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Mangrove sponges from Bangka Island (North Sulawesi, Indonesia) with the description of a new species

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Mangroves create unique ecological environments, furnishing a habitat opportunity for many species. The majority of published information on mangrove sponges comes from the Caribbean while few data are available from Indo-Pacific mangrove sponges. In general, species diversity of sponges in mangroves is lower than adjacent subtidal habitats in both the Caribbean and Indo-Pacific. The aim of this study is to report the first data about sponge species diversity of two mangrove forests from Bangka Island (North Sulawesi, Indonesia) and to describe a new sponge species associated with the mangroves. The survey found 19 species, belonging to 11 families and 15 genera; the samples were collected on mangrove trunks, on the roots or on the surrounding bottom. The majority of the species are typical of coral reef but two of them have been previously found only in lagoons or in mangrove habitats. These new data enlarge our knowledge about Indonesian sponges diversity and suggest the urgency to consider Indonesian mangroves as an important but underestimated element in coral reef ecological dynamics.

Keywords: Porifera, Mangroves, Indonesia, new species, *Dercitus*

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INTRODUCTION

Mangroves are salt-tolerant trees that build complex coastal habitats, restricted to subtropical and tropical areas. These habitats are defined by the presence of marine organisms able to cope with fluctuating salinity, low oxygen concentration, presence of natural sulphide, high temperatures and periodic exposure to air (Puce *et al.*, 2004). They show extraordinary high rates of productivity, providing through the mangrove litter the basis of a complex food web; moreover they play a paramount economical and social role for the local communities (Tomascik *et al.*, 1997), significantly reduce coastal erosion and provide protection from tropical cyclones and tidal waves (UNESCO, 1979; Danielsen *et al.*, 2005). Moreover, their key role as one of the most important sink areas for CO_2 has recently been highlighted (Donato *et al.*, 2011). Unfortunately, mangroves are among the most imperilled marine ecosystems since they are subjected to extreme anthropogenic pressures, such as organic run-off from land, disturbances from suspended sediment and damage from clear-cutting (Alongi, 2002).

The mangrove forests of South-east Asia are among the most species-rich, since the Indo-Malayan region is considered a hotspot of biodiversity (Chapman, 1977). In particular in Indonesia, mangroves are dispersed throughout the Archipelago (Tomascik *et al.*, 1997). Mangroves create habitats for numerous species; the stilt roots and pneumatophores play the role of hard substrata in an otherwise soft sediment environment (Ellison & Farnsworth, 1992).

Most of the knowledge about mangrove ecosystems derives from studies about ecology, distribution and taxonomy in the Caribbean (Díaz & Rützler, 2009; Guerra-Castro *et al.*, 2011; Díaz, 2012). The Caribbean mangroves sponge communities are distinct from those in reefs, and contain species that appear to be specifically adapted to survive extremes in salinity, temperature and sedimentation (Rützler, 1995; Wulff, 2000, 2005; Engel & Pawlik, 2005; Pawlik *et al.*, 2007; Nagelkerken *et al.*, 2008).

Competition for space in the mangroves is considered intense and hard substrate required by sponges is limited; as a consequence, species with high growth rates and good competence for spatial competition are considered favoured (Engel & Pawlik, 2005; Wulff, 2005, 2010; Nagelkerken *et al.*, 2008).

Taxonomic knowledge on sponges associated with mangroves, from the Indo-Pacific and, in particular, from the Indonesian Archipelago is very poor, and new data have only very recently become available from that area (Calcinai *et al.*, 2012; Becking *et al.*, 2013).

This paper aims to provide initial data on sponge composition in two small mangrove forests at Bangka Island (North Sulawesi, Indonesia) and to describe a new species associated with the mangrove habitat.

MATERIALS AND METHODS

The studied material comes from two different mangrove forests located at the western coast of Bangka Island (North

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Sulawesi, Indonesia) (Figure 1). The first sampling station (ST1) is an artificial, narrow channel about 500 m long, cutting a *Rhizophora* sp. forest (from 1.758256°N125.136779°E to 1.755319°N 125.133107°E). *Rhizophora* is the dominant mangrove, while *Sonneratia alba* and *Bruguiera* spp. are rarely present.

