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Description Sponges Associative with Mangrove Species from Tampora Beach, East Java, Indonesia

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Abstract

Indonesia hosts approximately 10% of the world's sponge species, highlighting its significance as a central hub of marine and sponge biodiversity on a global scale. Sponges associated with mangrove ecosystems are particularly important because of their essential roles in nutrient cycling and supporting these beach ecosystems. However, there is a notable lack of data on the diversity of mangrove associated sponges in Indonesia, with limited studies addressing their taxonomy and distribution patterns. This study was conducted at Tampora Beach in Situbondo Regency, which is situated on the northern coast of East Java in Indonesia. The site is in proximity to the renowned Pasir Putih Beach tourist destination but remains relatively undisturbed by human activities because of its proximity to protected areas. Sponge samples from mangrove habitats were collected and identified based on their macroscopic and microscopic morphological features. Species identification involved a comprehensive analysis of morphological features, including growth form, surface texture, consistency, color, oscula, and pore distribution, along with microscopic examination of the spicule morphology. In total, nine sponge specimens were identified, encompassing six orders, seven families, and eight genera. The collection included one order, two families, and two genera of keratose sponges (*Dysidea* and *Euspongia*), while the remaining specimens belonged to five orders, five families, and six genera of non-keratose sponges, including *Chalinula*, *Biemna*, *Spheciospongia*, *Haliclona*, *Tedania*, and *Cinachyrella*. These

findings provide foundational insights into the diversity of mangrove associated sponges in northern East Java and contribute to the limited understanding of sponge biodiversity along the Indonesian beaches.

Keywords: Demospongiae; Indonesian waters; Mangrove habitat; Sponge taxonomy; Tropical marine biodiversity.

Introduction

Indonesia is recognized as a major marine biodiversity hotspot, encompassing the largest portion of the Coral Triangle and hosting approximately 9500 identified species, along with a historical record of 850 sponge species (Calcinaï, et al., 2017; N. de Voogd, 2005; N. J. de Voogd et al., 2022). Although sponge diversity has been extensively studied in coral reef ecosystems, sponge communities within mangrove ecosystems remain insufficiently documented despite their ecological significance.

Mangrove forests are highly productive coastal ecosystems that function as unique transitional zones between terrestrial and marine environments (Rahman et al., 2025). These ecosystems are characterized by fluctuating salinity, periodic tidal inundation, low dissolved oxygen, and high organic matter accumulation, creating challenging conditions that support specialized biological communities (Calcinaï, et al., 2017; Cooray et al., 2021). Within these habitats, sponges play a vital role in ecosystem functioning by filtering water, cycling nutrients, linking benthic and pelagic zones, and providing habitats for numerous microorganisms and invertebrates (Cooray et al., 2021). Furthermore, mangrove associated sponges have garnered increasing interest as potential sources of novel bioactive compounds for pharmaceutical and biotechnological applications (Deshmukh et al., 2018; Kiran Kumar & Pola, 2023; Setiawan et al., 2025) .

Over the past decade, research on tropical sponges has predominately focused on coral reef habitats, where species richness and distribution have been relatively well documented (Aulia et al., 2021; Lim et al., 2023; Morais et al., 2024). In contrast, sponge communities associated with mangrove are poorly understood, particularly in Southeast Asia (SEA). Recent studies have revealed that mangrove ecosystems host unique sponge assemblages and may contain endemic or previously unknown species that differ significantly from adjacent reef communities (Calcinaï, et al., 2017). These findings suggest that mangrove habitats are important, yet underexplored, reservoir of sponge biodiversity.

Taxonomic studies on mangrove associated sponges in Indonesia is limited and geographically restricted. Investigations have primarily been conducted in select locations, such as North Sulawesi, Java, and several islands in eastern Indonesia (Calcinaï, et al., 2017; Putra et al., 2024). Most earlier surveys in East Java have

concentrated on shallow water reef sponges within coral ecosystems (Abdillah et al., 2013; Setiawan, Muzaki, et al., 2018), whereas information on sponge diversity in mangrove habitats is scarce. Consequently, the spatial distribution and taxonomic composition of mangrove sponge communities in many coastal areas of Indonesia remain largely unknown. Tampora Beach, situated in Kalianget Village, Banyuglugur District, Situbondo Regency, East Java, is an understudied coastal ecosystem. Located on the northern coast of Java Island near the popular Pasir Putih beach tourist area, Tampora beach maintains relatively intact mangrove vegetation owing to its proximity to a protected coastal zone and low human disturbance. The coexistence of mangrove forests and natural coastal habitats renders this area a potentially significant refuge for marine invertebrates, including sponges. However, no published research has comprehensively documented sponge fauna associated with the mangrove ecosystem of Tampora beach.

The primary research gap identified is the lack of fundamental taxonomic data on sponges associated with mangrove in Northern East Java. This gap persists despite the increasing recognition of mangrove ecosystems as vital biodiversity hotspots and essential coastal conservation area. Furthermore, existing records from Indonesia are spatially fragmented, impeding comprehensive assessments of species distribution and habitat specificity in the region. This study is pioneering as it provides the inaugural taxonomic inventory of sponges species associated with mangrove at Tampora beach, Situbondo, where no previous records of sponge species have been documented. Through detailed macroscopic and microscopic morphological analysis, this study elucidated the composition of sponge taxa within the mangrove ecosystem, establishing baseline biodiversity data to support future ecological, taxonomic, and conservation research. The generated dataset enhances our current understanding of sponge diversity in Indonesian mangrove ecosystems and serves as valuable reference for subsequent molecular taxonomic and biodiversity studies

Material & Methods

Field sampling was conducted on May 11, 2025, along the mangrove lined shore of Tampora beach in Situbondo Regency, East Java, Indonesia (7°43'23"S, 113°38'41"E) (Fig. 1), between 15.00 and 18.00 western Indonesian times (WIB). This timing was strategically chosen to align with the full moon spring tide, which maximally exposed the intertidal zone facilitating access to the submerged habitat of sponge associated with mangrove.

