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New species of *Haliclona* (Demospongiae: Haplosclerida: Chalinidae) from Western Australia

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Abstract

Two new sponge species, *Haliclona durdong* **sp. nov.** and *Haliclona djeedara* **sp. nov.** from the south west of Western Australia are described. Morphologically distinct from each other, both species are assigned to the genus *Haliclona* subgenus *Haliclona*. *Haliclona djeedara* **sp. nov.** individuals are ficiform to lobate, brown to beige in colour and have numerous apical oscules. *Haliclona durdong* **sp. nov.** individuals have a massive morphology, green colour, and large funnel-like oscules. The description of these two new species brings the species of *Haliclona* (*Haliclona)* in Australia to 25.

Key words: taxonomy, systematics, sponges, Porifera, Haplosclerida, *Haliclona*, new species

Introduction

Chalinid sponges (order Haplosclerida) are global in their distribution, with potentially hundreds of extant species (de Weerdt 2002). While they are found across all depths, they tend to be common in shallower subtidal habitats (de Weerdt 2002). They are one of the most difficult groups to study taxonomically, with highly variable and simple morphological characteristics (de Weerdt 2000, 2002). The Chalinidae are characterised by having an ectosomal skeleton that if present, is a regularly hexagonal, unispicular, tangential reticulation. They have a delicate reticulated choanosomal skeleton of uni-, pauci- or multispicular primary lines regularly connected by unispicular secondary lines (de Weerdt 2002).

Of the four valid genera of chalinid sponges, the genus *Haliclona* consists of sponges of variable morphology and consistency including erect, tube-shaped and branching forms, and both soft and fragile, and firm and elastic consistencies. *Haliclona* was first established by Grant (Grant 1836) for the species *Spongia oculata* Pallas, 1766, reported from England. The genus is speciose with 436 valid species presently recognised worldwide (van Soest *et al.* 2014) of which 44 have been reported from Australia (Hooper 2012).

Haliclona contains six subgenera and the two species described here conform to the largest of these, *Haliclona* (*Haliclona*), on morphological characters. This subgenus is characterised by a very regular, ladder-like reticulation, and an ectosomal skeleton that is unispicular, tangential and isotropic. Spongin can be moderate to abundant (de Weerdt 2002). Currently 23 species of this subgenus are recognised in Australia (Hooper, 2012).

The new species described here were compared with known species from the biogeographic areas surrounding their type localities, principally the temperate Australasian realm (Spalding *et al.* 2007), but also with species from the Northwest Australian Shelf, Sahul Shelf, Northeast Australian Shelf, Java transitional and Western Indian Ocean ecoregions (Spalding *et al.* 2007). We examined type descriptions and type material as well as non-type original historical specimens where these had similarities to our specimens. Some of the species names given to Australian specimens by early sponge taxonomists were of European species and may be misidentifications. However, it is important to re-examine these historical specimens to ensure earlier taxonomists had not seen

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specimens identical to ours. If we had found our material to be identical to historical specimens we would then have examined the type specimens of that species to determine if the historical and our recent material agreed with them, this situation did not arise.

The molecular taxonomy of the Haplosclerida is unresolved. Recent studies (Redmond *et al.* 2007, Redmond *et al.* 2011, Redmond *et al.* 2013) found both the Chalinidae and the genus *Haliclona* to be polyphyletic. Repeated secondary losses of characters (such as masses of spicules at the base of the sponge and multispicular fibre tracts) in multiple lineages, coupled with the simple skeletal architecture of their skeletons, may explain this polyphyletic pattern (Redmond *et al.* 2013).

Here we describe two new species of *Haliclona (Haliclona)* from the temperate coastal seas of southwest Western Australia. *Haliclona durdong* **sp. nov.** was first collected during a biodiscovery fieldtrip along the Western Australian coast, from Hamelin Bay, in 1980 (Capon *et al.* 1982, Ghisalberti and Jefferies 1990), and subsequently from Rottnest Island in 1989 (Erickson *et al.* 1997). The species received considerable attention from natural product chemists due to the presence of a potent cytotoxic natural product salicylihalamide A (Erickson *et al.* 1997). Subsequent ecological studies revealed an apparent sympatric species, *H. djeedara* **sp. nov.** which was also believed to produce salicylihalamide A (Battershill *et al.* 2004).

Material and methods

Preserved material from the Australian Museum, Sydney, Australia (AM); Natural History Museum, London, United Kingdom (BMNH); the Museum National d'Histoire Naturelle, Paris, France (MNHNP); NMV, Museum Victoria, Melbourne; and the Western Australian Museum, Perth, Australia (WAM) were examined during the course of this study. Collected specimens were preserved in 75% ethanol. Skeletal structure and spicule morphology were examined using light microscopy. Spicules were prepared by boiling small pieces of sponge (including the ectosome and choanosome) in concentrated nitric acid, followed by two consecutive washes with both distilled water and absolute alcohol. The resulting spicule extracts were dried on a glass slide and mounted in Shandon EZ-Mount (Thermo Electron Corporation). Spicule dimensions were determined by measurement of 20 randomly selected spicules per specimen using an eyepiece graticule with an Olympus BX50 or Leica DME microscope.

The skeleton was prepared for examination by cutting a representative section at right angles to the surface of the sponge. The section was dehydrated through an ascending ethanol series, cleared in Histolene (Fronine Laboratory Supplies) and infiltrated in paraffin wax (Shandon Histoplast) using an automatic tissue processor on a nine hour cycle. The sponge tissue was further infiltrated with paraffin under a vacuum of 635 mmHg for 30 min prior to embedding. Blocks were sectioned at 90 µm thickness with a Leitz slide microtome, and section rolling was eliminated by placing filter paper, moistened with distilled water, on top of the paraffin block. Sections were placed on a glass slide smeared with egg albumin for adhesion, dried overnight at 60°C, and dehydrated in two changes of Histolene. Sections were mounted in Shandon EZ-Mount and examined using light microscopy. Spicule and skeletal images were recorded with a Leica DFC420 camera on a Leica DME microscope.

Additional abbreviations used in the text: NCI, prefix for specimens collected by the Australian Institute of Marine Science (AIMS), Townsville; SAM, South Australian Museum, Adelaide, Australia.

