Sea anemones (Cnidaria: Anthozoa: Actiniaria) of Moreton Bay

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Citation: Fautin, D.G., Crowther, A.L. & Wallace, C.C., 2008 12 01. Sea anemones (Cnidaria: Anthozoa: Actiniaria) of Moreton Bay. *In*, Davie, P.J.F. & Phillips, J.A. (Eds), Proceedings of the Thirteenth International Marine Biological Workshop, The Marine Fauna and Flora of Moreton Bay, Queensland. *Memoirs of the Queensland Museum — Nature* 54(1): 35–64. Brisbane. ISSN 0079-8835.

ABSTRACT

Nineteen species of sea anemones *sensu stricto* (Anthozoa: Zoantharia: Actiniaria) are documented from the Moreton Bay region in eastern Australia, based primarily on specimens observed and collected during the Moreton Bay International Marine Biological Workshop in February 2005. Each species is taxonomically diagnosed, and information on the distribution of these species elsewhere in Australia is provided based on new field observations and museum records. Three species (*Anthopleura handi*, *A. buddemeieri* and *Verrillactis paguri*) were not previously recorded from Australia. *Actinia australiensis* was previously known only from south of Moreton Bay, and *Gyractis sesere* was recorded from eastern Australia for the first time. An unidentified species of *Diadumene* was found, providing the first record of the genus from Australia. A key to the 18 fully identified species is included. The sea anemone fauna reported in this paper is predominantly tropical to subtropical, with 14 species known primarily from the tropics, and four known primarily from the temperate zone; the other was not identified to species. ❑ *Australia, biogeography, new records, taxonomy.*

The Moreton Bay International Marine Biological Workshop, held in February 2005, provided us an opportunity to study species composition and distribution of sea anemones (cnidarian order Actiniaria) within and adjacent to Moreton Bay. We review the fauna from this region, and provide an account of 19 species, based mainly on external features of live animals, and update Australian distribution records for those species. A key that can be used to identify the 18 fully identified species in life is included.

This subtropical location in southeast Queensland has a marine biota with both temperate and tropical elements, including corals and associated coral reef organisms (Tibbetts *et al.* 1998; Dennison & Abal 1999). The environment is influenced by outflows from several rivers, and proximity to Greater Brisbane, a large and rapidly growing city. The offshore region is still relatively pristine and is affected by the tropical East Australian Current, as well as intermittent northerly flowing currents. Rainfall is variable in the region, typically being high during the summer months (December to February). Episodic freshwater flooding may profoundly influence the fauna of inner Moreton Bay: such events have led to temporary extirpation of corals at the family level (Lovell 1989). All these factors, as well as the risk of introduction of invasive species, are potentially relevant to the sea anemone fauna of Moreton Bay.

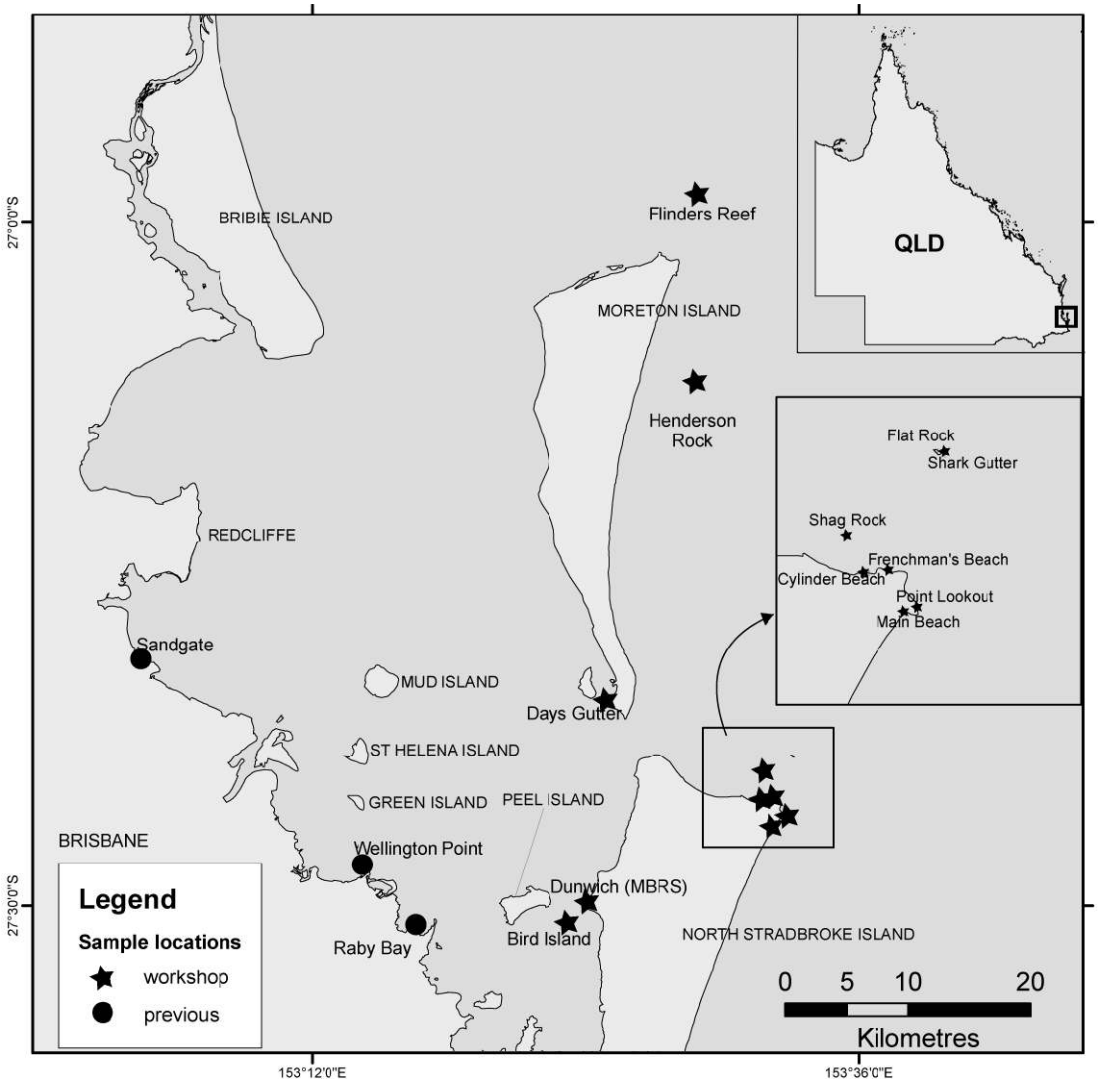

FIG. 1. Map of the Moreton Bay region, indicating locations of specimens reported in this account. MBRS = Moreton Bay Research Station of the University of Queensland, base for The Thirteenth International Marine Biological Workshop. Two locations not shown, Caloundra and Point Cartwright lie just to the north.

Australia's sea anemones have had scant attention in comparison with other members of Anthozoa (especially scleractinian corals and octocorals). The 110 species of anemones recorded from Australia, including its Antarctic waters (Fautin 2008), have been estimated to represent perhaps half of Australia's actiniarians (Wolstenholme & Wallace 2004). As is true for sea anemones in most parts of Australia, large- to medium-sized shallow-water species of Moreton Bay have been documented (e.g. Hadley 1973; Richardson *et al.* 1997), but some smaller, cryptic, or deeper water species may have been overlooked. Eight species of Actiniaria are mentioned in a guide to the Moreton Bay biota (Davie *et al.* 1998): *Actinia tenebrosa*, *Oulactis muscosa,* and *Aulactinia veratra* (rocky shores), the swimming anemone *Boloceroides mcmurrichi* (coastal wetlands), and anemonefish hosts *Stichodactyla haddoni* and *Macrodactyla doreensis* (sand, mud, and seagrass), and *Entacmaea quadricolor* and *Heteractis crispa* (coral reefs).

MATERIALS AND METHODS

SITES, HABITATS, AND COLLECTING METHODS

Sites sampled during the Moreton Bay International Marine Biological Workshop were within and immediately outside Moreton Bay (approx. 26°50′ to 27°50′S and 153°13' to 153°26'E) (Fig. 1). Habitats included intertidal mud and sand flats (Fig. 2A), rocky reefs, platforms, and outcrops adjacent to sandy beaches (Fig. 2B), and subtidal fringing coral reefs. Collecting was done mainly by hand, either at low tide or by SCUBA diving, although some specimens were obtained from samples taken during the dredging program of the Workshop.

TAXONOMIC INFORMATION

Appearance in life is described from specimens from Moreton Bay and surrounding waters. Terminology follows Carlgren (1949); explanations and illustrations of most terms can be found in Fautin & Mariscal (1991) and Tangney *et al.* (2007). Bibliographic and published distributional information comes from the database `Hexacorallians of the World' (Fautin 2008). Definitions of higher taxa are taken from Carlgren (1949) or published updates, some reworded or reformatted for consistency; nomenclatural and type specimen data are from Fautin *et al.* (2007b).

MATERIAL EXAMINED

Specimens collected during the Workshop were deposited in the Museum of Tropical Queensland (MTQ), Townsville, a campus of the Queensland Museum. Additional specimens from Moreton Bay were examined in the collections of the Queensland Museum, Brisbane (QM) and the Australian Museum, Sydney (AM). Previously unpublished occurrence records from elsewhere in Australia come from specimens collected by us and others during 2005 and 2006 from Queensland, Northern Territory, and around Sydney, New South Wales, and specimens we examined in the Museum and Art Gallery of the Northern Territory, Darwin (NTM), MTQ, South Australian Museum (SAM), Queen Victoria Museum and Art Gallery, Launceston (QVM), and Western Australian Museum (WAM). Type specimens examined by Daphne G. Fautin in museums worldwide (abbreviations below) are mentioned in the text. Those who assisted in collecting the material reported here are: Robert W. Buddemeier (RWB), Andrea L. Crowther (ALC), Daphne G. Fautin (DGF), Michela Mitchell (MM), Paul R. Muir (PRM), and Carden C. Wallace (CCW).

Specimens were photographed live in the field wherever possible, and most were returned to the laboratory where they were examined alive and/or preserved for taxonomically important details. For most specimens, nematocysts from tentacles, actinopharynx, mesenterial filaments, column, and, if present, acrorhagi and acontia were measured. Specimens to be deposited in museums were relaxed in isotonic magnesium chloride/sea water solution, and fixed in 10% formalin. Histological sections were cut from some specimens, and stained with Mallory Heidenhain Trichrome.

Our report does not include members of the family Edwardsiidae — worm-like, burrowing anemones. Specimens of this family were sent to Marymegan Daly, who is revising the family and will include the Moreton Bay material in her study.

MUSEUMS

Museums from which type material was examined by DGF, in addition to those listed above, are: American Museum of Natural History, New York, New York, USA (AMNH); Bernice P. Bishop Museum, Honolulu, Hawai'i, USA (BPBM); Natural History Museum, London, UK (BMNH); California Academy of Sciences, San Francisco, California, USA (CAS); Canterbury Museum, Christchurch, New Zealand (CM); Museum für Naturkunde der Humboldt Universität, Berlin, Germany (MNB); Museum of Zoology, Lund University, Sweden (LO); Natural History Museum, Göteborg, Sweden (NHMG); Phyletisches Museum, Jena, Germany (PMJ); Senckenberg Museum, Frankfurt am Main, Germany (SMF); Swedish Museum of Natural History, Stockholm, Sweden (SMNH); University of Kansas Natural History Museum, Lawrence, Kansas, USA (KUNHM); University Museum of Zoology, Cambridge, UK (UMZ); Yale Peabody Museum, New Haven, Connecticut, USA (YPM); and Zoologisches Museum, Hamburg, Germany (ZMH).

RESULTS AND DISCUSSION

Eighteen species of Actiniaria were recorded in and around Moreton Bay (Table 1), and an additional species identified only to the genus

Diadumene. This is not a complete inventory of Moreton Bay sea anemones. Aside from the edwardsiids, the identity of some species has not been resolved, including one that was photographed in the field but not collected, and one that is taxonomically problematic and will be the subject of a separate publication. New records for Australia are *Anthopleura handi* and *A. buddemeieri*; *A. handi* is common in the rocky intertidal zone on protected sites inside Moreton Bay, and *A. buddemeieri* occurs on exposed beach sites outside the Bay. We include other new Australian records of these species from the Northern Territory and the Sydney region of New South Wales. *Verrillactis paguri* is also newly recorded from Australia. *Actinia australiensis*, previously known only from New South Wales, is newly recorded from Moreton Bay. The unidentified species of *Diadumene* is possibly new to science; anemones of this genus, which is a well-known invasive (e.g. Zabin *et al.* 2004), have not previously been recorded from Australia to our knowledge.

The record of sea anemones new for Moreton Bay and, in some cases, for Australia, is an important step in the documentation of Australia's anemone fauna, and the role of these animals in coastal ecosystems.

Actiniarians from the Moreton Bay region include 14 predominantly tropical species and four predominantly temperate species (Table 1). The presence of these two faunal types is a characteristic of the region's biota (Davie & Hooper 1998; Tibbetts *et al.* 1998; Dennison & Abal 1999). This finding was also true of other taxa studied by participants in the Moreton Bay Workshop.

The Workshop inventory of marine organisms forms an important baseline. Moreton Bay, at the interface of tropical and temperate faunas of eastern Australia, represents a vital part of the eastern Australian coastal zone, which must be continuously monitored for changes in species diversity, altered competition for habitat and resources, and species extinctions and arrivals associated with global climate change. It is possible that tropical sea anemones not currently present in the region might expand southwards in response to elevated sea surface temperatures associated with climate change. This may introduce competition for resources and thus have an impact on species currently present in the Bay. Warmer conditions may also affect distribution of temperate species, most of which (from records so far) are concentrated in shallow water. Pressure on the Bay due to the demands of a rapidly growing human population will increase alongside the ameliorating effects of changes such as improvements in habitat conditions and/or water quality due to marine protected areas, cessation of coral mining, and other

FIG. 2. Examples of intertidal sampling sites at Moreton Bay, photographed at low tide. **A**, mud-sand flat, Dunwich, North Stradbroke Island, showing eelgrass (*Zostera capricorni*). **B,** wave-exposed rocky outcrops on sandy beach, Frenchman's Beach, North Stradbroke Island.

Table 1. Distribution in the Moreton Bay region of the 18 species of actiniarians identified to species.

Species	Soft substratum; intertidal, shallow subtidal	Rocky inter-tidal	Reefal	Hermit crab associates
Tropical to subtropical				
Anthopleura buddemeieri Fautin, 2005		x		
Anthopleura handi Dunn, 1978		x		
Boloceroides mcmurrichi (Kwietniewski, 1898)	x		x	
Calliactis polypus (Forsskål, 1775)				x
Entacmaea quadricolor (Leuckart in Rüppell & Leuckart, 1828)			x	
Gyractis sesere (Haddon & Shackleton, 1893)		x		
Heteractis crispa (Hemprich & Ehrenberg in Ehrenberg, 1834)	x		x	
Heteractis malu (Haddon & Shackleton, 1893)	x		x	
Heteranthus verruculatus Klunzinger, 1877		x	x	
Macrodactyla doreensis (Quoy & Gaimard, 1833)	x		x	
Stichodactyla haddoni (Saville-Kent, 1893)	x			
Stichodactyla tapetum (Hemprich & Ehrenberg in Ehrenberg, 1834)	x			
Triactis producta Klunzinger, 1877			x	
Verrillactis paguri (Verrill, 1869)				x
Temperate to subtropical				
Actinia australiensis Carlgren, 1950		x		
Actinia tenebrosa Farquhar, 1898		x		
Aulactinia veratra (Drayton in Dana, 1846)		x		
Oulactis muscosa (Drayton in Dana, 1846)		x		

environmental initiatives associated with the Moreton Bay Marine Park (Harrison *et al.* 1998). Success in managing the marine park and enhancement of water quality and other factors will be critical to ensuring that these changes take place against a background of maximal environmental quality.

Species recorded only on the ocean side of North Stradbroke Island, particularly subtidal species associated with coral reefs (*Entacmaea quadricolor*, *Heteractis* spp., see Table 1), might be expected to establish themselves inside the Bay in response to improved conditions. In the case of corals, entry or re-entry of species is already occurring (C. Wallace, I. Fellegara & P. Harrison pers. comm.), possibly enhanced by the absence of spikes in freshwater input into the Bay due to several recent seasons of low rainfall in the catchment regions.

Key to Living Sea Anemones of Moreton Bay

This key uses characters such as behaviour, posture, stickiness, and colour that disappear in preservation. But beware that tentacle form (length, existence of bulbs) may change while the animal is alive. There may be 2, 3, or 5 choices at each junction point.

