5818	Dawson Rock, 3 km SSE Rankin Point, Bynoe Harbour, NT, 12°42.21′S, 130°35.459′E, 6 m, 27 Apr 2007, coll. Alvarez, B
Z.5819	East Point, Fannie Bay, Darwin, Australia, 12° 24.484′S, 130° 48.471., 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5820	East Point, Fannie Bay, Darwin, Australia, 12° 24.484′S, 130° 48.471., 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5821	East Point, Fannie Bay, Darwin, Australia, 12° 24.484′S, 130° 48.471., 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5822	East Point, Fannie Bay, Darwin, Australia, 12° 24.484′S, 130° 48.471., 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5823	East Point, Fannie Bay, Darwin, Australia, 12° 24.484′S, 130° 48.471., 11 m, 7 Jun 2007, coll. Alyarez, B
Z.5824	East Point, Fannie Bay, Darwin, Australia, 12° 24.48′S, 130° 48.47′E, 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5825	East Point, Fannie Bay, Darwin, Australia, 12° 24.48′S, 130° 48.47′E, 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5826	East Point, Fannie Bay, Darwin, Australia, 12° 24.48′S, 130° 48.47′E, 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5827	East Point, Fannie Bay, Darwin, Australia, 12° 24.48′S, 130° 48.47′E, 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5828	East Point, Fannie Bay, Darwin, Australia, 12° 24.48′S, 130° 48.47′E, 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5829	East Point, Fannie Bay, Darwin, NT, 12° 24.49′S, 130° 48.43′E, 14 m, 25 May 2007, coll. Alvarez, B
Z.5830	South Shell I., East Arm, Darwin Harbour, NT, 12°29.87′S, 130°53.14′E, 7–11. m, 19 Aug 2002, coll. Alvarez, B and party
Z.5831	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.17′S, 130°47.19′E, 17 m, 8 May 2006, coll. Alvarez, B
Z.5832	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.17′S, 130°47.19′E, 14 m, 8 May 2006, coll. Alvarez, B
Z.5835	Stevens Rock, 1.25 km SE Tale Head, off Cox Peninsula, Darwin Harbour, NT, 12°29.103′S, 130°47.111′E, 8–14 m, 7 May 2002, coll. Alvarez, B and party
Z.5836	Stevens Rock, 1.25 km SE Tale Head, off Cox Peninsula, Darwin Harbour, NT, 12°29.071′S, 130°47.103′E, 10–15 m, 9 May 2002, coll. Alvarez, B and party
Z.5839	East Point, Fannie Bay, Darwin, Australia, 12° 24.48′S, 130° 48.47′E, 11 m, 7 Jun 2007, coll. Alvarez, B
Z.5840	East Point, Fannie Bay, Darwin, NT, 12° 24.49′S, 130° 48.43., 14 m, 25 May 2007, coll. Alvarez, B
Z.5841	East Point, Fannie Bay, Darwin, NT, 12° 24.49′S, 130° 48.43., 14 m, 25 May 2007, coll. Alvarez, B
Z.5842	East Point, Fannie Bay, Darwin, NT, 12° 24.49′S, 130° 48.43., 14 m, 25 May 2007, coll. Alvarez, B
Z.5843	Mengalum I., off Kota Kinabalu, Malaysia, 6 10.87′N, 115 35.97′E, 10–13 m, 24 Oct 2005, coll. Alvarez, B
Z.5844	Stevens Rock, 1.25 km SE Tale Head, off Cox Peninsula, Darwin Harbour, NT, 12°29.103′S, 130°47.111′E, 8–14 m, 7 May 2002, coll. Alvarez, B and party

APPENDIX (continued)

Collection and locality data of material examined in the collections of QM and NTM.

NTM material

Z.5848	Stevens Rock, Weed Reef, Darwin Harbour, NT, 12°29.17′S, 130°47.19′E, 14 m, 8 May 2006, coll. Alvarez, B
Z.5853	Dawson Rock, 3 km SSE Rankin Point, Bynoe Harbour, NT, 12°42.2′S, 130°35.459′E, 3–12 m depth, 1 June 2005, coll. Alvarez, B
Z.5854	Dawson Rock, 3 km SSE Rankin Point, Bynoe Harbour, NT, 12°42.2′S, 130°35.459′E, 3–12 m depth, 1 June 2005, coll. Alvarez, B
Z.5855	Stevens Rock, 1.25 km SE Talc Head, off Cox Peninsula, Darwin Harbour, NT, 12°29.103′S, 130°47.111′E, 8–14 m, 7 May 2002, coll. Alvarez, B and party