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Shallow water sponges along the south coast of Java, Indonesia

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Abstract. *Hadi TA, Hafizt M, Hadiyanto, Budiyanto A, Siringoringo RM. 2018. Shallow water sponges along the south coast of Java, Indonesia. Biodiversitas 19: 485-493.* Sponges are the most diverse benthic filter feeders, occupying many different types of marine habitat. The south coast of Java is one such marine habitat, very exposed to the open sea. This study investigated the sponge diversity as well as their morphological characters across the south coast of Java. The observations were carried out from 2011 to 2016 in four different locations, including Pamang Peuk, Gunungkidul, Prigi Bay and Bayuwangi. The study found 96 sponge species, from 15 orders, and described them in terms of nine morphological characters. The most common species included *Spheciospongia inconstans*, *Stylissa massa*, *Callyspongia* sp. and *Cinachyrella australiensis*, while the most common growth forms were massive and encrusting, accounting respectively for 34.4% and 28.1% of the total number of species. There was a significant difference in the number of species found between sub-tidal and intertidal habitats; subtidal sponges were approximately 50% more diverse than intertidal sponges. Apart from the habitat types, the number of sponges varied in relation to the longitude; east Java had more sponge species with more variations in morphology compared to central and west Java. Encrusting and globular growth forms were the most common characteristics of intertidal sponges in west and central Java, while other growth forms comprised the diverse characteristics of the subtidal sponges in the east Java. This baseline information is essential for management of marine biodiversity hotspots in taking decisions for marine life conservation, because the global trajectory of marine habitat degradation is predicted to rise.

Keywords: Intertidal, morphology, subtidal, south coast of Java, sponges

INTRODUCTION

Declining marine biodiversity is one of the most serious global issues of our era (Tittensor et al. 2010). In the central and southern parts of the Great Barrier Reef, habitat degradation has caused key species to shrink in number (GBRMPA 2014). In the Caribbean, the foundation species, mainly corals, have been severely impacted in terms of biodiversity, abundance and percent covers; especially as a result of local human impacts (Coelho and Manfrino 2007). In Indonesia, studies related to such decline mainly focus on corals and fishes, which are highly impacted by human activities and natural disturbances (Haapkyla et al. 2009; Giyanto 2017; Sjafrie 2012). In spite of this, there is very little information, even baseline data, regarding lesser studied marine biota, especially sponges. Sponges are typically ubiquitous and often abundant in shallow water habitats, making them a significant component of biodiversity (Van Soest et al. 2012). Thus, it is necessary to investigate sponges as part of marine biodiversity, in order to develop enhanced marine conservation management strategies.

Sponges are one of the most diverse sessile organisms, having around 8,876 valid species world-wide (Van Soest et al. 2018). Many studies related to Indonesian sponges have been conducted, mainly in the eastern part of the archipelago, with more than 850 species recorded (Van Soest 1989; De Voogd 2005; De Voogd et al. 2006; De Voogd et al. 2009; Becking et al. 2013; Calcinai et al. 2017). Although the unfixed state of the taxonomy of Indonesian sponges has been a major obstacle in developing sponge studies, nevertheless, investigations need to be carried out using this current taxonomic identification system applied across a wide geographic area, in order to record as much as possible of the current distribution of sponges in the archipelago. By such means, the biodiversity and distribution pattern for the region's sponges can be revealed.

Sponges exhibit many morphological variations in response to environmental conditions, such as sea current, turbidity and depth (Mendola et al. 2008; Lesser et al. 2009; Pineda et al. 2016). Variations in morphological characters are vital in maintaining sponge attachment to substrate, minimizing energy expenditure during the feeding process, and obtaining sufficient food resources from the water column (McMurray et al. 2008; Leys et al. 2011). Nevertheless, morphological variation is predetermined by genetic factors, given that true branching sponges cannot turn into encrusting sponges (Bell et al. 2002). Thus, only certain adaptive morphological characters can survive in particular environmental conditions: encrusting and massive sponges are adapted to high energy environments, as they attach themselves to substrate better than branching sponges which are more exposed to high water velocity. Branching sponges are adapted to high turbidity environments (Bell and Barnes 2000). Variation within morphological characters in sponges needs to be observed in addition to their identification at species level, in order to obtain a better understanding about the pattern of species and morphological diversity in different environmental conditions.

