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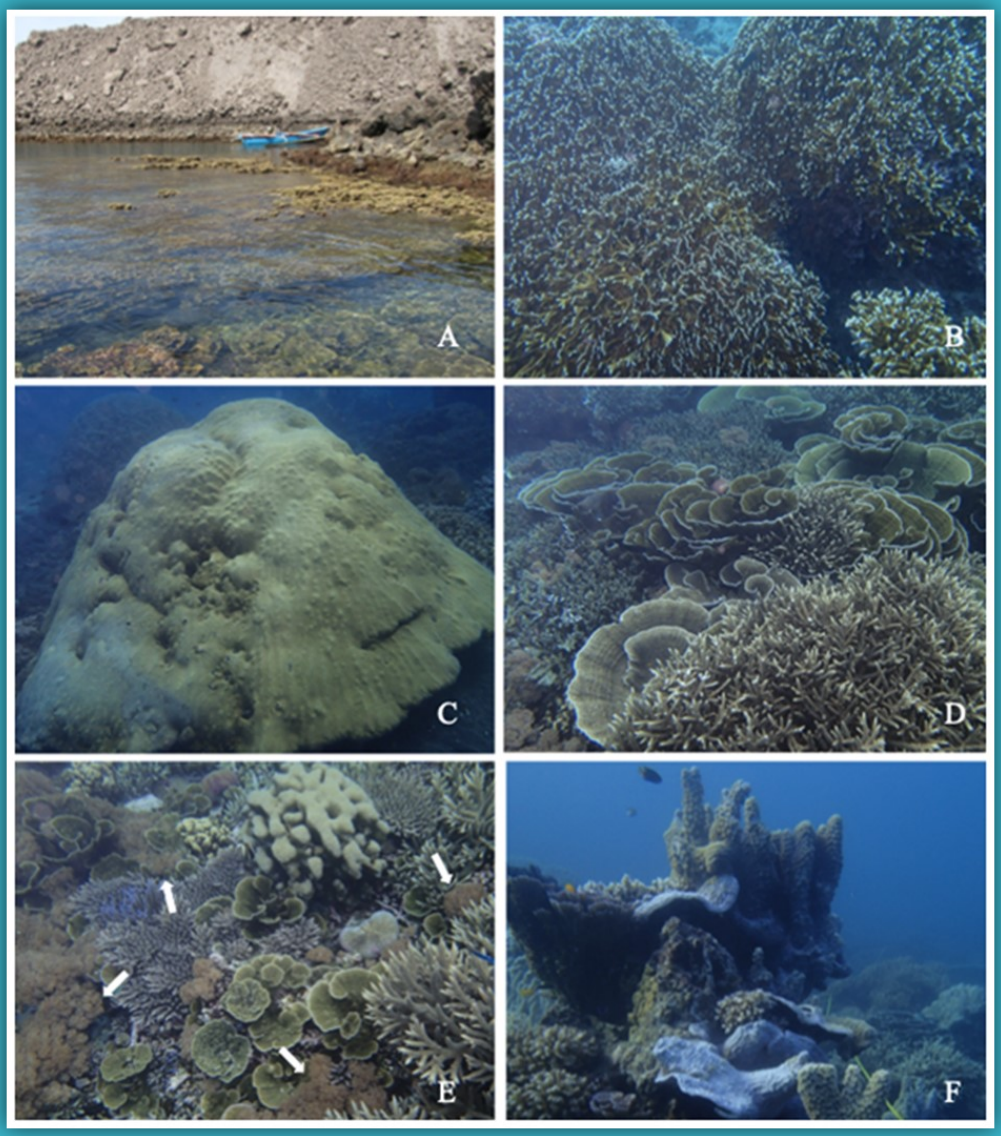

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Alamat (*Address*)
Pusat Penelitian Biologi-LIPI
Kompleks Cibinong Science Center (CSC-LIPI)
Jalan Raya Jakarta-Bogor KM 46,
Cibinong 16911, Bogor-Indonesia
Telepon (021) 8765066 - 8765067
Faksimili (021) 8765059
Email: berita.biologi@mail.lipi.go.id
jurnalberitabiologi@yahoo.co.id
jurnalberitabiologi@gmail.com

Keterangan foto cover depan: Stony corals community on the shallow-waters of the Krakatau Islands
(*Notes of cover picture*): *Komunitas karang batu pada perairan dangkal Kepulauan Krakatau* 114 (*as in page 114*).

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RAPID SURVEYS REVEAL HEALTHY CORAL-SPONGE COMMUNITIES ON KRAKATAU REEFS

[Kaji Cepat Ungkap Kondisi Sehat Komunitas Spons Karang Pada Terumbu Karang Kepulauan Krakatau]

Singgih Afifa Putra

Lembaga Pengembangan dan Pemberdayaan Pendidik dan Tenaga Kependidikan
Bidang Kelautan Perikanan Teknologi Informasi dan Komunikasi, Jl. Diklat No. 30 Pacellekang, Pattallassang, Gowa, Sulawesi Selatan, Indonesia.
email: singgih.afifa@kemdikbud.go.id

ABSTRAK

Kepulauan Krakatau yang terletak di Selat Sunda telah mendapat dampak yang signifikan dari bencana erupsi vulkanik pada Tahun 1883 dan 2018 yang lalu. Habitat laut di wilayah ini sangat jarang dikaji secara ilmiah, baik pada masa sekarang maupun dimasa lalu. Penelitian ini merupakan laporan tentang distribusi dan ekologi komunitas karang dan spons di Komplek Vulkanik Krakatau pada tiga pulau entitasnya yaitu Anak Krakatau, Rakata, dan Panjang. Penelitian ini menggunakan transek garis sepanjang 100 m pada kedalaman sekitar 5–7 m. Komunitas karang keras dan karang lunak dijumpai hidup dengan varasi tutupan antara 25–53% dan 0–24%. Kerangka karang mati menutupi substrat dasar sebanyak 14–40% dan terlihat tidak berdampak terhadap catatan kelimpahan spons. Komunitas spons mengokupasi 0–6% dari seluruh area kajian, dan terkadang mereka dijumpai sebagai kompetitor karang, membantu pembentukan ekosistem bentik. Spons yang terekam hanya berasal dari kelas Demospongiae, yaitu spesies-spesies Suberitid yang umum dijumpai di perairan Indonesia, e.g., *Amorphinopsis excavans, Protosuberites collaris*, dan *Terpios* sp. Spons penggali (*excavating sponge*) *Cliona* cf. *orientalis* seringkali dijumpai sebagai kompetitor utama karang *Porites* sp., dimana secara agresif tumbuh pada skeleton hidup dari karang tersebut. Selanjutnya, ada dua spons *Haliclona* dan *Mycale relicta*yang mendiami kerangka karang mati. Secara umum, komunitas bentik terlihat sehat dan sebanding dengan lokasi lain serupa yang tidak terdampak aktivitas vulkanik.

Kata kunci: Demospongiae, kompetisi, distribusi, ekologi spons, pemulihan habitat

ABSTRACT

The Krakatau Islands in the Sunda Strait have been significantly impacted by catastrophic volcanic eruptions in 1883 and 2018. The marine habitats are not well studied, neither in the past nor in the present. This research is a report on the distribution and ecology of corals and sponges in the Krakatau Volcanic Complex at the three islands of Anak Krakatau, Rakata, and Panjang. This study used 100 m transects long in 5–7 m depth. Hard coral and soft coral communities are found to live with a coverage varied between 25-53% and 0-24%. Dead coral skeletons covered 14–40% of the surveyed area and did not seem to affect the abundance of sponges recorded. The Sponges occupied 0–6% of the area, and they often acted as coral competitors, shaping the benthic ecosystems. The recorded sponges only belong to the Demospongiae class, which are the Suberitid species that are commonly found in Indonesian waters, e.g., Amorphinopsis excavans, Protosuberites collaris, and Terpios sp. The excavating sponge *Cliona* cf. *orientalis* was frequently found to be a successful competitor of massive *Porites* sp., aggressively overgrowing live parts of the coral. Two *Haliclona* species and *Mycale relicta* colonized dead coral skeleton. Overall, the benthic communities appear healthy and are comparable to other similar locations that are not affected by volcanic activity.

