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Short Communication

Re-description of two marine sponge species (Demospongiae: Haplosclerida) from the coast of Karachi, Pakistan, Northern Arabian Sea

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Marine sponges are a highly diversified group of invertebrates (phylum Porifera) which inhabit different substrates in the coastal regions of the world. These sponges play an important role in the food web and provide a protected and nutrient-rich habitat for a variety of organisms. This is the first report on the re-description of two marine sponges belonging to the class Demospongiae, order Haplosclerida inhabiting the coastal waters of Karachi (Pakistan; Northern Arabian Sea). *Callyspongia* (*Cladochalina*) *fibrosa* (Ridley and Dendy, 1886) (Family Callyspongiidae) was collected from Churna Island at 7 m depth through SCUBA diving and *Haliclona* (*Soestella*) *hornelli* (Dendy, 1916) (Family Chalinidae) was collected from the rock pools of Buleji rocky ledge. The skeletal framework of both sponges was observed in light and scanning electron microscope. The spicules of *C.* (*C.*) *fibrosa* were smooth and densely packed with thick ectosomal and choanosomal fibres. The choanosomal skeleton of *H.* (*S.*) *hornelli* was sub-anisotropic, forming a reticulation of meshes with unispicular and paucispicular lines, and its spicules were slender megascleres while microscleres absent. *H.* (*S.*) *hornelli* is assigned to the subgenus *Soestella* of the genus *Haliclona*.

[**Keywords**: Buleji, *Callyspongia*, Churna Island, *Haliclona*, New records, Taxonomy]

Introduction

Demospongiae Sollas 1885 form an extensively diverse class of Porifera inhabiting fresh water and marine habitats, from shallow water to the deep sea[1-2]. Demospongiae with an isodictyal, isotropic or anisotropic skeleton and diactinal spicule forms fall into the order Haplosclerida[3] included in the subclass Heteroscleromorpha[4]. According to the revised classification by Morrow & Cárdenas[4], six marine sponge families (Callyspongiidae, Chalinidae, Niphatidae, Calcifibrospongiidae, Petrosiidae and Phloeodictyidae) are confined within this order. The Family Callyspongiidae[5] is characterized by smooth or ridged surface, or provided with conules or spikes. The skeleton consists of rectangular spiculo-fibre meshwork with a compound, triangular or round-meshed tangential surface skeleton[6]. Presently, four valid genera are included in this family *viz*. *Arenosclera* Pulitzer-Finali, 1982[(ref. 7)], *Callyspongia*[8], *Dactylia*[9] and *Siphonochalina*[10] and are distributed in temperate, cold and tropical waters[6,11]. The genus *Callyspongia* contains four subgenera, of which the subgenus *Callyspongia* (*Cladochalina*)[12] is visibly distinguished by fine conulose or spined surface and absence of microscleres; while the choanosomal skeletal fiberes are fasciculated, *i.e*. they occur in bundles[13].

Sponges in the family Chalinidae are often cushion-shaped with oscular chimneys[6]. The skeleton in this family is composed of a delicate hexagonal tangential reticulation with unispicular, paucispicular or multispicular primary lines, which are joined regularly with unispicular or paucispicular secondary lines[6,11,14]. According to Hooper & Van Soest[6], based on the presence of an isodictyal skeleton of diactinal megascleres of Haplosclerida, most genera of the family Chalinidae are to be merged in a single genus *Haliclona*[15]. Within the Family Chalinidae[16], five genera are currently considered valid including *Chalinula*[17], *Cladocroce*[18], *Dendrectilla*[19], *Dendroxea*[20] and *Haliclona*[6,15]. The genus *Haliclona* has regular choanosomal reticulation of interconnected primary and secondary spiculofibres. Spicules are mostly oxeas and microscleres may be present in the form of sigmas and toxas[6]. It contains seven subgenera, *Haliclona*[21], *Reniera*[17], *Halichoclona*[22], *Soestella*[14], *Gellius*[16], *Rhizoniera*[20] and *Flagellia*[23]. The subgenus *Haliclona* (*Soestella*)[14] has a choanosomal skeleton consisting of a sub-anisotropic, paucispicular reticulation of primary lines irregularly interconnected by secondary unispicular lines. The smooth, slender oxeas with spongin at their nodes have a tendency to form rounded meshes[14,24].

The genus *Haliclona*[15] has been reported worldwide, and 56 species have been recorded from the regions bordering the Indian Ocean. Among them, 29 species have not been assigned to subgenera[23]. No species belonging to the subgenus *Soestella* have been

recorded from the coastal waters of the Indian Ocean[23]. Most species of the subgenus *Soestella*[14] have been recorded from the Mediterranean[20,25-26], Brazil[27-29], the Caribbean[14,30-34,], the North Atlantic[35] and from the North Pacific Ocean[36].