The second station (ST2) (from 1.815533°N 125.120133°E to 1.817000°N 125.120500°E) is a wide inlet, about 120 m long, characterized by *Rhizophora* and *Bruguiera* trees. These two forests are about 6.5 km apart and in the area the maximum tide excursion can be higher than 3 m, playing a key role in the mixing of seawater.

Specimens were collected by snorkelling during high tide period by visually oriented transect, on September 2011. The collection was intended to be qualitative and all the specimens detected were collected from the inner to the outer side of the mangrove forest.

The spicule complement was studied according to Rützler (1978). From 30 measurements for each spicule type, size range, mean and standard deviation (in parentheses) were calculated. Dissociated spicules were transferred onto stubs and sputtered with gold for SEM analyses and observed with a scanning electron microscope (Philips XL 20).

RESULTS

SYSTEMATICS
Order TETRACTINELLIDA Marshall, 1876
Family ANCORINIDAE Schmidt, 1870
Dercitus (*Stoeba*) *bangkae* sp. nov.
(Figure 2)

TYPE MATERIAL

Holotype: Indonesia, North Sulawesi, Bangka Island (1.756333°N 125.134666°E), water depth: 1 m, MSNG-58345, specimen MA16, 9 November 2011.

DIAGNOSIS

Encrusting *Dercitus* (*Stoeba*) with calthrops, dichocalthrops and sanidasters. Irregular dichocalthrops with bifid, bent or rounded extremities. Regular dichocalthrops are very rare. Sanidasters are very variable in shape from amphiaster-like to irregular forms with spines at the extremities.

DESCRIPTION

Encrusting sponge, 0.5–1 mm in thickness. The holotype covers and consolidates a coral piece about 8 cm long and two other small portions of coral (Figure 2A). Two other sponges were found in the same coral substrate (Table 1). The colour in the preserved state is light brownish; the surface is microhispid and full of sediment. Oscules are not visible.

Skeleton: A crust of calthrops with dispersed microscleres (Figure 2B).

Spicules: The spicule complement consists of calthrops, dichocalthrops and sanidasters. Calthrops regular in shape, but variable in size, with cladi 20–162.8 (±62.7) – 270 μm × 7.5–21.2 (±8.4) – 35 μm and cladomes 105–257 (±93.3) – 420 μm (Figure 2C, N); other calthrops have cladi terminally bent, rounded and often of different length (Figure 2G, H). Numerous irregular dichocalthrops with one, two or all the bifid cladi (Figure 2D–F). Dichocalthrops often have deuterocladi variable in length of 30–77.2 (±23.0) – 115 μm, protocladi 95–132.5 (±19.1) – 155 μm and rhabdomes 140 × 2 μm (only three spicules measured). Regular calthrops and modified dichocalthrops are the dominating spicules (64% and 35% respectively) with regular dichocalthrops occurring only for 1%.

Sanidasters are very variable in shape, but constant in size (7.5 – 14.0 (±3.4) – 17.5 μm); they may be amphiaster-like with groups of spines concentrated in two central clusters and with spined extremities (Figure 2I, M, N) and sanidasters with groups of spines concentrated at one extremity and in the centre of the spicule (Figure 2J–L). These sanidasters have often only one pointed, curved tip, covered with spines (Figure 2K). Numerous intermediated forms occur with a single, or both rounded tips (Figure 2L–N); microspines may occur along the axis (Figure 2M).

ETYMOLOGY

Named for its type locality, Bangka Island.

DISTRIBUTION

Known only from the type locality.

REMARKS

This species, characterized by calthrops and dichocalthrops as megascleres and by sanidasters clearly belongs to the genus *Dercitus* subgenus *Stoeba* (van Soest *et al.*, 2010).