Keywords: Demospongiae, competition, distribution, sponge ecology, habitat recovery

INTRODUCTION

The coral reefs of the Krakatau Islands located in the Indonesian Sunda Strait have been strongly damaged by the devastating series of volcanic eruptions in 1883 that were among the most violent recorded in history (Thornton and Rosengren 1988). After this geologic event, a number of surveys were conducted to assess the recovery of terrestrial ecosystems, but very little was reported from the marine environments (e.g., Dammerman, 1922). In 2018 partial collapse of Anak Krakatau caused the Sunda Strait tsunami (Williams et al. 2019; Walter *et al.,* 2019; Muhari *et al*., 2019). However, local marine ecosystems are not presently investigated in much detail to establish baseline knowledge of the benthic marine life. Few isolated studies are available on corals (Sukarno and Suharsono 1985; Starger *et al.,* 2010; Putra *et al*. 2014), stomatopods (Barber *et al*., 2002), and giant clams (DeBoer *et al.,* 2014), but far less is known about the local sponges.

Lacking baseline knowledge about sponges is a significant omission for an environment that may undergo occasional catastrophic remodelling. Sponges often accurately reflect environmental conditions (Alcolado 2007; Cebrian *et al.,* 2007; Schönberg and Fromont 2014), and it would have been of great value to obtain data on their recolonization after the historical eruptions. They not only reflect the environment but also shape it. As filter feeders they clear the water column and recycle

*Kontributor Utama
*Diterima: 16 Agustus 2019 - Diperbaiki: 4 Maret 2020 - Disetujui: 28 April 2020

nutrients (Jiménez and Ribes 2007; Hoffmann *et al*. 2009; Leys *et al.,* 2011), they are food for spongivores and hosts or substrate for a large range of epi- end endobionts, including significant microbial biomass (Belmonte *et al.,* 2015; Powell *et al.,* 2015; Burkepile *et al.,* 2019). They consolidate bottom materials by overgrowth (Wulff 2008) or weaken calcareous structures as bioeroders (Rützler 1975; van Soest 2007). Within the community, they belong to the top spatial competitors (Bell and Barnes 2003). Some sponge species have been proposed as good bioindicators suitable or needed during the monitoring of marine habitats (Cleary and De Voogd 2007; Schönberg 2015). An understanding of the diverse ecologies and distributions of the locally dominant sponges is important to manage marine environments and to understand how their ecosystem services shape the adjacent benthic communities.

Surveys on the diversity and distribution of sponges have been conducted throughout Indonesia (Appendix 1), but sponges at the Krakatau Volcanic Complex remain largely unknown. The present study assessed the areal cover of the three benthic groups sponges, soft and hard coral prior to the 2018 Sunda Strait tsunami. This approach included conspicuous bio-eroding sponges. The most dominant sponge species are listed, and observations on sponge-coral interactions recorded.

MATERIALS AND METHODS

Study locations

Field surveys were conducted from December 2012 to January 2013 (rainy season) at three islands of the Krakatau Volcanic Complex (see coordinates in Table 1). The Krakatau Volcanic Complex is a nature reserve located in the Sunda Strait between Sumatra and Java Island, Indonesia, consists of Rakata (formerly Krakatau Island), Sertung (formerly Verlaten Island), Panjang (formerly Lang Island or Krakatau kecil), and Anak Krakatau (Figure 1). Krakatau volcano is well known for its catastrophic eruption in August 1883. The series of explosions during that time were sterilized all ecosystem life entirely in the islands and surrounding area (Mandeville *et al.,* 1996). After the eruption, this region becomes a natural laboratory to study island succession and ecosystem development (Thornton *et al.,* 1988; Whittaker *et al.,* 1989). Almost five decades later, In 1930, Anak Krakatau volcano emerged from underwater of the central complex of Krakatau Islands. This new island was claimed has a new timeline on colonization for living organisms (Thornton *et al.,* 1992; Putra *et al.,* 2014). In December 2018, a sector collapse event occurred from the South-western side of Anak Krakatau volcano that triggered a deadly tsunami in the Sunda Strait (Walter *et al.,* 2019).

Table 1. Study locations, description, sponge records, and their host in Krakatau Islands. *(Lokasi penelitian, deskripsi, dan temuan komunitas spons di Kepulauan Krakatau).*

Study site *(Stasiun Penelitian)*	Locations *(Lokasi)*	Coordinates (DD) *(Koordinat (DD))*	Site description *(Deskripsi)*
Site 1	Anak Krakatau Island	06.09136°S 105.41795°E	Slope, substrate mainly basalt rocks *(Tubir, Substrat umumnya adalah batuan beku)*
Site 2	Rakata Island	06.14285°S 105.42282°E	Flat with black sand domination and rocks *(Rataan dengan pasir hitam mendominasi dan batu)*
Site 3	Rakata Island	06.13561°S 105.45014°E	Flat with rock and black sand *(Rataan dengan batu dan pasir hitam)*
Site 4	Rakata Island	06.14657°S 105.46241°E	Flat and slope after reef crest *(Rataan dan tubir setelah lereng terumbu)*
Site 5	Panjang Island	06.09782°S 105.46046°E	Flat with sand dominant, coral only occur to 1-5 m depth *(Rataan dengan dominasi pasir, karang hanya dijumpai pada kedalaman 1-5 m)*
Site 6	Panjang Island	06.09729°S 105.46157°E	Flat with sand dominant, corals only occur to 1-5 m depth *(Rataan dengan dominasi pasir, karang hanya dijumpai pada kedalaman 1-5 m)*

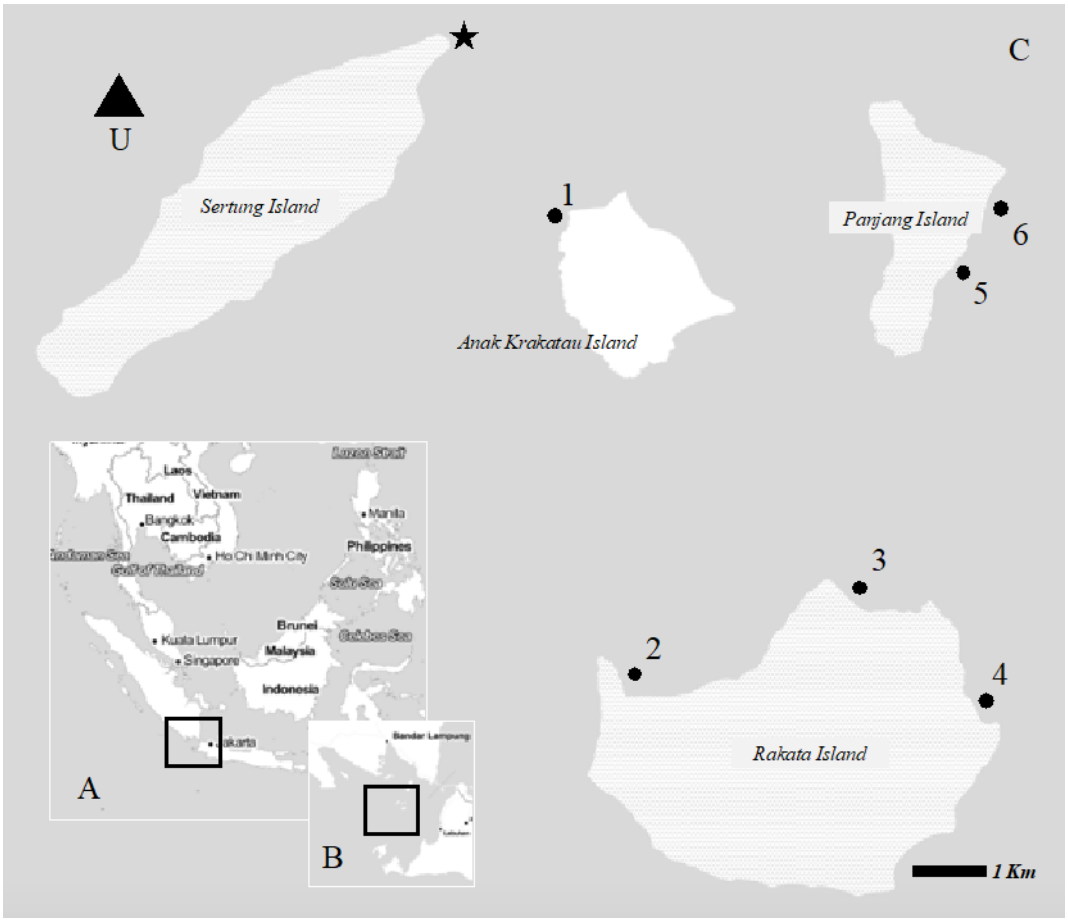

Figure 1. Map of the study location. A – Location of Sunda Strait. B – Location of the Krakatau Volcanic Complex in the Sunda Strait. C – Sampling sites (dots) in the Krakatau Islands Nature Reserve. Stars indicate brackish water lake in Sertung Island that no longer existed. Map source: Stamen Design 2020 *(Peta lokasi penelitian. A – Lokasi Selat Sunda. B – Lokasi Komplek Vulkanik Krakatau di Selat Sunda. C. Stasiun pengamatan (titik) di kawasan Cagar Alam Kepulauan Krakatau. Tanda bintang menunjukkan lokasi danau air payau di Pulau Sertung yang sudah tidak dijumpai lagi. Sumber Peta: Stamen Design 2020).*