Very little information is available on sponge fauna[37], and no taxonomic works have been published yet from the coastal waters of Pakistan. Therefore, the present study aims to explore and re-describe sponges found in the shallow intertidal regions of Karachi, Pakistan.

Materials and Methods

The specimen of *Callyspongia* (*Cladochalina*) *fibrosa* was collected from 7 – 10 m depth at Churna Island (66°36'32.64" E, 24°53'37.72" N) through SCUBA diving in February 2013, and the specimen of *Haliclona* (*Soestella*) *hornelli* was collected from a rock pool of Buleji rocky ledge (24°50'10.47" N, 66°48'34.87" E) at southwest of Karachi in January 2016 (Fig. 1). The specimens were thoroughly washed, fixed with 4 % buffered formalin solution and later on preserved in 85 % ethanol. Methodological techniques of identification were made following Hooper & Van Soest[6]. The material is deposited in the Centre of Excellence in Marine Biology, University of Karachi. Karachi, Pakistan.

For spicule isolation and examination, a small segment from the preserved specimen was digested in 5 % sodium hypochlorite for a few minutes and washed three times with Milli-Q water, and re-preserved in alcohol. This digested material was mounted with a glass cover slip. The cover slip was adhered on a stub and coated with 300°A gold layer for 5 min by auto ion-sputtering coater (JEOL JFC-1500), and about 20 – 30 spicules were measured and scanned under SEM (JEOL JSM-6380A, Japan) at 10 kV.

Results

Phylum: Porifera
Class: Demospongiae[38]
Order: Haplosclerida[3]
Family: Chalinidae[16]
Genus: *Haliclona*[15]
Subgenus: *Soestella*[14]
Haliclona (*Soestella*) *hornelli*[40] (Fig. 2a)

Synonymy

Reniera hornelli[40], 110, Pl II, Figure 11.

Material examined

CEMB-POR-03; Buleji, Karachi; 26 January 2016; 1.0 to 1.5 m (rock pool).

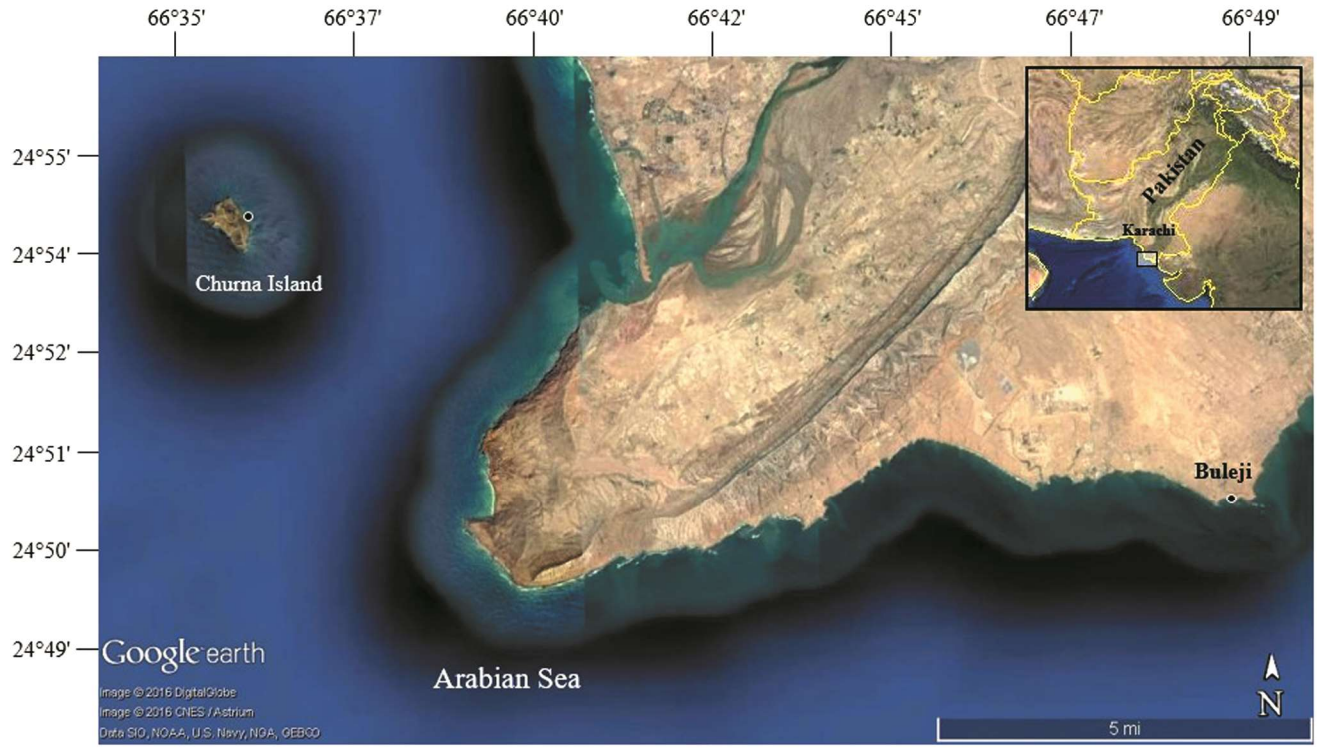

Fig. 1 — Map of Karachi, Pakistan coast showing the collection site of Churna Island and Buleji. (Google Earth Pro: version 7.1.4.1529)