1. Tentacles not deciduous. 2
— Tentacles deciduous, can move in coordinated rowing motion to effect swimming; so

numerous they hide oral disc and may hide entire animal; each tentacle pointed. Column typically less than 10 mm long. . . . . *Boloceroides mcmurrichi*

2. Tentacles all alike. 3
— Tentacles of two distinct types. Discal tentacles sparse, papillose; marginal ones longer, slender. . . *Heteranthus verruculatus*
3. No acontia. 4
— Pink or salmon acontia can be emitted through cinclides located proximally; pedal disc attached to gastropod shell; column length and base diameter similar. . . . . *Calliactis polypus*
— White acontia not readily emitted. Attached at columella or aperture of gastropod shell; pedal disc very broad relative to column; tentacles short, stubby, white; column white. . . . . *Verrillactis paguri*
4. Each tentacle lacking a bulb although its end may be blunt or swollen. 5
— Tentacles brown, cylindrical; some or all may have terminal or subterminal bulb tipped with red. Column typically brown. Animals may be clonal. Expanded oral disc broader than pedal disc; expanded diameter typically greater than 80 mm. . . . . *Entacmaea quadricolor*
5. Column smooth. 6
— Column with verrucae, to which debris may adhere. 7
— Column with branched outgrowths that bear stalked spheres. . . . . *Triactis producta*
6. Column, oral disc, tentacles dull red; each tentacle with blue-grey tip, oral disc flecked with white. . . . . *Actinia australiensis*
— Column and oral disc typically brown to maroon; tentacles bright solid red. . . . . *Actinia tenebrosa*
7. Expanded oral disc much broader than pedal disc. 8
— Expanded oral disc not much broader than pedal disc. 11
8. Tentacles short, cover most of oral disc. . 9
— Tentacles long, tentacles sparse on central oral disc, most at margin. 10
9. Oral disc flat, usually less than 100 mm diameter, tentacles arranged in distinct fields, may be so crowded that each resembles a kernel of maize. . . . *Stichodactyla tapetum*
— Flat to wavy oral disc usually greater than 100 mm diameter, densely covered with sticky tentacles, each pointed or with blunt to mildly swollen end; exocoelic tentacles maybe more robust than endocoelic ones. . . . . *Stichodactyla haddoni*
10. Column thin with eye-shaped verrucae; long tentacles sparse, may assume cork screw form, each inner one brown, may have light longitudinal stripe; oral disc may be brown with radial light stripes. . . . . *Macrodactyla doreensis*
— Column thin, flared, with few verrucae per row; tentacles short, sparse; distal column violet-brown, lower column may be solid or splotched with yellow, orange or red. . . . . *Heteractis malu*
— Column thick, leathery, flared, with many verrucae per row; distal column grey-white. Tentacles abundant, normally long. . . . . *Heteractis crispa*
11. Column grey with attached shell grit; acrorhagi marginal, large, white, feathery. . . . . *Oulactis muscosa*
— Column grey with red punctations, the proximal ones simply pigment spots; to 25 mm in length and pedal disc diameter.. . . . . *Anthopleura buddemeieri*
— Column beige, 15–30 mm in diameter; oral disc grey; tentacles to 30 mm long, with light bars across them. . . *Anthopleura handi*
— Column green or brown, 50–60 mm in diameter; tentacles to 40 mm long, rusty red or green or light brown. . *Aulactinia veratra*
— Column grey, oral disc greenish; tentacles without bars, more than 100 in number. . . . . *Gyractis sesere*

SYSTEMATIC TREATMENT

BOLOCEROIDIDAE

Boloceroides Carlgren, 1899

Definition. Pedal disc present but lacking basilar muscles; column smooth, lacking outgrowths; no marginal sphincter muscle; no distinct siphonoglyphs. Inner tentacles much longer than marginal ones; tentacles non-retractile; each with basal sphincter muscle that allows tentacle to be cast off. Longitudinal muscles of tentacles and column, and radial muscles of oral disc ectodermal; mesenterial retractor muscles weak. Six

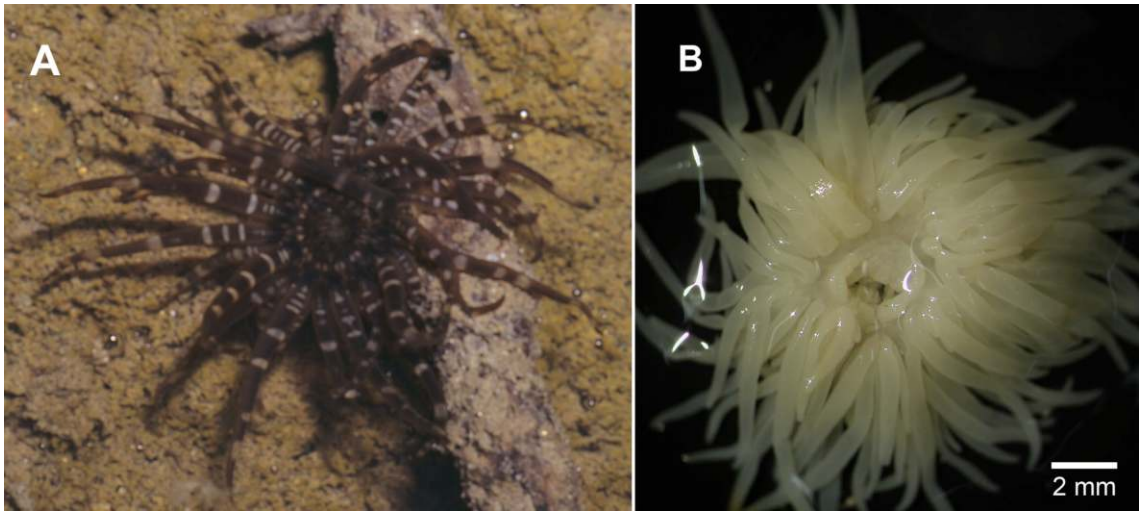

FIG. 3. *Boloceroides mcmurrichi.* **A,** live animal from Boggy Ck, Myrtletown, mouth of the Brisbane River (Photo QM). **B,** preserved specimen, MTQ-G59757, from Magnetic I., north Queensland, showing many tentacles.

pairs of mesenteries commonly complete, but more may be present in asexually-produced individuals; more mesenteries distally than proximally. All mesenteries except directives may be fertile. Cnidom: spirocysts, basitrichs, microbasic *p*-mastigophores, microbasic amastigophores. Spirocysts occur in the column. Capable of swimming by rowing movements of tentacles.

Type species: *Bolocera mcmurrichi* Kwietniewski, 1898.

Boloceroides mcmurrichi (Kwietniewski, 1898) (Fig. 3)

Bolocera mc murrichi Kwietniewski, 1898: 387, 389, 394–395, pl. 25, figs 10–11.
Boloceroides hermaphroditica Carlgren, 1900: 18–19.
Nectothela lilae Verrill, 1928: 14, fig. 2d–f.

Material Examined. HOLOTYPE: *Nectothela lilae*, AMNH-1476, Malaekahana, Oahu, Hawai'ian Islands. OTHER MATERIAL: *Moreton Bay*. Flat Rock, North Stradbroke I., M. Preker, 17.02.2005 (disintegrated). *Australia Elsewhere*. MTQ-G55344, Pallarenda, NE Qld; MTQ-G59757, 5 spec., Cockle Bay, Magnetic I., NE Qld; NTM-C5550–51, South Shell I., Darwin, NT, 1988; NTM-C10072, East Point Sponge Gardens, Darwin, NT, 1990; NTM-C11907, Nhulunbuy (Gove), NT, 1971; NTM-C12767, Darwin Harbour, NT, 1999; NTM-C14766, Bathurst I., NT, 2003; NTM-C13653, Darwin, NT.

Appearance. Pedal disc weakly adherent. Column thin-walled, translucent, to 10 mm long. Tentacles pointed, not all same size; transparent with or without white or cream transverse stripes; number variable, usually around 200 (Fig. 3), but as few as 12 in the Moreton Bay specimen examined from North Stradbroke Island.

Habitat. Lower intertidal and shallow subtidal of muddy or sandy areas; attaches to surfaces including mangroves and seagrasses. Observed attached to seagrass blades in seagrass meadows at Dunwich near the Moreton Bay Marine Station in 2001, by I. Lawn, M. Preker & ALC.

Distribution. Red Sea; Eastern Africa; Singapore; Western Australia; Northern Territory; eastern Australia; Indonesia; Papua New Guinea; French Polynesia; Hawai'i. Type locality: Ambon, Indonesia.

Comments. Because of its fragility, and perhaps seasonality of occurrence, this species is poorly represented in museum collections and seldom recorded in surveys. However, anecdotal evidence suggests it is not uncommon in Moreton Bay, and the specimen photographed by Davie (1998: 36) (Fig. 3A) was collected from a small muddy mangrove creek at the mouth of the Brisbane River (P. Davie, pers. comm.). It can cast off its tentacles, which regrow, accounting for the variability in number and size. DGF observed this species attached to the coral *Acropora* in Madang Lagoon, Papua New Guinea, in the late 1980s.

Further literature. TAXONOMY & DISTRIBUTION: Carlgren (1924a); Fishelson (1970); Doumenc (1973);

FIG. 4. *Actinia australiensis* from Frenchman's Beach, North Stradbroke Island. **A,** several individuals on under-surface of rock: note white flecks at base of tentacles. **B,** individual on dead oyster shell: two bright red siphonoglyphs (si) are visible.

Cutress (1977); Dunn (1982); Fautin (1988); Davie *et al.* (1998); Paulay *et al.* (2003). ECOLOGY & BEHAVIOUR: Lawn & Ross (1982); den Hartog (1997a); Erhardt & Knop (2005).

ACTINIIDAE

Actinia Linnaeus, 1767

Definition. Pedal disc wide. Column low, smooth; fosse deep, containing simple or slightly compound marginal spherules. Endodermal marginal sphincter muscle weak or strong, diffuse, rarely with slight tendency to be mesoendodermal. Tentacles retractile; longitudinal muscles ectodermal. Mesenteries more numerous basally than marginally; all stronger ones except directives fertile; mesenterial retractor muscles diffuse. Cnidom: spirocysts, holotrichs, basitrichs, microbasic *p*-mastigophores.

Type species: *Priapus equinus* Linnaeus, 1758.

Actinia australiensis Carlgren, 1950
(Fig. 4)

Actinia australiensis Carlgren, 1950a: 132–133, fig. 1.

Material Examined. SYNTYPES: LO-324-Kat 1, 11 spec., Sydney district, NSW, Australia; LO-324-Kat 2, 2 spec., along NSW coast, Australia. OTHER MATERIAL: *Moreton Bay.* MTQ-G55345, Frenchman's Beach, North Stradbroke I., J. Phillips, 2005; MTQ-G55347, Frenchman's Beach, North Stradbroke I., DGF, PRM, ALC, 2005; MTQ-G59390, Frenchman's Beach, North Stradbroke I., DGF, 2005; MTQ-G55346, Cylinder Beach, North Stradbroke I., DGF *et al.*, 2005; MTQ-G55348, Main Beach, North Stradbroke I., MM *et al.*, 2005. *Australia Elsewhere.* AM-G16963, Newport rock platform, NSW, K. Attwood & CCW, 2005.

Appearance. Pedal disc at least as broad as oral disc. Column red, to 30 mm long; may be slightly corrugated longitudinally. Oral disc flat, about half as broad as extended column length; red with white flecks near base of tentacles (Fig. 4A). Approximately 96 pointed tentacles, red with bluish-purple tips, hexamerously arranged; inner held upward, about half as long as oral disc diameter; outer shorter, extended horizontally. Fosse deep in life, may appear shallow in preserved specimens; to 48 whitish marginal spherules. Actinopharynx usually with two siphonoglyphs (Fig. 4B), in some specimens only one.

Habitat. Intertidal on rocks in surf zone, especially on underside of rocks and in crevices around low water mark.

Distribution. New South Wales; southeast Queensland. Type locality: Sydney, NSW, Australia.

Comments. Carlgren (1950a) described two colour variants, one as above. The other, having a light olive-green or light brown column with white streaks, and reddish brown tentacles, was not seen in Moreton Bay. Although this species occurs along the entire New South Wales coast, this appears to be the first record of it in Queensland.

Actinia tenebrosa Farquhar, 1898
(Fig. 5)

Actinia tenebrosa Farquhar, 1898: 527, 535–536.
Actinia c.f. *equina* — Blackburn, 1937: 369.

Material Examined. HOLOTYPE: CM-AQ3271, near Wellington, New Zealand. OTHER MATERIAL: *Moreton*

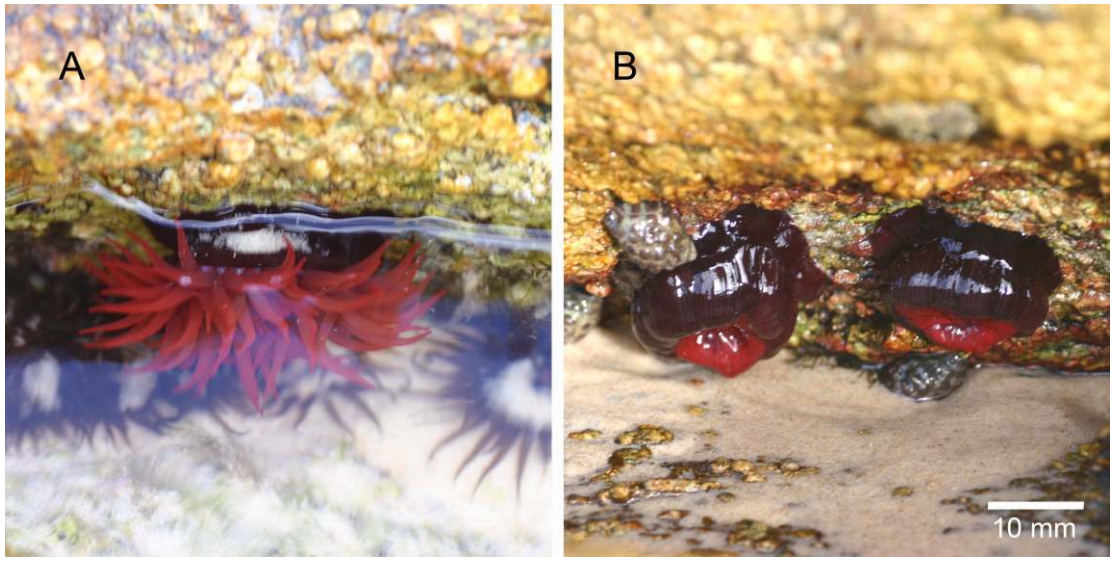

FIG. 5. *Actinia tenebrosa* from rock crevice at Frenchman's Beach, North Stradbroke Island. **A,** individual with tentacles expanded (anemones in background are *Aulactinia veratra).* **B,** two individuals with tentacles contracted at low tide. (photographs: P. Davie)

Bay. MTQ-G58751, Frenchman's Beach, North Stradbroke I., ALC & DGF, 2005; QM-G10529, Caloundra, 1951; QM-G304910, Point Cartwright, Mooloolaba; QM-G317223, Point Lookout, North Stradbroke I., J.N.A. Hooper *et al.*, 2000. *Australia Elsewhere.* AM-G15825, Long Reef, Colloroy, NSW, 1962; AM-G16869, Second Head, Forster, NSW, 2003; AM-G16966, Newport, NSW, M. Capa, 2005; QVM-20:580, Falmouth, Tasmania, 1993; QVM-29:1784, Beechport, Tasmania, 1993; QVM-20:1785, Sandy Point, Tasmania, Bridgeport, 1993. SAM-K3638, 3 spec., Kingston, South Australia, 1941.

Appearance. Pedal disc to approx. 40 mm diameter. Column dark maroon, to 30 mm long. Tentacles to 144, bright red, tapered to a point. Marginal spherules 24, bright blue, usually deep within the fosse. Actinopharynx with two siphonoglyphs. Sphincter muscle diffuse. Longitudinal muscles weak. See Carlgren (1924b) for anatomical details.

Habitat. Intertidal on rocks in surf zone, especially on underside of rocks and in crevices around low water mark.

Distribution. Western, southern, and eastern Australia from Shark Bay, Western Australia to Heron Island, central Queensland; New Zealand. Type locality: near Wellington, New Zealand.

Comments. One of the commonest and most easily identified Australian coastal species, *Actinia tenebrosa* is not well represented in museum collections. It can be distinguished in life by its patternless smooth maroon column, red tentacles and oral disc, and blue marginal spherules. It is often referred to as the Waratah Anemone due to the striking red colour of the tentacles. The young are brooded internally until they attain a considerable size. Some of the references below contain detailed anatomical descriptions. In referring to this species as *A. equina*, Blackburn (1937: 369) remarked, 'there seems, however, no more justification for separating [*A. tenebrosa*] than for many other colour varieties of *A. equina*.'

Further literature. TAXONOMY & DISTRIBUTION: Stuckey (1909); Stuckey & Walton (1910); Carlgren (1924b, 1950a, b, 1954); Blackburn (1937); Parry (1951); Cutress (1971); Ottaway (1975); Dunn (1982); Dawson (1992). BIOLOGY & ECOLOGY: Ottaway (1973, 1979a, b); Black & Johnson (1979); Ayre (1983, 1984a, b, 1995); Bennett (1987); Ayre *et al.* (1991); Edgar (1997); Sherman & Ayre (2008).