Benthic sampling and data analysis

Coral community (including dead corals) was observed in 5–7 m depth using SCUBA with 100 m line intercept transects at six stations (Figure 1C) (English *et al.,* 1997). No replications were performed for this observation. Dominant sponges were also assessed with these transects (Schönberg 2015). However, strong current during the rainy seasons around study sites prompts sponge samples difficult to be collected. The observation also had to be done quickly due to the warning alert after September 2012 eruption (lava flow deposit caused ~100m shoreline extended). Therefore, macro-morphological identification of sponges was performed to the closest taxon level using in situ photography and videography comparing obtained imagery to images from identification guides (Schönberg 2000; Hooper and van Soest 2002; van Soest *et al.,* 2020). Benthic community cover was presented as a percentage value based on their prevalence (in centimeters) along the transect lines of each site. Coral cover was evaluated as poor (<25%), fair (25–50%), good (51–75%), and excellent (>75%) conditions.

RESULTS AND DISCUSSION

Historic accounts on marine habitats in the Sunda Strait are sparse (Barber *et al.,* 2002; Starger *et al.,* 2010; Putra *et al.,* 2014), even though the local Krakatau Volcanic Complex would represent a promising case to understand coral reef recovery after a natural catastrophe. In the Sunda Strait, 213 species from 57 genera of stony corals were reported, with only 16 species (6 genera) recorded from Sertung Island (Sukarno and Suharsono 1985). This number were comparable to other locations within western Indonesia due to the regional variation in Indonesia coral diversity (Edinger *et al.,* 2000). The diversity of corals in the western Indonesia (including Java Sea) is the lowest in Indo-Pacific region (Edinger *et al.,* 2000; Hoeksema and Putra 2000; Veron *et al.,* 2015; Siringoringo *et al.,* 2019).

The most recent reports on the condition of coral reefs of the Krakatau Islands was provided by Putra *et al.* (2014), i.e. >130 years after the famous Krakatau eruptions and 4 years before the Sunda Strait tsunami. Stony corals such as *Acropora*, *Porites, Montipora, Millepora, Pocillopora,* and *Echinopora* were common and displayed large colony size of usually > 50 cm in diameter (Putra *et al.,* 2014). Solitary hard corals such as *Fungia, Ctenactis, Halomitra, Sandalolitha,* and *Heliofungia* were also found (the taxonomic status was not updated). The general reef condition at the Krakatau Islands was described as fair to good (25–75% coral cover). This was in accordance with results from the present intercept study, during which live corals made up 25–53% of the surveyed area. Soft corals covered 0-24% of the area (Figure 2). Apart from

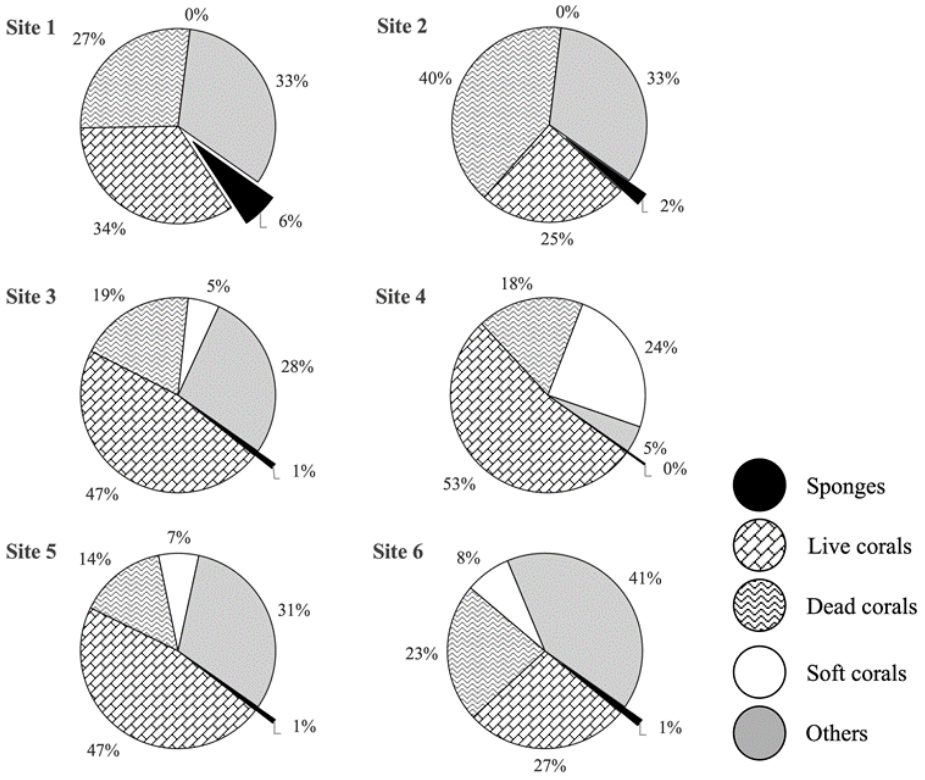

Figure 2. Benthic cover at the Krakatau Islands assessed by intercept transect in 2012/2013. Site 1 at Anak Krakatau Island, Site 2, 3, and 4 at Rakata Island, Site 5 and 6 at Panjang Island. *(Persentase tutupan komunitas bentik pada lokasi pengamatan di Kepulauan Krakatau, menggunakan transek menyinggung pada Tahun 2012/2013. Stasiun 1 terletak di Anak Krakatau, Stasiun 2, 3 dan 4 terletak di Pulau Rakata, dan Stasiun 5 dan 6 terletak di Pulau Panjang).*

corals little is known about other benthic organisms in this area.

Sponge areal cover in study location ranged from near 0 to 6% (Figure 2), with the densest communities at Anak Karakatau. Differences of sponge abundances between sites may in part rely on the fertilizing effect of repeated influx of volcanic ash (Felitsyn and Kirianov 2002), on availability of hard substrate, or on different current regimes due to locally strong tidal currents (Cleary and De Voogd 2007). While area of dead coral was quantified with 14-40% per study site (Figure 2), no other environmental parameters were quantified, and such patterns cannot be explained. However, at Rakata and Panjang Island hard and soft coral cover was high, and sponge cover tended to be low (Figure 2). These circumstances suggest that the cnidarians may mostly outcompete sponges in the surveyed habitats.

Further assessment of sponge distributions exclusively relied on identifications from under-water imagery. All observed sponges belonged to the Demospongiae and occurred at all islands that were investigated (see Fig. 2). Here, seven species from four orders were comparatively common (Clionaida, Haplosclerida, Poecilosclerida, Suberitida). This group included *Amorphinopsis excavans* Carter, 1887, *Cliona* cf. *orientalis* Thiele, 1900, *Haliclona (Reniera) cinerea* (Grant, 1826), *Haliclona* sp., *Mycale relicta* Annandale, 1924, *Protosuberites collaris* Annandale, 1924, *Terpios* sp (Appendix 2). Four of these species were already recorded from a previous study in a brackish lake on Sertung Island (formerly Verlaten Island), which is part of the Krakatau Islands (Annandale, 1924; Figure 1). However, considering only identification by underwater imagery, I expect more species will be found with further surveying. The present study in the fully marine environment detected only these three common demosponge species: *C.* cf. *orientalis*, *Haliclona* sp. and *Terpios* sp. Recently also reported from various regions in Indonesia (Madduppa *et al.,* 2017; Hadi *et al.,* 2018; Marlow *et al.,* 2019). Overall, most species belonged to the Suberitida.

The high density of hard corals almost found at all observation sites (Figure 3a-f). However, some local sponges were observed to attack and kill hard corals such as massive *Porites* sp. (Fig. 4a-f). Beta morphology, encrusting specimens of *Cliona* cf. *orientali*s overgrew reef-building corals and acted as an aggressive and competitive species in this interaction (Fig. 4f). This species belongs to the *Cliona viridis* species complex, species of which have previously been recognized to have key ecological roles in their habitat (Schönberg 2000, 2001; Schönberg *et al.,* 2017). *C. orientalis* itself is known as a successful colonizer on coral reefs and a species that can kill corals (Schönberg 2000, 2003; Schönberg and Wilkinson 2001). During earlier studies this clionaid sponge or morphologically similar species was frequently found in eastern Indonesia (van Soest 1990; Marlow *et al.,* 2019).