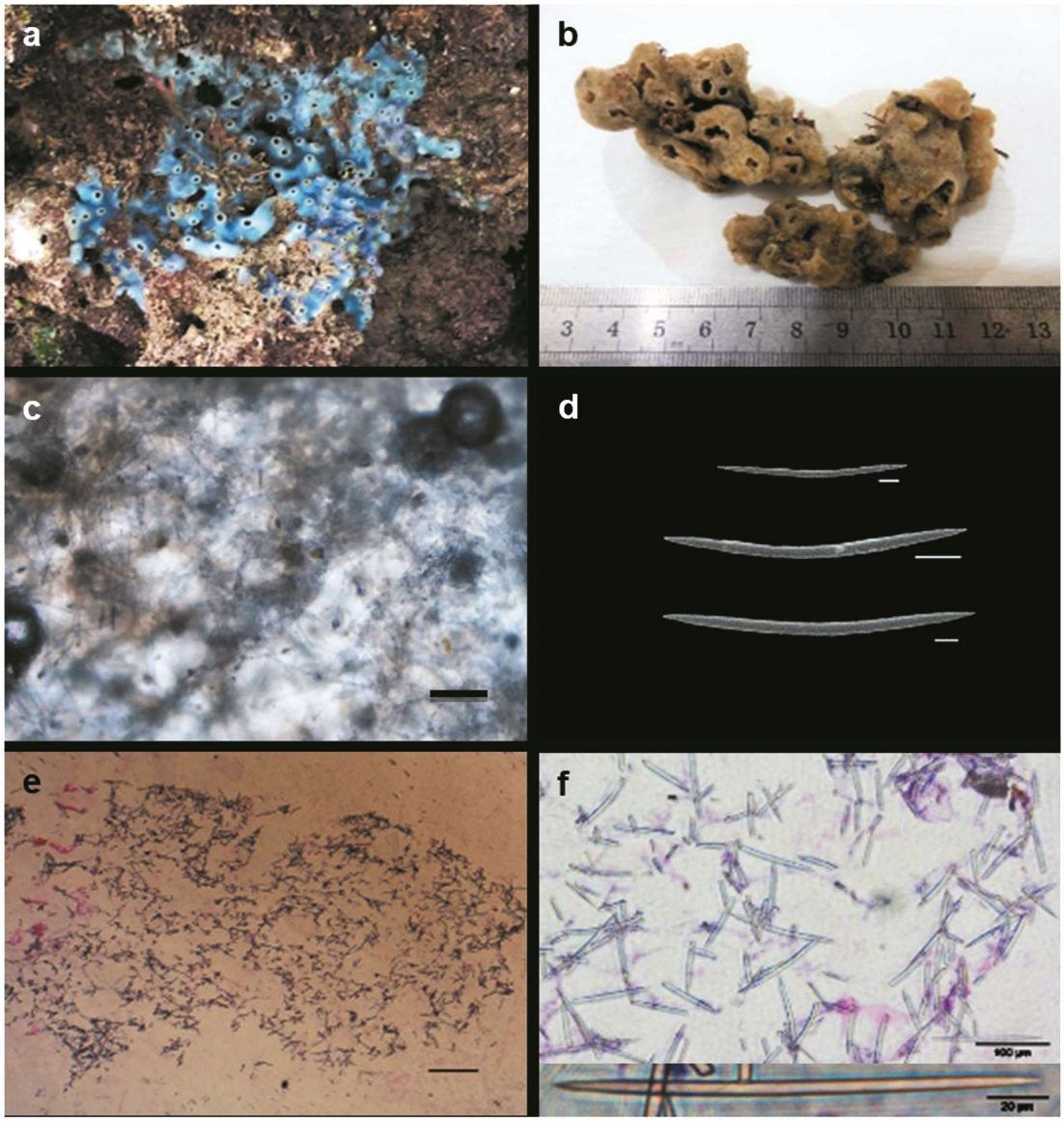

Fig. 2 — (a) Specimen of *Haliclona (Soestella) hornelli* (Dendy, 1916) in a rock pool, (b) Preserved specimen of *H. (S.) hornelli*, (c) Light microscopic image of internal skeletal structure, (d) Scanning electron microscopic image of oxeas (scale = 20 µm), (e) Histological section of ectosomal and choanosomal skeleton (scale = 500 µm), and (f) Spicules (oxeas) in tangential section

Material description

Cushion-shaped, spread over the surface of rocks, firmly attached in the form of thickly encrusting sheets. Surface smooth and even, small chimney-like volcano elevations on the surface with 0.8 – 1.0 cm height, inner tube length of 0.4 – 0.8 cm and width was 0.6 cm. The oscules (diameter 0.2 – 0.4 cm) were scattered irregularly over the surface. Consistency was soft, delicate and fragile.

