

Species richness, endemism and distribution patterns of South African sea anemones (Cnidaria: Actiniaria & Corallimorpharia)

Fabian H. Acuña¹ & Charles L. Griffiths^{2*}

¹Departamento de Ciencias Marinas, FCEyN, Universidad Nacional de Mar del Plata. Funes 3250, 7600 Mar del Plata, Argentina

²Marine Biology Research Institute, University of Cape Town, Rondebosch, 7700 South Africa

Received 1 August 2002. Accepted 16 October 2003

A revised and updated list of South African sea anemones is compiled and the distribution pattern and endemism of each determined from museum and literature records. Forty-nine valid species are recognized. Species richness appears fairly uniform around the coast, although marked peaks occur at Cape Town, False Bay and Durban – almost certainly the result of disproportionately intense sampling effort at these locations. Forty-nine per cent of species are endemic, slightly above the average for the South African marine fauna (31%), but well within the range shown by component taxa. Endemics are absent in the northwest, but otherwise comprise a fairly consistent proportion of species in each region. The fact that existing records are strongly biased towards a few centres of high sampling activity, indicates a pressing need for additional systematic collection of this group in under-represented areas.

Key words: distribution, sea anemones, biodiversity, biogeography.

INTRODUCTION

South Africa's marine fauna comprises over 11 000 described species, more than 31% of which are endemic (Gibbons *et al.* 1999). This high species richness may largely be attributed to the habitat diversity of the region, which incorporates cool-temperate, warm-temperate and subtropical zoogeographic provinces (Williams 1990; Emanuel *et al.* 1992). Despite this diversity, many taxonomic groups remain poorly described (Gibbons *et al.* 1999); indeed some have not been studied for over 50 years. This patchy taxonomic knowledge precludes accurate overall evaluation of the regional fauna and limits the potential for global comparisons.

Much attention has also been focused on documenting the biogeographical distribution patterns of various marine invertebrate taxa in South Africa (e.g. Day 1967a,b, 1974; Millard 1975; Clark & Courtman-Stock 1976; Griffiths 1976; Kensley 1978, 1981; Gosliner 1987; Williams 1992a,b; Monniot *et al.* 2001). These distribution patterns are summarized by Awad *et al.* (2002) and exhibit a variety of forms. Many groups show increasing species richness around the coast from west to east, but in several other groups diversity peaks in the Western Cape. Endemism rates are also

extremely variable, ranging from as low as 19% in echinoderms to 84% in isopods. In geographical terms, numbers of endemic species generally peak along the south coast, as might be expected, as this region is the farthest from the political boundaries of the country (i.e. for species of any given distribution of ranges a declining proportion of those ranges will cross the border as one moved further from it) (Awad *et al.* 2002).

The sea anemone fauna of South Africa is one of the groups that remain poorly studied, both in terms of species richness and distributional pattern. The first sea anemones reported from South Africa were by Lesson (1830), who described two species from the 'Cape of Good Hope'. Shortly thereafter Quoy & Gaimard (1833) gave a short description of another species from the same locality, while Milne-Edwards (1857) added a record for *Cystiactis reynaudi* (now *Bunodactis reynaudi*). Additional species were recorded by Verrill (1865, 1867, 1868) and Studer (1878). The Challenger expedition, which dredged numerous invertebrates new to science from off the Cape Peninsula, obtained only four sea anemones in this area, most of which were incorrectly determined by Hertwig (1882, 1888). Further contributions include a series of papers by Pax (1908, 1909, 1914, 1920, 1922, 1924, 1926), but his determinations are usually quite unreliable. Sea anemones from the German