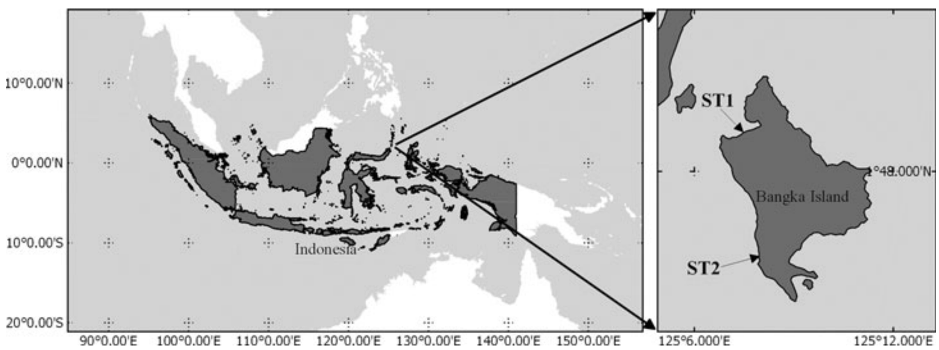

Fig. 1. Indonesian archipelago with Bangka Island. The arrows point to the two sampled stations.

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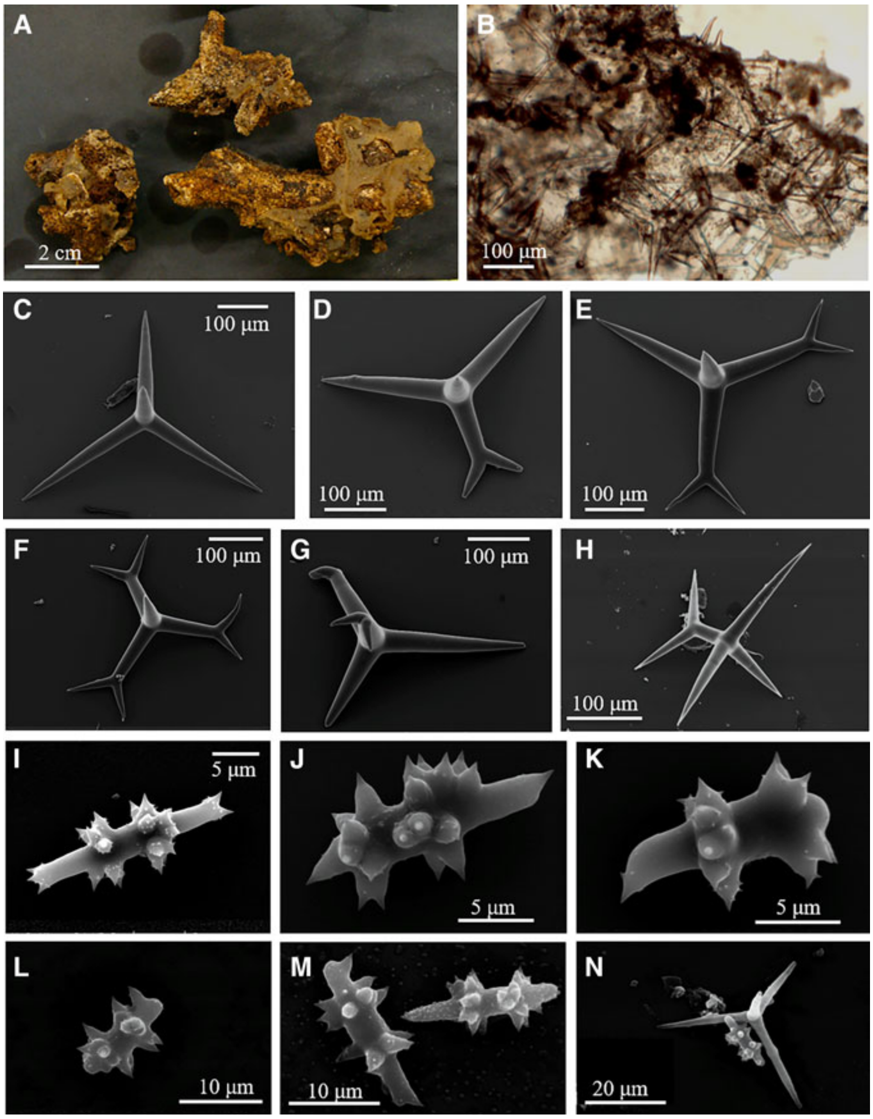

Fig. 2. *Dercitus bangkae* sp. nov.: (A) the holotype covering coral pieces; (B) Skeleton made of a crust of calthrops with dispersed microscleres; (C, N) regular calthrops; (D, E) irregular dichocalthrops; (F) regular dichocalthrop; (G, H) modified calthrops; (I, M, N) amphiaster-like sanidasters; (J–L) modified sanidasters.