Colour

Turquoise blue in life and grayish beige in alcohol (Fig. 2b).

Ectosomal skeleton

Unispicular, tangentially irregular reticulation of fibres.

Choanosomal skeleton

Delicate with sub-anisotropic, unispicular and paucispicular reticulation irregularly and tangentially connected with ectosomal unispicular surface lines forming the meshes.

Spicule

Oxeas, size range: length 80 – 148 µm and width 5 – 7 µm, with pointed ends, loosely attached with nodal sponging (Fig. 2c – f).

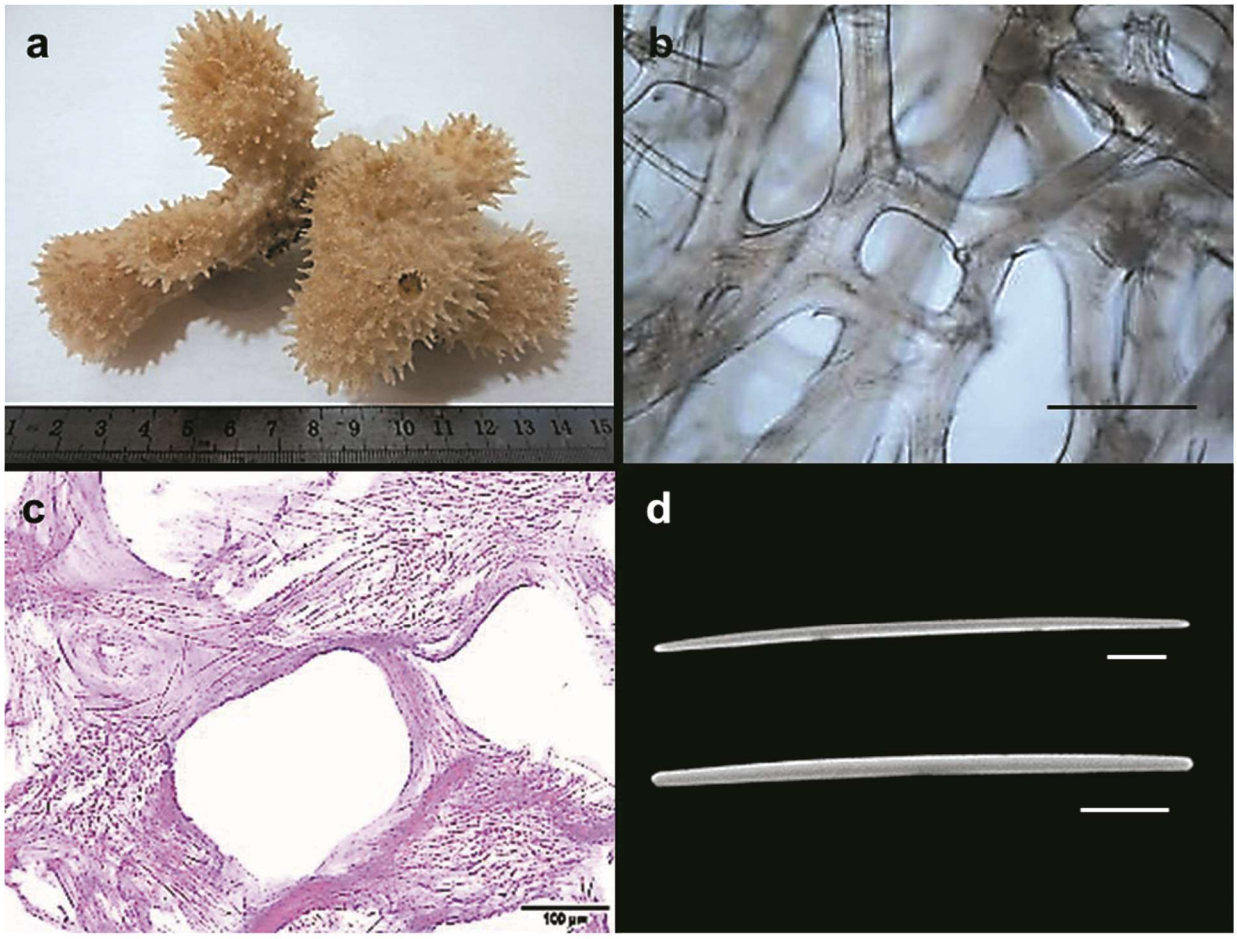

Fig. 3 — (a) Specimen of *Callyspongia* (Cladochalina*) fibrosa* (Ridley and Dendy, 1886), (b) Light microscopic image of tangential skeleton shows tufted spongin network (scale = 20 µm), (c) Light microscopic image of microtome-section showing spiculo-fibres, and (d) Scanning electron microscopic image of siliceous spicules (scale = 5 µm)

Ecology

Rock pool, shallow intertidal rocky shelf at depth 1.2 m (Fig. 2a).