*Author for correspondence. E-mail griffith@egs.uct.ac.za

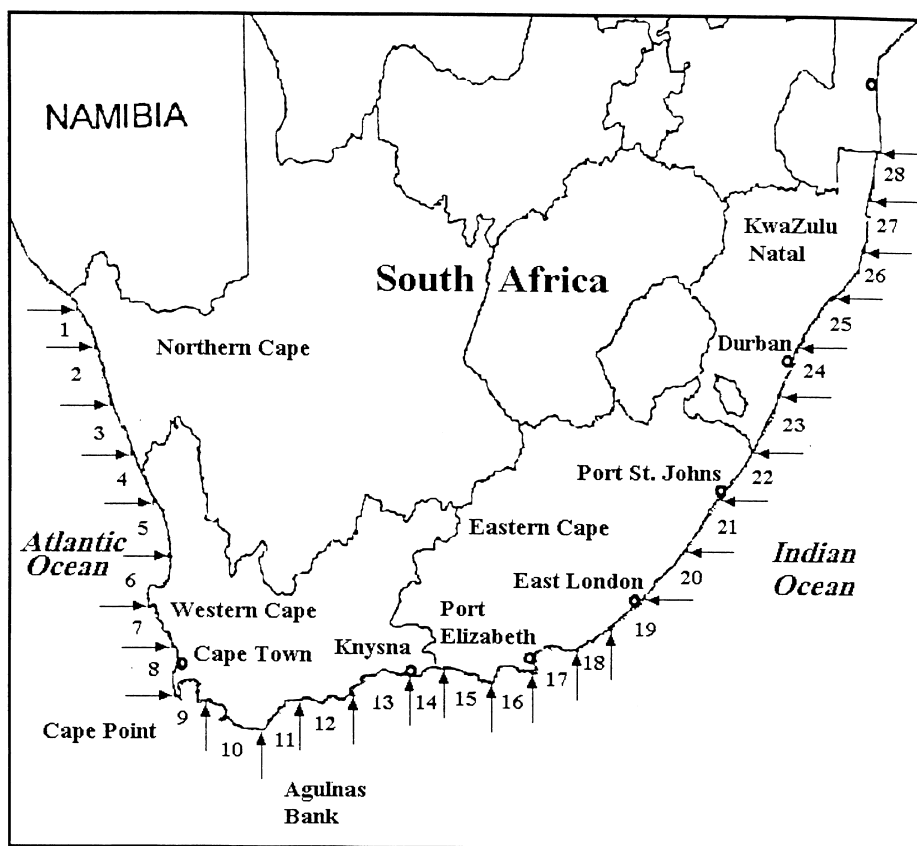


Fig. 1. Map of South Africa showing the twenty-eight 100-km units used in the analysis.

Deep-Sea Expedition of 1898/99 were reported on by Carlgren (1923, 1924, 1928). This author subsequently published a comprehensive study of South African Actiniaria and Zoantharia (Carlgren 1938), which, with an additional paper in 1940, remain the key references to the regional fauna. The last half-century and more has seen only a few minor further contributions by England & Robson (1984), Griffiths *et al.* (1996), Riemann-Zürneck & Griffiths (1999).

The present work has two aims. The first is to revise and update Carlgren's faunal list, now over 60 years old, and produce a current and taxonomically correct list of known anemone species from the region. We hope this will both add to the growing documentation of marine biodiversity of South Africa and act as an accessible reference source. The second aim is to examine biogeographic trends in species richness and endemism within the South African anemone fauna, so that these can be compared with similar published trends for other groups.

METHODS

The term 'sea anemones' is the common name for cnidarians belonging to the orders Actiniaria and Corallimorpharia and these are the groups covered here. Note that lately the status of the order Ptychodactiaria has been modified and they are now included as a suborder of the Actiniaria (Cappola & Fautin 2000). Taxonomic records were extracted from existing literature, as listed above, unpublished records from the collections of the Iziko Museums (formerly the South African Museum) in Cape Town and a limited amount of direct collecting in the Western Cape Province. The distribution patterns and endemism status of each species were also determined from these sources. Current classification of sea anemones, and information about the taxonomic status of some species, was taken from the electronic database 'Sea Anemones of the World' (Fautin 2002).

In order to standardize and display distribution patterns, the coastline was divided into twenty-eight 100 km units (Fig. 1). The presence or

Table 1. Classification and distribution of South African sea anemones.