Results

Taxonomic descriptions and systematic account

Phylum Porifera

Class Demospongiae

Order Haplosclerida Topsent 1928

Suborder Haplosclerina Topsent 1928

Family Chalinidae Gray, 1867

Genus *Haliclona* Grant, 1836

Subgenus *Haliclona* Grant, 1836

Type species: *Spongia oculata* Pallas, 1766 (by original designation).

***Haliclona djeedara* sp. nov.**
(Figs. 1–3)

Material examined. Holotype. Australia, Western Australia, Hamelin Bay (34°13.603'S, 115°00.842'E), 7m, D. Abdo, SCUBA, 23/02/2005 (WAM Z28839).

Paratypes. Australia: Western Australia: 1 specimen, Roe Reef (31°58.430'S, 115°32.213'E), 13m, J. Fromont, SCUBA, 8/11/2013 (WAM Z68531); 1 specimen, Cape Vlamingh, Rottnest Island, (32°01.230'S, 115° 26.800'S), 12 m, AIMS divers, SCUBA, 13/03/1989, NCI specimen Q66C 2640 L (WAM Z28840); 1 specimen, Crystal Palace, Rottnest Island (32°01.550'S, 115°32.700'E), 11m, D. Abdo, SCUBA, 25/01/2006 (WAM Z37488); 1 specimen, Favourite Island, Jurien Bay (30°16.823'S, 115°00.136'E), 6m, D. Abdo, SCUBA, 26/02/2006 (WAM Z37484); 3 specimens, Hamelin Bay (34°12.958'S, 115°00.553'E), 8m, S. Whalan, SCUBA, 13/11/2001 (NMV F200909 exWAM Z68508, SAM S1190 exWAM Z68509 and WAM Z68510).

Other material. Australia: Western Australia: 1 specimen, Roe Reef, Rottnest Island (31°58.420'S, 115°32.210'E), 10m, D. Abdo, SCUBA, 25/01/2006 (WAM Z37489); 2 specimens, Dillion Bay, Bremer Bay (34°27.216'S, 119°19.842'E), 16.5m, D. Abdo, SCUBA, 25/06/2005 (WAM Z37496 and Z37497); 2 specimens, Hamelin Island, Hamelin Bay (34°13.603'S, 115°00.842'E), 5m, D. Abdo, SCUBA, 24/02/2005 (WAM Z37493 and Z37494); 1 specimen, Favourite Island, Jurien Bay (30°16.823'S, 115°00.136'E), 5m, D. Abdo, SCUBA, 28/02/2006 (WAM Z37485).

Diagnosis. *Haliclona djeedara* **sp. nov.** is characterised by being erect with interconnected lobes and apical oscules; firm, compressible and springy texture with large internal canals, and brown throughout alive; no microscleres, and short, thick, hastate oxeas as megascleres (mean 137 x 7.4 µm, n =260). Skeleton a dense regular square-meshed to isodictyal reticulation with fibre development, spicules extend beyond surface to 150 µm. Ectosomal skeleton isodictyal, uni- or bispicular with spongin sheath.

Description. Habit as in Figure 2(a). Erect sponges, supported by multiple or single, short stalks. Main body is ficiform to lobate, frequently with multiple lobes. Dimensions of specimen (WAM Z28839: height ~120 mm, short stalk ~20 mm, width ~140 mm, breadth ~120 mm. Oscules apical, numerous, variable in size 2–10 mm wide, either flush with the surface or with raised rims ≤5 mm high. Surface smooth and finely porous, sticky and adherent to touch. Texture firm, compressible, springy.

Colour (Figure 2(a)): in the live state, brown to beige (Munsell 2.78 YR 6.15/4.14) throughout, in ethanol light to medium brown exterior, fawn interior.

General organization (Figure 3(a, c)): A narrow outer ectosomal region (~50 µm wide) consists of compact mesohyl with some subdermal spaces 100–150 µm wide. Primary tracts beneath surface are multispicular, cored by ≤6 spicules (≤50 µm thick), and form brushes at right angles to the surface. Spicules extend beyond the surface from 50 to 150 µm. Ectosomal skeleton isodictyal, uni- or bispicular with spongin sheath, undifferentiated from choanosomal skeleton. Choanosome dense and compact, a regular square-meshed to isodictyal reticulation, spongin sheath clearly visible around all fibres. Occasional internal canals (1000 µm across) throughout mesohyl. Primary fibres cored by 1–6 spicules and ≤35 µm wide, mesh spaces ≤140 µm across (one spicule length). Secondary fibres unispicular, occasionally bispicular, ~10 µm thick, with spongin sheath.

Spicules (Figure 3(e), Figure 4): Megascleres: oxeas short, thick, straight or slightly curved tapering to symmetrical hastate tips (137 x 7.4 µm, range 111–161 x 4–11 µm Table 1), tips can be variable with acerate, conical and mucronate forms occurring. Thin, developmental forms present (~118 x 3 µm). No microscleres.

TABLE 1. Spicule summary information for *Haliclona djeedara* **sp. nov.** and *Haliclona durdong* **sp. nov.**