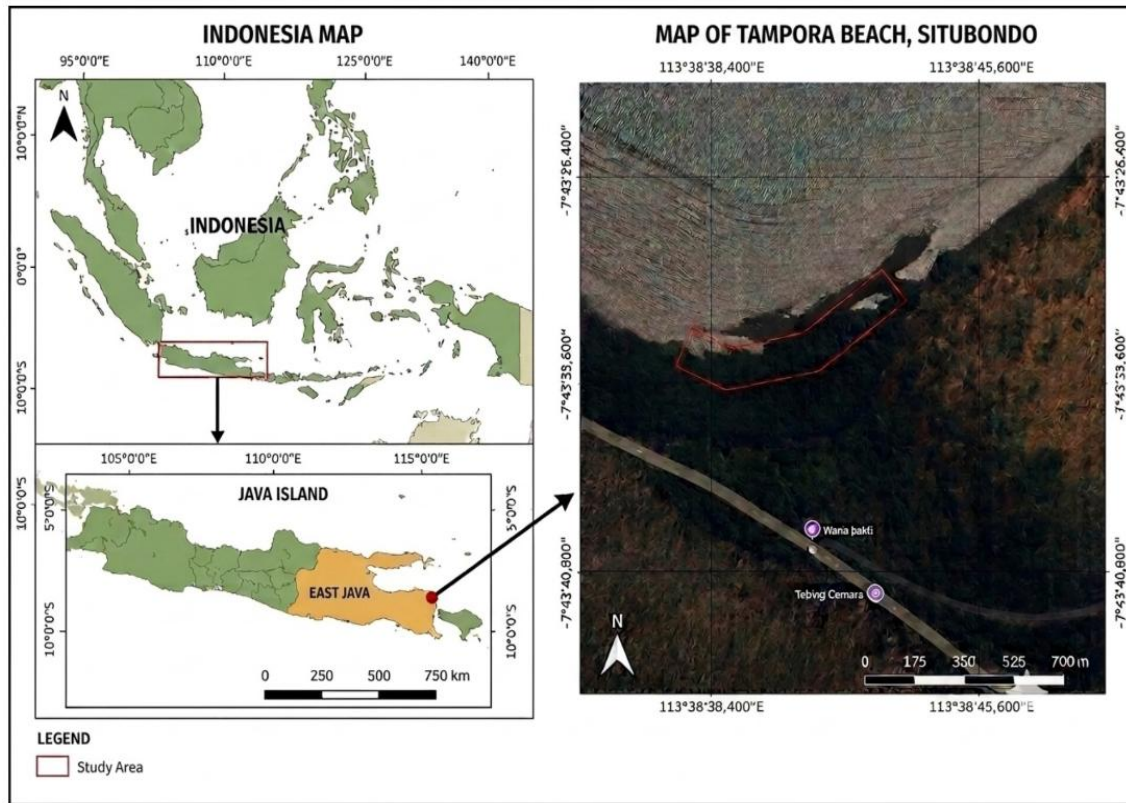


Fig. 1. Indonesian archipelago with java island. The arrow points to investigated area, which is outlined in red

Sponge samples were collected through direct exploration of mangrove regions. Sponge affixed to mangrove roots, trunks, rocks and other solid substrates were identified through visual inspection. Prior to collection, each sample was photographed in situ to document its original growth form, color, and environmental context. To minimize disturbance to the population while obtaining sufficient material for taxonomic analysis, only a small portion of each sponge was meticulously excised. The collected samples were placed individually placed in labelled screw cap vials and preserved in 70% ethanol for subsequently analysis. Subsequently, the preservative was replaced with 96% ethanol to ensure the long term preservation of the samples. To achieve complete dehydration and optimal preservation, 96% ethanol was refreshed every 24-48 hour for three to four consecutive changes. All preserved samples were transported to the laboratory for further examinations.

Morphological Identification

Species identification was conducted by examining both macroscopic and microscopic features, in accordance with established sponge taxonomic references. Macroscopic assessments included the observation of growth form, coloration of both living specimens and those preserved in ethanol, surface texture, surface morphology, osculum shape and distribution and the overall consistency of the specimens.

Microscopic analysis focused on the skeletal structure and spicule morphology. To prepare skeletal samples, thin transverse and longitudinal sections of the sponges tissue were excised using a sterile scalpel. These sections were compressed gently compressed between microscope slides to create a thin preparation, mounted with Entellan®, covered with a coverslip, and observed under a compound microscope equipped with an Optilab digital imaging system.

For spicule preparations, approximately 0.5 cm³ of tissue was extracted from the basal, ectosome, choanosome, and oscular region of each specimen. The tissue fragments were immersed in a 5.25% sodium hypochlorite (NaClO) solution to dissolve the organic matrix and release siliceous spicules. Following gentle agitation, the suspension was allowed to settle until spicules formed pellet at the bottom of the vial. The pellet was washed three to five times with distilled water and rinsed twice with 96% ethanol. The cleaned spicule suspension was then transferred onto a microscope slide, air dried on a laboratory hot plate until the ethanol evaporated completely, mounted with Entellan®, covered with a coverslip, and examined using a compound microscope equipped with an Optilab digital imaging system. The morphology of the spicules was analyzed to identify their type and dimensions. For each specimen, the length and width of 25 representative spicules were measured using the Optilab Imaging System. The average spicule dimensions were calculated using Microsoft Excel along with spicule morphology, to determine the corresponding spicule types. Taxonomic identification was achieved by integrating macroscopic characteristics, skeletal architecture, and spicule morphology. Diagnostic features were compared with descriptions found in *Sponguide: Guide to Sponge Collection and Identification*, *Systema Porifera: A Guide to the Classification of Sponges*, and the World Porifera Database (N. J. de Voogd et al., 2022). The specimens discussed herein were deposited in the biology laboratory of the Faculty of Mathematics and Natural Sciences, University of Jember, East Java, Indonesia

Data Analysis

The collected data comprised sponge genus identification, macroscopic and microscopic morphological characteristics, spicule types, and measurements of megascleres and microscleres. Morphological characteristics were compared with published taxonomic descriptions for genus determination. Measurements of megasclere and microscle dimensions were analyzed using descriptive quantitative statistics and are presented as measurement ranges and mean values.

Results

The materials collected along the Tampora beach yielded a total of nine specimens belonging to six orders, seven families, and eight different genera. The description and distributional features of the specimens are as follows:

Chalinula Schmidt, 1868

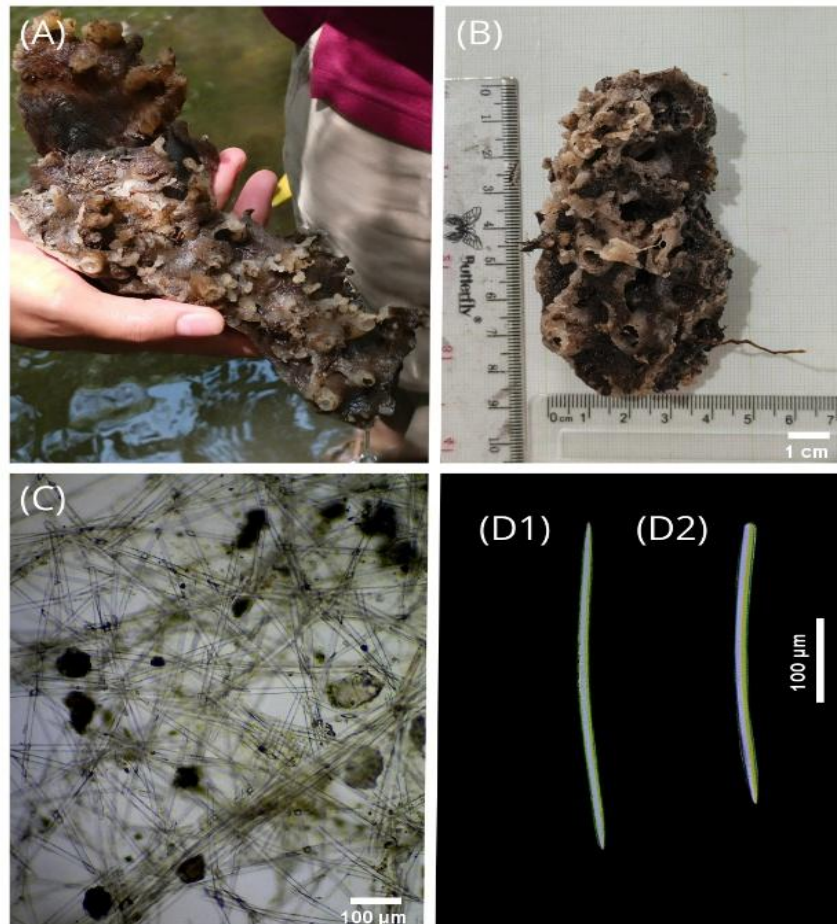


Fig. 2. *Chalinula* sp. Schmidt: (A) *Chalinula* (lifeform sample); (B) *Chalinula* (sample after preservation); (C) Choanosomal skeleton; (D1) Oxea ; (D2) Styles