Species classification	Previous name in South Africa	Range and distribution
ORDER ACTINIARIA		
SUBORDER ENDOCOELANTHEAE		
Family Halcuriidae		
<i>Halcurias capensis</i> Carlgren, 1928	–	Cape Town. Endemic
SUBORDER NYANTHEAE		
TRIBE (informal) ATHENARIA		
Family Edwardsiidae		
<i>Edwardsia capensis</i> Carlgren, 1938	–	False Bay. Endemic
Family Halcampidae		
<i>Halcampa capensis</i> Carlgren, 1938	–	False Bay. Endemic
<i>Halcampaster teres</i> Carlgren, 1938	–	East London. Endemic
<i>Halianthella annularis</i> Carlgren, 1938	–	Lamberts Bay to Kommetje. Endemic
Family Haloclavidae		
<i>Haloclava capensis</i> (Verrill, 1865)	<i>Eloactis brevicornis</i>	Simons Bay. Endemic
<i>Haloclava brevicornis</i> (Stimpson, 1856)	<i>Eloactis brevicornis</i>	False Bay. Outside South Africa: China.
TRIBE (informal) THENARIA		
SUBTRIBE (informal) ACONTIARIA		
Family Acontiphoridae		
<i>Acontiphorum mortenseni</i> Carlgren, 1938	–	Agulhas Bank. Endemic
Family Aiptasiidae		
<i>Aiptasia parva</i> Carlgren, 1938	–	East London. Outside South Africa: Seychelles.
Family Hormathiidae		
<i>Actinauge granulata</i> Carlgren, 1928	–	Off Cape Town. Cape Barracouta. Endemic
<i>Phelliactis capensis</i> Carlgren, 1938	–	Off Cape Point. Endemic
<i>Phelliactis algoaensis</i> Carlgren, 1928	–	Algoa Bay. Endemic
<i>Calliactis algoaensis</i> Carlgren, 1938	–	Algoa Bay. Endemic
<i>Calliactis polypus</i> (Forsk., 1775)	–	Durban northwards to Red Sea.
<i>Amphianthus laevis</i> Carlgren, 1938	–	Off Cape Town. Endemic
<i>Amphianthus capensis</i> Carlgren, 1938	–	Agulhas Bank, E of St Paul. Endemic
<i>Amphianthus natalensis</i> Carlgren, 1938	–	Off Durban. Endemic
Family Isophelliidae		
<i>Isophellia algoaensis</i> Carlgren, 1928	–	Algoa Bay. Endemic
<i>Telmatactis natalensis</i> Carlgren, 1938	–	Durban. Endemic
<i>Litophellia octoradiata</i>	–	Durban. Endemic
Family Metridiidae		
<i>Metridium senile</i> (Linnaeus, 1761)	–	Table Bay. Outside South Africa: east and west coast of N America, Europe, Japan, Argentina.
Family Sagartiidae		
<i>Anthothoe chilensis</i> (Lesson, 1830)	<i>Anthothoe stimpsoni</i>	West coast to Durban. Outside South Africa: Argentina, Chile, Brasil, Namibia, St Helena.
<i>Phellia aucklandica</i> (Carlgren, 1924)	–	Oudekraal. Outside South Africa: Auckland Is., Inaccessible Archipelago, Gough Is.
<i>Sagartia ornate</i>	–	Langebaan lagoon. Outside South Africa: North Atlantic and Mediterranean
SUBTRIBE (informal) ENDOMYARIA		
Family Actiniidae		
<i>Actinia equina</i> (Linnaeus, 1758)	–	South African coasts. Outside South Africa: Namibia, N Atlantic, Mediterranean, Black Sea, Japan.

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Table 1 (continued)