Distribution

Beyt Island, West and South shelf (71°43'8.4" E, 20°28'25.7" N), India and Buleji ledge, Karachi (64°50'21" E, 24°49'03" N), Pakistan (present study).

Remarks

Haliclona (S.) hornelli[40] was originally described as *Reniera hornelli*[40] from Okhamandal, Gujrat, India, with skeletal features of isodictyal choanosomal skeleton, the multispicular lines interconnected irregularly with unispicular secondary lines. De Weerdt[14] described the characteristic features of the subgenus *Haliclona* (*Reniera*) as having a choanosomal skeleton consisting of a regular unispicular isotropic reticulation, unlike the presently studied specimen's features. The specimen examined in the current study and the material described by Dendy[40] has a sub-anisotropic choanosomal skeleton, ascending paucispicular lines that are irregularly connected to secondary unispicular lines. The ectosomal skeleton is formed by rounded meshes. This combination of characters indicates that the species has to be placed in the subgenus *Haliclona* (*Soestella*).

Phylum: Porifera
Class: Demospongiae[38]
Order: Haplosclerida[3]
Family: Callyspongiidae[5]
Genus: *Callyspongia*[8]
Subgenus: *Callyspongia* (*Cladochalina*)[12]
Callyspongia (*Cladochalina*) *fibrosa*[39] (Fig. 3)

Synonymy

Pachychalina fibrosa Ridley & Dendy, 1887, 21-22, Pl IV, Figure 3 and 4, *Dasychalina fibrosa*[39], 330.

Material examined

CEMB-POR-02; 9 February 2013; Churna Island, Karachi; 7 – 10 m.

Material description

Erect, irregular, branched; stout branches, coarsely fibrous, aculeated, elastic, brittle, hard and compressible. Each branch bears on one side large circular shallow oscules. Length of tubular branch ranges 20 – 50 mm from base to osculum and the width ranged between 35 mm and 110 mm in diameter. Canal length from inside the tubular branch is about 35 mm, narrower towards the base.

Colour

Pale yellow in life and yellowish white in alcohol (Fig. 3a).

Ectosomal skeleton

Thin, spiny, distinct and translucent. Spines length ranges from 3 – 5 mm.

Choanosomal skeleton

Irregular coarse reticulation of stout spiculo-fibres (Fig. 3b and c).

Spicules

Densely packed in spongin fibres in the form of reticulate bundles about the thickness of 0.1 mm. They are small, smooth, and slender with blunt ends (length ranging from 66 – 84 µm and width from 2 – 3 µm) (Fig. 3d).

Ecology

Shallow coastal rocky shelf of about 7 m depth.

Distribution

Indo-Pacific, Eastern Philippines, Southern Vietnam, Australia and Pakistan (present study).

Remarks

The specimen is certainly comparable with the *Pachychalina fibrosa*[41] and *Dasychalina fibrosa*[39] with some exemptions, as the branches are larger than the original specimen. The colour of the specimen after preservation was whitish yellow. Spicules have blunt ends of similar size[39].

Discussion

This is the first work on the taxonomy of a marine sponge at Churna Island and Buleji along the Karachi coast. Churna Island has a rich, productive ecosystem due to nutrient-rich water that supports a highly symbiotic and strongly competitive association with diverse coral communities[42-43]. The rocky shelf of benthic organisms and coral associations benefit the sponge fauna in this region[42,44]. The marine sponge *Callyspongia* (*Cladochalina*) *fibrosa* is commonly known from the Gulf of Mannar, Indian Ocean[45]. This species has a considerably brittle consistency with reticulate meshes of tufted fibres, cemented with on rocky ledges[6]. The sandy-rocky beach of Buleji has numerous tidal and rock pools which contain a rich variety of fauna and flora[46]. However, no attention has been paid to the sponge fauna of the region. The sponge *Haliclona* (*Soestella*) *hornelli* (order Haplosclerida, family Chalinidae) is systematically re-described here from the Pakistan waters (North Arabian Sea). The identification of both species is primarily based on morphological features and skeletal framework. This is typically difficult to analyze, as external morphology may diverge due to changes in environmental conditions and habitat from the type localities of species[47-48].