Phylum: Porifera Grant, 1836

Class: Demospongiae Sollas, 1885

Order: Haplosclerida Topsent, 1928

Family: Chalinidae Bowerbank, 1862

Genus: *Chalinula* Schmidt, 1868

Material Examined

Chalinula sp. was collected from the mangrove associated habitat of Tampora Beach in Situbondo, East Java, Indonesia. The specimens were attached to hard substrates within the mangrove ecosystem.

Diagnosis

Chalinula sp. is characterized by a cushion shaped growth form, soft and compressible consistency, isodictyal reticulate skeleton, and spicule complement consisting of oxeas and styles. The examined specimens were devoid of microscleres.

Description

The specimen exhibited a cushion shaped growth form with a diameter of approximately 8.5 cm (Fig. 2A). The live coloration was grayish brown when attached to the substrate. After preservation in ethanol, the color changed to light brown and gradually faded to pale gray after repeated replacement with 96% ethanol (Fig. 2B). The surface was smooth, and ostia were indistinguishable under stereomicroscopic observation. Oscula were conspicuous and irregularly distributed across the surfaces. The consistency was soft and compressible, resembling wet cotton fibers.

Skeleton

The skeletal architecture was an isodictyal reticulate arrangement, characterized by a regular triangular network in which the sides of the meshes were approximately equivalent to the length of one spicule (Fig. 2 C). Primary and secondary tracts were not distinctly differentiated in this study.

Spicules

The spicule complement consisted of two megasclere categories: oxea and styles. No microscleres were observed in any of the specimens. Oxea: slender, pointed at both ends; length 359.4–474.7 μm and width 10.1–18.0 μm (Fig. 2 D1). Style: elongate spicules with one pointed end and one rounded end; length 292.5–381.3 μm and width 8.3–16.6 μm (Fig. 2 D2).

Remarks

The morphological characters of the examined specimen correspond with the diagnostic features of the genus *Chalinula* described by Hooper & Van Soest, (2002), including a cushion shaped growth form, soft to elastic consistency, brownish coloration, isodictyal reticulate skeletal architecture, and a megasclere complement dominated by oxeas. Although microscleres were absent, the presence of oxeas and styles is consistent with

the morphological variations reported for *Chalinula*. Based on the combination of external morphology, skeletal arrangement, and spicule characteristics, the specimen was assigned to *Chalinula*.

***Biemna* Gray, 1867**

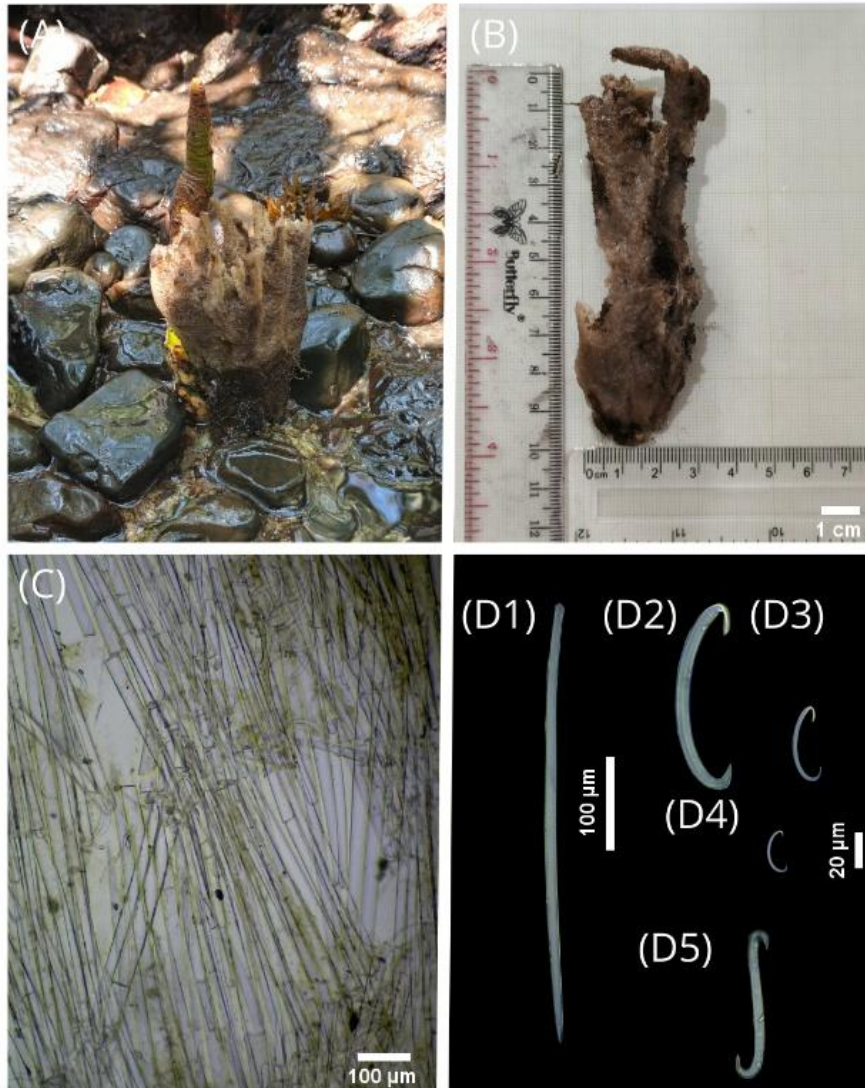


Fig. 3 *Biemna* sp. Gray: (A) *Biemna* (lifeform sample); (B) *Biemna* (sample after preservation); (C) Choanosomal skeleton; (D1) Styles; (D2-D5) Sigma

Phylum: Porifera Grant, 1836

Class: Demospongiae Sollas, 1885

Order: Biemnida Morrow, 2013

Family: Biemnidae Hentschel, 1923

Genus: *Biemna* Gray, 1867

Material Examined

One specimen of *Biemna* sp. was collected from the mangrove associated habitat of Tampora Beach, Situbondo, East Java, Indonesia. The specimen was attached to a hard substrate submerged within the mangrove ecosystem.