Species classification	Previous name in South Africa	Range and distribution
<i>Anemonia natalensis</i> Carlgren, 1938	–	Durban to Cape Vidal. Endemic
<i>Anthostella stephensoni</i> Carlgren, 1938	–	Port Nolloth to Qolora. Outside South Africa: Namibia.
<i>Bolocera kerguelensis</i> Studer, 1878	<i>Bolocera capensis</i>	Cape Town to East London. Outside South Africa: Antarctic and sub-Antarctic waters
<i>Bunodosoma capensis</i> (Lesson, 1830)	<i>Phymactis capensis</i>	West coast to Durban. Outside South Africa: Namibia.
<i>Pseudactinia flagellifera</i> (Drayton in Dana, 1846)	<i>Pseudactinia varia</i>	Port Nolloth to Durban. Outside South Africa: Namibia.
<i>Pseudactinia varia</i> Carlgren, 1938	<i>P. flagellifera</i>	Oudekraal to East London. Outside South Africa: St Helena.
<i>Anthopleura michaelsoni</i> (Pax, 1920)	–	Port Nolloth to Durban. Outside South Africa: Namibia.
<i>Anthopleura annea</i> Carlgren, 1940	–	Durban and Natal zone. Endemic
<i>Anthopleura insignis</i> Carlgren, 1940	–	Kleinmond, Port St Johns. Endemic
<i>Liponema multipora</i> Hertwig, 1882	<i>Liponema brevicirrata</i>	Off Knysna. Outside South Africa: Chile, Antarctica.
<i>Urticinopsis crassa</i> Carlgren, 1938	–	Off Cape Point. Outside South Africa: Argentina.
<i>Gyractis excavata</i> Boveri, 1893	<i>Actiniogeton sultana</i>	Durban, Port Edward. Outside South Africa: Zanzibar, Aden, Fiji, W. Australia, Torres Strait, Hawaii, Gan, Singapore, Seychelles.
<i>Korsaranthus natalensis</i> (Carlgren, 1938)	<i>Condylactis natalensis</i>	False Bay to Durban. Endemic
<i>Bunodactis reynaudi</i> (Milne-Edwards, 1857)	–	Port Nolloth to Durban. Outside South Africa: Namibia.
<i>Entacmaea quadricolor</i> (Rupell & Leuckart, 1828)	–	East coast. Outside South Africa: Micronesia and Melanesia to East Africa and the Red Sea, and from Australia to Japan.
Family Condylanthidae		
<i>Condylanthus magellanicus</i> Carlgren, 1899	–	Agulhas Bank, W of Cape Barracouta. Outside South Africa: Tierra del Fuego.
Family Stichodactylidae		
<i>Heteractis magnifica</i> (Quoy & Gaimard, 1833)	–	Natal region. Outside South Africa: French Polynesia to East Africa, and Australia to the Ryukyu Islands.
<i>Stichodactyla mertensii</i> Brandt, 1835	–	Natal region. Outside South Africa: Micronesia and Melanesia to East Africa, and Australia to the Ryukyu Islands.
SUBTRIBE (informal) MESOMYARIA		
Family Actinostolidae		
<i>Paractinostola capensis</i> Carlgren, 1928	–	Cape Point, Buffalo River. Endemic
<i>Anthosactis capensis</i> Carlgren, 1938	–	Cape Point. Endemic
Family Isanthidae		
<i>Isanthus capensis</i> Carlgren, 1938	–	Lamberts Bay to Cape Hangklip. Outside South Africa: Namibia.
SUBORDER PTYCHODACTEAE		
Family Preactiidae		
<i>Preactis millardae</i> England (in Engl. & Robson)	–	Table Bay, False Bay. Endemic
ORDER CORALLIMORPHARIA		
Family Corallimorphidae		
<i>Corynactis annulata</i> (Verrill, 1868)	–	Port Nolloth to Mossel Bay. Outside South Africa: Inaccessible Archipelago
Family Discosomatidae		
<i>Rhodactis rhodostoma</i> (Ehrenberg, 1934)	–	Durban. Outside South Africa: Red Sea, Madang Province (New Guinea)

