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Filling Biodiversity Knowledge Gaps: Sponges (Porifera: Demospongiae) Recorded off San Jorge Gulf (Argentina), SW Atlantic Ocean †

Laura Schejter * and Diego A. Giberto *

Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP-ARGENTINA), Mar del Plata 7600, Argentina

* Correspondence: schejter@inidep.edu.ar (L.S.); diegogiberto@inidep.edu.ar (D.A.G.)

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Abstract: The invertebrate by-catch of the Argentinean squid *Illex argentinus* collected by bottom trawls off San Jorge Gulf during an expedition performed in December 2020 was employed to characterize the bottom assemblages of the area, with special emphasis on sponges. According to the results, sponges were conspicuous and abundant components in these benthic communities, representing up to 40% of the total invertebrate by-catch (average: ~130 kg·nm^2 per site). *Tedania (T.) mucosa* was the dominant species. Other recorded species were *T. (T.) charcoti*, *T. (T.) murdochi*, *Isodictya verrucosa*, *Iophon proximum*, *Clathria (C.) microxa*, *C. (C.) discreta*, *Haliclona bilamellata*, *Siphonochalina fortis*, and *Myxilla (M.) mollis*. The results of this study contribute to filling in the gaps in the distribution records of sponges in the continental shelf of Argentina in a previously poorly studied area.

Keywords: sponge richness; benthic communities; by-catch

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1. Introduction

In Argentina, knowledge on the biodiversity of marine Porifera is closely related to the concentration of the sampling effort. Coastal areas such as Buenos Aires and Tierra del Fuego have several records, while the majority of the continental shelf have few or no records at all [1]. Pioneering studies, such as those developed after the "Challenger" and "Discovery" expeditions, attempt to determine and identify the sponge species inhabiting the Argentinian waters [2–10]. Later, several authors contributed to the study of sponges in specific areas [11–20]. The revision made by López Gappa and Landoni [1] provided the first checklist of marine sponges in Argentina and highlighted noticeable differences in records and sponge richness in different areas. In the past 15 years, there have been new contributions to the study of sponges and also the description of new species. The shelf break sponge-fauna was studied by Schejter et al. [21–23] and Bertolino et al. [24], while interesting contributions were performed for Burdwood bank region by Schejter et al. [25–27] and for Bahía San Antonio by Gastaldi et al. [28]. However, according to our knowledge, there are no specific records of sponge species in the area located off San Jorge Gulf, Patagonia; they are only sparsely mentioned as a general group in technical guides or reports (i.e., [29]).

Considering the former background, the aim of the present contribution was to provide information on sponge richness and abundance from this scarcely studied area (off San Jorge Gulf, Patagonia), taking advantage of the bottom by-catch collected during a stock assessment expedition of the Argentinean squid *Illex argentinus.* Complementary to this, we also provide some general information on the benthic communities of the area and other conspicuous by-catch invertebrate species.

2. Materials and Methods

In December 2020, the RV "Victor Angelescu" performed a regular stock assessment expedition in order to evaluate the population of the Argentinean squid *Illex argentinus* off San Jorge Gulf, between 44–46° S and isobaths 80–120 m depth. Sampling was developed using bottom trawls. At 23 random sites (Table 1), the invertebrate by-catch was preserved frozen and transported to the Laboratorio de Bentos at the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP). Sorting of the species was performed at the laboratory and sponge morphospecies were separated and weighted (wet weight) using an Ohause balance (precision 0.002 kg). By-catch species were identified using local guides [29,30], while sponge species were identified using the literature mentioned in the Introduction section. Biomass values (as densities) were calculated for each taxa, using the swept area for each sampling site, expressed in kilograms per square nautical miles ($kg \cdot nm^{-2}$).

Table 1. Location of the sampling stations in the study area. Benthic by-catch and Porifera biomass values are also provided.