South Java is a unique habitat, as it directly borders on the Indian Ocean. Sponges in this region have been less studied - based on the number of published papers - which might be attributable to field work issues; sampling in the intertidal zones is very difficult, particularly during high tides which are accompanied by big and strong waves. Only particular locations are able to be observed by diving, without causing unacceptable risk to the researchers. However, marine biodiversity research should be carried out to provide general information, at least baseline data, that can be used as a stepping-stone to other advanced studies related to marine biodiversity. Furthermore, such information can also be used to define the health of reefs, since sponges are one of the main competitors for space and nutrients in the sea (Powell et al. 2010). The study described in this paper was proposed as a preliminary investigation about sponges in the south coast of Java. It aimed to inventory shallow water sponges - the species and their morphological characters - in two different habitats, the intertidal and subtidal zones.

MATERIALS AND METHODS

Study area

This study was carried out at four different locations along the south coast of Java, Indonesia from 2011 to 2016; Prigi Bay, Trenggalek, East Java in 2011 (Hadi 2013), Gunungkidul, Yogyakarta in 2012 (Hadi 2015), Pameungpeuk, Garut, West Java in 2016 and Banyuwangi, East Java in 2016 (Figure 1). Each location had several study sites; Prigi Bay had 5 sites, Gunungkidul 5 sites, Pameungpeuk 5 sites and Banyuwangi 3 sites. Pameungpeuk's reefs are typically rocky with short reef flat (< 100 m). In Gunungkidul, the reefs are characterized by limestone with long reef flats (> 100 meters). Seagrass meadows, mainly dominated by *Thalassia hemprichii*, are also found in Gunungkidul's back reef. Both locations are strongly exposed to the open sea. On the other hand, Prigi Bay is typically less exposed and characterized by rocky shore with short reef flat. A sandy shore with patchy reefs is the main characteristic of Bayuwangi's east coast.

Procedures

The method used was exploratory sampling: in the intertidal zone, the observer collected samples during low tides on the shores as long as 75-100 meters for one hour; while in the subtidal zones, the observer dived at a depth of between 5 and 10 meters as long as 75-100 meters parallel to the coastline for one hour. Sponges found during the observation were recorded, then identified following Van Soest et al. (2018). Subtidal sponge sampling was conducted in Pameungpeuk (1 site), Prigi Bay and Bayuwangi, while intertidal sponge sampling was carried out in Pameungpeuk (4 sites) and Gunungkidul. This difference in sampling zone was due to the shore characteristics of each site. Small cryptic sponges and encrusting sponges less than 10 cm in diameter were excluded from the recorded observations.

Data analysis

Data for the number of species found in the intertidal and subtidal zones were analyzed using t-test to examine whether they were statistically different from each other; the data were first square root transformed to meet the assumptions of normal distribution and homogeneity. The study also examined the correlation between the number of species and the longitude based on the coordinates of the study sites. To understand about the spatial distribution of sponges based on morphological characters, nonmetric Multidimensional Scaling (nMDS) was used in Primer7 software; the data were also square root transformed to achieve a better balance between contribution from common and rare species, and then standardized by total to remove any contribution from totals.