Anthopleura Duchassaing & Michelotti, 1860

Definition. Pedal disc well developed. Column with adhesive verrucae arranged in more or less distinct longitudinal rows, especially in its upper part. Marginal spherules present. Endodermal marginal sphincter muscle weak or

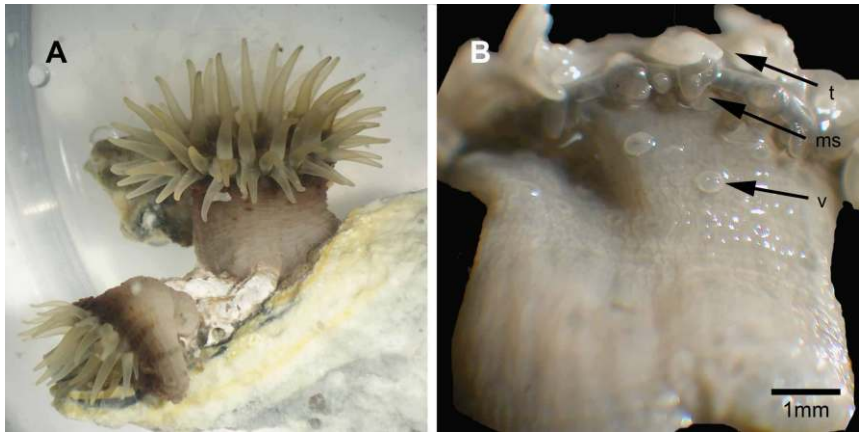

FIG. 6. *Anthopleura buddemeieri* from Main Beach, North Stradbroke I. **A,** two individuals on rock in laboratory (photograph: I. Lawn). **B,** preserved specimen, MTQ-G58753, showing column with arrows indicating adhesive verruca (v), marginal spherule (ms), and tentacle (t).

strong, restricted to circumscribed. Tentacles simple, hexamerously or irregularly arranged, their longitudinal muscles ectodermal or mesoectodermal. Numerous complete mesenteries, all the stronger ones fertile; mesenteries grow from base; retractor muscles of the stronger mesenteries diffuse, sometimes restricted. Cnidom: spirocysts, holotrichs, basitrichs, microbasic *p*-mastigophores.

Type species: *Anthopleura krebsi* Duchassaing & Michelotti, 1860.

Anthopleura buddemeieri Fautin, 2005
(Fig. 6)

Anthopleura buddemeieri Fautin, 2005: 379–389, figs 1–5.

Material Examined. HOLOTYPE: KUNHM-001992, Wongat I., Madang Lagoon, Madang, Papua New Guinea. PARATYPES: As listed in Fautin (2005, 2008). OTHER MATERIAL: *Moreton Bay*. MTQ-G55349, Frenchman's Beach, North Stradbroke I., J. Phillips, 2005; MTQ-G55350, Cylinder Beach, North Stradbroke I., DGF *et al*., 2005; MTQ-G58753, Main Beach, North Stradbroke I., MM *et al*., 2005. *Australia Elsewhere.* AM-G16965, Newport Beach, NSW, M. Capa, 2005.

Appearance. Pedal disc approx. same diameter as column. Column 9–12 mm long, 7–8 mm greatest diameter; grey (darker distally), with red verrucae distally, red punctations proximally. Fosse deep. Oral disc with central mouth raised on cone, two siphonoglyphs. Pale yellow-brown tentacles approx. 50, in 2–3 cycles, slender, tapering to blunt point, all approx. 5 mm long, 1 mm wide. Oral stomata large, marginal stomata small or absent.

Habitat. Attached to rock walls and platforms in high-energy surf areas. One specimen was attached to the red alga *Pterocladiella capitacea* growing on rocks.

Distribution. Fiji; Papua New Guinea; eastern Australia (Moreton Bay and Sydney region); Singapore. Type locality: Wongat Island, Madang Lagoon, Madang, Papua New Guinea.

Comments. These are the first records of this species from Australia.

Further literature. TAXONOMY & DISTRIBUTION: Fautin (2005).

Anthopleura handi Dunn, 1978
(Fig. 7)

Anthopleura handi Dunn, 1978: 54–63, figs 1–8.

Material Examined. HOLOTYPE: CAS-15674, Jeram Beach, Strait of Malacca, Selangor, Peninsular Malaysia. PARATYPES: all from type locality; BPBM-D515; BPBM-D516; BPBM-D517, 3 specs; CAS-15675; CAS-15676; CAS-15677; USNM-56557; USNM-56558. OTHER MATERIAL: *Moreton Bay*. MTQ-G58747, 2 spec., Dunwich, DGF & ALC, 2005; MTQ-G58759, 5 spec., Moreton Bay, 2005. *Australia Elsewhere*. NTM-C3584, Ludmilla Creek, Darwin, NT, 1982; NTM-C2263, no data; NTM-C2920, Creek 'H', East Arm, Ludmilla Creek, Darwin, NT, 1984.

Appearance. Column of specimens examined 14 mm long, 9 mm wide; grey with lighter verrucae

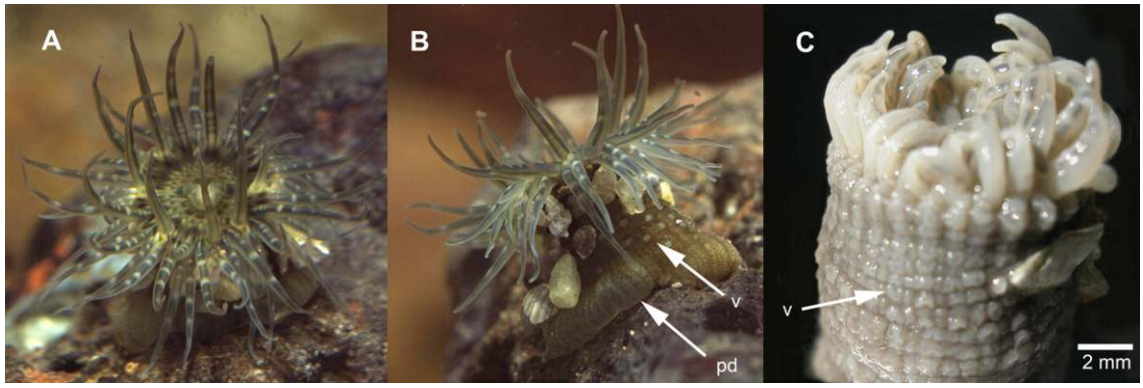

FIG. 7. *Anthopleura handi* from Dunwich, North Stradbroke Island. **A,** oral disc of living animal *in situ*, showing long, narrow tentacles with white blotches. **B,** side view of living animal *in situ*, showing broad pedal disc (pd) and sand grains adhering to verrucae (v). **C,** Preserved specimen, MTQ-G58747, showing verruca (v).

arrayed longitudinally; acrorhagus at distal end of each column of verrucae. Oral disc with slit-like mouth. Grey tentacles approx. 60; length to 30 mm, diameter approx. 2 mm at base; inner with white flecks and cross-bars (Fig. 7A). Fosse deep. Actinopharynx usually with two siphonoglyphs. Broods young internally.

Habitat. Attached to rock or oyster shells on intertidal mud flats, including the high intertidal regions, where the anemones occur around the base of rocks.

Distribution. Malaysia; Singapore; Philippines; northern and eastern Australia. Type locality: Jeram Beach, Strait of Malacca, Selangor, Peninsular Malaysia.

Comments. These are the first records of *A. handi* from Australia.

Further literature. TAXONOMY & DISTRIBUTION: England (1987); Fautin (1988). BIOLOGY & ECOL OGY: Dunn (1982).

Aulactinia Verrill, 1864

Definition. Pedal disc well developed, capable of distension. Column elongated, moderately contractile; upper part covered with prominent verrucae in longitudinal rows, the uppermost one in each row situated just below the tentacles, larger than the others, and lobed; foreign material often attached to verrucae. Tentacles numerous, simple, short. Marginal pseudospherules may be present. Mesenteries well developed, much narrower near the base, thickened above with strong longitudinal muscles. Cnidom: spirocysts, basitrichs, microbasic *p*-mastigophores.

Type species: *Aulactinia capitata* Agassiz in Verrill, 1864.

Aulactinia veratra (Drayton in Dana, 1846) (Fig. 8)

Actinia veratra Drayton in Dana, 1846: 129–130.
Cribrina verruculata Lager, 1911: 233–234.

Material Examined. SYNTYPE: *Cribrina verruculata*, MNB-5450, east coast of Rottnest I., WA. OTHER MATERIAL: *Moreton Bay*. MTQ-G58752, Frenchman's Beach, North Stradbroke I., DGF & ALC, 2005; MTQ-G58755, Cylinder Beach, North Stradbroke I., DGF *et al*., 2005; QM-G304911, Point Cartwright, Mooloolaba; MTQ-G60025, Point Arkright, Coolum, 2007. *Australia Elsewhere*. AM-G16870, Second Head, Forster, NSW, 2003; AM-G17453, 5 spec., Tasmania, 1958; AM-G16960, 4 spec., Newport, NSW, 2005.

Appearance. Expanded pedal disc diameter to 45 mm. Column to 60 mm expanded length, dark green to deep brown. Flat oral disc same colour as column, to 40 mm diameter. Tentacles tapered, brown, brownish red, or brownish green, hexamerously arranged; inner 20 mm long, outer to 30 mm long, may coil at ends.

Habitat. Intertidal rocks in surf zone, especially on underside and in crevices around low water mark.

Distribution. Southern Australia from Perth, Western Australia, to southeast Queensland. Type locality: Wollongong, NSW, Australia.

Comments. Retracted specimens of this species may appear black.

Further literature. TAXONOMY & DISTRIBUTION: Carlgren (1950a, b, 1954); Ottaway (1975); Edmands & Fautin (1991); Dawson (1992).

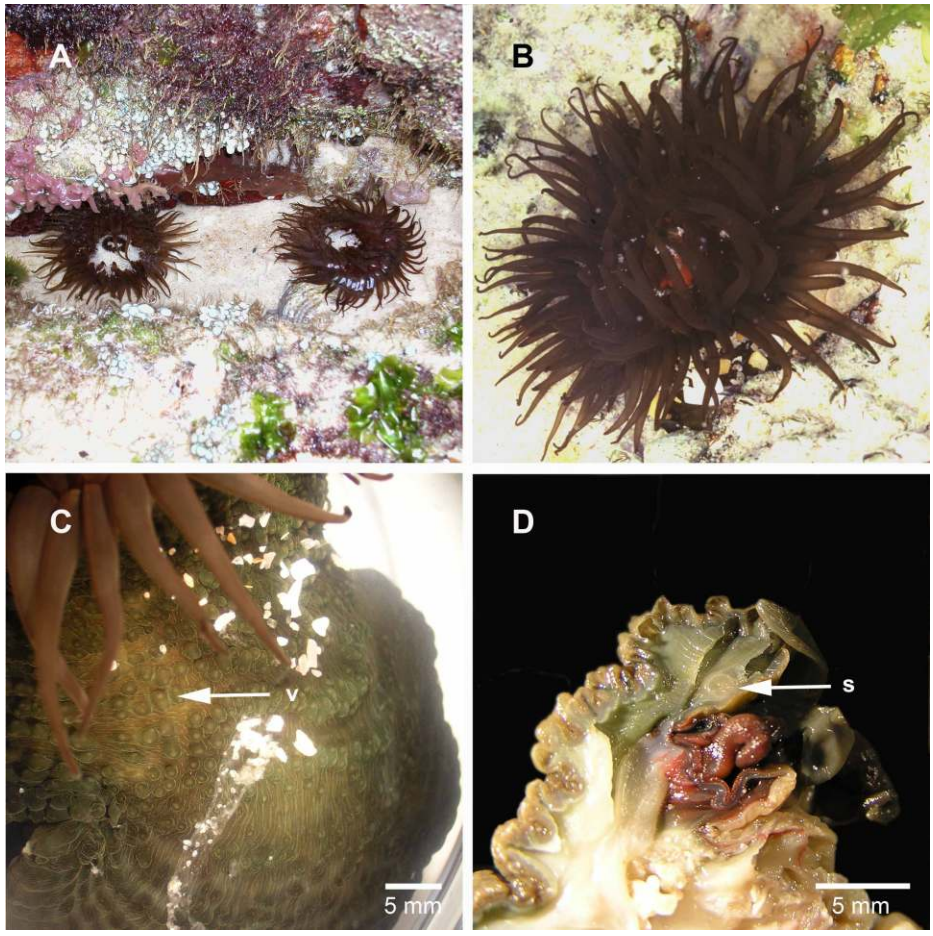

FIG. 8. *Aulactinia veratra* from Frenchman's Beach, North Stradbroke I. **A,** specimens in rock crevice. **B,** oral disc of living animal; note numerous long tentacles, the marginal ones held outward, and the inner ones held perpendicular to oral disc. **C,** living animal in laboratory, specimen showing column with verrucae (v) (photograph: I. Lawn); **D,** preserved specimen, MTQ-G58752, dissected to show circumscribed endodermal marginal sphincter muscle(s).

Entacmaea Ehrenberg, 1834

Definition. Pedal disc well developed. Column smooth; margin distinct, lacking spherules or pseudospherules; fosse generally deep. Endodermal marginal sphincter muscle diffuse, sometimes weak, in rare cases some lamellae invade mesogloea. Inner tentacles longer than outer; longitudinal muscles ectodermal, circular muscles endodermal. Number of siphonoglyphs variable. Mesenteries numerous, many complete, all stronger ones including directives fertile; mesenteries added at margin; a pair of directives usually connected to each siphonoglyph; retractor muscles diffuse, often band-like. Cnidom: spirocysts, basitrichs, microbasic *p*-mastigophores.

Type species: *Actinia quadricolor* Leuckart in Rüppell & Leuckart, 1828.

Entacmaea quadricolor (Leuckart in Rüppell & Leuckart, 1828) (Fig. 9)

Actinia quadricolor Leuckart in Rüppell & Leuckart, 1828: 4–5, fig. 3.

Actinia vas Quoy & Gaimard, 1833: 147–148, pl. 12, fig. 6.

Actinia erythrosoma Hemprich & Ehrenberg in Ehrenberg, 1834: 257.
Actinia adhaerens Hemprich & Ehrenberg in Ehrenberg, 1834: 258–259.
Actinia helianthus Hemprich & Ehrenberg in Ehrenberg, 1834: 259.
Actinia ehrenbergii Brandt, 1835: 11.
Crambactis arabica Haeckel, 1876: 4, fig. 2.
Condylactis Gelam Haddon & Shackleton, 1893: 123–124.
Condylactis Ramsayi Haddon & Shackleton, 1893: 124.
Anemonia Kwoiam Haddon & Shackleton, 1893: 125–126.
Gyrostoma Hertwigi Kwietniewski, 1897: 30–34.
Gyrostoma Stuhlmanni Carlgren, 1900: 39–40, pl. 1, fig. 16.
Gyrostoma Haddoni Lager, 1911: 229–230, fig. 10.
Gyrostoma sulcatum Lager, 1911: 230–232, figs 11, 12.
Antheopsis Carlgreni Lager, 1911: 243–244, fig. 19.

Material Examined. HOLOTYPE: *Actinia quadricolor*: SMF-34, near Suez, the Red Sea, Egypt. SYNTYPES: *Anemonia kwoiam*: UMZ-Co182, Torres Strait. *Condylactis ramsayi*: UMZ-Co183, 3 spec., Torres Strait. *Gyrostoma hertwigii*: PMJ-Coel 66, 2 spec., SMNH-57, 3 pieces, Thursday I. *Gyrostoma sulcatum*: WAM-Z887, SMNH-4876, ZMH-5334, ZMH-5336, MNB-5443, MNB-5444, 2 spec., Shark Bay, WA. OTHER MATERIAL: *Moreton Bay*. MTQ: no collection but specimens photographed February 2005 (see Fig. 9). *Australia Elsewhere*. AM-G15572, Bumbra Reserve, Norfolk I., 1980; AM-G16069, 2 spec., Rundle I., Qld, 1974; AM-G16908, Northwest I., Capricorn Group, Great Barrier Reef, Qld, 1931; AM-G16975, 3 spec., Ned's Beach, Lord Howe I., 1964; NTM-C3267, C3275, Coral Bay, Port Essington, NT, 1981; NTM-C5449, Coral Bay, Port Essington, NT, 1986; NTM-C5549, South Shell I., Darwin Harbour, Darwin, NT, 1988; NTM-C11912, C11914, Shore Reef, Nightcliff, Darwin, NT, 1975; BMNH-1054.6.28.30, 3 spec., Great Barrier Reef. PMJ-Coel66, 2 spec., Thursday I., Torres Strait, Qld; SMNH-667A, 2 spec., Shark Bay, WA; WAM-29-76, 5 spec., Abrolhos, WA; WAM-33-76, 3 spec., Abrolhos, WA.

Appearance. Pedal disc well developed, usually narrower than oral disc. Column to 500 mm long, oral disc to 400 mm diameter, at least twice as broad as pedal disc. Flared column typically rich brown but may be greenish or reddish; in some specimens paler near base. Deep fosse. Flat brown, greenish, or pink oral disc may have radial white stripes around mouth; most tentacles near margin. Tentacles cylindrical, hardly tapered; inner 2–3 times as long as marginal; typically brown with greenish cast and pink or purple tip; bulb at or just below tip may have a white equator or be flecked with white.

Habitat. Reef environments; base may be attached in hole or crevice so only tentacles are visible.

Distribution. Red Sea; eastern Africa; Indian Ocean; Melanesia; Micronesia; Japan; across northern Australia from Perth, WA to northern NSW. Type locality: Near Suez, Red Sea, Egypt.