Species	Voucher Number	Length		Width	
		Mean (± SE)	Range	Mean (± SE)	Range
Haliclona djeedara **sp. nov.**	Z28839	130.5 (± 1.2)	118–141	7.0 (± 0.2)	6–8
	Z28840	128.4 (± 1.7)	114–146	7.5 (± 0.2)	6–9
	Z37488	132.5 (± 2.3)	112–149	7.5 (± 0.2)	6–9
	Z37484	143.9 (± 2.1)	124–161	8.7 (± 0.2)	7–10
	Z68508	143.9 (± 1.7)	127–155	7.3 (± 0.2)	5–9
	Z68509	145.1 (± 2.1)	125–159	6.7 (± 0.2)	4–8
	Z68510	137.4 (± 1.3)	128–148	5.8 (± 0.1)	5–7
	Z37489	138.6 (± 1.7)	123–149	7.4 (± 0.2)	6–9
	Z37496	131.4 (± 1.8)	117–148	8.3 (± 0.3)	6–11
	Z37497	139.8 (± 2.0)	124–155	7.3 (± 0.2)	6–9
	Z37493	142.2 (± 1.8)	130–156	7.3 (± 0.2)	6–9
	Z37494	135.7 (± 1.5)	123–149	7.5 (± 0.2)	6–9
	Z37485	132.0 (± 2.1)	111–145	7.6 (± 0.2)	6–9
Haliclona durdong **sp. nov.**	Z28838	149.1 (± 1.9)	132–169	5.9 (± 0.1)	5–7
	Z28841	157.1 (± 1.7)	141–171	6.9 (± 0.2)	6–8
	Z13491	143.7 (± 1.8)	131–158	6.6 (± 0.1)	6–7
	Z37499	149.5 (± 2.6)	126–167	6.4 (± 0.2)	5–8
	Z68511	170.7 (± 1.9)	156–185	6.5 (± 0.1)	5–7
	Z68512	170.3 (± 1.4)	158–180	6.8 (± 0.2)	6–8
	Z68513	142.0 (± 1.9)	120–156	6.5 (± 0.2)	5–8
	Z37486	150.7 (± 2.3)	134–170	8.2 (± 0.2)	7–10
	Z37487	147.1 (± 2.6)	106–161	7.5 (± 0.2)	6–9
	Z37498	135.2 (± 2.0)	116–152	6.1 (± 0.1)	5–7
	Z37492	153.0 (± 1.7)	134–166	6.8 (± 0.2)	6–9
	Z37490	163.3 (± 2.4)	136–182	7.3 (± 0.2)	5–9
	Z37491	154.4 (± 2.7)	134–174	8.1 (± 0.2)	7–10
	Z37495	149.7 (± 2.9)	114–167	6.7 (± 0.2)	5–8

Larvae: Parenchymellae, cylindrical in form, slightly tapering to the posterior end, on average 100 µm larger than *Haliclona durdong* **sp. nov.** with a uniformly heavily ciliated body and lacking a posterior flagellated band. Larvae first observed annually in February (Abdo *et al.* 2008a).

Remarks. We compared this species to descriptions of all *Haliclona* species listed as present in Australia (http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/CERACTINOMORPHA/names) as well as additional species from southern Indonesia and the Western Indian Ocean (Spalding *et al.* 2007), and examined the type material of closely related species. The holotype of *Haliclona (Haliclona) flabellodigitata* Burton, 1934 (Burton 1934) (BMNH30.8.13.167) has pronounced fibre development similar to *Haliclona djeedara* but fibre meshes are twice as wide >200 µm compared to the predominantly ≤140 µm meshes of *Haliclona djeedara***.** In addition the oxeas are much thinner (4 µm compared to >7 µm). As a result of the wide meshes in *H. (H.) flabellodigitata* it has a much softer consistency than *Haliclona djeedara***.**

Other *Haliclona* species described from the temperate Australasian region do not have the solid lobate to ficiform morphology in conjunction with the pronounced fibre development of *Haliclona djeedara***.** For example the holotypes of *Haliclona (Reniera) clathrata* (Dendy 1895) (NMV G2331, RN1185) and *H. corticata* (Lendenfeld 1887) (AM G8999) lacked fibre development except at the nodes of the skeletal reticulation. *H. fryetti* (Dendy 1895) (NMV G2357, RN1141 and G2358, RN1183) was described as being dark brown in colour but this

species only has spongin at the nodes of the reticulation and smaller, thinner oxeas (115 x 5 µm) with mucronate ends. We examined type specimens of *H. proxima* (Dendy, 1895) (NMV G2402, RN288 and G2403, RN1191), now a junior synonym of *H. digitata* (Lendenfeld, 1887), which was described as having a palmodigitate morphology but has longer, thicker oxeas with mucronate ends, and minute oscules compared to the large oscules (2–10 mm) of *H. djeedara*. *H. punctata* Bergquist & Warne (1980) is described with multispicular fibres but it is an encrusting species with very small thin oxeas (96 x 3 µm). The above comparisons clearly demonstrate the morphological and skeletal differences that distinguish *Haliclona djeedara* from these similar species from nearby regions.

Haliclona djeedara is viviparous and gonochoric, reproducing in the Austral summer (Abdo *et al.* 2008a). It is characterized by numerous large apical oscules, brown colour and a more dense and compact mesohyl than *Haliclona durdong*, with a consequent compressible and springy texture. This species has a distinctive, regular, compact square-meshed reticulate skeleton with fibre development in the form of spongin sheaths around both primary and secondary tracts. The primary fibres are multispicular, the secondaries usually unispicular. The oxeas are consistently up to 20 µm shorter than *H. durdong* (Figure 4). *H. djeedara* also has a distinctive sticky and adherent surface not seen in *H. durdong*.

This new species conforms to the subgenus *Haliclona* based on the regular square-meshed reticulation, the substantial amount of spongin in the skeleton and the unispicular secondary tracts. The consistent multispicular nature of the primary lines is less usual for the subgenus and future molecular characterization of the species would support or refute this subgenus assignment.