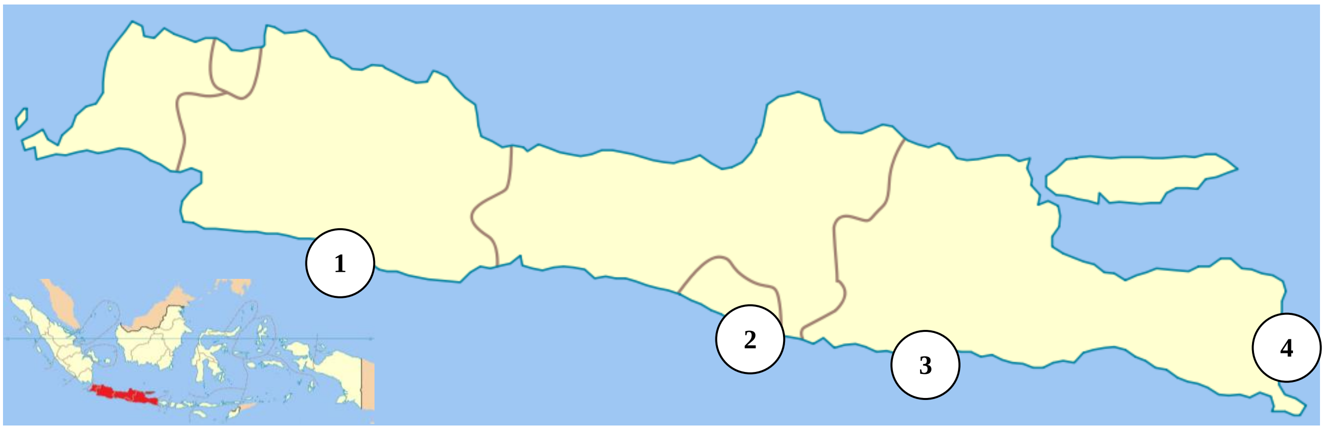

Figure 1. Map of sponge sampling locations along the south coast of Java, Indonesia. 1. Pameungpeuk, Garut, West Java, 2. Gunungkidul, Yogyakarta, 3. Prigi Bay, Trenggalek, East Java, 4. Banyuwangi, East Java

RESULTS AND DISCUSSION

There were about 96 sponge species, belonging to 49 genera, found from 5 locations on the south coast of Java (Table S1). This result is much lower, approximately 50 % and 10 % for species and genera respectively, compared to studies conducted in Eastern Indonesia (Derawan and Spermonde Islands) which is part of the center of marine biodiversity in the coral triangle (De Voogd et al. 2006, 2009). In general, distance-related decline in marine biodiversity appears to extend outward from this center which generates and disperses species (Hoeksema 2007; Bowen et al. 2013). Another reason is related to the high hydrodynamic force on the south coast of Java, which directly faces the open seas of the Indian Ocean. In this case, physical factors play an important role in driving the long-term structure of communities; eliminating those sponges that are vulnerable to the big waves and strong currents, and leaving the resistant sponges to dominate (Lopez-Victoria and Zea 2005). Furthermore, major natural disturbances have the potential to negatively impact those habitats crucial for maintaining marine biodiversity (Whanpetch et al. 2010). In the last two decades, the south coast has experienced natural disturbances, especially tsunamis, that damaged the coastal habitats (Hardjono 2006). Combination of these factors makes this area more stressful for sponges to thrive and very likely influence their interactions with other organisms.

The southern coastal edge of Java is well known as a barren landform with high energy pressure. The coastline is typically rocky with different platform sizes as a consequence of the type of parent rock and the orientation of coast to the Indian Ocean (Rahardjo 2003). Wave height ranges from 0.4 meters to 3.1 meters; this wide range in wave height creates relatively strong current action (Purba 2014). Furthermore, the waves can produce energy up to 4036 kg . m^2 s^{-2}which is categorized as high (Damayanti and Ayuningtyas 2008). These characteristics make this region a harsh environment for marine organisms, especially benthic communities.

Our study found four common species that have wide distribution, recorded in at least seven stations; including *Spheciospongia inconstans*, *Stylissa massa*, *Callyspongia* sp. and *Cinachyrella australiensis* (Figure 2; Table S1). These sponges are typically cosmopolitan in the West-Indo Pacific and Indian Ocean (Hooper and Van Soest 2002; Sivaleela 2014). *Spheciospongia* is categorized as a boring sponge that commonly attaches on calcareous substrates and even limestone (Azzini et al. 2007). In this study, this sponge was abundant at Gunungkidul, boring into the limestone substrate which is the dominant substrate. In Bayuwangi, this sponge was found on dead corals. *S. massa* is widely distributed over various geographic scales, from local to ocean basin, and produces a metabolic compound that can protect them from predation (Rohde et al. 2012). *Callyspongia* sp. has a repent (i.e. creeping) growth form that enables it to grow in a strong current environment. *C. australiensis* is commonly abundant in reef flats and reef slopes which have high turbidity characteristics (Cheng et al. 2008). The tolerance of turbidity allows *C. australiensis* to have a higher prevalence in this kind of habitat than the other species. All of these species were found in both intertidal and subtidal habitats.