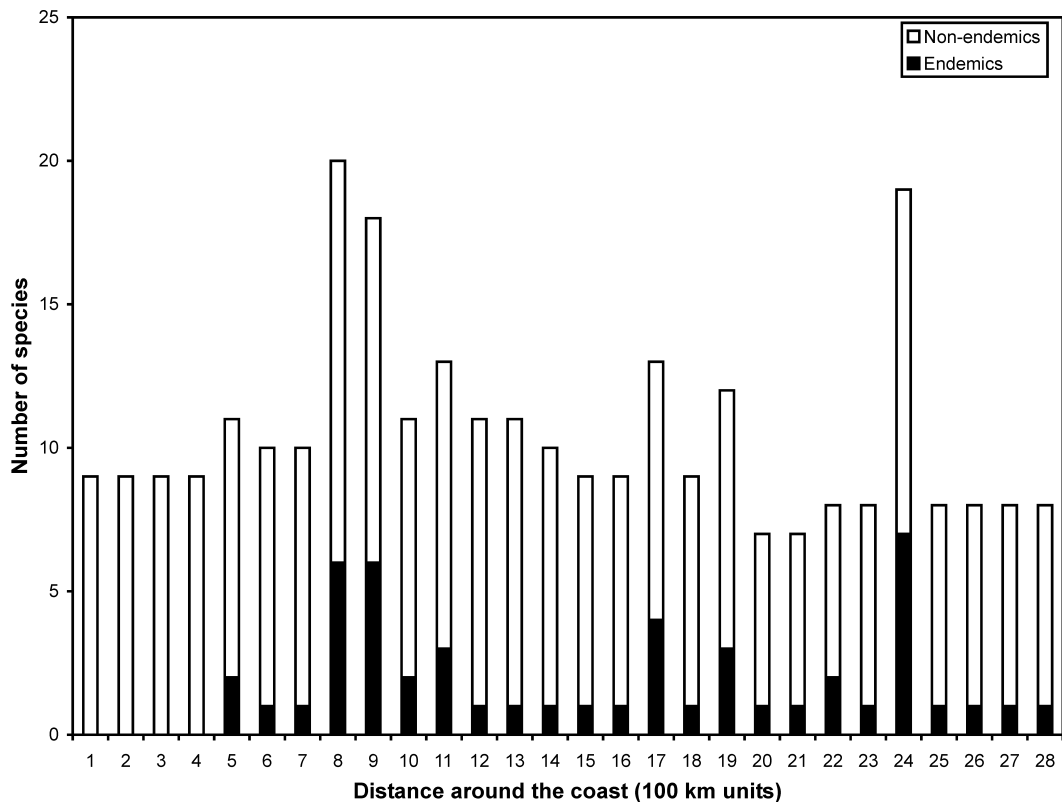


Fig. 2. Distribution of sea anemones species richness and endemism around South Africa, based on the coastal units shown in Fig. 1.

absence of each species was then recorded within each unit. The units correspond to those used by Awad *et al.* (2002) and are similar to those employed by Emanuel *et al.* (1992), although the latter paper extended coverage into Namibia and Mozambique. Since collection records were extremely patchy species ranges were assumed to be continuous between their limits, that is, distribution was presumed to extend from the most westerly to the most easterly record. Species richness is displayed as number of species occurring within each 100-km unit of coastline and endemism is defined as endemic to the boundaries of South Africa.

RESULTS

Taxonomy of South African sea anemones

Table 1 lists the 49 sea anemone species, as defined above, recorded from South African waters. They fall in 16 families from the order Actiniaria and two families from the order Corallimorpharia. Most of the species listed were recorded by Carlgren (1938), although the names of some have changed

in the intervening years. Additional species are derived from England & Robson (1984), Griffiths *et al.* (1996), Riemann-Zürneck & Griffiths (1999) and Acuña *et al.* (2004).

Patterns of richness and endemism

The numbers of species of sea anemones recorded in each 100 km section of coastline are shown in Fig. 2. The highest values occur at unit 8 (Cape Town) with 20 species, unit 24 (Durban) with 19 species and unit 9 (False Bay) with 18 species. All other sites have considerably lower numbers of species, varying from 13 (unit 11) to as few as 7 (units 20 and 21). Overall trends in species richness are unclear, with a fairly flat overall profile, but if anything, anemones appear to be more diverse in the temperate south and southwest. The Actiniidae are the best-represented family, with 16 species, followed by the Hormathiidae with eight. The remaining families are all poorly represented, with a maximum of three species each.