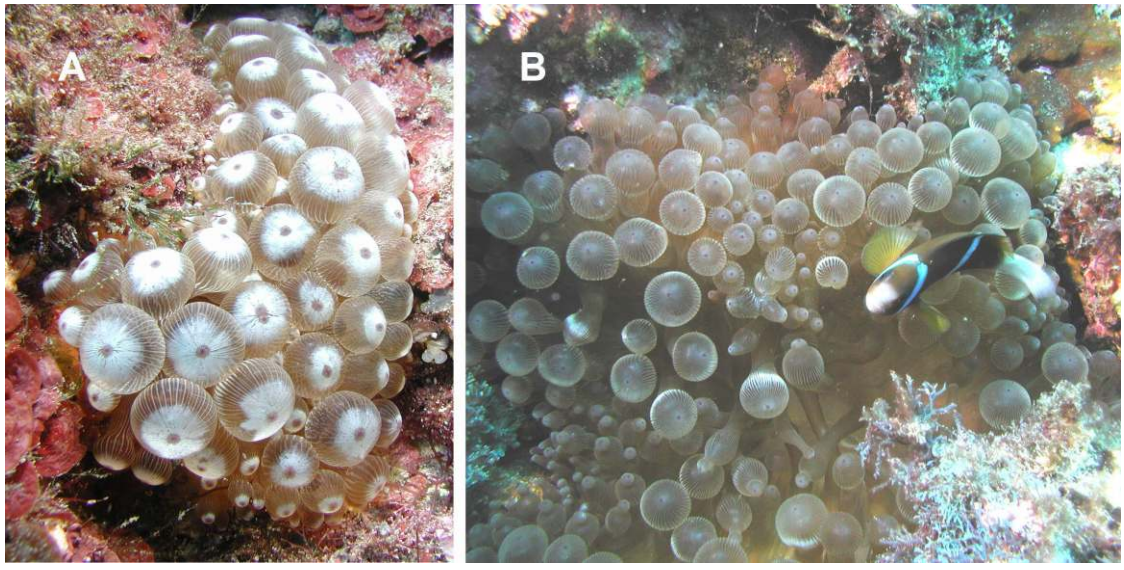

FIG. 9. *Entacmaea quadricolor* at Flat Rock, North Stradbroke I. **A,** individual with expanded tentacle tips. **B,** individual with tentacles in a range of expansion states; fish is *Amphiprion akindynos* (photographs: J. Hsieu).

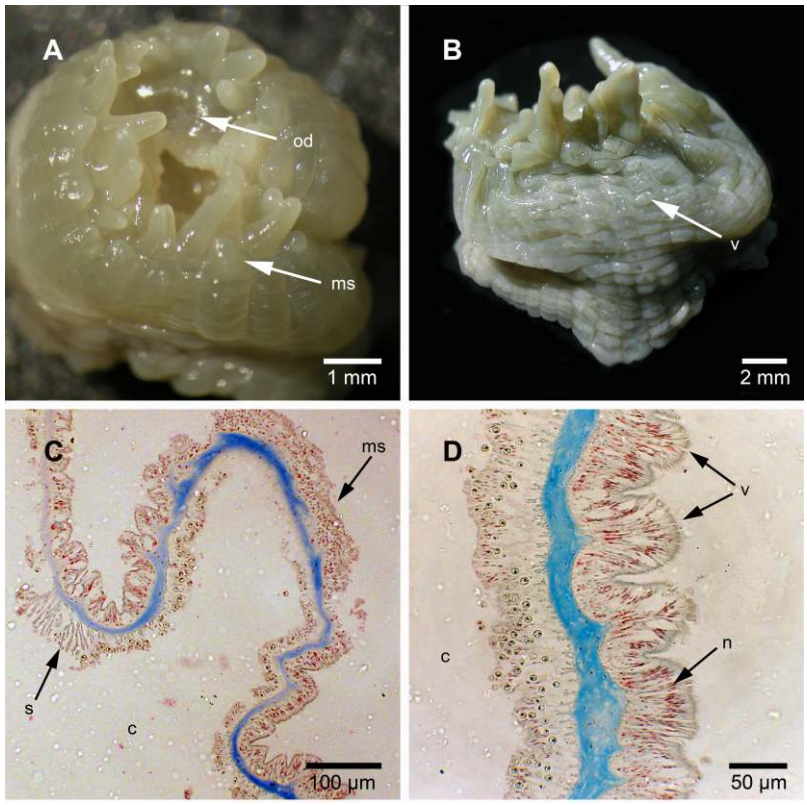

FIG. 10. *Gyractis sesere* from Adam's Beach, North Stradbroke I. Preserved whole animal, MTQ-G59436. **A,** view of oral disc (od) showing marginal spherules (ms). **B,** side view of column showing adhesive verruca (v). **C, D,** longitudinal section through distal column showing: **C**, diffuse endodermal sphincter muscle (s) and marginal spherule (ms); **D,** verrucae (v) with nematocyst (n). (c): coelenteron.

Comments. This species was recorded only outside Moreton Bay proper: specimens were common at all sites dived. It hosts anemonefish (Fautin & Allen 1992). When fish are present, most tentacles are swollen into a terminal or subterminal bulb: bulbs may disappear in anemones lacking fish. Both clonal and solitary forms occur.

Further literature. TAXONOMY & DISTRIBUTION: Dunn (1981); Fautin (1988); Fautin & Allen (1992); Richardson *et al.* (1997). BIOLOGY & ECOLOGY: Dunn (1981, 1985); Fautin (1985, 1986, 1991); Hirose (1985); Fautin & Allen (1992); den Hartog (1997b); Arvedlund *et al.* (1999); Srinivasan *et al.* (1999); Astalhov (2002); Scott & Harrison (2005).

Gyractis Boveri, 1893

Definition. Well-developed pedal disc. Column with longitudinal rows of adhesive verrucae. Marginal spherules well developed, commonly digitate. Endodermal marginal sphincter muscle weak and diffuse, or strong and circumscribed. Tentacles and mesenteries regularly or irregularly arranged. Siphonoglyphs two or more, some supported by directive mesenteries. About same number of mesenteries distally and proximally. Mesenterial retractor and parietobasilar muscles weak to strong, diffuse. Cnidom: spirocysts, basitrichs, microbasic amastigophores, microbasic *p*-mastigophores; in some species heterotrichs occur near the limbus.

Type species. *Gyractis excavata* Boveri, 1893.

Gyractis sesere (Haddon & Shackleton, 1893) (Fig. 10)

Actinioides sesere Haddon & Shackleton, 1893: 126–127; Haddon, 1898: 428, pl. 22, figs 8, 9, pl. 28, figs 1, 2.
Gyractis excavata Boveri, 1893: 250–251, figs 3, 4, 6.

Gyractis pallida Boveri, 1893: 251–252, figs 1, 2, 5.
Actinioides sultana Carlgren, 1900: 43–44, pl. 1, figs 12, 13.
Actinioides rapanuiensis Carlgren, 1922: 151–153, figs 8, 9, 10.

Material Examined. SYNTYPE: *Actinioides rapanuiensis*, NHMG-848, Easter I. OTHER MATERIAL: *Moreton Bay*. MTQ-G59435, North Stradbroke I., A.-N. Lörz, 2005; MTQ-G59436, 20 spec., Adam's Beach, North Stradbroke I., J. Phillips, 2005.

Appearance. Well developed pedal disc. Column to 8 mm long (preserved specimens), with verrucae in longitudinal rows. Fosse shallow. Sphincter muscle weak, diffuse tending to circumscribed. Tentacles to >100, longitudinal muscles ectodermal; siphonoglyphs weak, not connected to directive mesenteries.

Habitat. Intertidal, in crevices on rocky reef surfaces.

Distribution. Eastern Africa; Gulf of Aden; Singapore; Torres Strait; Western Australia; Queensland; Hawai'i. Type locality: Mabuiag, Torres Strait.

Further literature. TAXONOMY & DISTRIBUTION: Carlgren (1949, 1954); Dunn (1974); Cutress (1977); Cutress & Arneson (1987); Fautin (1988, 2005).

Macrodactyla Haddon, 1898

Definition. Pedal disc distinct, circular, narrower than oral disc. Column with adhesive verrucae distally, without marginal spherules. Fosse absent or deep. Endodermal marginal sphincter muscle restricted, rather weak. Tentacles long and stout, about 48, the inner considerably longer than the outer. Actinopharynx with two siphonoglyphs. Six pairs of complete mesenteries, two of them directives; all fertile; retractor muscles band-like, restricted. Parietobasilar muscles well developed, forming a fold. Cnidom: spirocysts, basitrichs, microbasic *p*-mastigophores.

Type species. *Condylactis aspera* Haddon & Shackleton, 1893.

Macrodactyla doreensis (Quoy & Gaimard, 1833) (Fig. 11)

Actinia doreensis Quoy & Gaimard, 1833: 149–150, pl. 12, fig. 7.
Condylactis gelam Haddon & Shackleton, 1893: 123–124.

Material Examined. SYNTYPE: *Condylactis gelam*, UMZ-Co181, 2 spec., Torres Strait. OTHER MATERIAL: *Moreton Bay*. MTQ-G58748, Dunwich, North Stradbroke I., P. Davie, 2005; AM-G16759, North Stradbroke I., E. Pope, 1961; AM-G16979, Dunwich, North Stradbroke I., E. Pope, 1961. *Australia Elsewhere*. MTQ-G59156, Arafura Sea, Nhulunbuy (Gove), NT, B. & B. Koenecke, 2005.

Appearance. Pedal disc circular, buried in sand/mud substrate, not as wide as column. Column to 150 mm long, distal end broadly flared (Fig. 11C); typically grey with splotches of orange or entire column orange with creamy yellow proximal end. Verrucae circular to eye-shaped, non-adhesive, in longitudinal rows, most endocoelic. Fosse pronounced. Oral disc with central, lipped mouth, sometimes on an elevated cone (Fig. 11A, B). Each pointed tentacle grey with pink or mauve tip, may have longitudinal white streak (Fig. 11A); sparse, 50–100 mm long; some with corkscrew form. Tentacles concentrated at margin of oral disc (Fig. 11B), few tentacles scattered on oral disc closer to mouth.

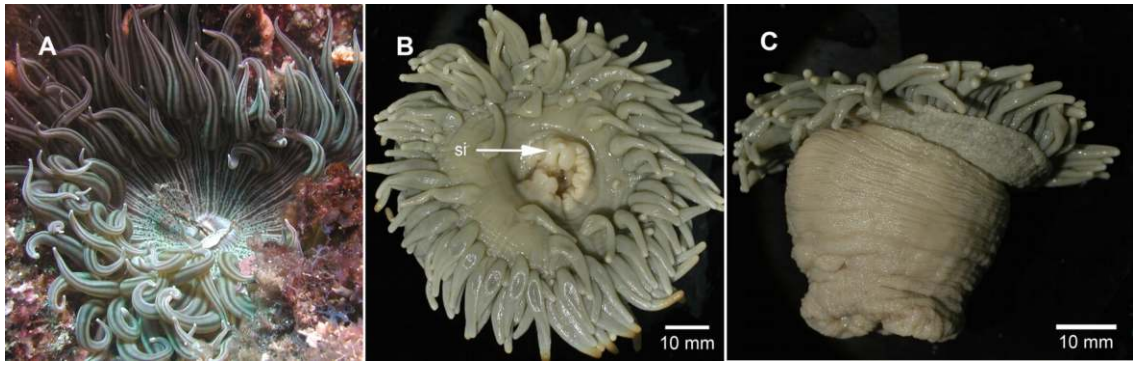

FIG. 11. *Macrodactyla doreensis.* **A,** individual *in situ* on Flat Rock, North Stradbroke I., showing white lips, patterning of oral disc and tentacles, and tentacle-free central area (photograph: J. Hsieu). **B, C,** preserved specimen, MTQ-G58748, from intertidal mudflats, Dunwich, North Stradbroke I.; arrow in B indicates white siphonoglyph (si).

Habitat. Intertidal and subtidal on mud or sand with column partly buried in the substrate.

Distribution. Japan; Papua New Guinea; Hawai'i; northern and eastern Australia, south to Moreton Bay. Type locality: Manokwari [Port Dorey], New Guinea.

Further literature. TAXONOMY & DISTRIBUTION: Moyer (1976); Dunn (1981); Fautin (1988); Fautin & Allen (1992); den Hartog (1997b); Richardson *et al.* (1997). BIOLOGY: Fautin (1991); den Hartog (1997a); Astalhov (2002).

Oulactis Milne Edwards & Haime, 1851

Definition. Pedal disc well developed. Column smooth basally, distally with longitudinal rows of verrucae; verrucae below margin small, frond-like, close-set on lobes. Fosse distinct. Marginal spherules present. Endodermal sphincter muscle diffuse. Tentacles rather short, hexamerously arranged, their longitudinal muscles ectodermal. Two well-developed siphonoglyphs and two pairs of directive mesenteries. Most mesenteries complete and fertile (directives may be sterile); retractor muscles more or less band-like. Cnidom: spirocysts, holotrichs, basitrichs, microbasic *p*-mastigophores.

Type species: *Metridium muscosum* Drayton in Dana, 1846.

Oulactis muscosa (Drayton in Dana, 1846) (Fig. 12)

Metridium muscosum Drayton in Dana, 1846: 153–154, pl. 5, figs 42, 43.
Oulactis muscosa Milne Edwards & Haime, 1851: 12.
Oulactis plicatus Hutton, 1878: 311–312.

Material Examined. *Moreton Bay*. MTQ-G58750, Frenchman's Beach, DGF, 2005; MTQ-G58756, Cylinder Beach, DGF *et al.*, 2005; QM-G10535, Sandgate, 1951; QM-G31722, Point Lookout, North Stradbroke I., J.N.A. Hooper *et al.*, 2000. *Australia Elsewhere*. AM-G2622, from Straham to Hobart, Tasmania; AM-G10871, Coogee, NSW; AM-G16868, 2 spec., Forster, NSW, 2003; AM-G16961, 2–4 spec., Newport, NSW, 2005; AM-G16974, 3 spec., Tasmania, 1958.

Appearance. Pedal disc broader than length of column, well developed, adhesive. Column to 13 mm long, grey with reddish-brown to dark green spots on verrucae especially near oral end, and brown radial stripes near pedal end. Oral disc dark red, flat, diameter to 10 mm; tentacles concentrated near margin. Tentacle length 3 mm in preservation. In live specimens each tentacle somewhat longer than oral disc diameter, pale brown with grey-striped white base. Acrorhagi prominent; distalmost frond-like verrucae form ruff at margin; sand and shell grit attached to more proximal verrucae. Cnidom: spirocysts, holotrichs, basitrichs, microbasic *p*-mastigophores.

Habitat. Crevices and rock pools on rocky platforms. Base of anemone attached deep in crevice makes collecting difficult.

Distribution. Eastern Australia from southern Queensland to South Australia; New Zealand. Type locality: Illawarra, Wollongong, New South Wales, Australia.

Comments. Two species of *Oulactis* are recognised from Australia (Edgar 1997): *O. muscosa* occurs from the east coast to the Spencer Gulf in South Australia, whereas *O. mcmurrichi* (Lager, 1911) occurs from South Australia westward to Perth, Western Australia. A study is under way to determine whether these species are distinct from one another.

Further literature. TAXONOMY & DISTRIBUTION: Milne Edwards & Haime (1851); Lager (1911); Carlgren (1949, 1950a, b, 1954); Parry (1951); Cutress (1971); Dawson (1992); Edgar (1997); Häussermann (2003). BIOLOGY & ECOLOGY: Hunt & Ayre (1989); Acuña & Zamponi (1999).

ALICIIDAE

Triactis Klunzinger, 1877

Definition. Pedal disc well developed. Column smooth except for central ring of stalked dichotomously ramified outgrowths, which increase in number and degree of branching with age of individual. Hemispheric vesicles containing microbasic and macrobasic amastigophores occur on the stalk near branches, and on the column near oral side of the stalk. Stalk with few, longitudinal, very weak bands of endodermal muscles. No marginal sphincter muscle. Margin tentaculate; tentacles not numerous, hexamerously arranged. Longitudinal muscles of tentacles and radial muscles of oral disc ectodermal. Two distinct siphonoglyhs. Six pairs of complete mesenteries and several incomplete; two pairs of directives; retractor muscles weak. Parietobasilar muscles very weak. Cnidom: spirocysts, basitrichs, microbasic *p*-mastigophores, microbasic amastigophores, macrobasic amastigophores.

Type species: *Triactis producta* Klunzinger, 1877.

Triactis producta Klunzinger, 1877
(Fig. 13)

Triactis producta Klunzinger, 1877: 85–86, pl. 6, fig. 8.
Viatrix cincta Haddon & Shackleton, 1893: 117, 127.
Phyllodiscus indicus Stephenson, 1922: 280–281.
Sagartia pugnax Verrill, 1928: 18–19, pls 3B, 4A, fig. 2j.

Material Examined. SYNTYPE: *Sagartia pugnax*, BPBM-D113, Hawai'i. OTHER MATERIAL: *Moreton Bay*. MTQ-G58758, Shark Gutter, M. Preker, 2005. *Australia Elsewhere*. MTQ-G59162, Nhulunbuy (Gove), NT, 2005; QM-G5300, Heron I., Qld.

Appearance. Pedal disc well developed. Column to 60 mm long (6 mm in Moreton Bay specimen), cylindrical; to 8 stalked hemispherical vesicles per branch in Moreton Bay specimen. Tentacles rather short, in three cycles (12+12+24 = 48). Pale brown colour due to endodermal zooxanthellae.