Overall, the coral-sponge communities were comparable to other sites in Indonesia (de Voogd *et al.,* 1999; Bell and Smith 2004; de Voogd and Cleary 2008; van Der Ent *et al.,* 2016), and the hard coral diameters and the live cover were good (Figure 2). This suggests that the benthos had recovered from the 1883 volcanic catastrophe and had adapted to or survived consecutive pumice falls. This study provides a rapid benthic assessment from a time prior to the 2018 Sunda straight tsunami, which may have caused another ecologic disaster for the local benthos. Data in the present context remain very sketchy, and further studies are needed to create a better baseline data to understand coral reef communities in areas with active volcanism.

CONCLUSION

The benthic community had recovered and adapted in the shallow-water of the Krakatau Volcanic Complex. Coral-sponge community occupied all of the study area. Sponge colonization on the Anak Krakatau Island was the most suitable space for occupation. The bio-eroding sponge from *Cliona* species complex was the most aggressive and dominant sponge species found to competitive and colonize of the Krakatau coral reefs.

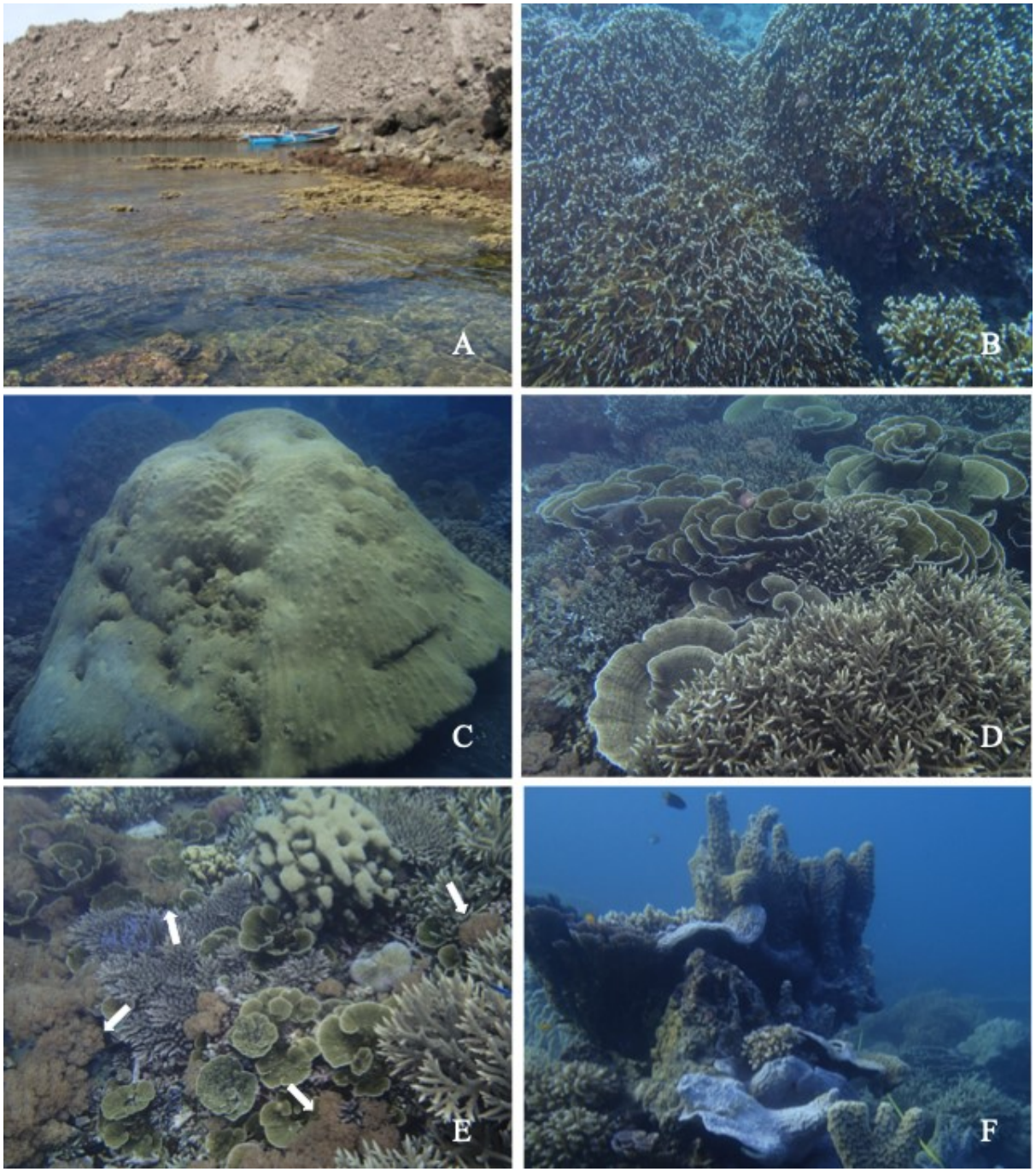

Figure 3. Stony corals community on the shallow-waters of the Krakatau Islands. A – Dense community of hard corals (mainly *Montipora* sp.) in the intertidal zone of Anak Krakatau Island (Site 1), B – Hydrocoral colony (*Millepora* sp.) in the Rakata Island (Site 2), C – Giant colony of Porites on Site 3 in the Rakata Island, D & E – Hard corals colony on Site 4 in the Rakata Island, arrow on E showing competition of Xeniid soft coral between hard corals colonies, F – Various hard corals colonized basalt rock in the Panjang Island (Site 6). *(Komunitas karang batu pada perairan dangkal Kepulauan Krakatau. A – Komunitas padat karang keras (didominasi Montipora sp.) pada zona pasang surut Pulau Anak Krakatau (Stasiun 1). B – Koloni Hydrocoral (Millepora sp.) di Pulau Rakata (Stasiun 2). C – Koloni besar Porites sp. di Stasiun 3 di Pulau Rakata. D & E – Koloni karang keras pada Stasiun 4 di Pulau Rakata, panah pada Gambar E menunjukkan kompetisi karang keras dengan karang lunak Xeniid. D – Beberapa jenis karang keras mengkoloni batu basal di Pulau Panjang).*