Diagnosis

The examined specimen is characterized by an erect cylindrical growth form, a firm and slightly elastic consistency, a plumoreticulate choanosomal skeleton, and a spicule complement consisting of styles and sigma microscleres of multiple size categories.

Description

The sponge exhibited an erect cylindrical morphology and reached a height of approximately 10 cm (Fig. 3A). The living specimens were cream to yellowish in coloration, turning brown after initial preservation in ethanol and gradually fading to gray following repeated ethanol replacement (Fig. 3B). The ostia were minute and evenly distributed over the external surface, whereas the osculum was conspicuous, relatively large, and located terminally at the apex of each digitiform branch. The consistency was firm, with slight elasticity.

Skeleton

The choanosomal skeleton displayed a plumoreticulate architecture, composed of longitudinal plumose tracts interconnected to form an open reticulate network (Fig. 3C). This skeletal organization is characteristic of members of the family Biemnidae.

Spicules

The spicule complement comprised one megasclere category and one microscelere category. Style: 391.4–523.4 μm long and 6.6–17.9 μm wide (Fig. 3D1). Sigma (large): 83.1–110.1 $\mu\text{m} \times 3.7$ –8.9 μm (Fig. 3D2). Sigma (medium): 30.1–49.2 $\mu\text{m} \times 1.2$ –2.2 μm (Fig. 3D3). Sigma (small): 12.7–26.5 $\mu\text{m} \times 0.6$ –2.9 μm (Fig. 3D4). S-shaped sigma: 50.1–70.3 $\mu\text{m} \times 3.1$ –5.5 μm (Fig. 3D5).

Remarks

The observed morphological characteristics were consistent with the generic diagnosis of *Biemna* provided by (Hooper & Van Soest, 2002). The erect habit, plumoreticulate choanosomal skeleton, and the presence of styles associated with multiple sigma microsclere size classes are diagnostic features of the genus. These characters support the assignment of the examined specimens to *Biemna*.

Spechiospongia Marshall, 1892

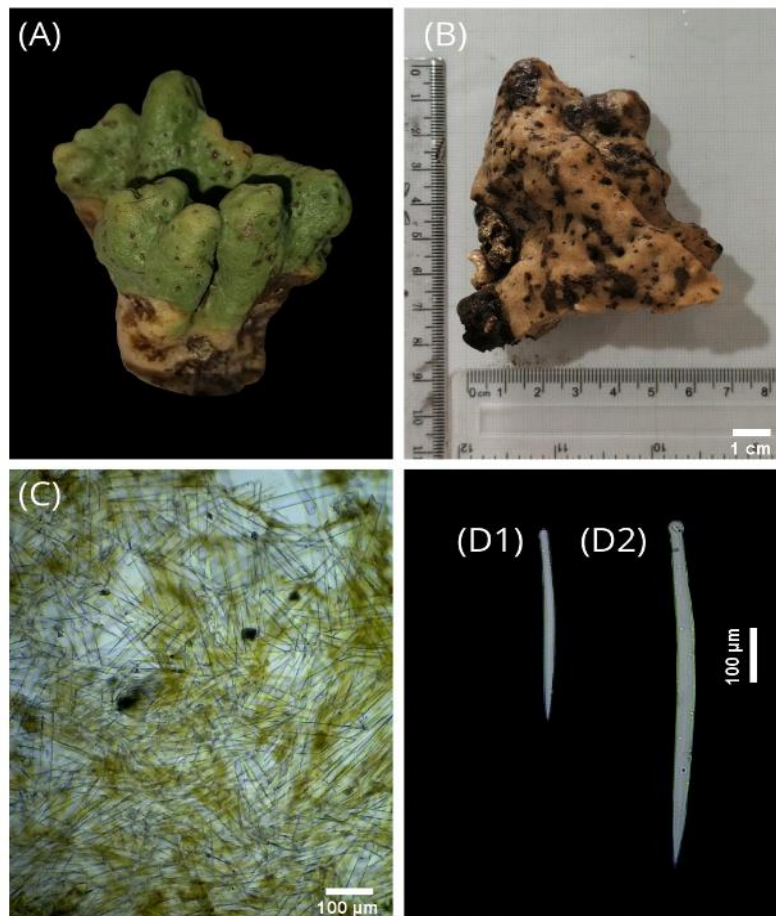


Fig. 4. *Spechiospongia* sp. Marshall: (A) *Spechiospongia* (lifeform sample); (B) *Spechiospongia* (sample after preservation); (c) Choanosomal skeleton; (D1 and D2) Tylostyle

Phylum: Porifera Grant, 1836

Class: Demospongiae Sollas, 1885

Order: Clionaida Morrow & Cárdenas, 2015

Family: Clionaidae d'Orbigny, 1851

Genus: *Spheciospongia* Marshall, 1892

Material Examined

One specimen of *Spheciospongia* sp. was collected from the mangrove-associated habitat of Tampora Beach, Situbondo, East Java, Indonesia for this study

Diagnosis

The specimen is distinguished by its branching cylindrical growth form, woody consistency, irregularly reticulate skeleton, and tylostyles represented by two distinct size classes.

Description

The sponge formed cylindrical branches approximately 8 cm in length (Fig. 4A). In life, the specimen was bright yellow in color. Following preservation, the color changed to green and subsequently returned to yellow after repeated ethanol replacements (Fig. 4B). Ostia were inconspicuous, whereas oscula were distinct and distributed laterally distributed along the branches. The sponge had an extremely rigid, resemble of wood consistency and could not be manually compressed.

Skeleton

The skeleton exhibited an irregularly reticulate arrangement composed of randomly organized tylostyles forming an irregular network without clearly differentiated primary and secondary tracts (Fig. 4C).

Spicules

Only one megasclere category, tylostyle, was observed, represented by two size classes. Short tylostyles: 351.5–489.1 μm long and 16.4–25.8 μm wide (Fig. 4D1). Long tylostyles: 525.4–760.4 μm long and 14.1–32.1 μm wide (Fig. 4D2).

Remarks

The specimen conforms closely to the generic diagnosis of *Spheciospongia* presented by Hooper and Van Soest (2002), particularly in possessing a rigid branching morphology, an irregular tylostyle skeleton, and two size classes of tylostyles. These features support the placement of this species in the genus *Spheciospongia*.