The ranges of individual species are extremely variable. However, a disproportionate number of

Actiniidae appear to be widespread, eight of the 16 species (50%) having South African ranges of over 1000 km and one, *Actinia equina*, being the only anemone found throughout the region. Only two of the remaining 32 species (6%), *Anthothoe chilensis* and *Corynactis annulata*, have ranges over 1000 km. A large proportion of species have very restricted ranges, with 22 (46%) so far reported from just a single 100 km coastal unit.

A total of 24 (49%) species are endemic, although this proportion might visually appear far lower when viewing the data in the form of a bar chart (Fig. 2). The reason for this illusion is that each endemic species tends to be represented in only one or a few coastal units, whereas most non-endemic species are far more widespread and thus represented in numerous histogram bars. The proportion of South African endemics is not strongly correlated with location (Fig. 2), although no endemic species were found in units 1–4 along the west coast and only one each (12%) in the most eastward units 25–28. Numbers of endemics were maximal in Cape Town (six, or 30% of species), False Bay (six, or 33%) and Durban (seven, or 37%). This reflects the pattern of total species richness. The family Hormathiidae, the majority of which are found in relatively deep waters, has the most endemic species with seven (87%). By contrast the family Actiniidae, which are mostly intertidal and littoral, only had four out of 16 (25%) endemic species.

DISCUSSION

For more than 60 years Carlgren (1938) has remained the principal source of data on the South African sea anemones fauna and has become progressively outdated. A new, revised and updated species list is provided here and recognizes 49 valid species. This represents some 7% of the global total, a value comparable with that of the marine fauna as a whole (5.5%), but low compared with some other comparable taxa, such as Hydrozoa, which have 457 South African species, or 14% of the global total (Gibbons *et al.* 1999). In terms of percentage endemism, sea anemones have a higher percentage endemism (50%) than the 31.4% average for the marine fauna as a whole (Gibbons *et al.* 1999). However, this value is well within the range of endemism rates for the invertebrate groups analysed by Awad *et al.* (2002), which vary from 19% (echinoderms) through to 84% (isopods).

Reported sea anemone species richness is

strikingly elevated in Cape Town, False Bay and Durban (and to a lesser extent at Port Elizabeth and East London). We attribute this to the fact that these sites lie adjacent to major centres of marine research, and have hence certainly been more intensively sampled than the intervening coastline. However, the peaks cannot be completely discounted, since they also coincide with the boundaries of biogeographical provinces, where overlap in species ranges tends to be high (Emanuel *et al.* 1992; Gibbons *et al.* 1999; Bolton & Stegenga 2002). Apart from these peaks, species richness is low, but quite uniform around the coast, perhaps with a slight increment in the southwest. Our main conclusion from this is that there is a pressing need for future sampling of anemones in under-represented areas. This is specially true of the east coast region, where few species appear to be recorded in relation to the known richness of the Indo-Pacific sea anemone fauna.

Endemics sea anemones, which represent 50% of the total number of species, show a very similar distribution pattern to overall species richness (Fig. 2). The highest proportion of endemics was 37% recorded at Durban and the highest absolute number seven, recorded both at Durban and in False Bay. The families Actiniidae (16 species) and Hormathiidae (eight species) are the most diverse families of South African sea anemones, but the latter contains a much higher proportion of endemics. The deep-water distribution of Hormathiidae could be the explanation for this high apparent endemism rate, since very few deep-sea samples have been collected in countries adjacent to South Africa.

Although these data reflect our current understanding we suspect that both the faunal list and endemism data are biased by under-collecting, the former by inadequate taxonomic work within the borders of South Africa and the latter by inadequate collecting in adjoining countries. Such collecting would be likely to substantially increase the number of reported species, but to reduce the proportions of endemics (should these be detected in adjoining countries). This emphasizes the strong need for systematic presence/absence survey data for this and other taxa around the coastline of the entire region.

ACKNOWLEDGEMENTS

We are grateful to the Third World Academy of Science (TWAS) for granting E.H.A. a South–South

Fellowship to visit the University of Cape Town. Financial support was provided through a grant to C.L.G. from The Sea and the Coast 2 Coast Programme, jointly funded by the National Research Foundation and Department of Environmental Affairs and Tourism. We thank Robyn Scott for help with figures and tables and to Mark Gibbons for his comments on the draft manuscript.

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