The sponge species *Haliclona* (*Soestella*) *hornelli* closely resembles *H.* (*Gellius*) *digitata* (Koltun, 1958), *H. Semifibrosa*[40] and *H. tenuiramosa*[49], but slight variations were found in the morphological and skeletal features of these species. The colour pattern and spicules size of the Pacific cold water species *H.* (*G.*) *digitata*[50] are similar, but surface morphology (specimen shape and tube length) differed from the studied specimen. According to Dendy[40], the outer structure and skeleton of *H. semifibrosa* revealed similar features but differed by the presence of ectosomal and sub-ectosomal spiculofibres. *Haliclona Tenuiramosa*[49] also has similar colour and morphological features as that of *H.* (*S.*) *hornelli*, but the skeletal structure is quite different. The morphology, entire surface structure (shape and size of surface elevations), oscules, skeletal features and spicules dimension of *H. hornelli* given by Dendy[40], closely resemble with the studied specimen.

The species *H. hornelli*[40] was originally described from Beyt Island, India and around coastal margins of Western India, as *Reniera hornelli* by Dendy[40] and Van Soest *et al.*[51]. Even though the species was originally described in the genus *Reniera*, it is here proposed to place it in the subgenus *Soestella* due to spicular morphology and skeletal arrangement of the studied sponge specimen and Dendy's specimen. Although the live colour of the specimen and some of the skeletal characteristic features of the subgenus *Soestella* were not mentioned in the original description, a comprehensive assessment of the

choanosomal skeleton, consisting of a multispicular, discontinuous, and irregular reticulation of spicules, and the spicule size and minimal spongin present in the ectosomal skeleton make it likely that the studied specimen is *H. hornelli* belonging to subgenus *Soestella*. So far, this subgenus has not been recognized in the Arabian Sea and is being reported for the first time from Pakistan.

These marine sponges have not been recorded previously from the coastal waters of Pakistan. Due to scarcity of literature on their taxonomy and ecological perspective, there is a dire need of further investigation and conservation of the diversity in this region.

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Conflict of Interest

The authors declare no conflict of interest.

Ethical Statement

This research did not require IRB approval because the research was supported from the dead specimen collected from Churna Island and rock pool of Buleji rocky ledge at southwest of Karachi.

Author Contributions

SS, ZB & MR: Conceptualization, methodology, sample collection, supervision/co-supervision, review & editing; HJ & AA: Data analysis, sample collection, writing–original draft; PJAS: reviewing & editing.

References

1 Cruz-Barraza J A & Carballo J L, Taxonomy of sponges (Porifera) associated with corals from the Mexican Pacific Ocean, *Zool Stud*, 47 (6) (2008) 741-758.

2 Diaz M C, Mangrove and coral reef sponge faunas: untold stories about shallow water Porifera in the Caribbean, *Hydrobiologia*, 687 (2012) 179-190. https://doi.org/10.1007/s10750-011-0952-5

3 Topsent E (ed), *Spongiaires de l'Atlantique et de la Méditerranéeprovenant des croisières du Prince Albert ler de Monaco*, Résultats des campagnes scientifiques accomplies par le Prince Albert I Monaco, 74, (Imprimerie de Monaco, Monaco), 1928, pp. 399.

4 Morrow C & Cárdenas P, Proposal for a revised classification of the Demospongiae (Porifera), *Front Zool*, 12 (7) (2015) 1-27. https://doi.org/10.1186/s12983-015-0099-8

5 De Laubenfels M W, A comparison of the shallow-water sponges near the Pacific end of the Panama Canal with those at the Caribbean end, *Proc U S Natl Mus*, 83 (2993) (1936) 441-466. https://doi.org/10.5479/si.00963801.83-2993.441

6 Hooper J N A & Van Soest R W M, A guide to the classification of sponges, In: *Systema Porifera*, edited by Hooper J N A, Van Soest R W M & Willenz P, (Springer, Boston, MA), 2002, pp. 1-7. https://doi.org/10.1007/978-1-4615-0747-5_1

7 Pulitzer-Finali G, Some new or little-known sponges from the Great Barrier Reef of Australia, *Boll Mus Ist Biol Univ Genova*, (1982) 48-49.

8 Duchassaing de Fonbressin P & Michelotti G, Spongiaires de la mer Caraibe, *Natuurkundige verhandelingen van de Hollandsche maatschappij der wetenschappen te Haarlem*, 21 (1864) 1-124.

9 Carter H J F R S, Descriptions of Sponges from the Neighbourhood of Port Phillip Heads, South Australia, *Ann Mag Nat Hist*, Series 5, 17 (101) (1986) 431-441. https://doi.org/10.1080/00222938609460169

10 Schmidt O, Die Spongien der Küste von Algier, Mit Nachträgen zu den Spongien des Adriatischen Meeres (Drittes Supplement), *Wilhelm Engelmann*, *Leipzig*, i-iv (1868) 1-44.

11 Hooper J N, *Sponguide*, A guide to sponge collection and identification, (Queensland Museum South Brisbane, Australia), 2000, pp. 129.

12 Schmidt O, GrundzügeeinerSpongien-Fauna des atlantischen Gebietes, *Wilhelm Engelmann*, *Leipzig*, iii-iv (1870) 1-88.