Sampling Station	Latitude (S)	Longitude (W)	Depth (m)	Total Benthic by-Catch ($kg \cdot nm^{-2}$)	Porifera ($kg \cdot nm^{-2}$)
1	46.084	62.041	107	6.54	4.04
2	45.307	61.542	103	110.83	19.02
3	45.462	61.143	110	18.76	17.8
4	45.287	61.068	114	297.5	14.2
5	45.086	61.075	110	563.3	266.01
6	45.046	61.342	106	24.94	13.98
7	45.186	61.501	104	1687	390.65
8	45.237	63.466	100	43.59	36.46
9	45.472	64.040	98	40.57	38.72
10	45.426	62.386	97	114.1	109.26
11	45.189	62.386	106	669.1	656.46
12	45.054	62.309	105	75.59	72.62
13	44.563	62.096	104	568.3	458.32
14	44.496	61.145	108	667.2	36.55
15	44.390	61.388	106	93.47	82.03
16	44.450	62.540	100	403.3	137.27
17	44.206	63.410	89	505.1	138.39
18	44.229	63.015	96	89.95	74.70
19	44.269	62.288	100	98.06	57.28
20	44.161	61.047	104	650.9	39.68
21	44.086	62.186	97	271.2	130.71
22	44.163	61.403	105	127.5	63.69
23	44.019	61.182	103	36.49	8.26

3. Results

Our results showed that the benthic assemblage was composed by 42 taxa. Sponges were conspicuous and abundant components in the benthic communities off San Jorge Gulf, Argentina. They represented 40% of the total invertebrate by-catch in the area (average of 124.61 $kg \cdot nm^{-2}$ per station, maximum value of 656.5 $kg \cdot nm^{-2}$ at station 11, minimum value of 4.04 $kg \cdot nm^{-2}$ at station 1) (Table 1). However, tunicates were the most important group in terms biomass (45%, average of 140.3 $kg \cdot nm^{-2}$), and the solitary ascidian *Paramolgula* sp. accounted for an average of 128.4 $kg \cdot nm^{-2}$ per station. An unidentified colonial tunicate accounted for an average of 11.36 $kg \cdot nm^{-2}$. Other conspicuous but less important groups in terms of biomass in this benthic community were crustaceans (6%), with the spider crab *Libidoclaea granaria* being the most important one in terms of biomass, reaching an average 11.67 $kg \cdot nm^{-2}$. Polychaetes represented 5% of the benthic assemblage, and the most conspicuous taxa was *Chaetopterus antarcticus* (average 15.61 $kg \cdot nm^{-2}$). Echinoderms only contributed 2.3% to the benthic assemblage. It is worth mentioning that egg cases of the catshark *Schroederichthys bivius* were recorded at stations 13, 18, and 21, always attached to the sponge *Tedania (Tedaniopsis) mucosa* (Figure 1A).

Overall, 12 sponge taxa were recorded: *Tedania (T.) mucosa*, *T. (T.) charcoti*, *T. (Tedania) murdochi*, *Isodictya verrucosa*, *Iophon proximum*, *Clathria (Clathria) microxa*, *C. (C.) discreta*, *Siphonochalina fortis*, *Myxilla (M.) mollis*, *Haliclona bilamellata*, and also 2 unidentified species belonging to Suberitidae and Haplosclerida (Figure 1). *Tedania (T.) mucosa*, which was the most common and abundant sponge species recorded in the area, was registered in 22 sites (95% of the sites), reaching up to 98% of the total wet biomass at station 11 (652.7 kg·nm^{-2}), with an average of 100.8 kg·nm^{-2}. The main characteristics of the sponge species recorded are listed below:

- *Tedania (T.) mucosa* specimens (Figure 1A) were massive, beige to red-brown in color, with a smooth surface and an evident ectosomal skeleton made of tornota arranged in palisade. This species was recorded in all the sampled sites, except at station 4. At stations 13, 18, and 21, egg cases of the catshark *Schroederichthys bivius* were found strongly attached to the sponges, as described in [31]. Spicules are smooth styles of 230–255 by 10 µm, mucronate tornota of 190–220 by 5–7.5 µm, and two categories of onichaete of 140–200 µm and 70–85 µm.
- *Tedania (Tedaniopsis) charcoti* specimens (Figure 1K) were massive, but fragile and friable in the dried state. The surface is uneven and looks porous, with no conspicuous ectosome. This species was recorded at stations 4, 5, 6, 11, 15, 17, 18, and 20. Spicules are styles of 245–380 by 5–10 µm, tornota of 180–250 by 5–7.5 µm, and two categories of onichaete of 230–270 µm and 65–105 µm. *Tedania (T.) charcoti* accounted for 14.72 kg·nm^{-2} on average in the studied area. This is a common species in Argentina [21], and our specimens fit very well with the previous records, although spicule dimensions in the holotype and Antarctic specimens are usually bigger.
- *Tedania (Tedania) murdochi* specimens (Figure 1H) were massive and rigid, beige in color, with some evident oscula. They were recorded at stations 10 and 17. Spicule dimensions are smaller than the other two recorded species: styles are 235–270 by 10–15 µm, tornota are 180–210 by 5–7.5 µm, and onichaete are 155–205 µm.
- *Isodictya verrucosa* specimens (Figure 1B) have the typical morphology of the genus, yellow-beige in color, with a plumoreticulate skeleton. This species was recorded at stations 12 and 13. Spicules are oxeas of 310–400 by 15 µm and small isochelae of 25–30 µm. As noted by [21], megascleres are shorter than in the holotype and Antarctic specimens, but the morphology of the spicules very much agrees with the description of the species. This is the second mention of the species for the SW Atlantic Ocean, after Schejter et al. [21].
- *Iophon proximum* specimens (Figure 1D) are massive and variable in shape, porous, and became dark brown in color after preservation. They were also found to be associated (attached) with other sponge species. They were recorded at stations 2, 5, 7, 10, 14, 20, and 21. This is a common and highly variable species; an extended description and revision could be found at Desqueyroux-Faundez and van Soest [32].
- *Clathria (Clathria) microxa* specimen (Figure 1C) is bushy and was found growing attached to a dead *Flabellum* coral. It was recorded at station 5. Spicules are two types of styles, 370–440 by 15–20 µm and 320–445 by 5–10 µm, acanthostyles of 100–115 by 5 µm, toxas of 230–460 µm, and microxeas of 45 µm. This is the third mention of the species for the SW Atlantic Ocean, after Schejter et al. [21,22].
- *Clathria (C.) discreta* specimen (Figure 1E) was found at station 14. This is a common, well-registered species in Argentina and detailed information can be found in the works of Burton [8,10] and Schejter et al. [21].
- *Siphonochalina fortis* specimen (Figure 1I) was found at station 17; it is characterized by their ramose morphology, highly compressible, with a skeleton conformed by quadrangular meshes of fibers with embedded oxeas of 55–60 by 3.5–5 µm. It is a common species in Argentina.
- *Myxilla (Myxilla) mollis* specimen (Figure 1G) was recorded at station 7; it is a very common species in Argentina. A detailed description can be found at Bertolino et al. [24].

- *Haliclona bilamellata* specimen (Figure 1J) has a massive to tubular morphology, soft and sticky, and was recorded at station 17. It has oxeas of 160–185 by 10 µm, and also some smaller and thinner of 140 by 5 µm. Our specimen agrees with the descriptions provided in the works of Burton [8] and Sará [12].
- Several unidentified specimens belonging to the Family Suberitidae (Figure 1L) were found at stations 17, 18, 21, and 22, and two fragments belonging to the order Haplosclerida (Figure 1F) were found at station 11. These specimens will require more studies to achieve a proper identification at the species level.