Habitat. Reef surfaces from intertidal to subtidal. Often associated with 'boxer crabs' (*Lybia* species) that grasp these anemones in their specially modified chelae. The Moreton Bay specimen reported here was unattached.

Distribution. Red Sea; tropical Australia; Hawai'i. Type locality: Red Sea.

Further literature. TAXONOMY & DISTRIBUTION: Haddon & Shackleton (1893); Fishelson (1970); Cutress (1977); Cutress & Arneson (1987); England (1987); den Hartog (1997a); Paulay *et al.* (2003). BIOLOGY & ECOLOGY: Karplus *et al.* (1998).

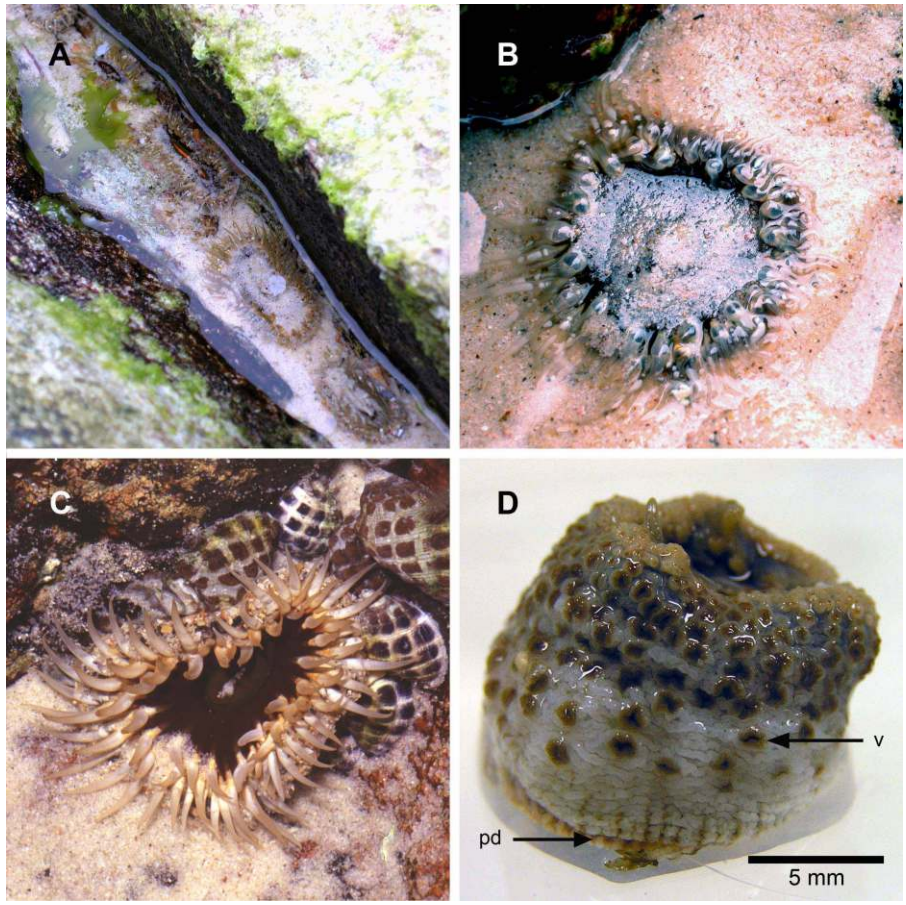

FIG. 12. *Oulactis muscosa.* **A,** specimens in a crevice between two rocks, Cylinder Beach, North Stradbroke I. **B,** individual partly hidden by sand. **C,** exposed individual surrounded by mulberry whelks *Morula marginalba* (photograph: QM). **D,** preserved individual, MTQ-G58750, from Frenchman's Beach, North Stradbroke I., showing broad pedal disc (pd) and column with adhesive verrucae (v).

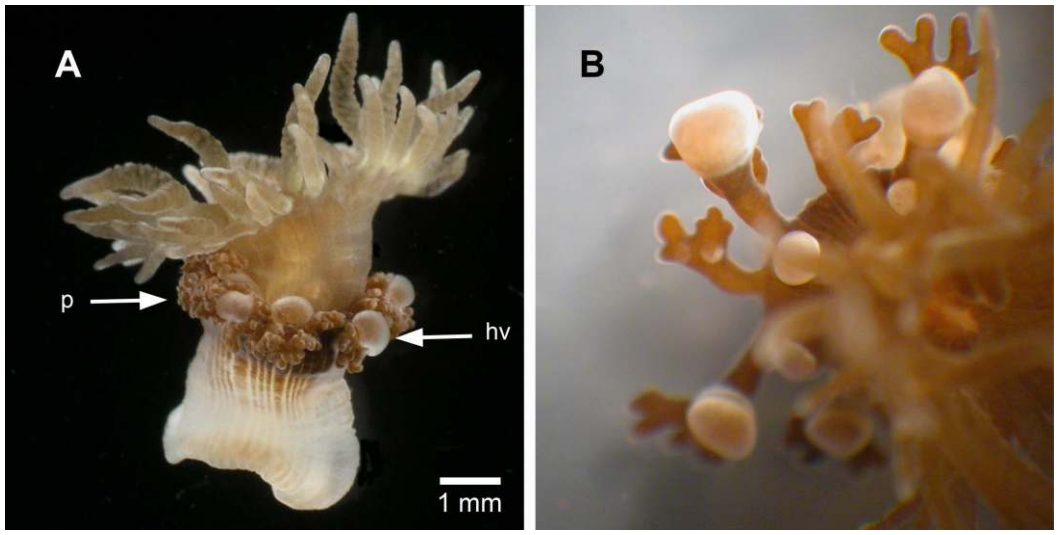

FIG. 13. *Triactis producta.* Individual from Shark Gutter, Flat Rock, North Stradbroke I., MTQ-G58758. **A,** live in laboratory, showing mid-column projections (p) with stalked hemispherical vesicles (hv) (photograph: I. Lawn). **B,** detail of projections.

PHYMANTHIDAE

Heteranthus Klunzinger, 1877

Definition. Pedal disc well developed. Column, apart from most proximal part, with verrucae, which are smaller and more numerous at the margin, and overhang the fosse. Endodermal marginal sphincter muscle weak, circumscribed, forming only a few folds. Marginal tentacles conical, simple, arranged in cycles; discal tentacles much shorter and papilliform, in radial rows. Two well-developed siphonoglyphs. Fairly numerous perfect pairs of mesenteries, two pairs of directives; retractor muscles diffuse, well developed. Parietobasilar muscles weak to fairly strong. Distribution of gametogenic tissue unknown. Cnidom: spirocysts, basitrichs, microbasic *p*-mastigophores.

Type species: *Heteranthus verruculatus* Klunzinger, 1877.

Heteranthus verruculatus Klunzinger, 1877
(Fig. 14)

Heteranthus verruculatus Klunzinger, 1877: 84, pl. 5, fig. 9.

Material Examined. SYNTYPES: MNB-1852, SMNH-4861, Red Sea. OTHER MATERIAL: *Moreton Bay*. MTQ-G59391, Bird I., A.-N. Lörz & DGF, 2005; MTQ-G59392, Shag Rock, G. Carini & I. Fellegara, 2005; MTQ- G59967, Shag Rock, M. Preker, 2005; MTQ-G59968, Moreton Bay, 2005. *Australia Elsewhere*. MTQ-G59393, Mystic Sands, north of Townsville, Qld, ALC & C. Bartlett, 2005.

Appearance. Column to 9 mm length, 11 mm diameter; pale yellowish-green proximally, greenish–brown distally (owing to zooxanthellae); verrucae bright green with central white spot, becoming tentacle-like at margin (Fig. 14A). Oral disc dark greenish-brown to sepia, with variable amounts of opaque white. Marginal tentacles smooth, pointed, inner longer than outer, pale greenish-brown with no patterning or with dense pattern of opaque white flecks and circular spots; discal tentacles papilliform, inconspicuous, same colour as oral disc .

Habitat. In sand or on rocks, often part-hidden by sand, from intertidal to subtidal, on coral reefs and rock platforms.

Distribution. Red Sea; Western Australia; Queensland; Hawai'i. Type locality: Red Sea.

Comments. This species seems to be common in Queensland: it occurs both within and outside Moreton Bay; dense aggregations occur in Townsville; and Carlgren (1950c) recorded it (with some hesitation) from the Great Barrier Reef.

Further literature. TAXONOMY & DISTRIBUTION: Haddon (1898); Carlgren (1950c); Cutress (1977); den Hartog (1997a). BIOLOGY: Stephenson (1922).

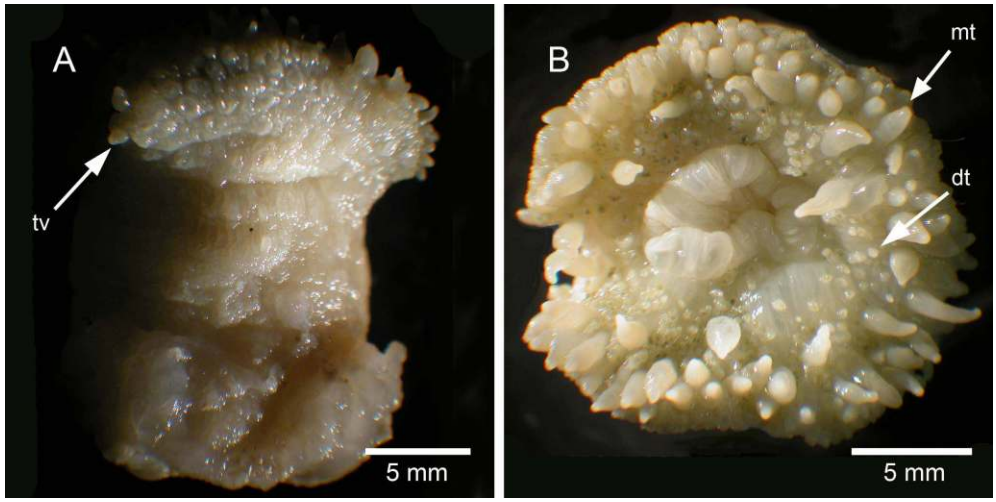

FIG. 14. *Heteranthus verruculatus* from Shag Rock, North Stradbroke I., preserved specimen, MTQ-G59392. **A,** side view of column indicating tentacle-like verruca (tv) at margin. **B,** oral disc, showing pointed marginal tentacles (mt) and papilliform discal tentacles (dt).

STICHODACTYLIDAE

Stichodactyla Brandt, 1835

Definition. Pedal disc well developed, adherent. Flat, undulating, and broad oral disc covered with many short tentacles; endocoelic tentacles radially arrayed, mostly two or more abreast, to five at margin; rows communicating with successively higher order endocoels shorter, more marginal; in most species all tentacles alike, but single exocoelic ones may be more robust. Column generally broader than tall, flared part verrucose. Fosse absent to shallow. Cnidom: spirocysts, basitrichs, microbasic *p*-mastigophores.

Type species: *Stichodactyla mertensii* Brandt, 1835.

Stichodactyla haddoni (Saville-Kent, 1893) (Fig. 15)

Discosoma Haddoni Saville-Kent, 1893: 32–33, chromo pl. 2, pl. 21.

Material Examined. *Moreton Bay*. QM-G10528, Dunwich, North Stradbroke I., 1951; QM-G309200, Flinders Reef; QM-G317137, Raby Bay, Cleveland, S.D. Cook *et al.*, 2000; QM-G327091, Dunwich, North Stradbroke I., J.N.A. Hooper *et al.*, 2000; QM-G327354, Wellington Point, S.E. List-Armitage, ALC & C.J. Bartlett. *Australia Elsewhere*. MTQ-G55351, Pallarenda, Townsville, Qld, ALC & PRM, 2005; NTM-C3240, Trepang Bay, van Dieman Gulf, NT, 1981; NTM-C10010–13, Ashmore Reef, WA, 1986.

Appearance. Well-developed pedal disc. Oral disc to 500 mm diameter, undulating, green, brown, or blue; densely covered with short tentacles (a few mm long, about 1 mm diameter) although area around mouth typically tentacle-free. Tentacles sticky to touch; basal portion of tentacle of uniform diameter, upper portion bluntly pointed to slightly bulbed; most single exocoelic tentacles white, about 3 mm diameter. Column white, yellow, or light green, widening gradually from pedal disc to flared upper column bearing small non-adhesive verrucae. Fosse shallow.

Habitat. Intertidal to subtidal sand or mud flats.

Distribution. Red Sea; eastern Africa; Singapore; northern and eastern Australia south to Moreton Bay; Japan; New Caledonia. Type locality: Flat Top Island, Great Barrier Reef, off Mackay, Qld, Australia.

Comments. This is the largest sea anemone in the Moreton Bay region. It is known as a 'carpet anemone' in the aquarium trade.

Further literature. TAXONOMY & DISTRIBUTION: Carlgren (1950c); Dunn (1981, 1985); Fautin (1988); den Hartog & Vennam (1993); Richardson *et al.* (1997); den Hartog (1997a, b); Uchida & Soyama (2001); Astalhov (2002); Paulay *et al.* (2003). BIOLOGY & ECOLOGY: Hadley (1973); Dunn (1981); Hirose (1985); Fautin (1991); Khan *et al.* (2003, 2004).

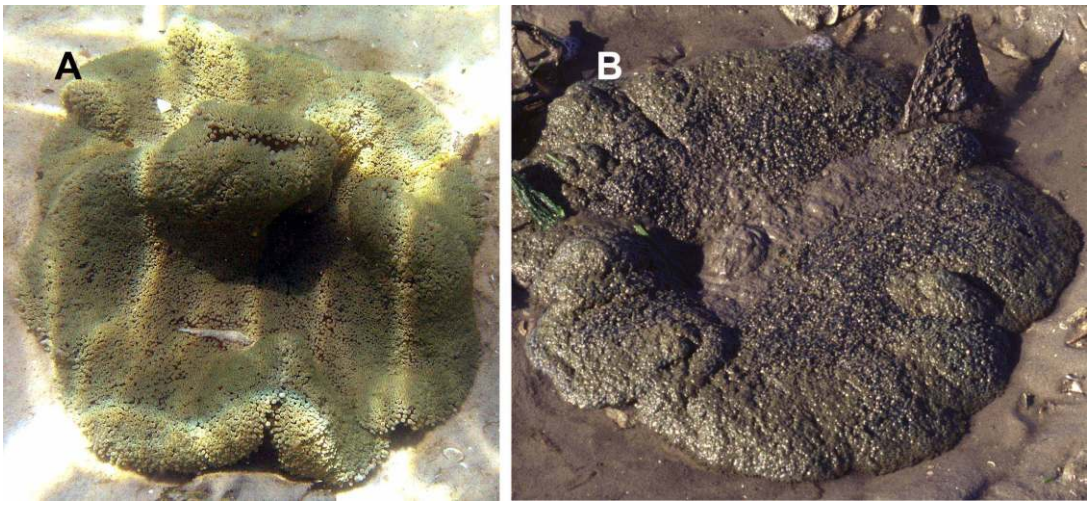

FIG. 15. *Stichodactyla haddoni.* **A,** individual from Days Gutter, off Moreton I., showing large oral disc with evenly distributed short tentacles. **B,** animal on mud flat exposed at very low tide (photograph: QM).

Stichodactyla tapetum (Hemprich & Ehrenberg in Ehrenberg, 1834) (Fig. 16)

Actinia (Isacmaea) Tapetum Hemprich & Ehrenberg in Ehrenberg, 1834: 256.
Homactis rupicola Verrill, 1869b: 71–72.
Discosoma ambonensis Kwietniewski, 1898: 387, 410–412, 413, pl. 29, figs 49–51.
Stoichactis laevis Lager, 1911: 240–241, figs 16, 17.
Stoichactis australis Lager, 1911: 241–243, fig. 18.

Material Examined. HOLOTYPES: *Stoichactis australis*, ZMH-5332; *Stoichactis laevis*, ZMH-5337; *Homactis rupicola*, YPM-6854. SYNTYPES: *Actinia tapetum*, MNB-162, 5 spec., MNB-163 3 spec.; SMNH-1157. *Discosoma ambonensis*, SMNH-5580. OTHER MATERIAL: *Moreton Bay*. AM-G4085, 3 spec., North Stradbroke I., Qld; AM-G16071, 3 spec., Dunwich, North Stradbroke I., Qld, 1961; AM-G16072, 3 spec., Dunwich, North Stradbroke I., Qld, 1961. *Australia Elsewhere*. QM-G16913, Northwest I., Capricorn Group, Great Barrier Reef, Qld, 1931.

Appearance. Pedal disc to 30 mm diameter; oral disc to 100 mm diameter, typically no greater than 40 mm. Column length typically about one half pedal disc diameter, but may be taller. Tentacles very short, 0.25–0.5 mm diameter; bulbous; densely packed, may be arrayed in fields on entire disc. Two symmetrical siphonoglyphs.

Habitat. In rock crevices on fringing coral reefs; on mud and sand flats.

Distribution. Red Sea; Hong Kong; China; Taiwan; Indonesia; Singapore; tropical eastern and western Australia. Type locality: Red Sea.

Comments. This species does not host anemonefish. During the Workshop this species was not observed inside the Bay, but specimens in the Australian Museum were collected from Dunwich, within Moreton Bay, in 1961.