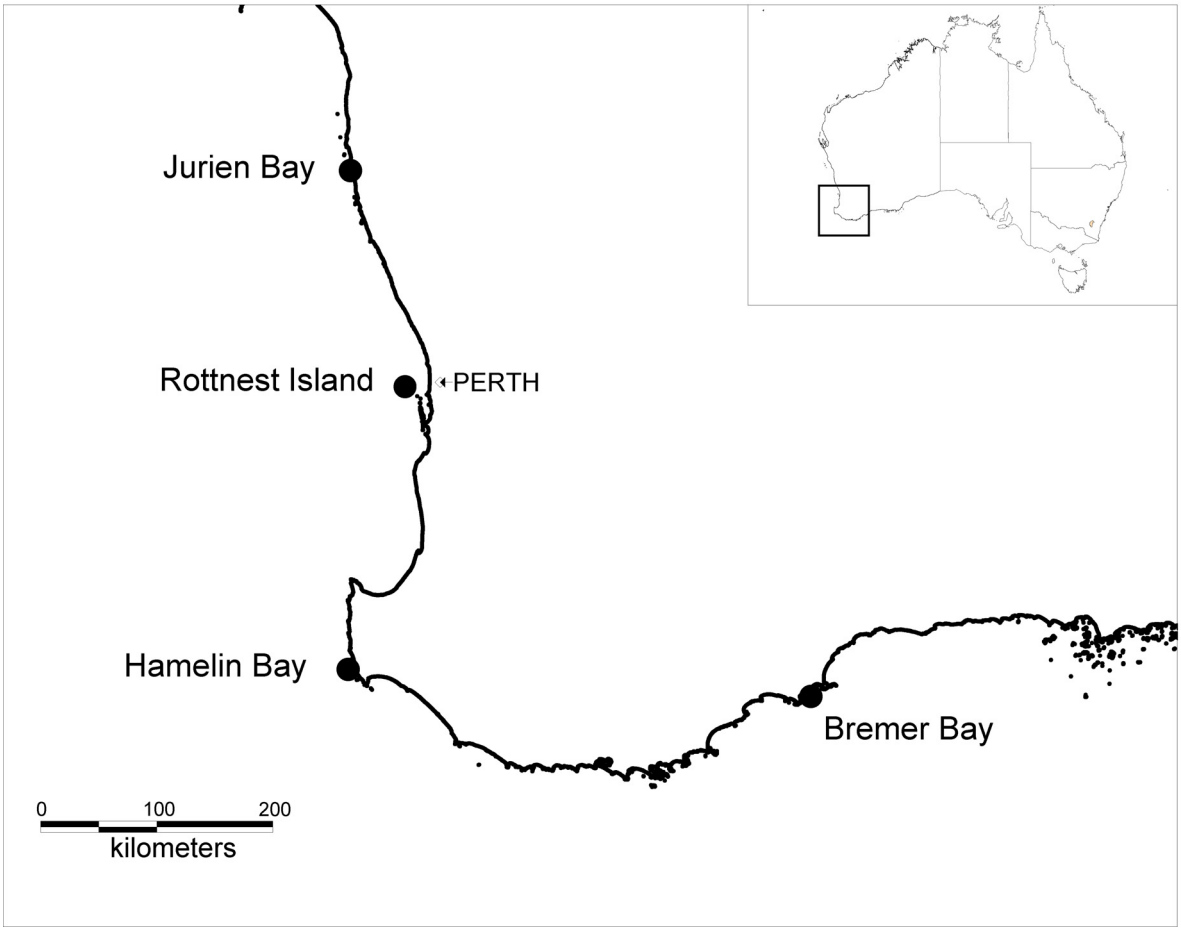

FIGURE 1. Locations where *Haliclona djeedara* **sp. nov.** and *Haliclona durdong* **sp. nov.** have been reported.

Distribution and habitat. *Haliclona djeedara* ***sp. nov.*** is found in temperate rocky reef habitats in south Western Australia from Jurien Bay in the north to Bremer Bay in the south. This is apparently an Australian west coast endemic species occurring in shallow water from 3 to 30 m depth on limestone rock and south of 30º latitude.

Etymology. This species name is a Nyoongar word meaning brown. The specific name is a noun in apposition describing the colour of the species. The Nyoongar peoples are the traditional owners of south Western Australia where this species occurs.

Haliclona durdong **sp. nov.**
(Figs. 1–3)

Holotype. Australia, Western Australia, Hamelin Bay (34°13.603'S, 115°00.842'E), 7m, D. Abdo, SCUBA, 23/02/2005 (WAM Z28838).

Paratypes. Australia: Western Australia: 1 specimen, Roe Reef (31°58.430'S, 115°32.213'E), 13m, J. Fromont, SCUBA, 8/11/2013 (WAM Z68530); 1 specimen, Abraham Point, Rottnest Island (32°00.25'S, 115° 28.02'S), 15 m, AIMS divers, SCUBA, 14/03/1989, NCI specimen Q66C 2670 S (WAM Z28841); 1 specimen, Cosy Corner, Hamelin Bay (34°15.540'S, 115°01.467'E), 5m, R. Capon, SCUBA, 09/1980 (WAM Z13491); 1 specimen, Point Henry, Bremer Bay (34°27.395'S, 119°25.175'E), 13m, D. Abdo, SCUBA, 24/06/2005 (WAM Z37499); 2 specimens, Hamelin Bay (34°12.958'S, 115°00.553'E), 7m, D. Abdo, SCUBA, 24/02/2001 (NMV F200910 exWAM Z68511 and SAM S1191 exWAM Z68512); 1 specimen, Horseshoe Reef, Rottnest Island (32°01.550'S, 115°32.700'E), 15m, C. Battershill, SCUBA, 26/1/2001 (WAM Z68513).

Other material. Australia: Western Australia: 2 specimens, Favourite Island, Jurien Bay (30°16.516'S, 114°58.062'E), 7m, D. Abdo, SCUBA, 28/02/2006 (WAM Z37486 and WAM Z37487); 1 specimen, Point Henry, Bremer Bay (34°27.395'S, 119°25.175'E), 12m, D. Abdo, SCUBA, 24/06/2005 (WAM Z37498), 1 specimen, Hamelin Island, Hamelin Bay (34°13.603'S, 115°00.842'E), 7m, D. Abdo, SCUBA, 24/02/2005 (WAM Z37492); 1 specimen, Crystal Palace, Rottnest Island (32°01.550'S, 115°32.700'E), 9m, D. Abdo, SCUBA, 25/01/2006 (WAM Z37490); 1 specimen, Roe Reef, Rottnest Island (31°58.420'S, 115°32.210'E), 11m, D. Abdo, SCUBA, 25/01/2006 (WAM Z37491); 1 specimen, Cosy Corner, Hamelin Bay (34°15.540'S, 115°01.467'E), 4m, D. Abdo, SCUBA, 23/02/2005 (WAM Z37495).

Diagnosis. *Haliclona durdong* **sp. nov.** is characterised by being erect or massive with wide apical oscules and well developed canals, compressible consistency but tearing and fragmenting easily, green throughout alive; no microscleres, slender oxeas as megascleres (mean 152.6 x 6.9 µm, n =280). Skeleton regular multispicular, isodictyal reticulation, spongin at nodes, spicules extend beyond surface to 80 µm. Ectosomal skeleton isodictyal, uni- or bispicular, spongin at nodes.