Dercitus (*S.*) *bangkae* sp. nov. is characterized by megascleres with numerous modifications and by sanidasters very variable in shape. In particular, the sanidasters with only one pointed tip are peculiar of this species and are not present in any other species of this genus.

There are five species of this subgenus described from the Indo-Pacific area (van Soest *et al.*, 2015). None of them fits with *D.* (*S.*) *bangkae* sp. nov. here described especially for the spicule shape.

Dercitus (*S.*) *extensus* (Dendy, 1905) has very thin, oxea-like sanidasters; *D.* (*S.*) *fijiensis* van Soest *et al.* (2010) has spicules different in shape: pointed sanidasters and deuterochlads have very short protocladi (19–26.5–30 × 13–25.2–42 µm). *D.* (*S.*) *occultus* Hentschel, 1909 is an endolithic species characterized only by dichocalthrops as megascleres; *D.* (*S.*) *pauper* Sollas, 1902 is pink in colour, has thin sanidasters (1 µm in thickness) and small megascleres (calthrops cladi 60–70 µm, van Soest *et al.*, 2010). *D.* (*S.*) *simplex* (Carter, 1880) has only dichocalthrops and sanidasters are rod-like without modification.

The survey has shown the presence of 19 species belonging to 11 families and 15 genera (Table 1). All the samples were collected on mangrove trunks or roots, or in the surrounding substratum (e.g. *Dercitus* (*Stoeba*) *bangkae* sp. nov. on coral fragments). The majority of collected species is typical of coral reef (e.g. *Biemna fortis, Amorphinospis excavans*). Only two species, *Spongia* (*Spongia*) cf. *matamata* and *Hyrtios communis* have been found in lagoon or in mangrove habitat respectively (de Laubenfelds, 1954). Also Becking *et al.* (2013) reported sponges living both on coral reef and inside mangrove habitat in Berau (Indonesia).

DISCUSSION

The present survey highlights strong differences between the sponge fauna of the studied mangroves and that of the mangroves of the Caribbean area. Considering the high heterogeneity and biodiversity of the Indonesian Archipelago and the wide distribution of mangroves, it is evidently important to

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Table 1. Species recorded in the two sampled stations with habitat, depth and distribution.

Station	Sample	Species	Family	Habitat	Depth (m)	Distribution	References
1 and 2	MA1 MA20	*Amorphinopsis excavans* Carter, 1887	Halichondriidae	Coral, coral rock		Indian Ocean, Australian region, Mergui Archipelago, Birmania and Bangka Island	Thomas (1973)
1	MA5	*Ciocalypta tyleri* Bowerbank, 1873	Halichondriidae	Buried in sand	Shallow water	South Africa, North Australia, India, New Zealand and Bangka Island	Bowerbank (1873); Dendy (1889)
2	MA18	*Topsentia halichondrioides* (Dendy, 1905)	Halichondriidae		Deep water	Off Galle, west Coast of Ceylon and Bangka Island	Dendy (1905)
1	MA3	*Amphimedon* sp. 1	Niphatidae	Mangrove	Shallow water	Bangka Island	
1	MA15	*Amphimedon* sp. 2	Niphatidae	Mangrove	Shallow water	Bangka Island	
1	MA11	*Biemna fortis* (Topsent, 1897)	Biemnidae	Buried in sand		Red Sea, Amboine, Indian Ocean, Australian region and Bangka Island	Thomas (1981)
1	MA13	*Clathria* (*Microciona*) sp.	Microcionidae	Mangrove	Shallow water	Bangka Island	
1	MA17	*Tetilla ridleyi* Sollas, 1888	Tetillidae			Banda Sea	Topsent (1897)
1	MA16	*Dercitus* (*Stoeba*) *bangkae* sp. nov.	Ancorinidae	Mangrove	Shallow water	Bangka Island	
1 and 2	MA6 MA19a MA19e	*Cladocroce burapha*, Putchakarn, de Weerdt, Sonchaeng and van Soest, 2004	Chalinidae	Rocky shore, crab gill net, low tide, coll	2–15	Thailand	Putchakarn *et al.* (2004)
1	MA10	*Haliclona* (*Gellius*) sp.	Chalinidae	Mangrove	Shallow water	Bangka Island	
1	MA4	*Haliclona* (*Halichoclona*) *centrangulata* (Sollas, 1902)	Chalinidae	Not reported Mangrove		Malay Peninsula and Bangka Island	Sollas (1902)
1	MA2	*Haliclona* (*Reniera*) sp. 1	Chalinidae	Mangrove	Shallow water	Bangka Island	
1	MA7	*Haliclona* (*Reniera*) sp. 2	Chalinidae	Mangrove	Shallow water	Bangka Island	
1	MA12	*Hyrtios communis* (Carter, 1885)	Thorectidae	Near mangrove	Very shallow water		de Laubenfelds (1954)
1	MA10	*Scalarispongia* sp.	Thorectidae	Mangrove		Bangka Island	
1	MA9	*Spongia* (*Spongia*) cf. *matamata* de Laubenfels, 1954	Spongiidae	Lagoon and dead coral	Just below low tide, until 6 m	Marshall Islands, Micronesian and Bangka Island	de Laubenfelds (1954)
2	MA21	*Tedania* (*Tedania*) *brevispiculata* Thiele, 1903	Tedaniidae			Ternate, Vietnam and Bangka Island	Thiele (1903); Lévi (1961)
1	MA16	*Timea* sp.	Timeidae	Mangrove	Shallow water	Bangka Island	