13 Desqueyroux-Faúndez R & Valentine C, Family Callyspongiidae de Laubenfels, In: *Systema Porifera*, *A guide to the classification of sponges*, edited by Hooper J N A & Van Soest R W M, (Kluwer Academic/ Plenum Publishers, New York, Boston, Dordrecht, London, Moscow), 2002, pp. 835-851.

14 De Weerdt W H, A monograph of the shallow-water Chalinidae (Porifera, Haplosclerida) of the Caribbean, *Beaufortia*, 50 (2000) 1-67.

15 Grant R E, Outlines of Comparative Anatomy: Designed to Serve as an Introduction to Animal Physiology, and to the Principles of Classification in Zoology London, *H Bailliere*, (1841) 1-656.

16 Gray J E, Notes on the arrangement of sponges with the descriptions of some new genera, *Proc Zool Soc London*, 2 (1867) 492-558.

17 Schmidt O, Die Spongien des adriatischen Meeres, *Wilhelm Engelmann*, *Leipzig*, i-viii (1862) 1-7.

18 Topsent E, Contribution à l'étude des Spongiaires de l'Atlantique Nord (Golfe de Gascogne, Terre-Neuve, Açores), Résultats des campagnes scientifiques accomplies par le Prince Albert I, *Monaco*, 2 (1892) 1-165.

19 Pulitzer-Finali G, A collection of marine sponges from east Africa, *Annales Museo Civico Storia Naturale "Giacomo Doria*", 89 (1993) 247-350.

20 Griessinger J M, Etude des Réniérides de Méditerranée (Démosponges Haplosclérides), *Bull Mus natl hist*, 3 (1971) 97-182.

21 Grant R E, *Animal kingdom: The cyclopaedia of anatomy and physiology*, edited by Todd R B, (Sherwood, Gilbert and Piper, London), 1836, pp. 107-118.

22 De Laubenfels M W, The marine and fresh-water sponges of California, *Proc U S Natl Mus*, 81 (1932) 1-140.

23 Van Soest R W M, *Flagellia*, a new subgenus of *Haliclona* (Porifera, Haplosclerida), *Eur J Taxon*, 351 (2017) 1-48. https://doi.org/10.5852/ejt.2017.351

24 De Weerdt W H & Van Soest R W M, Marine shallow-water Haplosclerida (Porifera) from the south-eastern part of the North Atlantic Ocean, *Zool Verh*, 225 (1986) 1-49.

25 Harmelin J G, Boury-Esnault N, Fichez R, Vacelet J & Zibrowius H, Peuplement de la grotte sous-marine de l'Ile de Bagaud (Parc National de Port-Cros, France, Méditerranée), *Sci Rep Port-Cros Natl Park France*, 19 (2003) 117-134.

26 Bertolino M, Bo M, Canese S, Bavestrello G & Pansini M, Deep sponge communities of the Gulf of St Eufemia (Calabria, southern Tyrrhenian Sea), with description of two new species, *J Mar Biol Assoc UK*, 95 (7) (2015) 1371-1387. https://doi.org/10.1017/S0025315413001380

27 Muricy G, Lopes D A, Hajdu E, Carvalho M S, Moraes F C, *et al*., *Catalogue of Brazilian Porifera Museum, (*Museu Nacional Série Livros, Rio de Janeiro, Brazil), 2011, pp. 303.

28 Sandes J, Bispo A & Pinheiro U, Two new species of *Haliclona* Grant, 1836 (Haplosclerida: Chalinidae) from Sergipe State, Brazil, *Zootaxa*, 3793 (2) (2014) 273-280. https://doi.org/10.11646/zootaxa.3793.2.7

29 Bispo A, Correia M D & Hajdu E, Two new shallow-water species of *Haliclona* from north-eastern Brazil (Demospongiae: Haplosclerida: Chalinidae), *J Mar Biol Assoc UK*, 96 (2) (2016) 237-249. https://doi.org/10.1017/S0025315414000344

30 Van Soest R W M, *Marine sponges from Curaçao and other Caribbean localities, Part II: Haplosclerida*, Vol 62, Issue 1, edited by Hummelinck P W & Vander Steen L J, Series: Studies on the fauna of Curaçao and other Caribbean islands, (Foundation for Scientific Research in Surinam and the Netherlands Antilles, Utrecht), 1980, pp. 1-173.

31 Rützler K, Díaz M C, Van Soest R W M, Zea S, Smith K P, *et al*., Diversity of sponge fauna in mangrove ponds, Pelican Cays, Belize, *Atoll Res Bull*, 476 (2000) 230-248.