Description. Habit as in Figure 2(b). Erect or massive sponges with wide funnel-like oscules and 1 to 3 basal attachment points. Dimensions of specimen (WAM Z28838): height ~100 mm, width ~130 mm, breadth ~90 mm. Oscules apical, wide, ~25 mm across and common. Surface smooth, with velvet appearance. Texture compressible, easily damaged, sponge pulls apart with minimal force.

Colour (Figure 2(b)): in the live state, green (Munsell 3.61 GY 1.94/3.54) throughout, in ethanol medium brown throughout.

General organization (Figure 3(b, d)): A thin outer ectosomal region (~50 µm wide) consists of compact mesohyl. Ectosomal skeleton isodictyal, uni- or bispicular, spongin at nodes, undifferentiated from choanosomal skeleton. Primary spicules extend beyond the surface to 80 µm. Subdermal spaces ~150 µm wide. Primary tracts multispicular cored by 2–5 spicules (≤30 µm wide) with spongin at nodes, tracts without fibre sheath, mesh spaces ~150 µm across (one spicule length). Secondary tracts isodictyal, unispicular, rarely bispicular, ≤15 µm wide, more commonly ≤10 µm wide. Skeleton a regular isodictyal reticulation, occasionally irregular and square-meshed. Choanosome cavernous with large canals and numerous internal pores of various sizes 1–3 mm wide.

Spicules (Figure 3(f), Figure 4): Megascleres: oxeas slender, straight or slightly curved with hastate tips (152.6 x 6.9 µm, range 106–185 x 5–10 µm Table 1), thin, developmental forms present (~138 x 4 µm). No microscleres.

Larvae: Parenchymellae, cylindrical in form, tapering to the anterior and posterior, with a ciliated body and posterior flagellated band. Larvae first observed annually in March (Abdo *et al.* 2008a). The holotype specimen, WAM Z28838, is a reproductive female containing embryos.

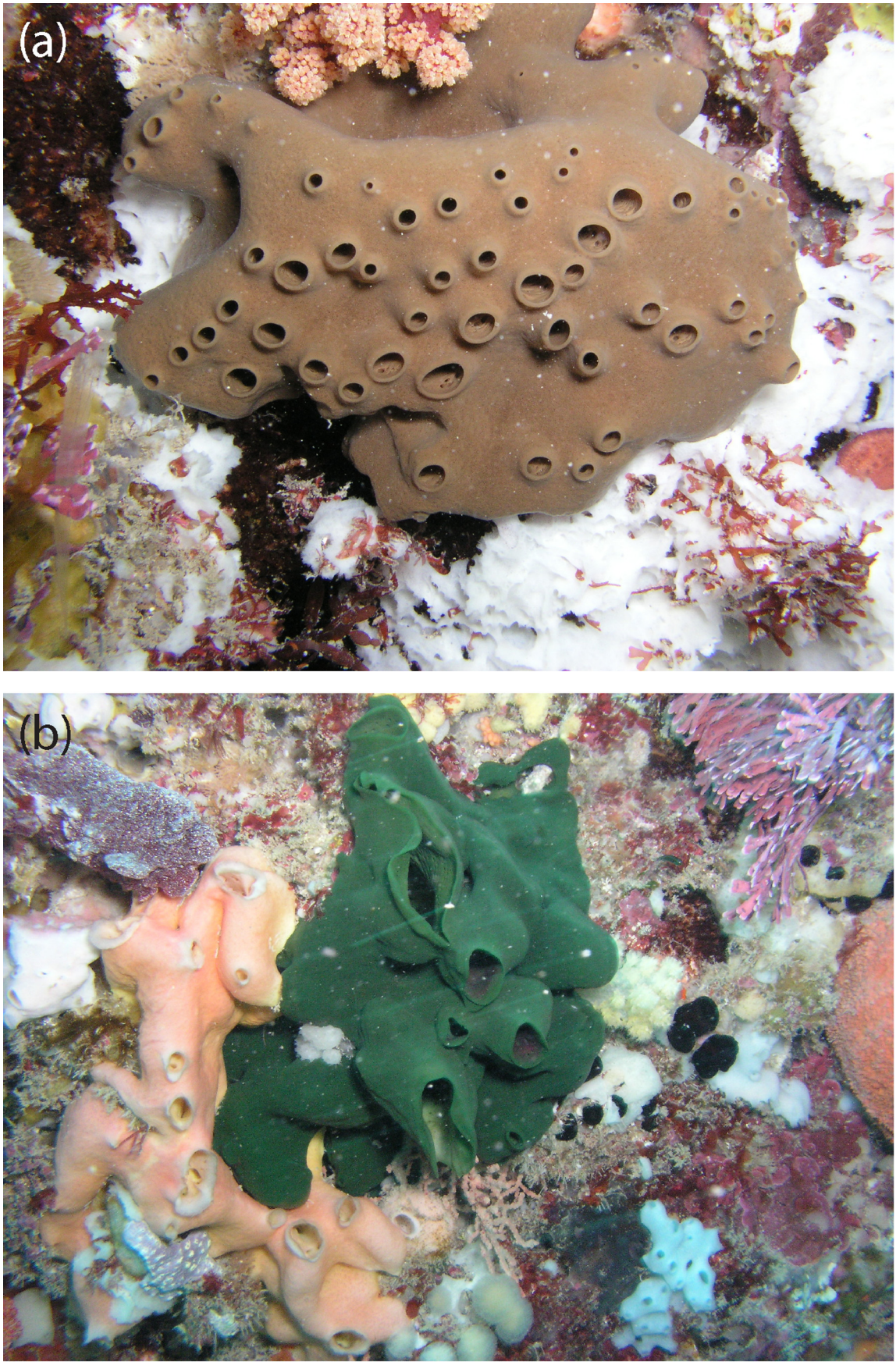

FIGURE 2. Underwater images of (a) *Haliclona djeedara* **sp. nov.** (WAM Z28839), and (b) *Haliclona durdong* **sp. nov.** (WAM Z28838). Images taken by D. Abdo at Hamelin Bay, 7m on 23/02/2005.