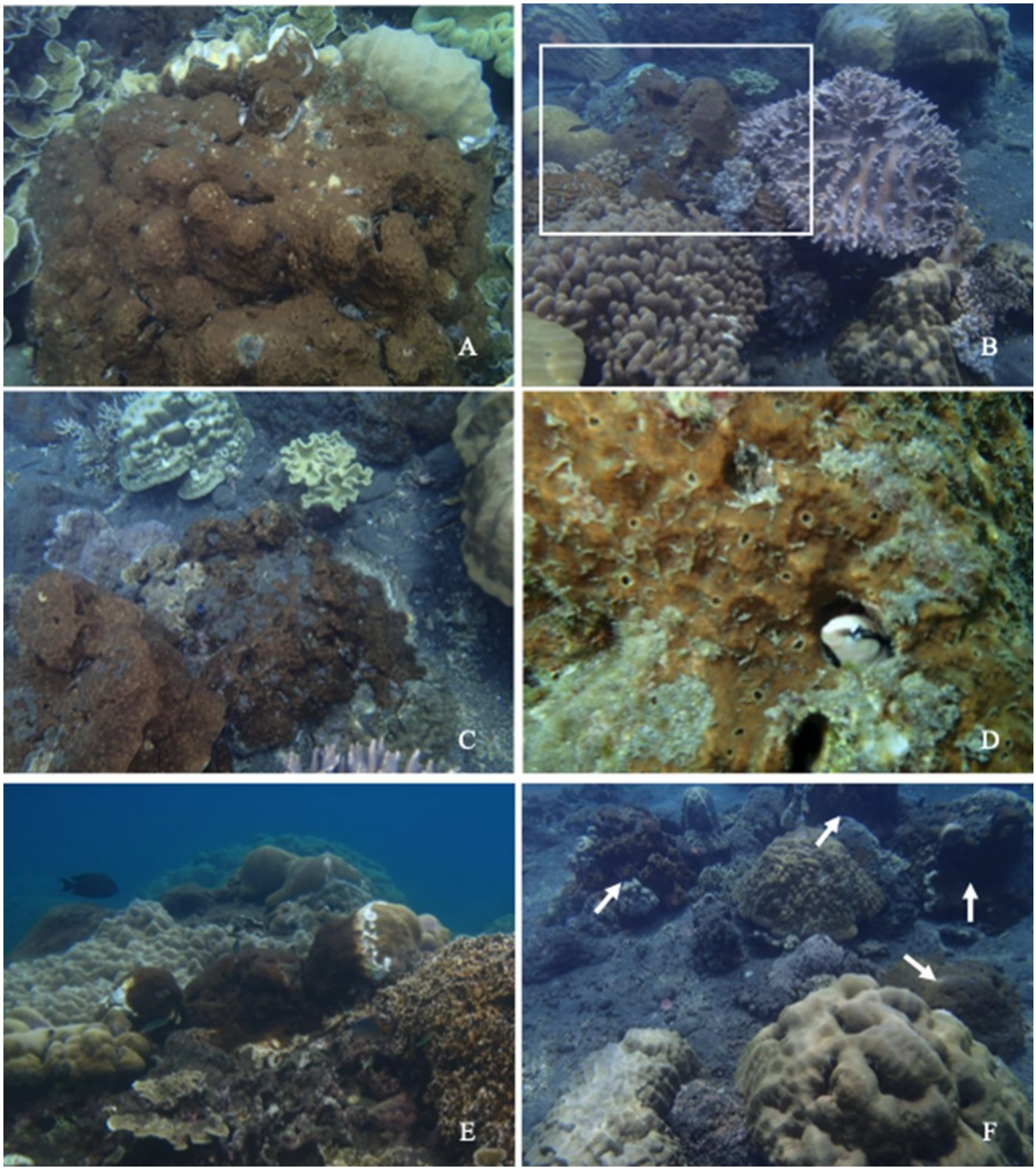

Figure 4. Sponge community on the shallow-waters of the Krakatau Islands. A & B – The excavating sponge (*Cliona* cf. *orientalis* Thiele 1900) covered this the *Porites* sp. C – The Enlarged view of the observed sponges indicated by white square in Figure B. D – Close up of excavating sponge *Cliona* cf. *orientalis* inhabited by Lance blenny *Aspidontus dussumieri*. E – Three colonies of *Porites* sp. that were covered by the sponge. F – Specimens of *C.* cf. *orientalis* Thiele 1900 (arrows) as they are commonly found at Rakata Island. *(Komunitas spons yang dijumpai pada perairan dangkal di Kepulauan Krakatau. A & B - Spons penggali (Cliona cf. orientalis Thiele 1900) menutupi koloni karang Porites sp. C – Foto pembesaran spons yang dikaji pada Gambar B (dalam kotak). D. Foto jarak dekat spesies spons Cliona cf. orientalis yang berasosiasi dengan ikan Blenny Aspidontus dussumieri. E – Tiga koloni karang Porites sp. ditutupi oleh spons yang dimaksud. F – Spesimen C. cf. orientalis (panah) yang umum ditemui di Pulau Rakata).*

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Appendix 1. List of bibliographic records of sponge research conducted in Indonesia region. *(Daftar pustaka kajian ilmiah komunitas spons di wilayah Indonesia).*

Author *(Kontributor)*	Locations *(Lokasi)*	Highlights *(Hasil Kajian Utama)*
(Ridley, 1885)	Maluku	A new sponge species *Amphilectus challenger* was discovered from deep sea of Moluccas strait *(Spons laut baru ditemukan dengan nama ilmiah Amphilectus challenger dari laut dalam Selat Makassar)*
(Topsent, 1897)	Ambon, Maluku	Describe more than 80 species of sponges, 27 were new species *(Mengungkap lebih dari 80 spesies spons laut, dimana 27 diantaranya merupakan baru bagi ilmu pengetahuan)*
(Thiele, 1899)	Kema Bay, NE Sulawesi	A total of 31 species of sponges were described, 23 were new species *(Sejumlah 31 spesies spons laut diungkap, dengan 23 diantaranya merupakan spesies baru)*
(Jima, 1900)	Various locations from Siboga Expedition (Indo-Australia)	A total of 15 families were represented in the Siboga collection of the Hexactinellida *(Sejumlah 15 keluarga spons laut diungkap dari koleksi Kelompok Hexactinellida dari Ekspedisi Siboga)*
(Thiele, 1900)	Ternate, Maluku	Revised of siliceous sponges from Ternate *(Revisi spons silika dari Pulau Ternate)*
(Annandale, 1924)	Sunda Strait	Described four species from brackish pool of Sertung Island (formerly Verlaten Island), Krakatau Islands *(Menggambarkan 4 spesies spons dari danau asin/payau di Pulau Sertung (sebelumnya dikenal Pulau Verlaten), Kepulauan Krakatau)*
(Brøndsted, 1934)	Various locations	28 species of sponges were described from Indo-Autralian waters, 8 were new to science *(28 spesies spons laut dari perairan Indo-Australia digambarkan, 8 diantaranya baru bagi ilmu pengetahuan)*
(van Soest, 1990)	Eastern Indonesia	56 species of sponges were found to be common in Eastern Indonesia *(56 spesies spons laut dikategorikan umum djumpai di perairan Indonesia Timur)*
(Amir, 1992)	Eastern Indonesia	61 species were identified from Maisel, Sumba, Sumbawa, and Bahuluang (Eastern Indonesia) *(61 spesies spons laut diidentifikasi dari Maisel, Sumba-Sumbawa, Bahuluang* (*Indonesia Timur*)
(van Soest, 1998)	Ambon, Jedan, Selayar, Komodo, Java, and Papua (formerly Irian Jaya)	A new Poecilosclerid Sponge species *Desmapsamma vervoorti* was described *(Spesies baru Spons Poecilosclerid Desmapsamma vervoorti diungkap)*
(de Voogd *et al.*, 1999)	SW Sulawesi	Distribution pattern of shallow water reef sponges were described from Spermonde Archipelago. The highest number of sponge species richness and abundance was found in a middle-shelf reef, whereas the lowest was found in an inner-shelf reef *(Pola distribusi spons laut perairan dangkal digambarkan dari Kepulauan Spermonde. Jumlah spesies spons tertinggi baik kekayaan maupun kepadatan dijumpai pada zona terumbu tengah, sedangkan jumlah terendah dijumpai pada terumbu bagian dalam)*
(de Weerdt and van Soest, 2001)	SW Sulawesi and NE Sulawesi	A new sponge species, *Haliclona (Halichoclona) vanderlandi* was described from Take Bone Rate Islands, Kapoposang Island (SW Sulawesi) and Manadotua Island (NE Sulawesi). *(Spesies baru spons laut, Haliclona (Halichoclona) vanderlandi dari Take Bone Rate, Pulau Kapoposang (Sulawesi Selatan bagian Barat), dan Pulau Manadotua (Sulawesi Utara bagian Timur)).*
(de Voogd and van Soest, 2002)	SW, NE, and SE Sulawesi, Sumba	Descriptions of seven species of Petrosia collected from SW Sulawesi reefs (Eastern Indonesia), and two of which were new to science: *Petrosia (Petrosia) alfiani*. and *Petrosia (Petrosia) hoeksemai (Deskripsi 7 spesies Petrosia yang dikoleksi dari karang Sulawesi Selatan (Indonesia Timur), dan 2 spesies diantaranya adalah spesies baru: Petrosia (Petrosia) alfiani dan Petrosia (Petrosia) hoeksemai)*

Appendix 1. List of bibliographic records of sponge research conducted in Indonesia region. *(Daftar pustaka kajian ilmiah komunitas spons di wilayah Indonesia). (continued)* lanjutan