Further literature. TAXONOMY & DISTRIBUTION: Dunn (1981); den Hartog (1997a); Uchida & Soyama (2001); Song & Cha (2004).

Heteractis Milne Edwards, 1857

Definition. Pedal disc well developed, adherent, slightly wider than lower column, narrower than oral disc. Column length of some equal to oral disc width, of some equal to pedal disc width. Proximal column smooth, distally with inconspicuous to prominent verrucae. Fosse absent to deep. Oral disc hardly retractile, flat to shallowly undulating. Tentacles on one individual all alike, sinuous to digitiform; one species has swellings on lateral and oral surfaces. Usually more than one tentacle per endocoel. Cnidom: spirocysts, basitrichs, microbasic *p*-mastigophores.

Type species: *Actinia aurora* Quoy & Gaimard, 1833.

Heteractis malu (Haddon & Shackleton, 1893) (Fig. 17)

Discosoma Malu Haddon & Shackleton, 1893: 120.
Stichodactis papillosa Kwietniewski, 1898: 415–417, pl. 28, figs 41–45.
Antheopsis concinnata Lager, 1911: 244–245, fig. 20.
Stichodactis glandulosa Lager, 1911: 246–247, fig. 21.

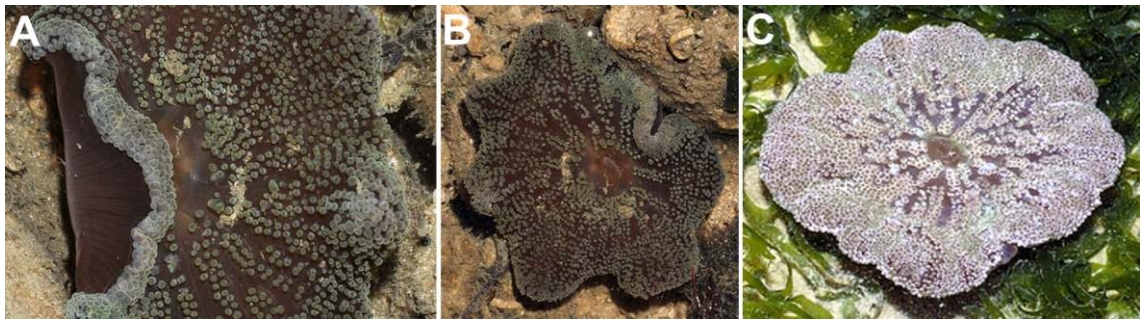

FIG. 16. *Stichodactyla tapetum*. **A-C** (photographed in Singapore waters, but typical of those found in Moreton Bay. (photographs: Ria Tan, wildsingapore.com)

Stichodactis Kwietniewskii Lager, 1911: 247–248, fig. 22.
Macranthea cookei Verrill, 1928: 12–13, pl. 3, fig. A.

Material Examined. HOLOTYPES: *Stichodactis kwietniewskii*, ZMH-5342, Barrow I., WA. *Discosoma malu*, UMZ-Co206, Torres Strait. *Stichodactis glandulosa,* SMNH-667, Broome, WA. SYNTYPE: *Antheopsis concinnata*, ZMH-5318, Shark Bay, WA. OTHER MATERIAL: *Moreton Bay*. MTQ-G58749, Shag Rock, MM & CCW, 2005; MTQ-G59738, Shag Rock, G. Carini & I. Fellegara, 2005; MTQ-G59971, Shag Rock, M. Preker, 2005; MTQ-G59970, Flat Rock, I. Fellegara, 2005; MTQ-G59973, Henderson Rock, A.-N. Lörz, 2005; MTQ-G59972, Manta Ray Bombies, North Stradbroke I., G. Carini, 2005; QM-G309201, Days Gutter off Moreton I., AIMS/NCI, 1988. *Australia Elsewhere*. QM-G309350, Cockburn Sound, WA; WAM-23-76, Shark Bay, WA; WAM-26-76, Ningaloo, WA.

Appearance. Pedal disc thin-walled, colourless, mesenterial insertions seen as light radial lines. Column to 200 mm long; diameter increases distally; colour cream; verrucae adhesive. Fosse shallow. Oral disc brown, purple, or green, with white markings; flat in expansion, to 200 mm diameter, but smaller in Moreton Bay specimens. Mouth 10–20 mm long, slit-like to circular. Tentacles uniform size, evenly tapered from base or slightly wider in central region, to 40 mm long and 3 mm diameter when expanded; lower portion same colour as oral disc, upper portion light in some individuals, ringed with several broad white bands in others, or white in centre third and green at end; tip may be mauve or red; grey-green in contraction due to endodermal zooxanthellae.

Habitat. Reef environments, commonly burrowed into soft sediment.

Distribution. Indonesia; Papua New Guinea; Japan; Hawai'i; Australia from Broome to Point Peron in Western Australia, Torres Strait to Moreton Bay in Queensland. Type locality: Torres Strait, Australia.

Further literature. TAXONOMY & DISTRIBUTION: Dunn (1981); Fautin (1988); Fautin & Allen (1992); Uchida & Soyama (2001). BIOLOGY & ECOLOGY: Dunn (1981); Fautin (1991); den Hartog (1997b); Arvedlund *et al*. (1999); Astalhov (2002).

Heteractis crispa (Hemprich & Ehrenberg in Ehrenberg, 1834)
(Fig. 18)

Actinia crispa Hemprich & Ehrenberg in Ehrenberg, 1834: 260, pl. 8, fig. 1.
Actinia paumotensis Couthouy in Dana, 1846: 141, pl. 3, fig. 25.
Discosoma macrodactylum Haddon & Shackleton, 1893: 117, 120–121.
Radianthus Kükenthali Kwietniewski, 1896: 389–390.
Discosoma tuberculata Kwietniewski, 1898: 387, 412–413, pl. 28, figs 46–48.
Radianthus lobatus Kwietniewski, 1898: 387, 414–415, pl. 28, figs 38–40.

Material Examined. HOLOTYPE: *Radianthus lobatus*, PMJ-Coel69. LECTOTYPE: *Actinia paumotensis*, USNM-1690. SYNTYPES: *Discosoma macrodactylum*, UMZ [no catalogue number], 3 spec., Torres Strait. *Discosoma tuberculata*, PMJ-Coel65, 3 spec., SMNH-5881, Ambon. *Radianthus kükenthali,* SMF-101; SMNH-5686; MNB-3579; PMJ-Coel67; PMJ-Coel68. OTHER MATERIAL: *Moreton Bay*. MTQ-G59969, Flat Rock, M. Preker, 2005. *Australia Elsewhere*. QM- G309064, Big Broadhurst Reef, off Townsville, Qld; CAS-010397, Heron I., Qld.

Appearance. Column widens gradually from pedal disc, flared at oral end; texture leathery, grey, each prominent verruca with raised rim. Fosse shallow or absent. Expanded specimens about as long as oral disc diameter. Oral disc flat, to 500 mm diameter. Tentacles sinuous,

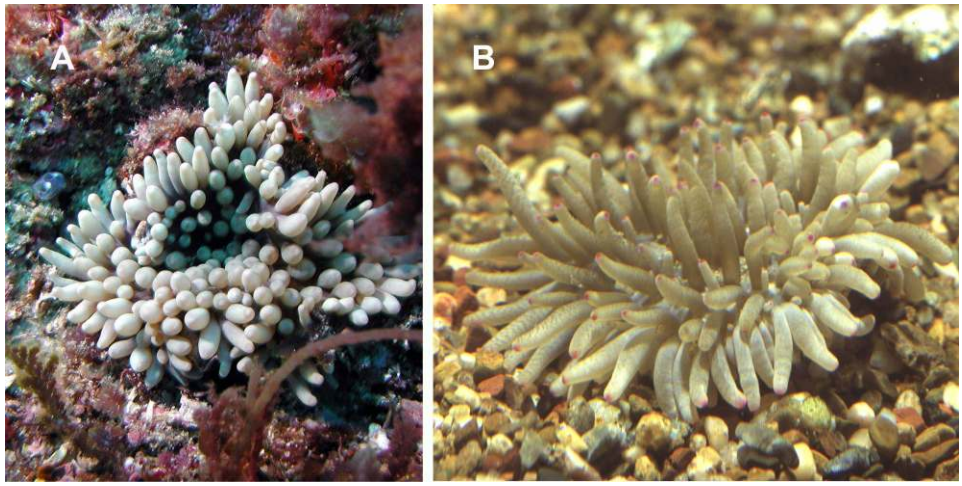

FIG. 17. *Heteractis malu*. **A,** individual *in situ* at Flat Rock, North Stradbroke I. (photograph: J. Hsieu). **B,** individual from Shag Rock, North Stradbroke I., MTQ-G58749, in aquarium, showing sturdy cylindrical tentacles arranged most densely around margin (photograph: G. Cranitch).

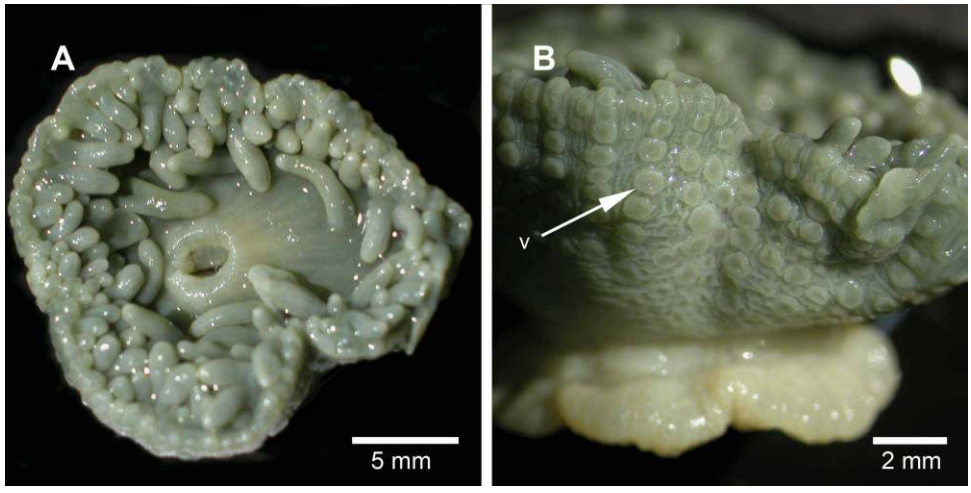

FIG. 18. *Heteractis crispa* from Flat Rock, North Stradbroke I., preserved juvenile specimen, MTQ-G59969. **A,** oral disc, showing tentacles concentrated around outer edge; **B,** side view of column, showing flaring upper section with conspicuous verrucae (v).

tapering to pointed tip; length generally a quarter to a third oral disc diameter, inner may be longer than outer; same colour as oral disc, some with pink, mauve, or blue tip. Mouth elongate. Actinopharynx white to yellow with two deep white siphonoglyphs. Base adherent, generally flat, rarely exceeding diameter of lower column.

Habitat. Reef environment. May be attached to branching coral, but column commonly buried in sediment with oral disc at surface.

Distribution. Red Sea; Seychelles; Micronesia; Melanesia; Japan; Australia northern and eastern coasts; French Polynesia. Type locality: Red Sea.

Comments. The leathery texture of the column is one of the distinguishing features of this species.

Further literature. TAXONOMY & DISTRIBUTION: Haddon & Shackleton (1893); Dunn (1981, 1985); Hirose (1985); Fautin (1988); Fautin & Allen (1992); den Hartog (1997a, b); Richardson *et al.* (1997); Paulay *et al.* (2003). BIOLOGY: Dunn (1981); Hirose (1985); Fautin (1991); Astalhov (2002); Hermansen *et al.* (2005); Scott & Harrison (2005).

DIADUMENIDAE

Diadumene Stephenson, 1920

Definition. Pedal disc well developed. Smooth column divisible into scapus and capitulum, separated by collar; scapus with cinclides. Margin of capitulum tentaculate. No distinct marginal sphincter muscle. Tentacles long, numerous, more or less regularly arranged, imperfectly or not at all retractile; some or all inner tentacles may form catch-tentacles; some outer tentacles with macrobasic amastigophores. Six or a few more perfect pairs of mesenteries; mesenteries more numerous distally than proximally; retractor muscles diffuse, more or less restricted. Perfect mesenteries and the stronger imperfect ones fertile. Parietobasilar and basilar muscles weak. Acontia well developed, with basitrichs and microbasic *p*-mastigophores. Cnidom: spirocysts, basitrichs, holotrichs, microbasic *p*-mastigophores, microbasic amastigophores, macrobasic amastigophores.

Type species: *Sagartia schilleriana* Stoliczka, 1869.

Diadumene sp.

(Fig. 19)

Material Examined. MTQ-G59437, 15 spec., Frenchman's Beach, North Stradbroke I., Moreton Bay, J. Phillips, 2005.

Appearance. Pedal disc diameter 1.2–2.8 mm. Column 1.0–4.4 mm long and 1.0–1.4 mm diameter, pale brown in life. Oral disc diameter 0.8–1.8 mm, darker brown centrally. Tentacles number 44–58; one specimen had a catch tentacle.

Habitat. Underside of rocks in the intertidal zone; one attached to algal frond.

HORMATHIIDAE

Calliactis Verrill, 1869

Definition. Pedal disc well developed. Column smooth, not differentiated or only slightly differentiated into scapus (often with a weak cuticle) and scapulus, often thick; some proximal cinclides do not pierce body wall. Radial muscles of oral disc more or less embedded in the mesogloea. Marginal sphincter muscle strong. Tentacles rather short, conical; more numerous than mesenteries at the base; longitudinal muscles ectodermal. Two broad siphonoglyphs. Six pairs of complete and sterile mesenteries, two pairs of directives; retractor muscles fairly weak, diffuse. Parietobasilar and basilar muscles weak or rather well developed. Often commensal with hermit crabs. Cnidom: spirocysts, basitrichs, microbasic *p*-mastigophores.

Type species: *Actinia decorata* Couthoy in Dana, 1846.

Calliactis polypus (Forsskål, 1775)

(Fig. 20)

Priapus polypus Forsskål, 1775: 102.
Actinia decorata Couthoy in Dana, 1846: 139–140, pl. 3, fig. 24.
Adamsia miriam Haddon & Shackleton, 1893: 117, 130–131.
Calliactis armillatas Verrill, 1928: 20–21, pl. 4B.
Calliactis valdiviae Carlgren, 1949: 97.

Material Examined. SYNTYPES: *Calliactis armillatas*, BPBM-D295, D299, D114, Hawai'i. OTHER MATERIAL: *Moreton Bay*. MTQ-G58757, Henderson Rock, C. Buxton & A.-N. Lörz, 2005.

Appearance. Pedal disc follows contour of gastropod shell to which it is attached; to 50 mm diameter. Column 7–14 mm long, maroon, divided into very short smooth scapulus and thicker-walled scapus; small tubercles near distal end; mesenterial insertions visible through column near limbus. Perforate cinclides on prominent white tubercles arranged in a single circle above base. Thin cuticle present, especially near base. Tentacles numerous, smooth, conical, inner longer than outer; occupy marginal third of oral disc. Oral disc flat, circular, diameter 7–20 mm; central mouth with two prominent siphonoglyphs.

Habitat. Attached to shell of hermit crab; may be more than one anemone per shell.

Distribution. Red Sea; Indian Ocean; tropical Pacific Ocean. Type locality: Ghomfodam, Red Sea.

Comments. Specimens in the Australian Museum not identified to species may belong to this species. England (1971) synonymised many species from throughout the Indo-Pacific because of considerable morphological overlap among them, but it is likely there is more than one species (Fautin *et al.*, 2007a).

Further literature. TAXONOMY & DISTRIBUTION: Carlgren (1938, 1950c); England (1971); Cutress (1977); Cutress & Arneson (1987); Pei (1996); den Hartog (1997a); Paulay *et al.* (2003). BIOLOGY: Reimer (1973).