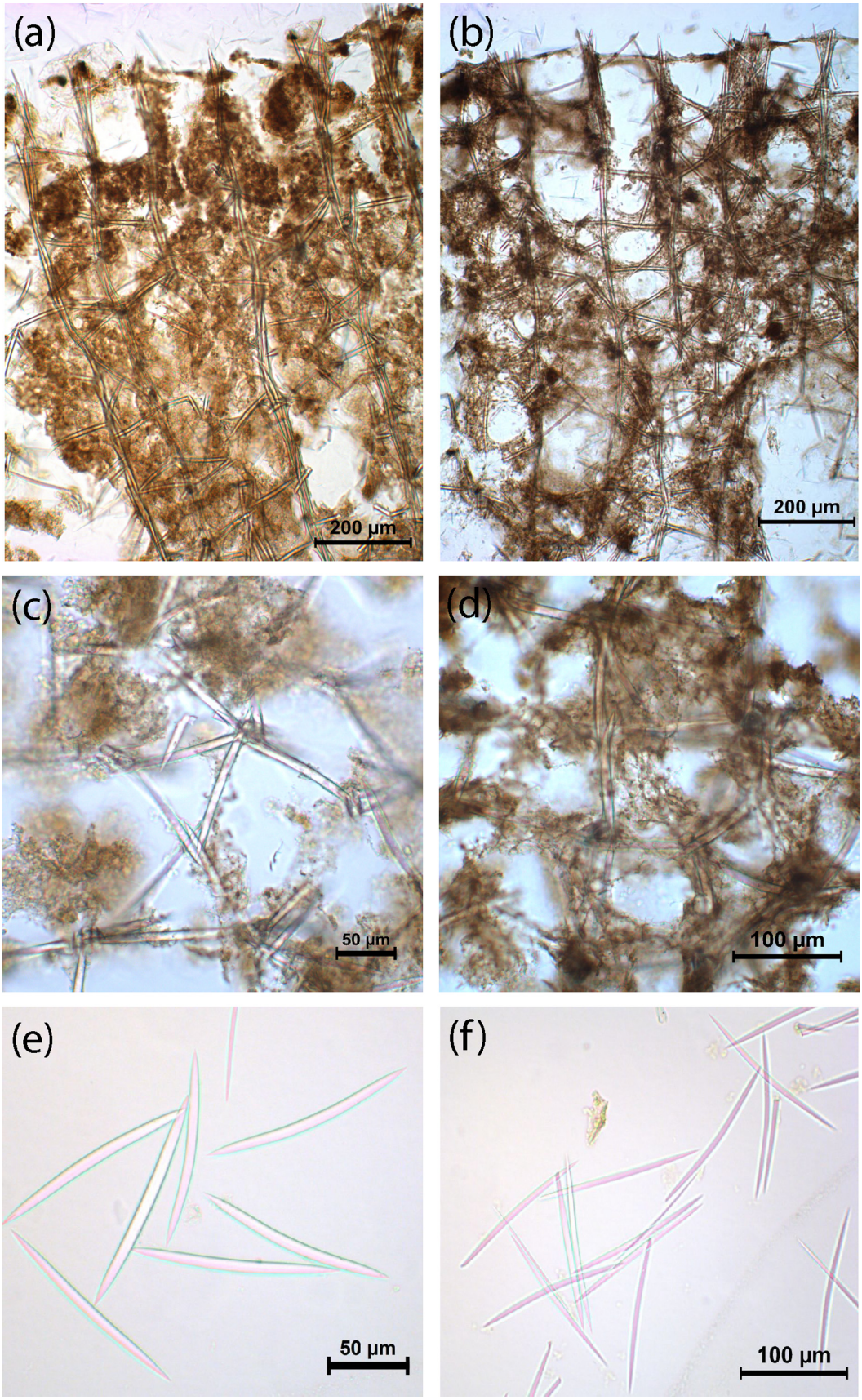

FIGURE 3. Light micrographs of the choanosomal skeleton (a, b), ectosomal skeleton (c, d), and spicules (e, f) of *Haliclona djeedara* **sp. nov.** (a—WAM Z37484, c and e—WAM Z28839) and *Haliclona durdong* **sp. nov.** (b and f—WAM Z37495, d—WAM Z28838). Light micrographs taken by O. Gomez.

TABLE 2. Summary characteristics of *Haliclona djeedara* **sp. nov** and *Haliclona durdong* **sp. nov,** in comparison to other regional *Haliclona* species.

		***Haliclona djeedara* sp. nov.**	***Haliclona (Haliclona) flabellodigitata***	***H. (Reniera.) clathrata***	***H. corticata***	***H. fryetti***	***(H. proxima) H. digitata***	***H. punctata***
Morphology		erect, lobate to ficiform	erect branching	ramose, spreading, branching	thick, erect branches	fan	palmodigitate or fan	encrusting
Oscules		apical 2-10 mm	sides of branches or apical 3-6 mm	apical, size not known	large, apical	small, 2 mm	on one surface, small	small, 0.5-1 mm
Consistency		firm, compressible and springy	soft	soft, resilient	soft	compressible, resilient	soft, compressible	soft, compressible
Colour		brown	not known	not known	brown	dark brown	brown	cream to fawn
	Megascleres	137 x 7.4 µm	150 x 4 µm	83 x 5 µm	120 x 4 µm	115 x 5 µm	160 x 12 µm	96 x 3 µm
	Tip morphology	hastate	hastate	acerate	not known	mucronate	mucronate	not known
Skeleton	**Choanosome**	dense regular square mesh or isodictyal ≤140 µm across	isodictyal to irregular, wide reticulation ≥200 µm across	isodictyal or rectangular, irregular ≤90 µm across	150 µm across	isodictyal or rectangular, irregular ≤115 µm across	regular, square mesh ≤200 µm across	multispicular, polygonal irregular 100-200 µm across
	Fibre development	present, pronounced	present, pronounced	at nodes of reticulation	at nodes of reticulation	at nodes of reticulation	present as sheath	present as sheath
	Ectosome	isodictyal, uni- or bispicular with spongin sheath	isodictyal	not known	not known	not known	not known	not known

Continued.