Author *(Kontributor)*	Locations *(Lokasi)*	Highlights *(Hasil Kajian Utama)*
(Calcinai *et al.*, 2004)	Lembeh Strait, NE Sulawesi	The discovery of the association between the sponge *Desmapsamma anchorata* and the octocoral *Carijoa riisei* on an Indonesian reef.*(Penemuan hubungan unik antara spons Desmapsamma anchorta dan Octocoral Carijoa riisei di karang Indonesia).*
(Bell and Smith, 2004)	Wakatobi Islands (formerly Tukangbesi Islands), SE Sulawesi	The influence of sedimentation, depth and substratum angle on sponge assemblages in the Wakatobi region, SE Sulawesi, Indonesia was studied *(Kajian pengaruh sedimentasi, kedalaman, dan substrat dasar terhadap komunitas spons laut di wilayah Kepulauan Wakatobi, Sulawesi Tenggara, Indonesia).*
(de Voogd, 2004)	NE Bali, SW & NE Sulawesi, and NE Kalimantan	A new sponge species *Callyspongia (Euplacella) biru* is described from various locations within Indonesia. *(Spesies baru spons laut Callyspongia (Euplacella) biru diungkap dibeberapa lokasi di Indonesia)*
(Calcinai *et al.*, 2005)	NE Sulawesi	Six excavating sponge species from the Indo-Pacific area (North Sulawesi, Indonesia, and the Philippines) are described here. Four of those species recorded in Indonesia were new (*Cliona albimarginata, Cliona favus, Cliona liangae, and Cliona utricularis*) *(Enam spesies baru spons laut penggali dari wilayah Indo-Pasifik (Sulawesi Utara dan Filipina) telah ditemukan. Empat diantaranya adalah baru* (*Cliona albimarginata, Cliona favus, Cliona liangae, and Cliona utricularis)).*
(de Voogd *et al.*, 2006)	SW Sulawesi	This paper studied spatial patterns of sponge similarity among sites were significantly related to remotely sensed environmental variables, the degree of human settlement and depth, but not to the distance between sites *(Kajian pola spasial kesamaan antar lokasi yang signifikan dipengaruhi oleh variable lingkungan, keberadaan manusia, serta kedalaman, namun tidak dengan jarak antar lokasi)*
(Calcinai *et al.*, 2006)	NE Sulawesi	The symbiotic association between the new sponge species *Mycale vansoesti* and the coralline alga *Amphiroa* sp. from the Bunaken Marine Park was described *(Hubungan symbiosis antara spesies baru spons laut Mycale vansoesti dan alga coralline Amphiora sp. dijumpai di Taman Nasional Bunaken)*
(Azzini *et al.*, 2007)	NE Sulawesi	A new sponge species *Coelocarteria agglomerans* was described from the reef slopes of Bunaken National Marine Park, Indonesia *(Spesies spons baru Coelocarteria agglomernas ditemukan di tubir karang Taman Nasional Bunaken, Indonesia).*
(Calcinai *et al.*, 2007)	NE Sulawesi	A new species of the boring sponge genus Aka, *Aka microterebrans* was described from Bunaken Island. *(Spesies baru spons laut penggali dari genus Aka, Aka microterebrans di Pulau Bunaken).*
(de Voogd and van Soest, 2007)	NE Sulawesi	A new megacanthoxea- bearing tetillid *Acanthotetilla celebensis* (Spirophorida: Tetillidae) was described from Bunaken Island, Indonesia *(Spons Tetillid Acanthotetilla celebensis (Spirophorida) ditemukan di Pulau Bunaken, Indonesia)*
(de Voogd *et al.*, 2008)	NW Java	*Agelas linnaei* (Agelasida: Agelasidae) was described from the Seribu Islands reef complex *(Agelas linnaei (Agelasida: Agelasidae) ditemukan di rataan terumbu Kepulauan Seribu)*

Appendix 1. List of bibliographic records of sponge research conducted in Indonesia region. *(Daftar pustaka kajian ilmiah komunitas spons di wilayah Indonesia). (continued)* lanjutan

Author *(Kontributor)*	Locations *(Lokasi)*	Highlights *(Hasil Kajian Utama)*
(de Voogd and Cleary, 2008)	NW Java	Recorded a total of 118 sponge species, 64 genera and 36 families. The sponges variation in composition at higher taxonomic levels was a good indicator of variation at lower taxonomic levels, at least when there was a pronounced environmental gradient *(Mencatat sebanyak 118 spesies spons laut yang terdiri dari 64 genus dan 36 keluarga. Keragaman komposisi pada tingkatan taksonomi yang lebih tinggi merupakan indikasi baik dari keragaman pada tingkatan taksonomi yang lebih rendah, setidaknya menunjukkan gradien lingkungan yang jelas)*
(de Voogd *et al.*, 2009)	NE Kalimantan	A total of 168 sponge species were identified, *Stelletta clavosa, Lamellodysidea herbacea, Niphates* sp., *Ircinia ramosa* and *Petrosia nigricans* were the most common. *(Sejumlah 168 spesies spons laut diidentifikasi, Stelletta clavosa, Lamellodysidea herbacea, Niphates sp., Ircinia ramose, dan Petrosia nigricans merupakan spesies yang paling umum)*
(Abigail *et al.*, 2010)	SE Sulawesi	The loss of hard coral at lower quality sites (some of study sites) mean that these sites are characterised by sponges and algae rather than by any other groups of benthic organisms *(Kerusakan karang keras pada lokasi yang tertentu (buruk) menunjukkan karakteristik lokasi seperti ini lebih mungkin ditumbuhi spons dan alga dibandingkan kelompok organisme bentik lainnya)*
(Smith and Kelly, 2011)	NE Sulawesi	A new species *Podospongia colini* from Torowitan, Northern tip of Sulawesi was described *(Mendeksripsikan spesies spons baru Podospongia colini dari Torowitan, Ujung Utara Pulau Sulawesi)*
(Muricy, 2011)	NE Sulawesi	A new species *Plakortis bergquistae* was described from Bitung, Indonesia *(Spesies spons baru yaitu Plakortis bergquistae dijumpai di Bitung, Indonesia)*
(de Voogd *et al.*, 2013)	NE Kalimantan, SE and NE Sulawesi	First reported on the coral-killing sponge *Terpios hoshino-ta* invaded Indonesia *(Kajian pertama menunjukkan bahwa spons pembunuh karang Terpios hoshinota telah menginvasi perairan Indonesia)*
(Cavalcanti *et al.*, 2013)	Bone Baku and Kudingareng keke, SW Sulawesi	*Leucascus flavus* and *Ascoleucetta sagittate* (Calcarea: Leucascidae) were described from Sulawesi waters *(Spons laut jenis Leucascus flavus dan Ascoleucetta sagittae (Calcarea: Leucascidae) ditemukan di perairan Sulawesi)*
(Becking *et al.*, 2013)	Berau, NE Kalimantan	Recorded a total of 115 sponge species. First report on mangrove sponges from Indonesia *(Pencatatan sejumlah 115 spesies spons, dan merupakan catatan perdana tentang spons yang berasosiasi dengan mangrove di Indonesia)*
(Becking, 2013)	Berau, NE Kalimantan	A new species *Placospongia santodomingoae* was reported from Anchialine lake in Maratua Island *(Spesies baru spons Placospongia santodomingoae dilaporkan dari danau payau di Pulau Maratua)*
(Calcinai *et al.*, 2013)	NE Sulawesi	Described four new sponge species for the Indonesian area: *Chondropsis subtilis, Hymedesmia (Hymedesmia) spinate, Hymedesmia (Stylopus) perlucida,* and *Mycale (Aegogropila) furcate (Empat spesies spons baru dijumlai di wilayah Indonesia: Chondropsis subtilis, Hymedesmia (Hymedesmia) spinate, Hymedesmia (Stylopus) perlucida,* and *Mycale (Aegogropila) furcate)*

Appendix 1. List of bibliographic records of sponge research conducted in Indonesia region. *(Daftar pustaka kajian ilmiah komunitas spons di wilayah Indonesia). (continued)* lanjutan