***Haliclona* Grant, 1841**

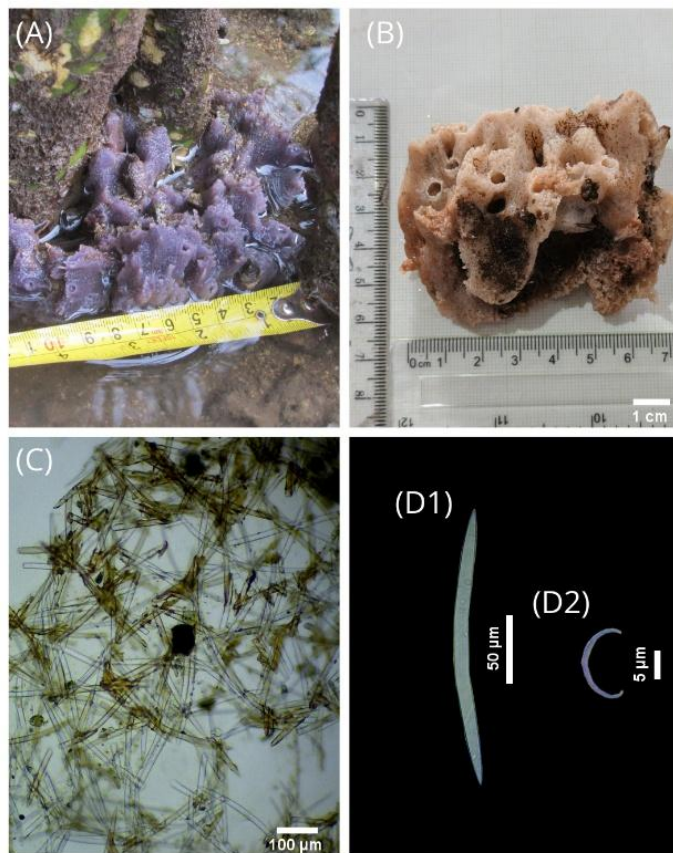


Fig. 5. *Haliclona* sp. Grant (A) *Haliclona* (lifeform sample); (B) *Haliclona* (sample after preservation); (C) Choanosomal skeleton; (D1) Oxea; (D2) Sigma

Phylum: Porifera Grant, 1836

Class: Demospongiae Sollas, 1885

Order: Haplosclerida Topsent, 1928

Family: Chalinidae Bowerbank, 1862

Genus: *Haliclona* Grant, 1841

Material Examined

One specimen of *Haliclona* sp. was collected from the mangrove ecosystem of Tampora Beach, Situbondo, East Java, Indonesia, where it was firmly attached to mangrove roots.

Diagnosis

The specimen is characterized by a cushion-shaped growth form, soft compressible consistency, an isodictyal reticulate skeleton, and a spicule complement composed of oxeas and sigma microscleres.

Description

The sponge formed a cushion-shaped colony approximately 7 cm in diameter with a broad basal attachment to the mangrove substrate (Fig. 5A). Living specimens were purple, becoming cream after preservation and finally fading to white following repeated ethanol replacement (Fig. 5B). The ostia were minute and inconspicuous, whereas numerous oscula were distributed across the sponge surface. The consistency was soft and compressible, resembling wet cotton.

Skeleton

The choanosomal skeleton exhibited an isodictyal reticulate architecture composed of triangular meshes, with sides approximately equivalent to the length of a single spicule (Fig. 5C). Primary and secondary tracts were weakly differentiated in this study.

Spicules

The spicule complement consisted of one megasclere and one microsclere category. Oxea: 200.0–244.6 μm long and 8.9–17.0 μm wide (Fig. 5D1). The sigma was 10.8–13.9 μm long and 0.6–1.4 μm wide (Fig. 5D2).

Remarks

The morphological characteristics observed in the present specimen correspond closely with the generic diagnosis of *Haliclona* provided by Hooper and Van Soest (2002). Diagnostic features include a cushion-shaped growth form, soft consistency, isodictyal reticulate skeleton, oxea megascleres, and sigma microscleres. Collectively, these characters support the assignment of the specimen to *Haliclona*.

***Tedania* Gray, 1867**

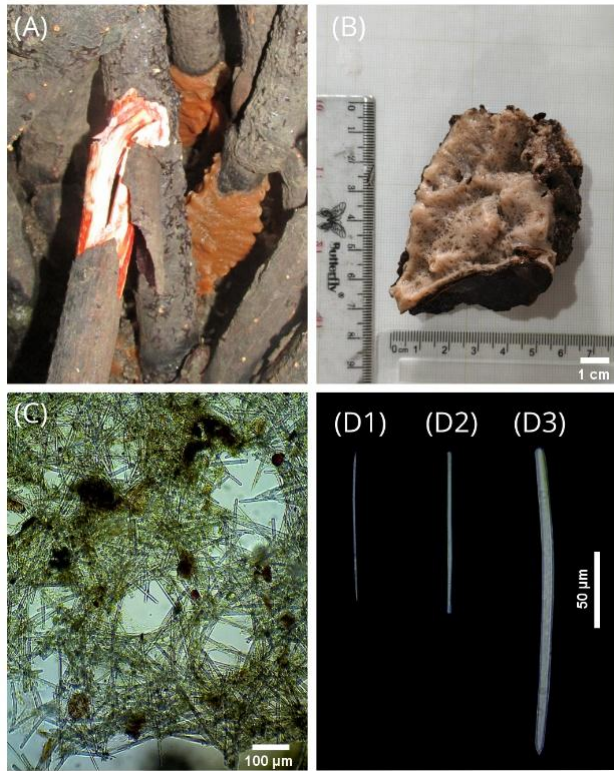


Fig. 6. *Tedania* sp. Gray: (A) *Tedania* (lifeform sample); (B) *Tedania* (sample after preservation); (C) Choanosomal skeleton; (D1) Onychaetes; (D2) Tylotes; (D3) Style

Phylum: Porifera Grant, 1836

Class: Demospongiae Sollas, 1885

Order: Poecilosclerida Topsent, 1928

Family: Tedaniidae Ridley & Dendy, 1886

Genus: *Tedania* Gray, 1867

Material examined

One specimen of *Tedania* sp. was collected from the mangrove-associated habitat of Tampora Beach, Situbondo, East Java, Indonesia. The specimen was attached to submerged mangrove roots of the species.

Diagnosis

The specimen is characterized by an encrusting to massive growth form, soft and compressible consistency, a reticulated skeletal architecture supported by styles, and a spicule complement consisting of styles, onychaetes, and toxa microscleres.

Description

The sponge formed an irregular encrusting mass measuring approximately 7 cm in diameter (Fig. 6A). In life, the specimen was bright orange, which became pale orange after ethanol preservation and subsequently faded to cream after repeated replacement with fresh ethanol (Fig. 6B). The surface was smooth with numerous minute ostia that were difficult to identify. The oscula were circular, conspicuous, and irregularly distributed on the sponge surface. The consistency was soft, compressible, and slightly elastic.

Skeleton

The choanosomal skeleton consisted of ascending reticulated bundles of styles interconnected by secondary fibers, forming an irregular reticulate architecture (Fig. 6C). The ectosomal skeleton was supported by tangentially arranged styles.

Spicules

The spicule complement comprised one megasclere category and two microscelere categories. Style: 320.8–472.5 μm long and 7.9–15.6 μm wide (Fig. 6D1). Onychaete: 118.6–169.7 μm long and 1.4–3.2 μm wide (Fig. 6D2). Toxa: 95.4–138.5 μm long and 1.2–2.8 μm wide (Fig. 6D3).

Remarks

The examined specimen exhibits the principal diagnostic characters of *Tedania*, including an encrusting growth form, reticulated skeletal organization, style megascleres, and the presence of onychaetes and toxas. These characters are consistent with the generic diagnosis proposed by Hooper and Van Soest (2002), supporting its identification as *Tedania*.