		***Haliclona durdong* sp. nov.**	***Chalinula camerata***	***Haliclona (R.) cribricutis***	***(H. permollis) H.(R.) cinerea***	***H. (R.) aquaeductus* (Houtman Abrolhos specimen)**	***H. (R.) aquaeductus var. infundibularis***	***H. (Rhizoniera) australis***
Morphology		erect, massive	encrusting	lobed	encrusting	erect tubular	open tubes	encrusting, lobed
Oscules		apical 25 mm across	irregular 3-5 mm	apical 4mm wide	apical 3-4mm wide	apical 3mm wide	not known	apical 3-5 mm
Consistency		compressible, fragments	compressible	soft	soft	delicate, fragile	soft and fragile	not known
Colour		green	pale brown	pale yellow brown	light to medium brown	grey brown	not known	red
	Megascleres	152.6 x 6.9 µm	163-203 x 5-6 µm	150 x 6 µm	120 x 3 µm	190 -230 x 6-8 µm	136-161 x 6-8 µm	120-125 x 4-5 µm
	Tip morphology	hastate	hastate/acerate	mucronate	hastate	hastate	hastate/acerate	acerate
Skeleton	**Choanosome**	regular isodictyal ~150 µm across	irregular to isodictyal ≥150 µm across	irregular isodictyal or square meshed ~140 µm across	irregular or isodictyal ≤120 µm across	square meshed or isodictyal ≥150 µm across	irregular 150 µm across	irregular isodictyal to square meshed ~120 µm across
	Fibre development	spongin at nodes	no fibre development	faint at nodes	faint at nodes	faint at nodes	no fibre development	no fibre development
	Ectosome	isodictyal, uni- or bispicular without spongin sheath	not known	isodictyal	isodictyal	not known	not known	not known

Remarks. We compared this species to descriptions of all *Haliclona* species listed as present in Australia (http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/CERACTINOMORPHA/names) as well as additional species from southern Indonesia and the Western Indian Ocean, and examined the type material of closely related species. The holotype of *Chalinula camerata* (Ridley 1884) (BMNH1882.10.17.117), is a tiny, encrusting specimen with a very irregular skeleton, occasional multispicular tracts of loosely aggregated spicules parallel to the surface, no fibre development at the nodes of the reticulation, and the spicules are longer and thinner than in *Haliclona durdong***.**

We examined specimens from the Houtman Abrolhos identified by Dendy and Frederick (1924) as *Reniera cribricutis* (BMNH1925.11.1.194), now *Haliclona (Reniera) cribicutis* (Ridley and Dendy 1886), and *Reniera permollis* (BMNH1925.11.1.200), now a synonym of *Haliclona (R.) cinerea,* respectively (Dendy and Frederick 1924). These specimens were very similar to each other and were not the same species as *Haliclona durdong***.** Both these specimens were small, soft and porous, with small apical oscules (4 mm wide), and minimum fibre development around the spicules. The specimen identified as *H. (R.) cribricutis* has similar sized oxeas to *Haliclona durdong* but with mucronate tips, while in the specimen of *H. (R.) permollis* the spicules were smaller (120 x 3 μm).

Dendy & Frederick (1924) also recorded *R. aquaeductus* (BMNH1925.11.1.195), now *Haliclona (Reniera) aquaeductus,* from the Houtman Abrolhos, but this was a smooth, slender branching specimen without the wide funnels characteristic of *Haliclona durdong***.** Specimens of *R. aquaeductus* (BMNH1882.2.23.284; 238-9; 297) identified by Ridley (1884) were also not the same as *Haliclona durdong***.** These specimens were firm, incompressible and brittle in contrast to the compressible texture of *Haliclona durdong***.** In contrast, the specimens of *R. aquaeductus* var. *infundibularis* (BMNH1887.5.2.228; 219) had a similar morphology to *H. durdong* forming wide, open tubes but these are very porous, soft and fragile, and the specimens lacked nodal fibre development, as well as being from Patagonia, a disjunct distribution to *H. durdong*. The type of *Haliclona (Rhizoniera) australis* (Lendenfeld 1888) (AM Z2017) is an encrusting specimen 1 cm thick with much smaller skeletal mesh spaces and spicule sizes than *H. durdong*, as well as being red in colour alive. The above comparisons clearly demonstrate the morphological and skeletal differences that distinguish *H. durdong* from these similar species from nearby regions.

No *Haliclona* species described from Australia have the wide apical, flared oscules in conjunction with the compressible texture, development of fibre only at the nodes of the reticulation, and spicule sizes and morphology of *Haliclona durdong* **sp. nov.** We could find no described species of *Haliclona* with the unique characters of this species.

Haliclona durdong **sp. nov.** is viviparous, with both gonochoric and hermaphroditic individuals, and reproduces in the Austral summer (Abdo *et al.* 2008a). It is characterized by wide apical, funnel-like oscules and large internal canals, green colour, compressible texture, fibre only at the nodes of the skeletal reticulation, never forming sheaths, and ready fragmentation. The species is much more porous and softer than *Haliclona djeedara* and its skeleton is isodictyal rather than square-meshed. It consistently has longer spicules, up to 20 μm in maximum length than *H. djeedara*, which has shorter, thicker oxeas (Figure 4)**.**

This species conforms to the subgenus *Haliclona* based on the regular isodictyal reticulation, and the consistent spongin at the nodes of the reticulation. The consistent multispicular nature of the primary lines is less usual for the subgenus and future molecular characterization of the species would support or refute this subgenus assignment.

Distribution and habitat. *Haliclona durdong* **sp. nov.** is found in temperate rocky reef habitats in south Western Australia from Jurien Bay in the north to Bremer Bay in the south. This is apparently an Australian west coast endemic species occurring in shallow water from 3 to 45 m depth on limestone rock and south of 30º latitude.

Etymology. This species name is a Nyoongar word meaning green. The specific name is a noun in apposition describing the colour of the species. The Nyoongar peoples are the traditional owners of the south Western Australia where this species occurs.