develop a general assessment of the sponge fauna associated with Indonesian mangroves. At the moment, even if at a very small spatial scale, it is clear that the two sampled mangrove forests have different species assemblages. In ST2, only four species were collected (Table 1), while 17 species were collected from ST1 (Table 1). Out of a total of 19 species only two species (*Cladocroce burapha* and *Amorphinopsis excavans*) were found in both of the mangrove forests, while two species were exclusively present in ST2 (*Topsentia halichondrioides* and *Tedania* (*Tedania*) *brevispiculata*) and 15 exclusively in ST1 (Table 1).

While in the Caribbean, mangrove sponges often are large in size, with massive growth forms, and brilliant colours (Rützler & Feller, 1996; Díaz *et al.*, 2004) in Bangka Island mangrove sponges are all of small dimensions (up to 12 × 10 cm) and dull coloured. Also Barnes & Bell (2002), from the West Indian Ocean, found that almost the majority of sponges were encrusting, and Becking *et al.* (2013) showed that mangrove habitat in Berau is characterized by small sponges.

In Caribbean mangroves, Chalinidae is generally the most diversified family (de Weerdt, 2000; Díaz *et al.*, 2004; Wulff, 2004; Guerra-Castro *et al.*, 2011; Díaz, 2012). *Tedania* (*Tedania*) *ignis, Lissodendoryx* (*Lissodendoryx*) *isodictyalis, Geodia gibberosa, Halichondria* (*Halichondria*) *melanadocia, Haliclona* (*Reniera*) *manglaris, Dysidea etheria, Hyrtios proteus, Mycale* (*Carmia*) *microsigmatosa* and *Spongia* (*Spongia*) *tubulifera* are considered the most common sponge species of Caribbean mangrove (Sutherland, 1980; Díaz *et al.*, 2004; Engel & Pawlik, 2005). In a survey of the Quirimba Archipelago of Mozambique a few species belonging to the family Chalinidae and Biemnidae (genera *Haliclona* sp. and *Biemna* sp.) were recorded (Nagelkerken *et al.*, 2008). In Berau (Indonesia) mangroves, species of the families Chalinidae, Halichondriidae, Tethyidae are reported as the most common (Becking *et al.*, 2013). This aspect is here confirmed, since species of the family Chalinidae and Halichondriidae were the most common. Species belonging to genera *Haliclona* (four out of 19) together with the genera *Tedania* and *Biemna* have been recorded in Bangka mangroves. The species *Cladocroce burapha* and *Biemna fortis* were found both in Berau and Bangka regions.

Considering the key role mangrove habitats play in the functioning of tropical ecosystems, and the pivotal role of sponges in reef dynamics (Wulff, 2006) and as a refuge for several species (Cerrano *et al.*, 2006), it is important to fill the lack of knowledge on the Porifera adapted to survive in these unique and endangered habitats.

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