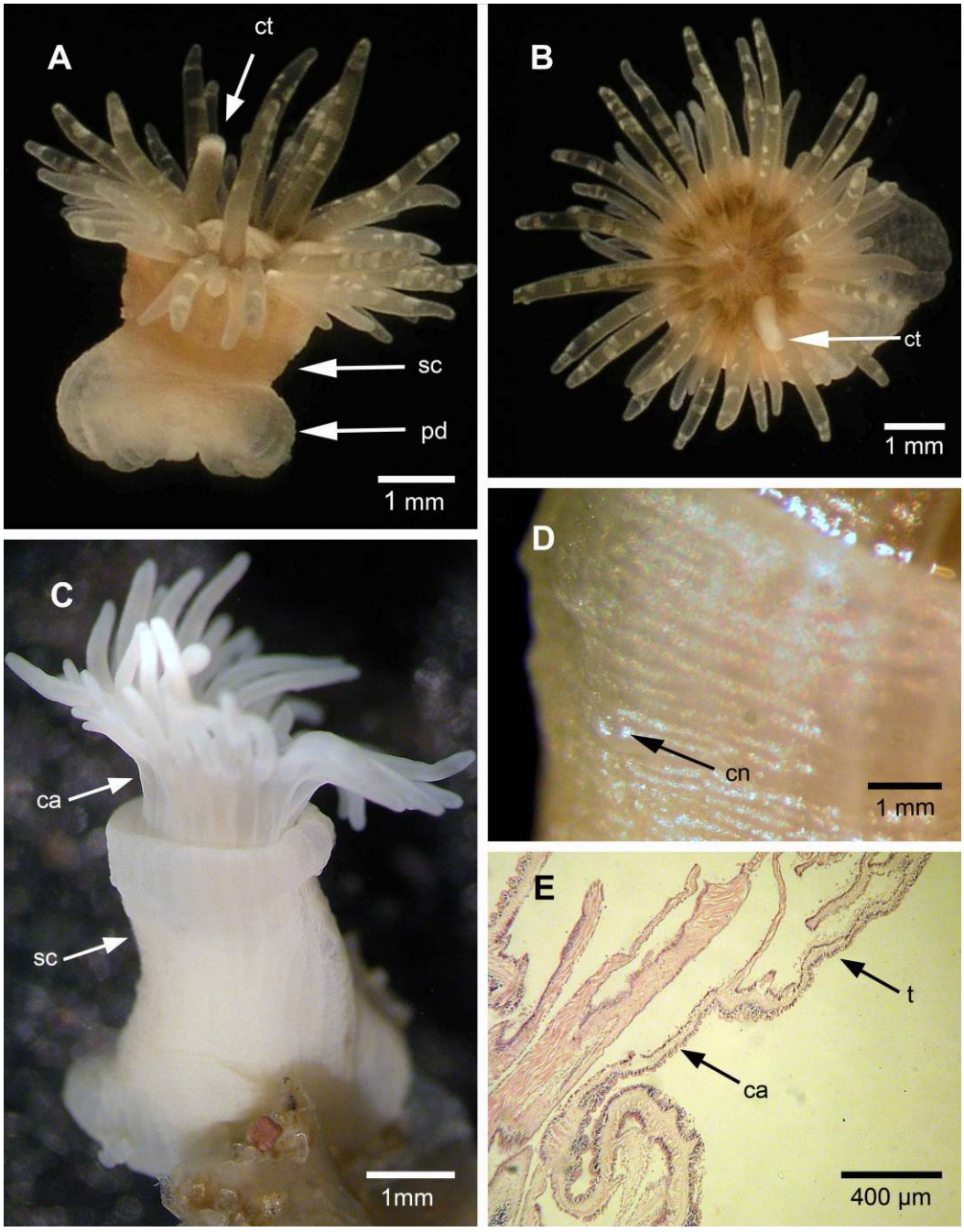

FIG. 19. *Diadumene* sp. from Frenchman's Beach, North Stradbroke I., MTQ-G59437. A-D whole specimen in the laboratory. **A,** showing pedal disc (pd) and scapus (sc) section of column without projections, and blunt catch tentacle (ct) among regular tentacles. **B,** oral disc showing the catch tentacle, which is opaque. **C,** specimen attached to algae, showing scapus (sc) and capitulum (ca) separated by collar. **D,** close-up of scapus at collar showing cinclide (cn). **E,** longitudinal section showing collar region, capitulum (ca), and tentacles (t).

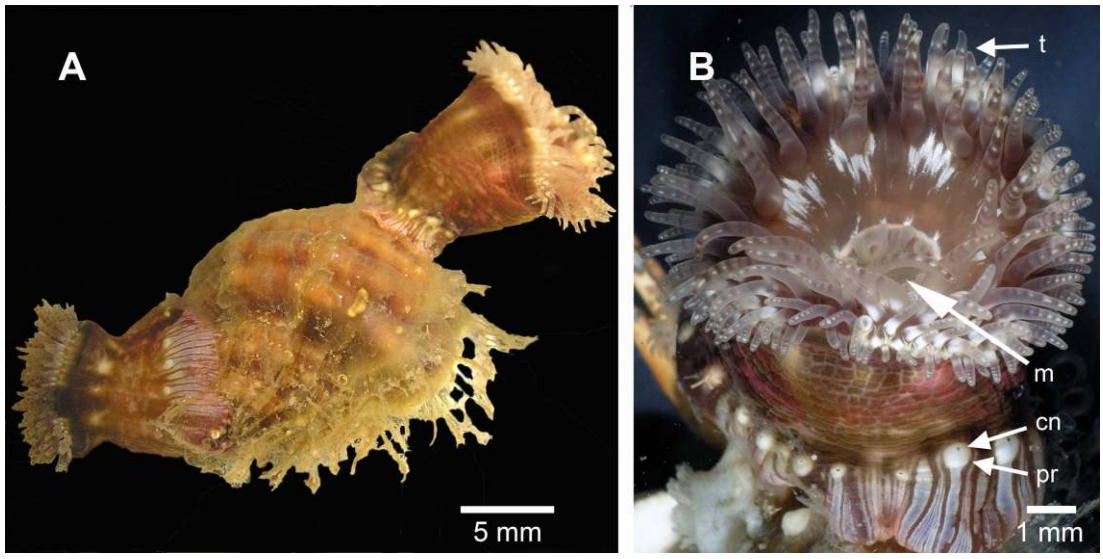

FIG. 20. *Calliactis polypus* from Henderson Rock, MTQ-G58757. **A,** two specimens on gastropod shell. **B,** detail of larger specimen, showing cinclides (cn) on white protuberances (pr), tentacles (t) and central mouth (m) (photograph: I. Lawn).

SAGARTIIDAE

Verrillactis England, 1971

Definition. Pedal disc well developed, adhesive. Column smooth or with ectodermal invaginations that do not pierce column wall; divisible into scapus and scapulus. Mesenteries arranged hexamerously or irregularly; number at base about twice that at margin; 6–12 pairs complete and sterile. One or two siphonoglyphs; may not be supported by directives. Mesogloeal marginal sphincter muscle strong. Inner tentacles longer than outer; some form catch tentacles bearing large holotrichs. Acontia with basitrichs and microbasic amastigophores. Symbiotic with hermit crabs, which are often associated also with *Calliactis polypus.* Cnidom: spirocysts, basitrichs, holotrichs, microbasic amastigophores, microbasic *p*-mastigophores.

Type species: *Sagartia paguri* Verrill, 1869.

Verrillactis paguri (Verrill, 1869) (Fig. 21)

Sagartia Paguri Verrill, 1869b: 57.

Material Examined. *Moreton Bay*. MTQ-G59434, Henderson Rock, C. Buxton & A.-N. Lörz, 2005.

Appearance. Pedal disc 20 mm x 18 mm, adherent to hermit crab shell. Column white; 3 mm long. Marginal sphincter muscle almost completely fills margin, tapers from ectodermal side proximally. Tentacles conical, smooth, inner longer and thicker than outer; no catch tentacles on Moreton Bay specimens.

Habitat. Lives along aperture of gastropod shell inhabited by hermit crab.

Distribution. Maldives; Taiwan Strait; Korea; Micronesia; eastern Australia; French Polynesia. Type locality: Taiwan Strait, Taiwan.

Comments. Moreton Bay specimens were attached to a shell inhabited by a hermit crab and to which specimens of *Calliactis polypus* were attached also; anemones of the two species occupied different parts of the shell.

Further literature. TAXONOMY & DISTRIBUTION: Verrill (1869b); McMurrich (1903); Carlgren (1949); England (1971, 1987); Cutress & Arneson (1987); Song (1992, 2000); den Hartog (1997a); Song & Lee (1998); Cha & Song (2001); Uchida & Soyama (2001).

ACKNOWLEDGEMENTS

We thank: the organisers and support team of the Moreton Bay International Marine Biological Workshop for facilitating this research; M. Mitchell for field and laboratory assistance at Moreton Bay and elsewhere in Australia; I. Lawn and M. Preker for specimens and photo-

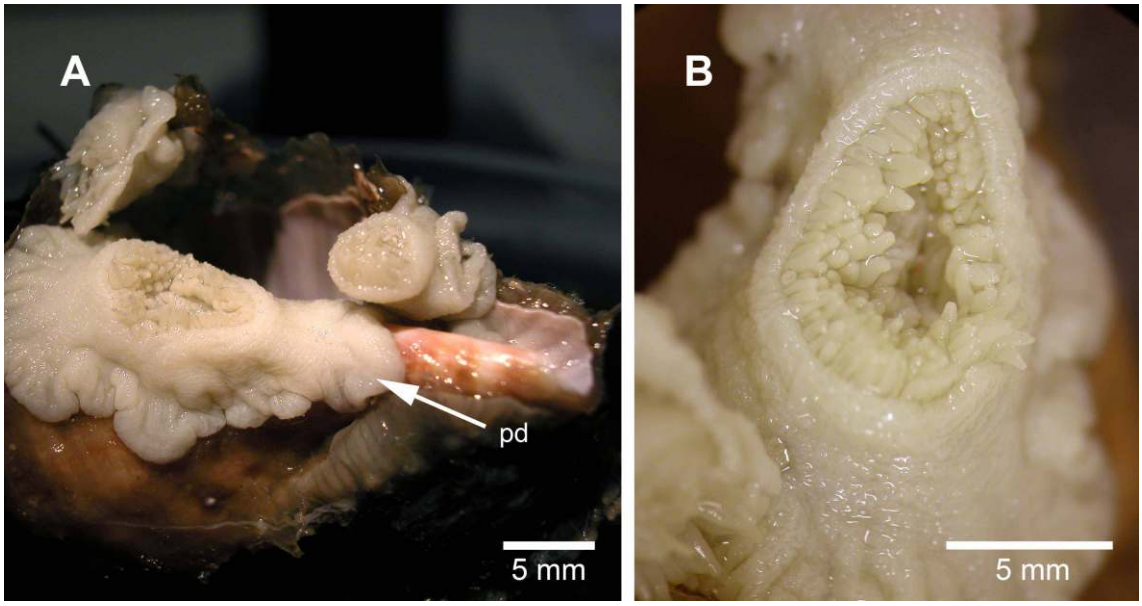

FIG. 21. *Verrillactis paguri* from Henderson Rock, MTQ-G59434. **A,** three specimens on gastropod shell occupied by hermit crab. Note expanded pedal disc (pd). **B,** oral disc and margin of largest specimen.

graphy; members of the three-day Anemone Identification Workshop for field assistance; directors and staff of Moreton Bay Research Station for hospitality and assistance; P. R. Muir for field photography and assistance; W. Napier for laboratory analyses, nematocyst counts, photography, and preparation of plates; E. Slaughter for Figure 1; D. Seabright for editing assistance; R. Springthorpe, K. Attwood, and staff and students of the Australian Museum; P. Alderslade and S. Horner from NTM, and B. and B. Koenecke for facilitating and assisting field research in Nhulunbuy (Gove), NT, and Reef HQ aquarium (Great Barrier Reef Marine Park Authority). This project was funded by grant no. 284-83 from the Australian Biological Resources Study (ABRS) to CCW and U.S. National Science Foundation grant DEB99-78106 (in the program Partnerships to Enhance Expertise in Taxonomy [PEET]) to DGF.

LITERATURE CITED

Acuña, F.H. & Zamponi, M.O. 1999. Estructura poblacional y ecología trófica de *Oulactis muscosa* Dana, 1849 (Actiniaria, Actiniidae) del Litoral Bonaerense (Argentina). *Physis* **57**: 11–16.

Arvedlund, M., McCormick, M.I., Fautin, D.G., & Bildsøe, M. 1999. Host recognition and possible imprinting in the anemonefish *Amphiprion melanopus* (Pisces: Pomocentridae). *Marine Ecology Progress Series* **188**: 207–218.

Astalhov, D.A. 2002. Species composition of anemonefishes (Perciformes, Pomacentridae) and their host sea anemones (Cnidaria, Actiniaria) in the Khanhhoa Province (South Vietnam). *Journal of Ichthyology* **42**: 37–50.

Ayre, D.J. 1983. The effects of asexual reproduction and inter-genotypic aggression on the genotypic structure of populations of the sea anemone *Actinia tenebrosa*. *Oecologia* **57**: 158–165.

1984. The sea anemone *Actinia tenebrosa*: an opportunisitic insectivore. *Ophelia* **23**: 149–153.

1995. Localized adaptation of sea anemone clones: evidence from transplantation over two spatial scales. *Journal of Animal Ecology* **64**: 186–196.

Ayre, D.J., Read, J. & Wishart, J. 1991. Genetic subdivision within the eastern Australian population of the sea anemone *Actinia tenebrosa*. *Marine Biology* **109**: 379–390.

Bennett, I. 1987. *W. J. Dakin's Classic Study Australian Seashores*. (Angus and Robertson: Sydney). 411 pp.

Black, R. & Johnson, M.S. 1979. Asexual viviparity and population genetics of *Actinia tenebrosa*. *Marine Biology* **53**: 27–31.

Blackburn, M. 1937. Coelenterata *in* Reports of McCoy Society for Field Investigation and Research. No. 1. Lady Julia Percy Island 1935 Expedition. *Proceedings of the Royal Society of Victoria* **49**: 364–371.

Boveri, T. 1893. Das Genus *Gyractis*, eine radialsymmetrische Actinienform. *Zoologische Jahrbücher Abteilung für Systematik, Geographie und Biologie der Thiere* **7**: 241–253.

Brandt, J.F. 1835. *Prodromus Descriptionis Animalium ab H. Mertensio in Orbis Terrarum Circumnavigatione Observatorum* ***1****. Polypos, acalephas discophoras et siphonophoras, nec non echinodermata continens.* (Sumptibus Academiae: Petropoli).

Carlgren, O. 1899. Über abschnürbare Tentakel bei den Actiniarien. *Zoologischer Anzeiger* **22**: 39–44.

1900. Ostafrikanische Actinien. Gesammelt von Herrn Dr. F. Stuhlmann 1888 und 1889. *Mittheilungen aus dem Naturhistorischen Museum* **17**: 21–144.

1922. Actiniaria und Zoantharia von Juan Fernandez und der Osterinsel. Pp. 145–160. *In*, Skottsberg, C. (Ed.), *The Natural History of Juan Fernandez and Easter Island*, Vol. 3(2). (Almquist & Wiksells Boktryckeri-A.-B.: Uppsala).

1924a. On *Boloceroides, Bunodeopsis* and their supposed allied genera. *Arkiv för Zoologi* **17A**(1): 1–20.

1924b. Actiniaria from New Zealand and its Subantartic Islands. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening* **77**: 179–261.

1938. South African Actiniaria and Zoantharia. *Kungliga Svenska Vetenskapsakademiens Handlingar, Ser. 3,* **17**: 1–148.

1949. A survey of the Ptychodactiaria, Corallimorpharia and Actiniaria. *Kungliga Svenska Vetenskapsakademiens Handlingar*, *Ser. 4*, **1**: 1–121.

1950a. Corallimorpharia, Actiniaria and Zoantharia from New South Wales and South Queensland. *Arkiv för Zoologi* **10**: 131–146.

1950b. Actiniaria and Zoantharia from South Australia. *Kungliga Fysiografiska Sallskapets i Lund Förhandlingar* **20**: 121–135.

1950c. Actiniaria and Corallimorpharia. *Great Barrier Reef Expedition 1928–29 Scientific Reports* **5**: 427–457.

1954. Actiniaria and Zoantharia from South and West Australia with comments upon some Actiniaria from New Zealand. *Arkiv för Zoologi* **34**: 571–595.

Cha, H.-R. & Song, J.-I. 2001. Taxonomy of two subtribes, Mesomyaria and Acontiaria (Anthozoa, Actiniaria) in Korea. *Korean Journal of Systematic Zoology* **17**: 91–113.

Cutress, C.E. 1971. Corallimorpharia, Actiniaria and Zoanthidea. *Memoirs of the National Museum of Victoria (Melbourne)* **32**: 83–92.

1977. Corallimorpharia, Actiniaria, Ceriantharia. Pp. 130–147. *In*, Devaney, D.M. & Eldredge, L.G. (Eds), *Reef and Shore Fauna of Hawaii*. (Bishop Museum Press: Honolulu).

Cutress, C.E. & Arneson, A.C. 1987. Sea anemones of Enewetak Atoll. Pp. 53–62. *In*, Devaney, D.M., Reese, E.S., Burch, B.L. & Helfrich, P. (Eds), *The Natural History of Enewetak Atoll. Vol. 2: Biogeography and Systematics.* (Office of Scientific and Technical Information, US Department of Energy).

Dana, J.D. 1846. Zoophytes. United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842. Under the Command of Charles Wilkes, U. S. N. (Lea and Blanchard: Philadelphia).

Davie, P. (and other authors) 1998. *Wild Guide to Moreton Bay*. (Queensland Museum: Brisbane).

Davie, P.J.F. & Hooper, J.N.A. (1998). Patterns of biodiversity in marine invertebrate and fish communities of Moreton Bay. Pp. 331–346. *In*, Tibbetts, I.R., Hall, N.J. & Dennison, W.C. (Eds), *Moreton Bay and Catchment*. (School of Marine Science, The University of Queensland: Brisbane).

Dawson, E.W. 1992. The Coelenterata of the New Zealand region: a handlist for curators, students and ecologists. *Occasional Papers of the Hutton Foundation* **1**: 1–68.

den Hartog, J.C. 1997a. The sea anemone fauna of Indonesian coral reefs. Pp. 351–370. *In*, Tomascik, T., Mah, A.J., Nontji, A. & Moosa, M.K. (Eds), *The Ecology of the Indonesian Seas*. (Periplus Editions: Republic of Singapore).