Author *(Kontributor)*	Locations *(Lokasi)*	Highlights *(Hasil Kajian Utama)*
(van Soest and de Voogd, 2015)	Various locations	A total of 37 species of calcareous sponges from Indonesia were distinguished, of which 16 were new to science, while several others were very poorly known *(Sejumlah 37 spesies spons calcarea dari Indonesia dibedakan, dimana 16 spesies diantaranya adalah baru untuk ilmu pengetahuan, dan beberapa lainnya sangat jarang dikaji)*
(Rossi *et al.*, 2015)	Eastern part of Sulawesi Island	A first baseline knowledge for *Chalinula nematifera*, along the eastern coast of the Sulawesi Island *(Kajian awal pertama untuk Chalinula nematifera di sepanjang pantai Timur Pulau Sulawesi)*
(Alvarez *et al.*, 2016)	Various locations from Museum collections	Nine species of the family Axinellidae (in five genera) and three new species*, Axinella badungensis, A. balinensis.* and *Phycopsis pesgalli*. were recorded from Indonesian waters *(Sembilan spesies spons dari Keluarga Axinellidae sebanyak lima genus dijumpai di Indonesia, tiga spesies diantaranya adalah baru: Axinella badungensis, A. balinensis.* and *Phycopsis pesgalli)*
(van Der Ent *et al.*, 2016)	SW Sulawesi	A baseline study of *Terpios hoshinota* in the Spermonde Archipelago, Indonesia, where the first observed in 2012 (de Voogd *et al.*, 2013). A total of 27 reefs were surveyed and recorded patches between 14 and 217 cm^2, at four reef sites *(Kajian awal terhadap Terpios hoshinota di Kepulauan Spermonde, Indonesia, dimana kajian pertama di Tahun 2012 (de Voogd et al. 2013). Sebanyak 27 rataan terumbu diobservasi)*
(Calcinai *et al.*, 2017a)	NE Sulawesi	Reported 94 species of Demosponge during different research campaigns mainly from the Bunaken Marine Park, NE Sulawesi. Six species were new for science and seven represent new records for the area. *(Laporan 94 spesies spons laut Demosponge berdasarkan beberapa kali kajian dan observasi di Taman Nasional Bunaken. Enam spesies spons diketahui adalah spesies baru, dan tujuh spesies merupakan catatan baru untuk wilayah tersebut)*
(Calcinai *et al.*, 2017b)	Bangka Island, NE Sulawesi	Recorded 19 species, belonging to 11 families and 15 genera; all samples were collected on mangrove trunks, on the roots or on the surrounding bottom around Bangka Island, NE Sulawesi *(Catatan 19 spesies spons dari 11 Keluarga, dan 15 genus. Semua sampel contoh diambil dari batang, akar, dan sekitar hutan mangrove di Pulau Bangka, Sulawesi Utara)*
(Hadi *et al.*, 2018)	S Java	Recorded 96 sponge species (15 orders) and described them within the nine morphological characters *(Catatan 96 spesies spons dari 15 ordo dan membaginya ke dalam Sembilan karakter morfologi)*

Appendix 1. List of bibliographic records of sponge research conducted in Indonesia region. *(Daftar pustaka kajian ilmiah komunitas spons di wilayah Indonesia). (continued)* lanjutan

Author *(Kontributor)*	Locations *(Lokasi)*	Highlights *(Hasil Kajian Utama)*
(Setiawan *et al.*, 2018)	W Java, NE & SE Sulawesi	Described the true identity of *Neopetrosia exigua* should be *Neopetrosia chaliniformis*. *N. exigua* and *N. pacifica* should be considered as junior synonyms of *N. chaliniformis*. Also provided an advocate that molecular barcoding could significantly aid on sponge species' delimitation that possess limited morphological characters *(Menggambarkan identitas sebenarnya dari Neopetrosia exigua yang seharusnya adalah N. chaliniformis. N. exigua dan N. pacifica merupakan sinonim junior dari N. chaliniformis. Juga menganjurkan teknik barcoding molekuler sebagai alat pembantu yang signifikan dalam kajian spesies kompleks yang terbatas pada kajian morfologi)*
(van Soest, 2018)	Museum collections from Snellius II expedition	A new species of the large genus Mycale Gray, 1867 was described, from 300 m depth in the Flores Sea, during cruises of the Indonesian-Dutch Snellius II Expedition in 1984 *(Spesies baru dari genus besar Mycela Gray, 1867 dijumpai dari kedalaman 300 m Laut Flores pada Ekspedisi Snellius II Tahun 1984)*
(Turicchia *et al.*, 2018)	Komodo Islands	Reported the coral-killing sponge *Chalinula nematifera* overgrowing various coral species at Komodo National Park in October 2016 *(Laporan spons pembunuh karang Chalinula nematifera menyerang beberapa karang keras di Taman Nasional Komodo pada Oktober 2016)*
(Rovellini *et al.*, 2019)	Wakatobi National Park	Reported the abundance and biodiversity of Indo-Pacific sponge assemblages undergo dramatic temporal changes driven by species-specific population variability *(Laporan kelimpahan dan keanekaragaman spons Indo-Pasifik yang mengalami perubahan dramatis secara temporal yang dipengaruhi oleh variabilitas populasi spesies tertentu)*
(Marlow *et al.*, 2019)	Wakatobi National Park	Report on the importance of understanding the drivers of bio-eroding sponge abundance and assemblage composition in order to predict possible impacts of different stressors on reefs communities *(Laporan tentang pentingnya pemahaman penyebab kelimpahan spons bio-eroding dalam rangka memprediksi dampak dari sumber yang berbeda di komunitas terumbu)*

Appendix 2. Annotated species list of demosponges observed on photographic and video imagery from intercept transects studied 2012/2013 in the Krakatau Volcanic Complex. Species marked with asterisk were reported by Annandale from a brackish lake from Sertung in 1924. **according to van Soest *et al.* 2020.*(Daftar spesies Demospongiae dengan anotasi yang diobservasi dengan gambar dan video pada transek menyinggung dari kajian Tahun 2012/2013 di Komplek Vulkanik Krakatau. Spesies spons dengan tanda bintang dilaporkan oleh Annandale pada Tahun 1924. **menurut van Soest et al., 2020).*

Species (*Spesies*)	Presently accepted taxonomy ** *(Taksonomi valid**)*	Local distribution patterns *(Pola distribusi lokal)*	Reported distribution ** *(Laporan distribusi)*	Other relevant Information *(Informasi lain yang relevan)*
Amorphinopsis excavans Carter, 1887*	Halichondriida, Suberitida	N/A	Indian Ocean, Coral Triangle	N/A
Cliona cf. *orientalis* Thiele, 1900	Clionaidae, Clionaida	very com-mon	Indian Ocean, Coral Triangle	Mostly abundance and overgrowing *Porites* sp. *(Umumnya melimpah dan menutupi karang Porites sp.)*
Haliclona (Reniera) cinerea (Grant, 1826) *	Chalinidae, Haplosclerida	uncertain	North Atlantic	Only reported from North Atlantic, probably misidentification. *(Hanya pernah dilaporkan dari perairan Atlantik Utara, kemungkinan salah identifikasi)*
Haliclona sp.	Chalinidae, Haplosclerida	common	NA	N/A
Mycale relicta Annandale, 1924*	Mycalidae, Poecilosclerida	N/A	Sunda Strait, West Indian Ocean (brackish lake on Verlaten Island)	N/A
Protosuberites collaris Annandale, 1924*	Suberitidae, Suberitida	N/A	Indonesia and southern Java, West Indian Ocean (brackish lake on Verlaten Island)	N/A
Terpios sp.	Suberitidae, Suberitida	common	NA	*Terpios* spp. are increasingly published as nuisance species that overwhelm corals, e.g., (van Der Ent *et al.*, 2016). *(Terpios spp. sedang banyak dilaporakan sebagai spesies yang mengganggu karang keras e.g. van Der Ent et al. 2016)*

Pedoman Penulisan Naskah Berita Biologi

Berita Biologi adalah jurnal yang menerbitkan artikel kemajuan penelitian di bidang biologi dan ilmu-ilmu terkait di Indonesia. Berita Biologi memuat karya tulis ilmiah asli berupa makalah hasil penelitian, komunikasi pendek dan tinjauan kembali yang belum pernah diterbitkan atau tidak sedang dikirim ke media lain. Masalah yang diliput harus menampilkan aspek atau informasi baru.

Tipe naskah

1. **Makalah lengkap hasil penelitian (*original paper*)**
   Naskah merupakan hasil penelitian sendiri yang mengangkat topik yang *up to date*. Tidak lebih dari 15 halaman termasuk tabel dan gambar. Pencantuman lampiran seperlunya, namun redaksi berhak mengurangi atau meniadakan lampiran.
2. **Komunikasi pendek (*short communication*)**
   Komuniasi pendek merupakan makalah hasil penelitian yang ingin dipublikasikan secara cepat karena hasil termuan yang menarik, spesifik dan atau baru, agar dapat segera diketahui oleh umum. Hasil dan pembahasan dapat digabung.
3. **Tinjauan kembali (*review*)**
   Tinjauan kembali merupakan rangkuman tinjauan ilmiah yang sistematis-kritis secara ringkas namun mendalam terhadap topik penelitian tertentu. Hal yang ditinjau meliputi segala sesuatu yang relevan terhadap topik tinjauan yang memberikan gambaran '*state of the art*', meliputi temuan awal, kemajuan hingga issue terkini, termasuk perdebatan dan kesenjangan yang ada dalam topik yang dibahas. Tinjauan ulang ini harus merangkum minimal 30 artikel.