Sponge morphologies varied, but the dominant morphologies were massive (34.38%) and encrusting (28.13%) (Figure 3). A study conducted in the West Indian Ocean also find a somewhat similar result in which encrusting and massive growth forms appeared to dominate; suggesting that water flow complexity and substratum heterogeneity could determine sponge assemblage morphological diversity (Bell and Barnes 2002). In our study, hard substrates such as rocks, limestone and dead corals, were more common on the coast due to their stability, while soft substrate, mainly sand, is commonly found in the backreef area and in the straits (e.g. Banyuwangi). Both these substrate types provide an opportunity for many types of sponges to attach. Nevertheless, the hydrodynamic regime on the south coast might have more influence in structuring sponge assemblages than the type of substrate, given that not all of the existing growth forms have an equal growth form-related resistance to the physical force.

Figure 2. The most common sponges in the south coast of Java. From left to right; *S. inconstans*, *S. massa*, *Callyspongia* sp., *C. australiensis*

The results indicate that massive and encrusting growth forms represent a bigger proportion than other growth forms, as they are more adapted to the south coast's prevailing conditions; they are resistant to the high hydrodynamic force as they have more basal area compared to their exposed surface that faces strong currents and high energy waves. This enables them to adhere stably to the substrates (Bell et al. 2002). Severe physical disturbances can eliminate other more vulnerable sponge morphologies, such as branching, tubular and flabellate forms (Wulff 2006). In this study, the branching sponges, the third highest percentage of growth forms, were represented by four genera, namely *Amphimedon*, *Callyspongia*, *Dasychalina*, and *Gelliodes*. These genera were found in the subtidal zones and the last two genera were more frequent than the first two. *Dasychalina*, and *Gelliodes* are tough, composed mainly of siliceous spicules rather than sponge fibers, therefore can withstand strong current (Desqueyroux-Faundez and Valentine 2002). In contrast to massive and encrusting sponges, the lowest percentage of morphological types were the foliose sponges which were represented by a single species recorded in the subtidal zone at station B3. Hence, in general it can be assumed that the hydrodynamic regime of the south coast has structured the sponge assemblage to be especially adapted to high hydrodynamic pressures.

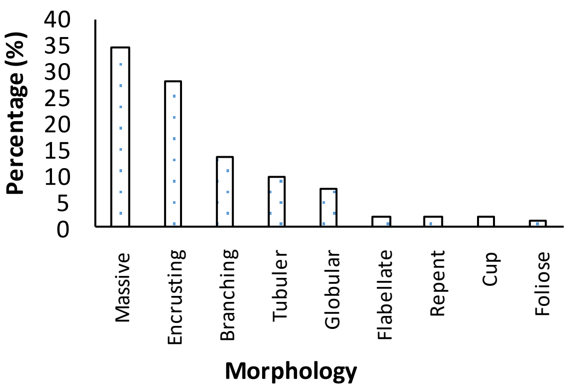

Figure 3. Proportion of sponge morphological characters in the south coast of Java

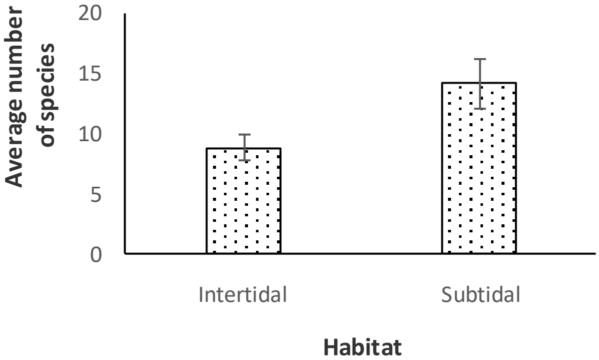

Figure 4. Comparison of average number of sponges found in intertidal and subtidal habitats

The statistical analysis indicates that there is a significant difference between intertidal and subtidal zones in the average number of sponge species (p-value = 0.036) (Figure 4). The number of subtidal sponge species is almost double the number of the intertidal sponges. The intertidal habitat appears to be a more stressful environment, especially in terms of wave action, temperature variation and light exposure, which are intolerable for many sponges (Wulff 2012). During the air exposed conditions of low tide, sponges' filtering capacity is reduced. Thus, lack of nutrition threatens the survival and regeneration of those sponge species that lack photosynthetically active symbionts such as cyanobacteria (Steindler et al. 2002). Furthermore, high wave exposure negatively impacts the substrate stability by eroding and overturning the substrate, thus hampering the recruitment process which is essential for structuring diverse benthic communities (Walker et al. 2008). In addition, it is found that the intertidal zone is more vulnerable to human impacts than the substidal zone, resulting in intertidal macrofaunal diversity decline (Vaghela et al. 2010).