***Paratetilla* Dendy, 1905**

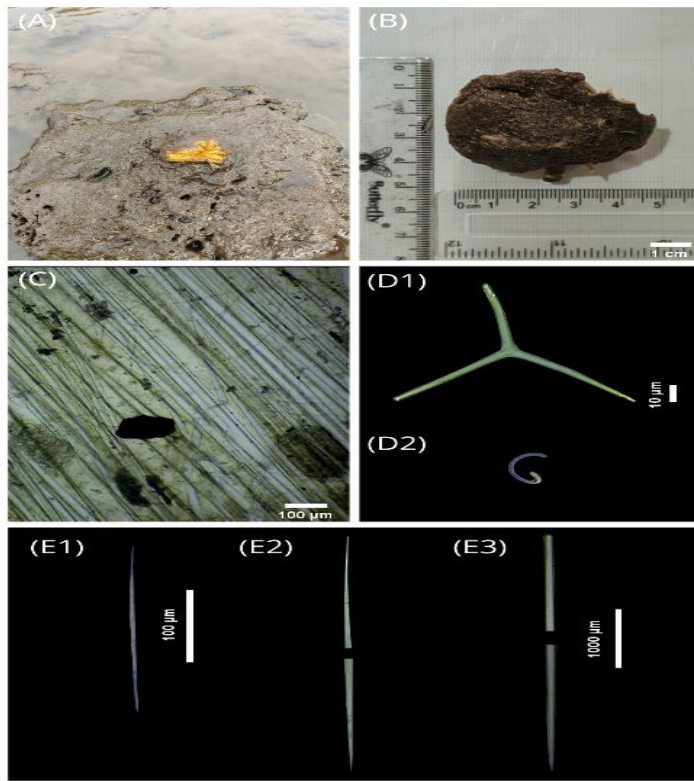


Fig. 7. *Paratetilla* sp. Dendy: (A) *Paratetilla* (lifeform sample); (B) *Paratetilla* (sample after preservation); (C) Choanosomal skeleton; (D1) Kaltrop; (D2) Sigmaspires; (E1) Microxea; (E2) Macroxea; (E3) Macrostyle
Phylum: Porifera Grant, 1836

Class: Demospongiae Sollas, 1885

Order: Tethyida Morrow & Cárdenas, 2015

Family: Tetillidae Sollas, 1886

Genus: *Paratetilla* Dendy, 1905

Material Examined

One specimen of *Paratetilla* sp. was collected from the mangrove-associated habitat of Tampora Beach, Situbondo, East Java, Indonesia, where it was attached to hard substrate within the intertidal mangrove zone.

Diagnosis

The specimen is characterized by a globular growth form, compact consistency, a radial skeletal arrangement, and a spicule complement consisting of oxeas, protriaenes, anatriaenes, and sigmaspires.

Description

The sponge was nearly spherical with a diameter of approximately 6 cm (Fig. 7A). The living specimens were dark brown and became light brown following preservation in ethanol (Fig. 7B). The surface was hispid owing to projecting spicules. Numerous inconspicuous ostia were distributed across the surface, while a single terminal osculum was present at its apex. The consistency was compact, firm, and slightly compressible in all cases.

Skeleton

The skeletal architecture consisted of densely packed radial bundles extending from the centre of the sponge towards the surface, with projecting triaenes producing the characteristic hispid appearance (Fig. 7C).

Spicules

The spicule complement consisted of several megasclere categories together with microscleres. Oxea: 812.5–1086.4 µm long and 14.3–22.5 µm wide (Fig. 7D1). Protriaene: 926.4–1358.6 µm long (Fig. 7D2). Anatriaene: 1045.8–1486.2 µm in length (Fig. 7D3). Sigmaspire: 18.6–34.5 µm long (Fig. 7D4).

Remarks

The combination of a globular morphology, radial skeleton, projecting triaenes, and characteristic tetillid microscleres agrees closely with the generic diagnosis of *Paratetilla* presented by Hooper and Van Soest (2002). These morphological characters clearly support the placement of the specimens within *Paratetilla*.

***Dysidea* Johnston, 1842**

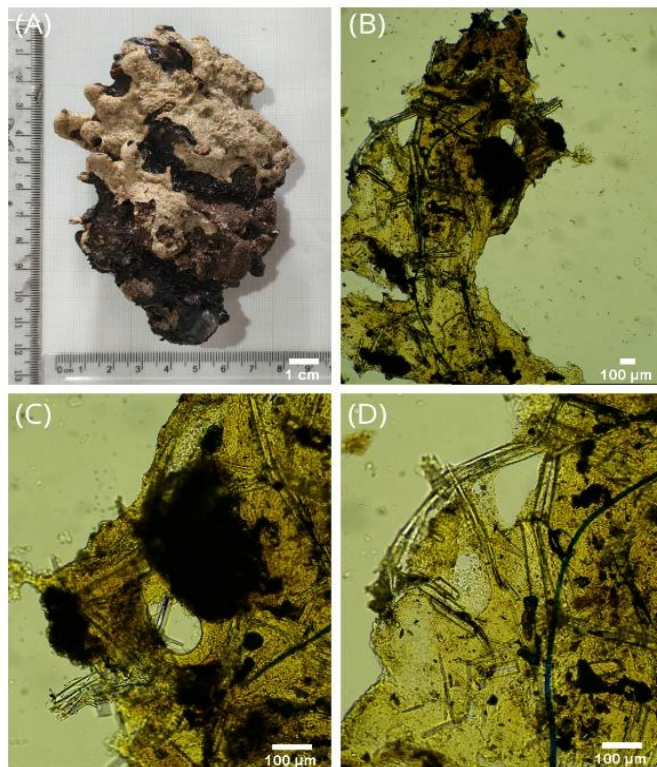


Fig. 8. *Dysidea* sp. Johnston: (A) *Dysidea* (sample after preservation); (B-C) sponge fiber morphology; (D) reticulate skeletal architecture.

Phylum: Porifera Grant, 1836

Class: Demospongiae Sollas, 1885

Order: Dictyoceratida Minchin, 1900

Family: Dysideidae Gray, 1867

Genus: *Dysidea* Johnston, 1842

Material Examined

One specimen of *Dysidea* sp. was collected from the mangrove-associated habitat of Tampora Beach, Situbondo, East Java, Indonesia. The sponge was attached to the submerged mangrove roots of the mangrove trees.

Diagnosis

The specimen was characterized by an irregular massive growth form, a soft and resilient consistency, a fibrous skeleton composed entirely of spongin fibers, and the complete absence of mineral spicules.

Description

The sponge exhibited an irregular massive morphology measuring approximately 9 cm in diameter (Fig. 8A). In life, the specimen was dark purple and gradually changed to pale brown after preservation in ethanol (Fig. 8B). Numerous small oscula were irregularly distributed over the sponge surface, whereas ostia were not readily distinguishable. The consistency was soft, elastic, and resilient to gentle compression.