Struktur naskah

1. **Bahasa**
   Bahasa yang digunakan adalah Bahasa Indonesia atau Inggris yang baik dan benar.
2. **Judul**
   Judul diberikan dalam bahasa Indonesia dan inggris. Judul ditulis dalam huruf tegak kecuali untuk nama ilmiah yang menggunakan bahasa latin, Judul harus singkat, jelas dan mencerminkan isi naskah dengan diikuti oleh nama serta alamat surat menyurat penulis dan alamat email. Nama penulis untuk korespondensi diberi tanda amplop cetak atas (*superscript*). Jika penulis lebih dari satu orang bagi pejabat fungsional penelitian, pengembangan agar menentukan status sebagai kontributor utama melalui penandaan simbol dan keterangan sebagai kontributor utama dicatatan kaki di halaman pertama artikel.
3. **Abstrak**
   Abstrak dibuat dalam dua bahasa, bahasa Indonesia dan Inggris. Abstrak memuat secara singkat tentang latar belakang, tujuan, metode, hasil yang signifikan, kesimpulan dan implikasi hasil penelitian. Abstrak berisi maksimum 200 kata, spasi tunggal. Di bawah abstrak dicantumkan kata kunci yang terdiri atas maksimum enam kata, dimana kata pertama adalah yang terpenting. Abstrak dalam Bahasa Inggris merupakan terjemahan dari Bahasa Indonesia. Editor berhak untuk mengedit abstrak demi alasan kejelasan isi abstrak.
4. **Pendahuluan**
   Pendahuluan berisi latar belakang, permasalahan dan tujuan penelitian. Perlu disebutkan juga studi terdahulu yang pernah dilakukan terkait dengan penelitian yang dilakukan.
5. **Bahan dan cara kerja**
   Bahan dan cara kerja berisi informasi mengenai metode yang digunakan dalam penelitian. Pada bagian ini boleh dibuat sub-judul yang sesuai dengan tahapan penelitian. Metoda harus dipaparkan dengan jelas sesuai dengan standar topik penelitian dan dapat diulang oleh peneliti lain. Apabila metoda yang digunakan adalah metoda yang sudah baku cukup ditulis sitasinya dan apabila ada modifikasi maka harus dituliskan dengan jelas bagian mana dan hal apa yang dimodifikasi.
6. **Hasil**
   Hasil memuat data ataupun informasi utama yang diperoleh berdasarkan metoda yang digunakan. Apabila ingin mengacu pada suatu tabel/ grafik/diagram atau gambar, maka hasil yang terdapat pada bagian tersebut dapat diuraikan dengan jelas dengan tidak menggunakan kalimat 'Lihat Tabel 1'. Apabila menggunakan nilai rata- rata maka harus menyertakan pula standar deviasinya.
7. **Pembahasan**
   Pembahasan bukan merupakan pengulangan dari hasil. Pembahasan mengungkap alasan didapatkannya hasil dan arti atau makna dari hasil yang didapat tersebut. Bila memungkinkan, hasil penelitian ini dapat dibandingkan dengan studi terdahulu.
8. **Kesimpulan**
   Kesimpulan berisi infomasi yang menyimpulkan hasil penelitian, sesuai dengan tujuan penelitian, implikasi dari hasil penelitian dan penelitian berikutnya yang bisa dilakukan.
9. **Ucapan terima kasih**
   Bagian ini berisi ucapan terima kasih kepada suatu instansi jika penelitian ini didanai atau didukungan oleh instansi tersebut, ataupun kepada pihak yang membantu langsung penelitian atau penulisan artikel ini.
10. **Daftar pustaka**
    Tidak diperkenankan untuk mensitasi artikel yang tidak melalui proses *peer review*. Apabila harus menyitir dari "laporan" atau "komunikasi personal" dituliskan '*unpublished*' dan tidak perlu ditampilkan di daftar pustaka. Daftar pustaka harus berisi informasi yang *up to date* yang sebagian besar berasal dari *original papers* dan penulisan terbitan berkala ilmiah (nama jurnal) tidak disingkat.

Format naskah

1. Naskah diketik dengan menggunakan program Microsoft Word, huruf New Times Roman ukuran 12, spasi ganda kecuali Abstrak spasi tunggal. Batas kiri-kanan atas-bawah masing-masing 2,5 cm. Maksimum isi naskah 15 halaman termasuk ilustrasi dan tabel.
2. Penulisan bilangan pecahan dengan koma mengikuti bahasa yang ditulis menggunakan dua angka desimal di belakang koma. Apabila menggunakan Bahasa Indonesia, angka desimal ditulis dengan menggunakan koma (,) dan ditulis dengan menggunakan titik (.) bila menggunakan bahasa Inggris. Contoh: Panjang buku adalah 2,5 cm. Lenght of the book is 2.5 cm. Penulisan angka 1-9 ditulis dalam kata kecuali bila bilangan satuan ukur, sedangkan angka 10 dan seterusnya ditulis dengan angka. Contoh lima orang siswa, panjang buku 5 cm.
3. Penulisan satuan mengikuti aturan *international system of units*.
4. Nama takson dan kategori taksonomi ditulis dengan merujuk kepada aturan standar yang diakui. Untuk tumbuhan menggunakan *International Code of Botanical Nomenclature* (ICBN), untuk hewan menggunakan International *Code of Zoological Nomenclature* (ICZN), untuk jamur *International Code of Nomenclature for Algae*, *Fungi and Plant* (ICFAFP), *International Code of Nomenclature of Bacteria* (ICNB), dan untuk organisme yang lain merujuk pada kesepakatan Internasional. Penulisan nama takson lengkap dengan nama author hanya dilakukan pada bagian deskripsi takson, misalnya pada naskah taksonomi. Penulisan nama takson untuk bidang lainnya tidak perlu menggunakan nama author.
5. Tata nama di bidang genetika dan kimia merujuk kepada aturan baku terbaru yang berlaku.
6. Untuk range angka menggunakan en dash (–), contohnya pp.1565–1569, jumlah anakan berkisar 7–8 ekor. Untuk penggabungan kata menggunakan hyphen (-), contohnya: masing-masing.
7. Ilustrasi dapat berupa foto (hitam putih atau berwarna) atau gambar tangan (*line drawing*).
8. Tabel
   Tabel diberi judul yang singkat dan jelas, spasi tunggal dalam bahasa Indonesia dan Inggris, sehingga Tabel dapat berdiri sendiri. Tabel diberi nomor urut sesuai dengan keterangan dalam teks. Keterangan Tabel diletakkan di bawah Tabel. Tabel tidak dibuat tertutup dengan garis vertikal, hanya menggunakan garis horisontal yang memisahkan judul dan batas bawah.

8. Gambar
   Gambar bisa berupa foto, grafik, diagram dan peta. Judul gambar ditulis secara singkat dan jelas, spasi tunggal. Keterangan yang menyertai gambar harus dapat berdiri sendiri, ditulis dalam bahasa Indonesia dan Inggris. Gambar dikirim dalam bentuk .jpeg dengan resolusi minimal 300 dpi, untuk *line drawing* minimal 600dpi.
9. Daftar Pustaka
   Sitasi dalam naskah adalah nama penulis dan tahun. Bila penulis lebih dari satu menggunakan kata 'dan' atau *et al*. Contoh: (Kramer, 1983), (Hamzah dan Yusuf, 1995), (Premachandra *et al*., 1992). Bila naskah ditulis dalam bahasa Inggris yang menggunakan sitasi 2 orang penulis maka digunakan kata 'and'. Contoh: (Hamzah and Yusuf, 1995). Jika sitasi beruntun maka dimulai dari tahun yang paling tua, jika tahun sama maka dari nama penulis sesuai urutan abjad. Contoh: (Anderson, 2000; Agusta *et al*., 2005; Danar, 2005). Penulisan daftar pustaka, sebagai berikut:

   a. **Jurnal**
      Nama jurnal ditulis lengkap.
      Agusta, A., Maehara, S., Ohashi, K., Simanjuntak, P. and Shibuya, H., 2005. Stereoselective oxidation at C-4 of flavans by the endophytic fungus *Diaporthe* sp. isolated from a tea plant. *Chemical and Pharmaceutical Bulletin*, *53*(12), pp.1565–1569.
   b. **Buku**
      Anderson, R.C. 2000. *Nematode Parasites of Vertebrates, Their Development and Tramsmission*. 2nd ed. CABI Publishing. New York. pp. 650.
   c. **Prosiding atau hasil Simposium/Seminar/Lokakarya.**
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Redaksi Jurnal Berita Biologi, Pusat Penelitian Biologi-LIPI
Cibinong Science Centre, Jl. Raya Bogor Km. 46 Cibinong 16911
Telp: +61-21-8765067, Fax: +62-21-87907612, 8765063, 8765066,
Email: berita.biologi@mail.lipi.go.id
jurnalberitabiologi@yahoo.co.id atau
jurnalberitabiologi@gmail.com

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