In contrast, the less dynamic environmental conditions of the subtidal zones appear to enable many sponges to thrive. Previous studies have confirmed that the influence of wave energy drops significantly at depths below 5 meters and the diversity of sponge starts to increase down to 20 meters (Alcolado 1994). In this study, the subtidal observation was carried out between 5 and 10 meters in coral reef habitat. In the subtidal zone, sponges appear to have more efficient energy consumption (food intake and respiration), indicating that food supply and a continuous moderate current is sustained (Lesser 2006; Trussell et al. 2006). Hence, it can be concluded that the habitat types influence sponge diversity.

Our results demonstrated a significant relationship between longitude and the number of sponge species (p-value = 0.002) (Figure 5). Although the results indicate that sponge diversity varied in relation to the distance from the west to the east coast of Java, different habitat sampling affected the results. The Prigi Bay and Banyuwangi sites (in the eastern half of Java) were relatively less exposed and had several feasible dive sites, enabling observations to be easily taken in their subtidal zones. In comparison, Pameungpeuk and Gunungkidul were very exposed and risky for diving, making intertidal observations is more practicable than subtidal observations (only one site).

This difference in access to the subtidal zone between east and west could have biased our results. However, it should also be noted that Banyuwangi is close to the biodiverse coral triangle and is highly influenced by the Bali Sea and the Indian Ocean. The current in the strait moves from south (Indian Ocean) towards north (Bali Sea) between September and October during the southeast monsoon season, but towards the south during the ensuing months, resulting in a mixed marine biota composition (Pranomo dan Realino 2006). Furthermore, an upwelling phenomenon that occurs in the strait might increase nutrient concentration in the water column, and this could benefit the sponges in gaining food through their filtration processes (Susilo et al. 2015).

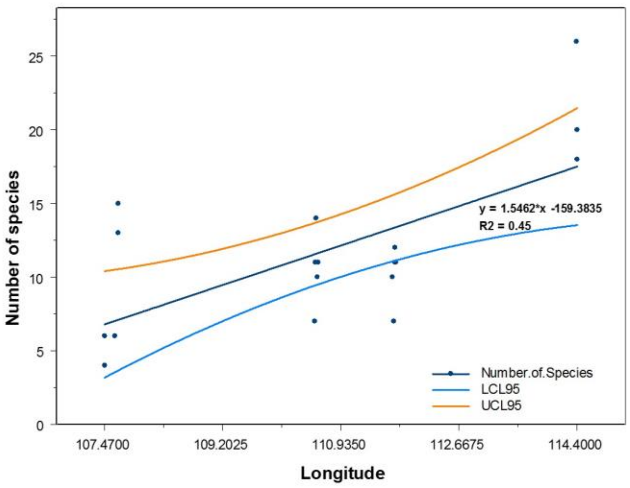

Figure 5. Relationship between longitude and the number of species along the south coast of Java

The nMDS analysis indicates that there is spatial variation in sponge composition in terms of their morphological characters (Figure 6).

Prigi Bay and Banyuwangi sponges, grouped in one big cluster in the nMDS analysis, were characterized by diverse morphological characters, as the sampling was conducted in the subtidal zones. On the other hand, Pameungpeuk and Gunungkidul sponges are clustered together as they were collected in the intertidal zones, characterized mainly by encrusting and globular sponges. Subtidal zones offer more substrate variability - both stable and unstable substrates - including corals, dead corals, rubble, rock, dead shells, silt and sand, and thus generate many types of sponge attachments (Duckworth and Wolff 2011). Moreover, subtidal zones are less stressful compared to intertidal zones, having less variation in physical parameters and less physical disturbances. Therefore, many crumbly and brittle sponges with vulnerable morphologies can thrive in the subtidal zone (Bell and Smith 2004). In addition, sponges' larval settlement is better in subtidal than intertidal habitats, because they have lower water velocities thus enhancing the opportunity for larvae to contact suitable substrates. Therefore, many types of sponges can be found in subtidal habitats (Maldonado 2006).