Skeleton

The skeleton consisted exclusively of an irregular three dimensional network of spongin fibers without siliceous spicules (Fig. 8C). Primary fibers were relatively thick and interconnected by finer secondary fibers, forming a characteristic dictyoceratid fiber network.

Spicules

No mineral spicules were observed in the examined specimen after sodium hypochlorite digestion. The absence of megascleres and microscleres is consistent with the diagnostic characteristics of Dictyoceratida sponges.

Remarks

The absence of siliceous spicules, together with a skeleton composed solely of spongin fibers and a soft, elastic consistency are the principal diagnostic features of *Dysidea*. The examined specimen corresponds closely with the generic diagnosis provided by Hooper and Van Soest (2002), supporting its identification as *Dysidea* sp.

***Dysidea* Johnston, 1842**



Fig. 9. *Dysidea* sp. Johnston: (A) *Dysidea* (sample after preservation); (A-C) sponge fiber morphology; (D) reticulate skeletal architecture.

Phylum: Porifera Grant, 1836

Class: Demospongiae Sollas, 1885

Order: Dictyoceratida Minchin, 1900

Family: Dysideidae Gray, 1867

Genus: *Dysidea* Johnston, 1842

Material Examined

One specimen of *Dysidea* sp. Was collected from a mangrove associated habitat of Tampora Beach, Situbondo, East Java, Indonesia. The specimens were attached to submerged mangrove roots within the intertidal zone.

Diagnosis

The examined specimen is characterized by an irregular massive to lobate growth form, a soft and highly compressible consistency, and a fibrous skeleton composed exclusively of spongin fibers (Fig. 9B). Mineral spicules were also absent in the samples.

Description

The sponge exhibited irregular massive morphology with short lobate projections, reaching approximately 11 cm in maximum diameter (Fig. 9A). The living specimens were dark brown to blackish brown and gradually became light brown after ethanol preservation (Fig. 9A). The surface was uneven and slightly convoluted in nature. The ostia were inconspicuous, whereas several circular oscula were irregularly distributed across the upper surface of the sponge. The sponge was soft, resilient, and readily compressible under a gentle pressure.

Skeleton

The skeleton consisted entirely of an anastomosing network of spongin fibers forming a three dimensional reticulate framework (Fig. 9C). Thick primary fibers were interconnected by thinner secondary fibers, producing the typical fibrous skeleton of dictyoceratid sponges. No mineral skeletal elements were observed.

Spicules

Siliceous spicules were not observed in this study. Digestion of sponge tissue using sodium hypochlorite confirmed that the skeletal framework was composed exclusively of spongin fibers without megascleres or microscleres.

Remarks

The complete absence of siliceous spicules, together with a skeleton consisting solely of anastomosing spongin fibers and a soft, compressible consistency, agrees with the generic diagnosis of *Dysidea* proposed by Hooper and Van Soest (2002). Although the external morphology differs slightly from that of Specimen 5 in term of overall shape and surface configuration, both specimens shared the principal diagnostic characters of the genus and were therefore assigned to *Dysidea*. The observed morphological differences likely represent interspecific variation or phenotypic plasticity commonly reported within the genus.

Spongia Linnaeus, 1759

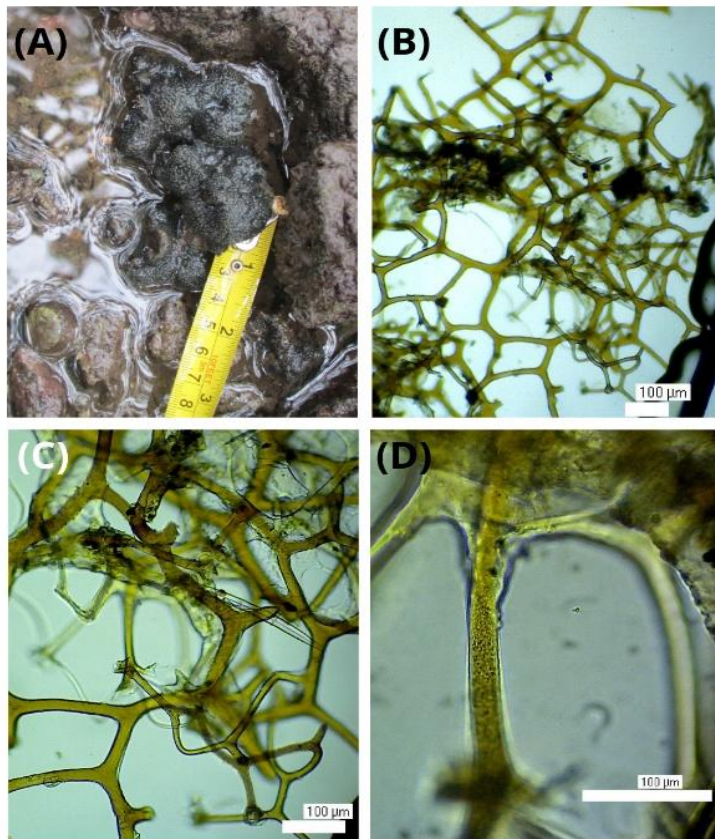


Fig. 10. *Spongia* sp. Linnaeus: (A) *Spongia* (lifeform sample); (B-D) sponge fiber morphology

Phylum: Porifera Grant, 1836

Class: Demospongiae Sollas, 1885

Order: Dictyoceratida Minchin, 1900

Family: Spongiidae Gray, 1867

Genus: *Spongia* Linnaeus, 1759

Material Examined

One specimen of *Spongia* sp. was collected from the mangrove associated habitat of Tampora beach, Situbondo, East Java, Indonesia for this study. The specimen was attached to submerged mangrove roots that were exposed during low tide periods.

Diagnosis

The specimen is characterized by an irregular massive growth form, a highly elastic and fibrous consistency, and a skeleton composed exclusively of well-developed spongin fibers arranged in a regular reticulate network. Mineral spicules were also absent in the samples.

Description

The sponge formed an irregular massive colony approximately 12 cm in diameter (Fig. 10A). The living specimen was dark brown, becoming pale brown following ethanol preservation (Fig. 10B). The surface was uneven with shallow conules and numerous circular oscula distributed irregularly on the upper surface. The ostia were not readily visible in the images. The consistency was extremely elastic and resilient, rapidly returning to its original shape after compression, reflecting the well developed spongin skeleton characteristic of commercial bath sponges.

Skeleton

The skeletal architecture consisted entirely of a dense reticulate network of laminated spongin fibers (Fig. 10C). Thick primary fibers formed the principal supporting framework and were interconnected by finer secondary fibers, producing a regular three-dimensional network typical of the family Spongiidae. Sand grains and foreign inclusions were either absent or rarely observed.

Spicules

No siliceous spicules were detected after the sodium hypochlorite digestion. The absence of both megascleres and microscleres is consistent with the diagnostic characters of *Spongia* and other members of the family Spongiidae.