1997b. Notes on the genus *Amphiprion* Bloch & Schneider, 1801 (Teleostei: Pomacentridae) and its host sea anemones in the Seychelles. *Zoologische Mededelingen* **71**: 181–188.

den Hartog, J.C. & Vennam, J. 1993. Some Actiniaria (Cnidaria: Anthozoa) from the west coast of India. *Zoologische Mededelingen* **67**: 601–637.

Dennison W.C. & Abal, E.G. 1999. *Moreton Bay Study. A Scientific Basis for the Healthy Waterways Campaign*. (South East Queensland Regional Water Quality Management Strategy: Brisbane).

Doumenc, D. 1973. Notes sur les actinies de Polynésie Française. *Cahiers du Pacifique* **17**: 173–204.

Duchassaing de Fonbressin, P. & Michelotti, G. 1860. *Mémoire sur les Coralliaires des Antilles*. (Imprimerie Royale: Turin).

Dunn, D.F. 1974. *Actiniogeton sesere* (Coelenterata, Actiniaria) in Hawaii. *Pacific Science* **28**: 181–188.

1978. *Anthopleura handi* n. sp. (Coelenterata, Actiniaria), an internally brooding, intertidal sea anemone from Malaysia. *Wasmann Journal of Biology* **35**: 54–64.

1981. The clownfish sea anemones: Stichodactylidae (Coelenterata: Actiniaria) and other sea anemones symbiotic with pomacentrid fishes. *Transactions of the American Philosophical Society* **71**: 1–115.

1982. Zoantharia: Actiniaria. Pp. 693–699. *In*, Parker, S.P. (Ed.), *Synopsis and Classification of Living Organisms*. (McGraw-Hill Book Company: New York).

1985. Sea anemones that harbor symbiotic pomacentrid fishes in the western Pacific. *National Geographic Society Research Reports* **18**: 279–283.

Edgar, G.J. 1997. *Australian Marine Life: the Plants and Animals of Temperate Waters*. (Reed Books: Kew).

Edmands, S. & Fautin, D.G. 1991. Redescription of *Aulactinia veratra* n. comb. (=*Cnidopus veratra*) (Coelenterata: Actiniaria) from Australia. *Records of the Western Australian Museum* **15**: 59–68.

Ehrenberg, C.G. 1834. Beiträge zur physiologischen Kenntniss der Corallenthiere im allgemeinen, und besonders des rothen Meeres, nebst einem Versuche zur physiologischen Systematik derselben. *Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin* **1**: 225–380.

England, K.W. 1971. Actiniaria from Mururoa Atoll Tuamotu, Polynesia (Hormathiidae; *Calliactis polypus* Sagartiidae: *Verrillactis* n. gen. *paguri*). *Cahiers du Pacifique* **15**: 23–40.

1987. Certain Actiniaria (Cnidaria, Anthozoa) from the Red Sea and tropical Indo-Pacific Ocean. *Bulletin of the British Museum (Natural History)* **53**: 205–292.

Erhardt, H. & Knop, D. 2005. *Corals: Indo-Pacific Field Guide*. (IKAN-Unterwassararchiv: Frankfurt).

Farquhar, H. 1898. Preliminary account of some New-Zealand Actiniaria. *Journal of the Linnean Society, Zoology* **26**: 527–536.

Fautin, D.G. 1985. Competition by anemone fishes for host actinians. *Proceedings of the Fifth International Coral Reef Congress* **5**: 373–377.

1986. Why do anemonefishes inhabit only some host actinians? *Environmental Biology of Fishes* **15**: 171–180.

1988. Sea anemones (Actiniaria and Corallimorpharia) of Madang Province. *Science in New Guinea* **14**: 22–29.

1991. The anemonefish symbiosis: What is known and what is not. *Symbiosis* **10**: 23–46.

2005. Three species of intertidal sea anemones (Anthozoa: Actiniidae) from the tropical Pacific: description of *Anthopleura buddemeieri* n. sp., with remarks on *Anthopleura asiatica* and *Gyractis sesere*. *Pacific Science* **59**: 379–391.

2008. Hexacorallians of the World. Available from: http://hercules.kgs.ku.edu/hexacoral/anemone2/order.cfm.

Fautin, D.G. & Allen, G.R. 1992. *Field Guide to Anemonefishes and their Host Sea Anemones*. (Western Australian Museum: Perth).

Fautin, D.G. & Mariscal, R.N. 1991. Cnidaria: Anthozoa. Pp. 267–358. *In*, Harrison, F.G. & Westfall, J.A. (Eds), *Microscopic Anatomy of Invertebrates*, Vol. 2 (Wiley-Liss: New York City).

Fautin, D.G., Hickman, C.P. Jr., Daly, M. & Molodtsova, T. 2007a. Shallow-water sea anemones (Cnidaria: Anthozoa: Actiniaria) and tube anemones (Cnidaria: Anthozoa: Ceriantharia) of the Galápagos Islands. *Pacific Science* **61**: 549–573.

Fautin, D.G., Zelenchuk, T. & Raveendran, D. 2007b. Genera of orders Actiniaria and Corallimorpharia (Cnidaria, Anthozoa, Hexacorallia), and their type species. *In*, Zhang, Z.-Q. & Shear, W.A. (Eds), Linnaeus Tercentenary: Progress in Invertebrate Taxonomy. *Zootaxa* **1668**: 183–244.

Fishelson, L. 1970. Littoral fauna of the Red Sea: the population of non-scleractinian anthozoans of shallow waters of the Red Sea (Eilat). *Marine Biology* **6**: 106–116.

Forsskål, P. 1775. *Descriptiones Animalium Avium, Amphibiorum, Piscium, Insectorum, Vermium; Quae in Itinere Orientali Observait*. (Mölleri: Havniæ).

Haddon, A.C. 1898. The Actiniaria of Torres Straits. *Scientific Transactions of the Royal Dublin Society* **6**: 393–520.

Haddon, A.C. & Shackelton, A.M. 1893. Description of some new species of Actiniaria from Torres Straits. *Scientific Transactions of the Royal Dublin Society* **8**: 116–131.

Hadley, D.J. 1973. Ecological studies on relationships between the anemone *Stoichactis haddoni* (Saville-Kent) and its animal symbionts. Unpubl. M. Sc. Thesis (University of Queensland: Brisbane).

Haeckel, E. 1876. Arabische Korallen. (Georg Reimer: Berlin).

Harrison, P.L., Harriott, V.J., Banks, S.A. & Holmes, N.J. 1998. The coral communities of Flinders Reef and Myora Reef in the Moreton Bay Marine Park, Queensland, Australia. Pp. 525–536. *In*, Tibbetts, I.R., Hall, N.J. & Dennison, W.C. (Eds), *Moreton Bay and Catchment*. (School of Marine Science, The University of Queensland: Brisbane).

Häussermann, V. 2003. Redescription of *Oulactis concinnata* (Drayton in Dana, 1846) (Cnidaria: Anthozoa: Actiniidae), an actiniid sea anemone from Chile and Perú with special fighting tentacles; with a preliminary revision of the genera with a "frond-like" marginal ruff. *Zoologische Verhandelingen* **345**: 173–207.

Hermansen, T.D., Arvedlund, M. & Fiedler, G.C. 2005. Calcium antagonists inhibit the discharge of cnidae in response to electrical stimulation in the giant tropical sea anemone *Heteractis crispa* Ehrenberger (Anthozoa). *Marine and Freshwater Behaviour and Physiology* **38**: 269–274.

Hirose, Y. 1985. Habitat, distribution and abundance of coral reef sea-anemones (Actiniidae and

Stichodactylidae) in Sesoko Island, Okinawa, with notes on expansion and contraction behavior. *Galaxea* **4**: 113–127.

Hunt, A. & Ayre, D.J. 1989. Population structure in the sexually reproducing sea anemone *Oulactis muscosa*. *Marine Biology* **102**: 537–544.

Hutton, F.W. 1878. The sea anemones of New Zealand. *Transactions and Proceedings of the New Zealand Institute* **11**: 308–314.

Karplus, I., Fiedler, G.C. & Ramcharan, P. 1998. The intraspecific fighting behaviour of the Hawaiian boxer crab, *Lybia edmondsoni*—fighting with dangerous weapons? *Symbiosis* **24**: 287–302.

Khan, R.N., Becker, J.H.A., Crowther, A.L. & Lawn, I.D. 2003. Sea anemone host selection by the symbiotic saddled cleaner shrimp *Periclimenes holthuisi*. *Marine and Freshwater Research* **54**: 653–656.

2004. Spatial distribution of symbiotic shrimps (*Periclimenes holthuisi, P. brevicarpalis, Thor amboinensis*) on the sea anemone *Stichodactyla haddoni*. *Journal of the Marine Biological Association of the United Kingdom* **84**: 201–203.

Klunzinger, C.B. 1877. *Die Korallthiere des rothen Meeres. Erster Theil: Die Alcyonarien und Malacodermen.* (Verlag der Gutmann'schen Buchhandlung: Berlin).

Kwietniewski, C.R. 1896. Actiniaria von Ternate, nach den Sammlungen von Herrn Prof. Dr. W. Kükenthal. *Zoologischer Anzeiger* **19**: 388–391.

1897. *Ein Beitrag zur Anatomie und Systematik der Actiniarien*. (Universität Jena: Jena).

1898. Actiniaria von Ambon und Thursday Island. Pp. 385–430. *In*, Semon, R. *Zoologische Forschungsreisen in Australien und dem Malayischen Archipel* (Gustav Fischer: Jena).

Lager, E. 1911. Actiniaria. *Die Fauna Südwest--Australiens. Ergebnisse der Hamburger südwest--australischen Forschungsreise 1905*. Vol. 3 (8). (Gustav Fischer: Jena).

Lawn, I.D. & Ross, D.M. 1982. The behavioural physiology of the swimming sea anemone *Boloceroides mcmurrichi*. *Proceedings of the Royal Society of London B* **216**: 315–334.

Linnaeus, C. 1758. *Systema Naturæ. Regnum Animale*. 10th Edition. (Cura Societatis Zoologiæ Germaniæ: Lipsiæ).

1767. *Systema Naturæ*. 12th Edition. (Laurenti Salvii: Holmiae).

Lovell, E.R. 1989. Coral assemblages of Moreton Bay, Queensland, Australia, before and after a major flood. *Memoirs of the Queensland Museum* **27**: 535–550.

McMurrich, J.P. 1903. Note on the sea anemone, *Sagartia paguri* Verrill. *Proceedings of the United States National Museum* **26**: 427–428.

Milne Edwards, H. 1857. *Histoire Naturelle des Coralliaires ou Polypes Proprement Dits*, Vol. 1. (Librairie Encyclopédique de Roret: Paris).

Milne Edwards, H. & Haime, J. 1851. Monographie des polypiers fossiles. *Archives du Muséum d'Histoire Naturelle* (Gide et J. Baudry: Paris).

Moyer, J.T. 1976. Geographical variation and social dominance in Japanese populations of the anemonefish *Amphiprion clarkii*. *Japanese Journal of Ichthyology* **23**: 12–22.

Ottaway, J.R. 1973. Some effects of temperature, desiccation, and light on the intertidal anemone *Actinia tenebrosa* Farquhar (Cnidaria: Anthozoa). *Australian Journal of Marine and Freshwater Research* **24**: 103–126.

1975. Review of *Actinia*, *Isactinia*, and *Cnidopus* (Cnidaria: Anthozoa) in New Zealand. *New Zealand Journal of Marine and Freshwater Research* **9**: 53–61.

1979a. Population ecology of the intertidal anemone *Actinia tenebrosa*. II. Geographical distribution, synonymy, reproductive cycle and fecundity. *Australian Journal of Zoology* **27**: 273–290.

1979b. Population ecology of the intertidal anemone *Actinia tenebrosa*. III. Dynamics and environmental factors. *Australian Journal of Marine and Freshwater Research* **30**: 41–62.

Parry, G. 1951. The Actiniaria of New Zealand, a check-list of recorded and new species, a review of the literature and a key to the commoner forms Part 1. *Records of the Canterbury Museum* **6**: 83–119.

Paulay, G., Puglisi, M.P. & Starmer, J.A. 2003. The non-scleractinian Anthozoa (Cnidaria) of the Mariana Islands. *Micronesica* **35/36**: 138–155.

Pei, Z. 1996. Three new species of the genus *Calliactis*. *Studia Marina Sinica* **37**: 177–187.

Quoy, J.R.C. & Gaimard, P. 1833. Voyage de Découvertes de l'Astrolabe Exécuté par Ordre du Roi, Pendant les Années 1826–1827–1828–1829, Sous le Commandement de M J Dumont D'Urville. (J. Tastu: Paris).

Reimer, A.A. 1973. Feeding behavior in the sea anemone *Calliactis polypus* (Forskål, 1775). *Comparative Biochemistry and Physiology* **44A**: 1289– 1301.

Richardson, D.L., Harriott, V.J. & Harrison, P.L. 1997. Distribution and abundance of giant sea anemones (Actiniaria) in subtropical eastern Australian waters. *Marine and Freshwater Research* **48**: 59–66.

Rüppell, E. & Leuckart, F.S. 1828. *Atlas zu der Reise im Nördlichen Afrika von Eduard Rüppell, Neue Wirbellose Thiere des Rothen Meers*. (Heinr. Ludw. Brőnner: Frankfurt am Main).

Saville-Kent, W. 1893. *The Great Barrier Reef of Australia; its Products and Potentialities*. (W.H. Allen & Co: Waterloo Place, London).

Scott, A. & Harrison, P.L. 2005. Synchronous spawning of host sea anemones. *Coral Reefs* **24**: 208.

Sherman, C.D.H. & Ayre, D.J. 2008. Fine-scale adaptation in a clonal sea anemone. *Evolution* **62**: 1373–80.

Song, J.-I. 1992. Systematic study on Anthozoa from the Korea Strait in Korea: subclasses Zoantharia and Ceriantipatharia. *Korean Journal of Systematic Zoology* **8**: 259–278.

2000. *Cnidaria 2: Anthozoa*. Vol. 5. (Korea Institute of Bioscience and Biotechnology: Seoul).

Song, J.-I. & Cha, H.-R. 2004. Three new records of Actiniaria (Anthozoa: Zoantharia) from Korea. *Korean Journal of Systematic Zoology* **20**: 201–214.

Song, J.-I. & Lee, I.S. 1998. Fauna of the anthozoans from adjacent waters of Geojedo Island in Korea. *Korean Journal of Systematic Zoology* **14**: 229–242.

Srinivasan, M., Jones, G.P. & Caley, M.J. 1999. Experimental evaluation of the roles of habitat selection and interspecific competition in determining patterns of host use by two anemonefishes. *Marine Ecology Progress Series* **186**: 283–292.

Stephenson, T.A. 1920. On the classification of Actiniaria. Part I — Forms with acontia and forms with a mesogloeal sphincter. *Quarterly Journal of Microscopical Science* **64**: 425–574.

1922. On the classification of Actiniaria. Part III — Definitions connected with the forms dealt with in Part II. *Quarterly Journal of Microscopical Science* **66**: 247–319.

Stoliczka, F. 1869. On the anatomy of *Sagartia schilleriana* and *Membranipora bengalensis*, a new coral and a bryozoon living in brackish water at Port Canning. *Journal of the Asiatic Society of Bengal* **38**: 28–63.

Stuckey, F.G.A. 1909. A review of the New Zealand Actiniaria known to science, together with a description of twelve new species. *Transactions of the New Zealand Institute* **41**: 374–398.

Stuckey, F.G.A. & Walton, C.L. 1910. Notes on a collection of sea anemones. *Transactions of the New Zealand Institute* **42**: 541–543.

Tangney, B., McCloskey, B. & Crowther, A.L. 2007. Interactive Glossary of Actinarian (Sea Anemone) Anatomical Terms Available from: http://darwin.nhm.ku.edu/inverts/InterGlossary/intro.html

Tibbetts, I.R., Hall, N.J. & Dennison, W.C. (Eds) 1998. *Moreton Bay and Catchment*. (School of Marine Science, The University of Queensland: Brisbane).

Uchida, H. & Soyama, I. 2001. *Sea Anemones in Japanese Waters*. (TBS: Japan).

Verrill, A.E. 1864. Revision of the polypi of the eastern coast of the United States. *Memoirs of the Boston Society of Natural History* **1**: 1–45.

1869a. Review of the corals and polyps of the west coast of America. *Transactions of the Connecticut Academy of Arts and Sciences* **1**: 377–567.

1869b. Synopsis of the polyps and corals of the North Pacific Exploring Expedition, under Commodore Ringgold, C. & Capt. Rodgers, J. U.S.N., from 1853 to 1856. Collected by Dr. W. Stimpson, Naturalist to the Expedition. *Communications of the Essex Institute* **6**: 51–104.

1928. Hawaiian shallow water Anthozoa. *Bernice P. Bishop Museum Bulletin* **49**: 3–30.

Wolstenholme, J.K. & Wallace, C.C. 2004. Australian anemones final report accompanied by attribution database of Australian anemones on CD. Unpublished report to the Department of Environment and Heritage. (Museum of Tropical Queensland: Townsville).

Zabin, C.J., Carlton, J.T. & Godwin, L.S. 2004. First report of the Asian sea anemone *Diadumene lineata* from the Hawaiian Islands. *Bishop Museum Occasional Papers* **79**: 54–58.