In general, shallow waters sponges along the south coast of Java are diverse and show tangible differences in term of growth form between intertidal and subtidal zones. Although the study did not observe sponges in the subtidal and intertidal in the same locations, the information provides baseline data that is useful for ensuing studies. Researching sponge diversity and abundance in relation to habitat conditions adds to our understanding of factors governing marine biodiversity and puts decision-making about its conservation on a firmer footing.

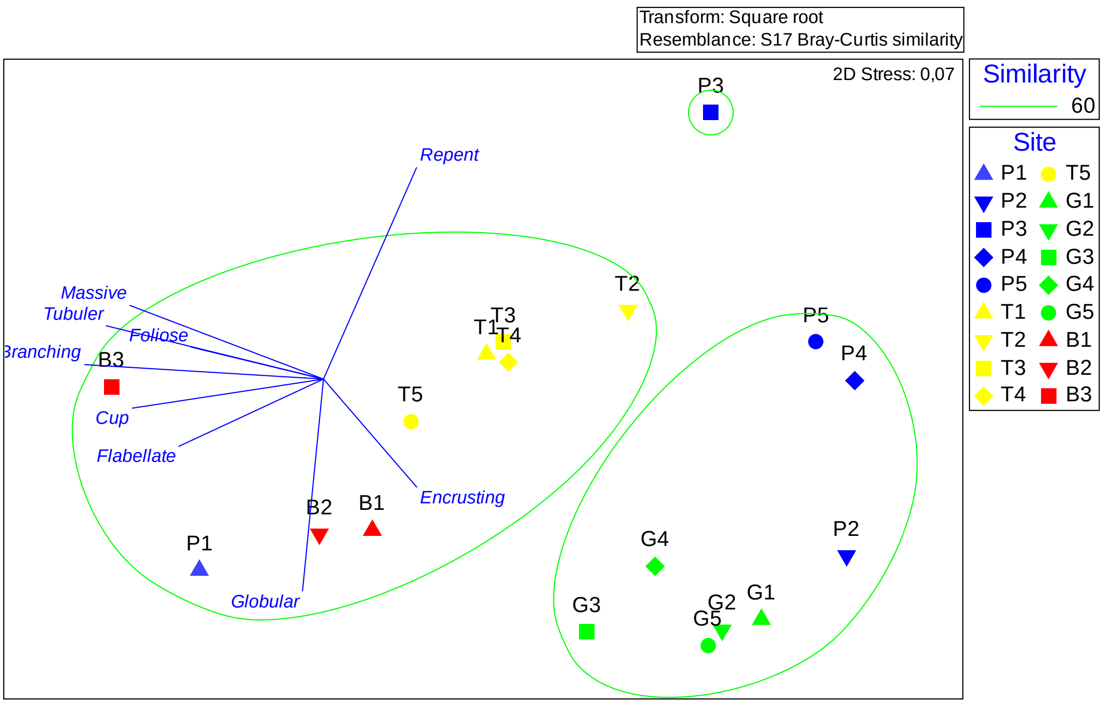

Figure 6. nMDS of sponges' morphological characters at 18 study sites in the south coast of Java (P: Pameungpeuk; T: Prigi Bay; G: Gunungkidul; B: Banyuwangi; numbers indicate the station)

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Table S1. Species list and distribution of sponges along the south coast of Java, Indonesia. P1-5= Pamengpeuk, T1-5= Prigi Bay, G1-5= Gunungkidul, and B1-3= Banyuwangi; "-" indicates absent, while "+" indicates present; "*" = subtidal, without asterisk = intertidal, M: massive, E: encrusting, F: flabellate, Fo: foliose, T: tubular, C: cup, R: repent, B: branching, G: globular