32 Miloslavich P, Díaz J M, Klein E, Alvarado J J, Díaz C, *et al*., Marine Biodiversity in the Caribbean: Regional Estimates and Distribution Patterns, *PLoS ONE*, 5 (8) (2010) p. e11916. https://doi.org/10.1371/journal.pone.0011916

33 Rützler K, Piantoni C, Van Soest R W M & Díaz M C, Diversity of sponges (Porifera) from cryptic habitats on the Belize barrier reef near Carrie Bow Cay, *Zootaxa*, 3805 (1) (2014) 1-129. https://doi.org/10.11646/zootaxa.3805.1.1

34 Pérez T, Díaz M C, Ruiz C, Cóndor-Luján B, Klautau M, *et al*., How a collaborative integrated taxonomic effort has trained new spongiologists and improved knowledge of Martinique Island (French Antilles, eastern Caribbean Sea) marine biodiversity, *PLoS ONE*, 12 (2017) p. e0173859. https://doi.org/10.1371/journal.pone.0173859

35 Van Soest R W M, Porifera, In: *European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification*, edited by Costello M J, Emblow C & White R, (Collection Patrimoines Naturels, 50. Muséum national d'Histoire Naturelle, Paris), 2001, pp. 85-103.

36 Eldredge L G & Smith C M, A guidebook of introduced marine species in Hawaii, *Bishop Mus Tech Rep*, 21 (2001) 1-70.

37 Nazim K, Sherwani S K, Khan M U, Kausar R & Rizvi G, Antibacterial activity of marine sponge collected from Sunhari beach, *FUUAST J Biol*, 4 (2014) p. 233.

38 Sollas W J, On the physical characters of calcareous and siliceous sponge-spicules and other structures, *Scient Proc R Dublin Soc*, 4 (1885) 374-392.

39 Ridley S O & Dendy A, Preliminary Report on the Monaxonida collected by H.M.S. 'Challenger', *J Nat Hist*, 18 (1986) 325-351.

40 Dendy A, *Report on the non-calcareous sponges collected by Mr James Hornell at Okhamandal in Kattiawar in 1905-6*, (Report to the Government of Baroda on the Marine Zoology of Okhamandal in Kattiawar, 2, 1916, pp. 93-146.

41 Ridley S O & Dendy A, Report on the Monaxonida collected by H.M.S. 'Challenger' during the years 1873-1876, Report on the scientific results of the voyage of H.M.S. 'Challenger', 1873-1876, *Zoology*, 20 (1887) 1-275.

42 Ali A, Ormond R, Leujak W & Siddiqui P J A, Distribution, diversity and abundance of coral communities in the coastal waters of Pakistan, *J Mar Biol Assoc UK*, 94 (1) (2014) 75-84. https://doi.org/10.1017/S0025315413001203

43Ali A, Siddiqui P J A & Aisha K, Characterization of macroalgal communities in the coastal waters of Sindh (Pakistan), a region under the influence of reversal monsoons, *Reg Stud Mar Sci*, 14 (2017) 84-92. https://doi.org/10.1016/j.rsma.2017.05.008

44 Raza A, Shaukat S S, Perveen R & Hussain R, Current status of coral research in Pakistan, *Int J Fauna Biol*, 1 (6) (2014) 105-107.

45 Pallela R & Janapala V R, Comparative ultrastructural and biochemical studies of four demosponges from Gulf of Mannar, India, *Int J Mar Sci*, 3 (37) (2013) 295-305. https://doi.org/10.5376/ijms.2013.03.0037

46 Nazim K, Ahmed M, Abbas A & Khan M U, Quantitative description and multivariate analysis of flora and fauna of Buleji area of Karachi coast, *FUUAST J Biol*, 2 (1) (2012) p. 117.

47 Qu Y, Song Y, Cao H & Zhang W, Comparative Study of Morphological and Molecular Characters Between Two Sponge Specimens (Porifera: Demosponge: Axinella) with Pharmacologically Active Compounds from the South China Sea, *Pak J Zool*, 44 (2012) 1727-1735.

48 Muricy G, Esteves E L, Monteiro L C, Rodrigues B R & Albano R M, A new species of *Haliclona* (Demospongiae: Haplosclerida: Chalinidae) from southeastern Brazil and the first record of *Haliclona vansoesti* from the Brazilian coast, *Zootaxa*, 3925 (4) (2015) 536-550. http://dx.doi.org/10.11646/zootaxa.3925.4.3

49 Burton M, Additions to the sponge fauna of the Gulf of Mannar, *Ann Mag Nat Hist*, 5 (30) (1930) 665-676. https://doi.org/10.1080/00222933008673180

50 Koltun V M, Cornacuspongia of sea waters washing the South Sakhalin and the South Kurile Island region, *Issledovaniya dal'nevostochnÿkh morei SSR*, 5 (1958) 42-77.

51 Van Soest R W M, Boury-Esnault N, Hooper J N A, Rützler K, de Voogd N J, *et al*., *World Porifera database*. Available online at: https://www.marinespecies.org/porifera/ (Accessed on 8 October 2017).