Discussion

These two new species of Porifera, endemic to the south west corner of Western Australia, conform to the genus *Haliclona* based on the morphological evidence presented here. The species have contrasting morphologies with

Haliclona djeedara **sp. nov.** having erect, ficiform to lobate forms, apical oscules, a firm and elastic consistency, and sticky and adherent surface, and *Haliclona durdong* **sp. nov.** having an erect morphology with wide, funnel-shaped apices and a soft and fragile consistency. The characters of their skeletons confirm both species placement within the subgenus *Haliclona*, as they are both characterised by multispicular regular reticulations, with *H. djeedara* having a square-meshed reticulation and consistent spongin sheath around tracts, and *H. durdong* having an isodictyal skeleton with spongin only at the nodes of the reticulation. Their ectosomal skeletons are unispicular, tangential and isotropic.

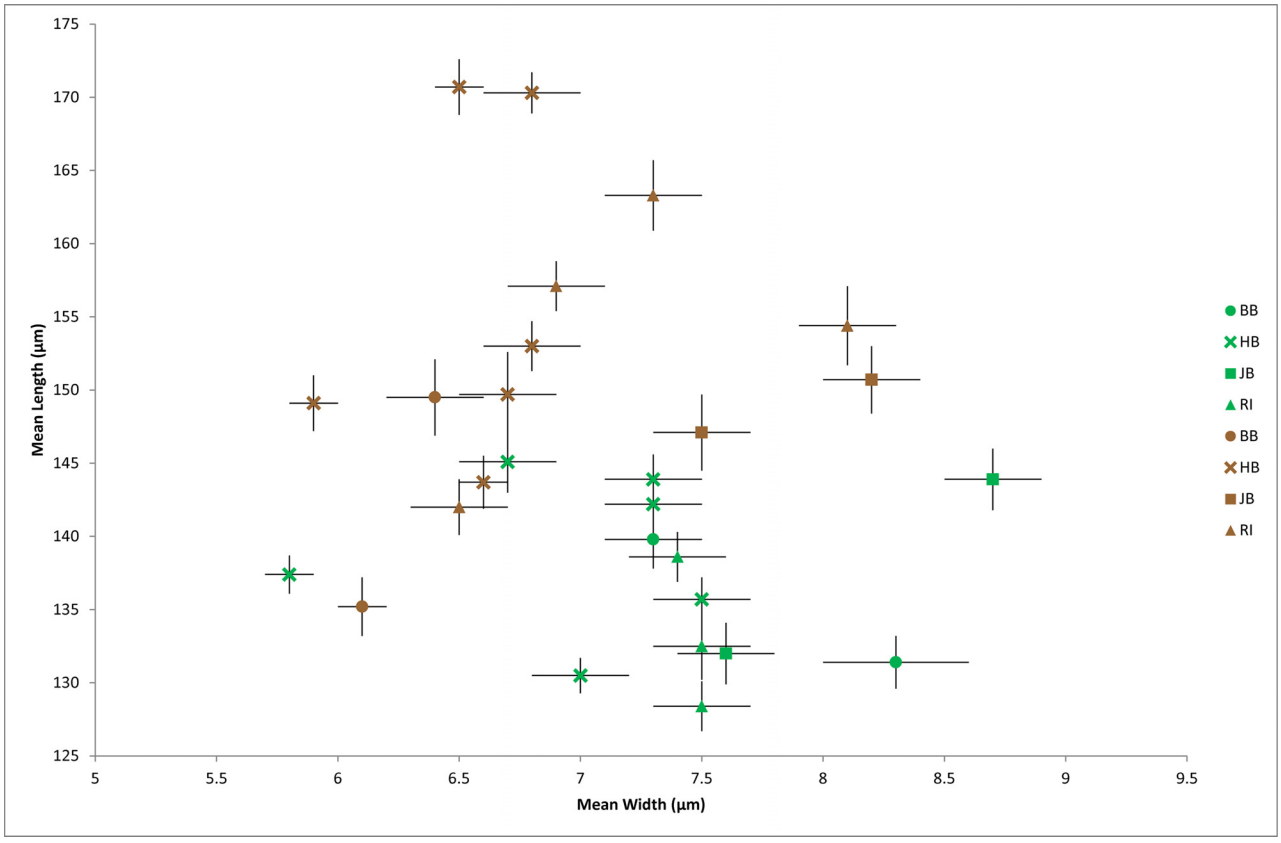

FIGURE 4. Comparison of mean spicule width and lengths (± 1 standard error) based on 20 measurements (for each specimen). Green symbols are *Haliclona durdong* **sp. nov.** and brown symbols are *Haliclona djeedara* **sp. nov.** square represent specimens from Jurien Bay, triangles are specimens from Rottnest Island, crosses are specimens from Hamelin Bay, and circles are specimens from Bremer Bay (see Table 1).

We examined descriptions and specimens of species of *Haliclona* from biogeographic areas surrounding their type localities, principally the temperate Australasian realm, but also the Northwest Australian Shelf, Sahul Shelf, Northeast Australian Shelf, Java transitional and Western Indian Ocean ecoregions (Spalding *et al.* 2007). The new Western Australian species do not conform to any previously described species. Further, the particular combinations of characters described here for *Haliclona djeedara* **sp. nov.** and *Haliclona durdong* **sp. nov.** have not been reported before now.

Beyond the species morphological differences, biological differences have been observed between each species including associated fauna. Abdo (2007) found epifaunal barnacles belonging to the genus *Euacasta* (Archaeobalanidae) and worms of the genus *Polydorella* in both species, but endofaunal assemblages differed with *H. djeedara* having a greater overall density of endofaunal taxa and a higher density of smaller individuals of *Ophiothrix,* while *H. durdong* had a lower overall density of taxa with larger sizes (Abdo 2007).

The species also differed in their reproductive biology (Abdo *et al.* 2008a), and growth patterns, with *H. djeedara* having distinct seasonal growth in summer and loss of volume in winter, while *H. durdong* did not have seasonal growth (Abdo *et al.* 2008b).

The most significant biological difference relates to the chemical profile of each species, with *Haliclona*

durdong **sp. nov.** producing salicylihalamide A across its known distribution while *Haliclona djeedara* **sp. nov.** does not. Although salicylihalamide A concentration was found to vary with temperature, it was always present and thus the chemical profile of *Haliclona durdong* **sp. nov.** makes a useful additional diagnostic character for this species (Thompson *et al.* 1987, Abdo *et al.* 2007).

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