Order/Species	Morphology	Pameungpeuk					Pigi Bay					Gunungkidul					Banyuwangi		
		P1*	P2	P3	P4	P5	T1*	T2*	T3*	T4*	T5*	G1	G2	G3	G4	G5	B1*	B2*	B3*
Agelasida																			
Agelas ceylonica	M	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Prosuberites sp.	E	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Astrophorida																			
Rhabdastrella sp.	M	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Axinellida																			
Echinodictyum sp.	M	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Reniochalina sp.	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
Myrmekioderma sp.	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Biemnida																			
Biemna sp.	T	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-
Biemna triraphis	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Biemna fortis	M	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Bubarida																			
Liosina sp.	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Acanthella cavernosa	M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Acanthella pulcherrima	F	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clionaida																			
Spheciospongia inconstans	M	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+
Spheciospongia vagabunda	M	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spheciospongia congenera	E	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cliona aff utricularis	E	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-
Cliona sp.	E	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-
Cliona sp2.	E	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	-	-	-
Dendroceratida																			
Aplysilla sp.	E	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Dictyoceratida																			
Dyisiydea sp.	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Hyrtios sp.	M	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	+
Ircinia sp.	E	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Ircinia sp2.	M	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ircinia sp3.	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Lamellodysidea herbacea	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
Haplosclerida																			
Acanthostrongylophora ingens	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+
Amphimedon paraviridis	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Amphimedon sp.	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Callyspongia sp	R	-	-	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-
Callyspongia sp2.	B	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Callyspongia sp3.	B	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Callyspongia sp4.	B	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+
Callyspongia sp5.	T	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-
Dasychalina fragilis	B	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	+	+
Gelliodes fibulata	B	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	+	-	+
Gelliodes sp.	B	-	-	-	-	-	+	-	-	+	+	-	-	-	-	-	-	-	-
Haliclona (Reniera) sp.	M	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haliclona (Reniera) sp2.	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Haliclona (Reniera) sp3.	E	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Haliclona (Reniera) sp4.	T	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Haliclona (Reniera) sp5.	E	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Haliclona (Reniera) sp6.	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Haliclona sp.	E	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-
Haliclona sp2.	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
Haliclona sp3.	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Haliclona sp4.	E	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	-	+	-
Haliclona sp5.	M	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Haliclona (Gellius) sp.	M	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-

Haliclona (Gellius) sp2.	M	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Haliclona (Gellius) sp3.	E	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	-	-	-
Haliclona (Gellius) sp4.	E	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	-	-	-
Niphates aff nitida	R	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Niphates olemda	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+
Niphates sp.	M	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-
Neopetrosia exigua	M	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Oceanapia sp.	T	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oceanapia cf amboinensis	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+
Ocenapia sp2.	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Petrosia (Petrosia) hoeksemai	M	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Petrosia (Petrosia) nigricans	M	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xestospongia sp.	M	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Xestopsongia sp2.	M	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+
Xestospongia testudinaria	C	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Homosclerophorida																			
Plakortis lita	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Poecilosclerida																			
Clathria sp.	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Clathria sp2.	E	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Clathria sp3.	E	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Clathria basilana	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Clathria cervicornis	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Clathria (Isociella) eccentric	M	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clathria reinwardti	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Iotrochota sp.	M	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Iotrochota baculifera	E	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-
Mycale sp.	E	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
Mycale sp2.	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Tedania sp.	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
Ulosa sp.	M	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Ulosa stuposa	B	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Scopalinida																			
Stylissa massa	M	-	-	+	-	-	+	-	-	-	+	-	-	-	+	-	+	+	+
Suberitida																			
Aaptos suberitoides	M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	+	+
Amorphinopsis excavans	M	-	-	+	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-
Axinyssa sp.	M	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Halichondria sp.	E	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Hymeniacidon sp.	E	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Suberites sp.	E	-	+	-	+	+	-	-	-	-	-	-	-	+	-	+	-	-	-
Tethyida																			
Tethya robusta	G	+	+	-	+	-	-	-	-	-	-	+	+	+	+	+	-	-	-
Tethya sp.	G	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetractinellida																			
Ancorina sp.	G	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-
Cinachyrella australiensis	G	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Theonella sp.	T	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-
Jaspis sp.	E	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Paratetilla bacca	G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+
Tetilla sp.	G	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetilla sp2.	G	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Verongiida																			
Ianthella basta	Fo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Suberea sp.	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-