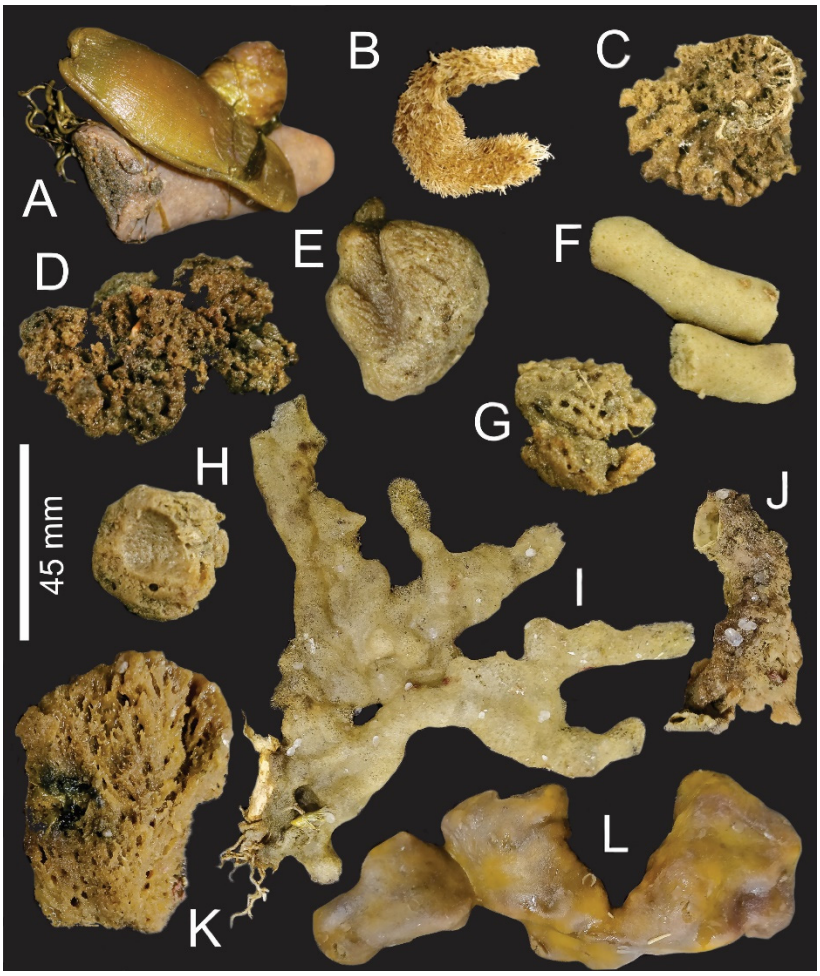

Figure 1. Sponge species recorded in the present study. A. *Tedania (T.) mucosa* with an egg case of the catshark *Schroederichthys bivious* attached; B. *Isodictya verrucosa*; C. *Clathria (C.) microxa* attached to a dead *Flabellum* skeleton; D. *Iophon proximum*; E. *Clathria (C.) discreta*; F. Haplosclerida; G. *Myxilla (M.) mollis*; H. *Tedania (T.) murdochi*; I. *Siphonochalina fortis*; J. *Haliclona bilamellata*; K. *Tedania (T.) charcoti*; L. Suberitidae.

4. Discussion

The results of this study contribute to better exploring the benthic assemblage off San Jorge Gulf, Patagonia, and filling in the gaps in the records and distribution of the sponges in this particular unknown region. Among the 42 registered taxa, 12 sponge species were recorded in this area. Although all these species were previously recorded in other sectors of the Argentinian waters, this new evidence contributes to building the distribution pattern of sponge species in Argentina. Additionally, it is worth mentioning that the studied area presented an unusually high abundance of sponges and tunicates in the benthic communities, which may reach up to 40% and 45% in wet weight, respectively, of the total by-catch. This is probably an indication that this area was relatively preserved

from intense bottom fishing (i.e., [33]) and may constitute a potential refugee for juveniles of species of commercial and non-commercial interest, as suggested for some regions of the San Jorge Gulf [34]. It must be noted that Argentinean hake (*Merluccius hubbsi*) fishing (developed using bottom trawlers) is banned in the studied area, but Argentine red shrimp (*Pleoticus muelleri*) fishing (also developed by a trawler fleet) is allowed. Finally, and considering the finding of egg cases of the catshark *S. bivius*, this area may also have interesting characteristics for oviparous chondrictian species and should be better explored in order to understand if it should be managed in order to preserve target species from anthropogenic impacts.

Author Contributions: L.S. wrote the MS, made the figures, identified the sponge species and collaborate in the sampling procedure. D.A.G. developed the sampling procedure, identified and quantified the by-catch species, collaborate with the discussion of the MS and revised the final version. All authors have read and agreed to the published version of the manuscript.

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