Remarks

The examined specimen corresponds closely with the generic diagnosis of *Spongia* presented by Hooper and Van Soest (2002). The diagnostic features include a robust spongin fiber skeleton, complete absence of mineral spicules, and a highly elastic consistency. Although *Spongia* shares the absence of siliceous spicules with *Dysidea*, the two genera can be readily distinguished by their skeletal organizations. *Spongia* possesses a more regular, laminated, and heavily developed spongin fiber network, whereas *Dysidea* is characterized by a lighter, irregularly anastomosing fibrous skeleton. The combination of skeletal architecture and external morphology therefore supports the assignment of the specimen to *Spongia*.

Discussion

The sponge assemblage observed in the mangrove area of the Tampora beach ecosystem in East Java, Indonesia, demonstrated a distinct taxonomic distribution comprising eight genera within the class Demospongiae. These genera are systematically categorized into two subclasses: Heteroscleromorpha and Keratosa. The subclass Heteroscleromorpha exhibits significant diversity within this unique ecotone, encompassing five distinct orders: Haplosclerida, Biemnida, Clionaida, Poecilosclerida, and Tetractinellida. In contrast, Keratosa is solely represented by the order Dictyoceratida. Overall, seven families were identified within this specialized intertidal zone; Chalinidae, Biemnidae, Clionaidae, Tedaniidae, Tetillidae, Dysideidae, and Spongiidae, which include the genera *Chalinula*, *Haliclona*, *Biemna*, *Spheciospongia*, *Tedania*, *Paratetilla*, *Dysidea*, and *Spongia* (Table 1).

The spatial arrangement and high representation of demosponges reflect the typical evolutionary adaptation of these filter feeding macroinvertebrates to the dynamic environments' characteristic of tropical Indo Pacific intertidal zones (Calcinai, et al., 2017)

Table 1. Specimens recorded associated with mangrove in Tampora beach ecosystems

Class	Subclass	Order	Family	Genus
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	<i>Chalinula</i>
				<i>Haliclona</i>
		Biemnida	Biemnidae	<i>Biemna</i>
		Clionaida	Clionaidae	<i>Spheciospongia</i>
		Poecilosclerida	Tedaniidae	<i>Tedania</i>
		Tetractinellida	Tetillidae	<i>Paratetilla</i>
	Keratosa	Dictyoceratida	Dysideidae	<i>Dysidea</i>
			Spongiidae	<i>Spongia</i>

A notable feature of this sponge community is its strict microhabitat preference and substrate specialization. The Genera *Dysidea*, *Spongia*, *Chalinula*, *Haliclona*, *Biemna*, *Spheciospongia*, and *Tedania* were exclusively documented as being attached to mangrove root structures. This selective colonization suggests that the structural configuration of mangrove roots provides a stable and advantageous substrate for sponge larval

settlements. The complex root matrices function as natural hydrodynamic dampeners, mitigating severe tidal shearing stress while simultaneously trapping suspended particulate organic matter, thereby enhancing food availability for sessile suspension feeders. In contrast, the genus *Paratetilla* was uniquely found on adjacent coral substrates, forming massive coral-like growth structures. This habitat segregation illustrates a clear ecological niche differentiation among sponge genera within the broader Tampora beach ecosystem. This spatial distribution pattern aligns with the findings of Becking et al. (2013) for the Berau region of East Kalimantan (Becking et al., 2013). In their investigation of mangroves and marine lakes on Kakaban and Maratua Islands, they recorded 115 sponge species, highlighting a sharp compositional gradient transitioning away from the shoreline, which is fundamentally determined by the interface between solid substrates (roots and rocks) and soft substrates (mud and sand).

Evaluating the taxonomic checklist of Tampora provides significant insights into the broader regional distribution and biogeographical shifts in the Indonesian archipelago. Genera such as *Haliclona*, *Biemna*, *Spheciospongia*, *Dysidea*, and *Spongia* have been consistently recorded across various Indonesian marine eco-regions (Table 2). However, the presence of *Chalinula*, *Tedania*, and *Paratetilla* is noteworthy, as these genera were absent from the previous localized survey conducted at Tampora Beach (Setiawan, et al., 2018), in establishing them as new geographic records for this area. Comparative local records indicate that neighboring systems, such as Pecaron beach, only host *Haliclona* and *Dysidea*, with the remaining six genera undocumented there. This disparity highlights the highly heterogeneous nature of beach microhabitats and the influence of variations in survey coverage on recorded biodiversity metrics. Similar documentation dynamics were observed by Calcinaï et al. (2017) on Bangka Island in North Sulawesi. In their assessment of two separate mangrove forests, they documented 19 sponge species across 15 genera on trunks, roots, and the adjacent benthos. Their work expanded the known geographic range of multiple taxa, including the discovery and description of a new species, *Dercitus (Stoeba) bangkae*, demonstrating that multi habitat sampling spanning the mangrove and coral reef interface is crucial for mapping the full extent of hidden marine biodiversity in this region.

Table 2. Comparative checklist of sponge genera recorded from several beach ecosystems in Indonesia and the present study

Class	Genus	Bangka Island (Calcinai et al., 2016)	Tampora, Situbondo (Alivy et al., 2016)	Spermonde Archipelago (Putra et al., 2024)	Pecaron Beach (2025)	Present study (Tampora Mangrove Situbondo)	Main substrate
Demospongiae	<i>Chalinula</i>	✓	-	✓	-	✓	Mangrove roots
	<i>Haliclona</i>	✓	✓	✓	✓	✓	Mangrove roots
	<i>Biemna</i>	✓	✓	✓	-	✓	Mangrove roots
	<i>Spheciospongia</i>	-	✓	✓	-	✓	Mangrove roots
	<i>Tedania</i>	✓	-	✓	-	✓	Mangrove roots
	<i>Paratetilla</i>	-	-	✓	-	✓	Coral
	<i>Dysidea</i>	✓	✓	✓	✓	✓	Mangrove roots
	<i>Spongia</i>	✓	✓	✓	-	✓	Mangrove roots

Notes: ✓ = recorded; – = not recorded

Beyond baseline taxonomy, the close association of sponges with mangrove roots has significant ecological implications for physiological adaptation and biochemical symbiosis in stressful marine ecosystems. Mangrove dwelling sponges are subjected to extreme environmental fluctuations, including regular aerial exposure during low tides, rapid salinity shifts due to freshwater runoff, and high levels of ambient suspended sedimentation. To survive these conditions, sponges have formed specialized relationships with internal microbial consortia. This ecological mechanism was demonstrated by Sibero et al. (2021) in the mangrove ecosystem of Kemujan Island, Karimunjawa National Park (Sibero et al., 2021). Their research detailed the remarkable diversity of sponge associated fungi isolated from intertidal hosts, indicating that these challenging ecosystems for resilient symbiotic microbiomes. These microorganisms produce distinct secondary metabolites that perform defensive chemical functions for the host sponge while serving as a prolific source of bioactive compounds with cytotoxic, antimicrobial, and pharmaceutical properties. Therefore, sponge assemblages in regions such as

Tampora, Berau, and Bangka island represent not only vital elements of macro benthic food webs but also critical reservoirs of functional chemical ecology within Indonesia's beach biomes.

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