Ecologic Integrity and Biodiversity of Reef Ecosystems in Oceanic Islands of Colombia in the Caribbean: Serranilla Cay

Integridad Ecológica y Biodiversidad de los Ecosistemas Arrecifales e Insulares de los Complejos Coralinos Oceánicos de Colombia en el Caribe: Cayo Serranilla

L'intégrité Écologique et la Biodiversité des Écosystèmes Insulaires et Récifs des Complexes de Coraux Océaniques de Colombie dans les Caraïbes: Cayo Seranilla

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EXTENDED ABSTRACT

The Archipelago of San Andres, Providence and Santa Catalina, only oceanic department of Colombia, is located in the northern portion of the country in the Western Caribbean, with a total area of 180'000 km^2 of which only 57 km^2 are terrestrial. Declared as the Seaflower Biosphere Reserve (SBR) by the UNESCO in 2000, the Archipelago shelters 77% of Colombian coral reefs, including three oceanic islands, seven cays, five atolls and three banks.

Coral reef communities have undergone significant changes, resulting in variations in species composition (phase shifts), productivity and biodiversity (Hughes 1994, Gardner et al. 2003, Hughes et al. 2003). In the Caribbean these changes are evidenced by loss in scleractinean coral cover (80%), benthic macroalgae dominance, and lately the appearance of cyanobacterial mats (Jackson et al. 2014). Given that the SBR harbors the most important coral reef areas of Colombian Caribbea, evaluating the state of reef ecosystems is of great value for management and conservation of marine biodiversity. Nevertheless, in a vast area such as the SBR, monitoring activities of remote areas as the northern cays require a great effort, economically and logistically. Consequently, on 2014 the Seaflower Scientific Expeditions were created, a joint effort that brings together researchers from around the country once a year for research and monitoring the SBR's marine biodiversity, oceanography and geomorphology. On 2017, the Seaflower Expedition travelled to the Serranilla Cays, located in the northern portion of the SBR, some 422 km north from San Andres Island.

The ecologic integrity of Serranilla was assessed by evaluating:

i) Shallow coral reefs' condition,
ii) Historic growth conditions of a species of massive coral to infer changes through the last century, and
iii) Bird colonies in the cays.

Coral cover and health were evaluated in monitoring stations through 10x2 m transects using 1x1 m photoquadrants at each side of the transect. Data included species per station, colonies/species, and presence of diseases. Prevalence of diseases was obtained using Raymundo and collaborators' (2008) equation. Benthic cover was estimated using Coral Point Count (Kohler and Gill 2006) with 25 aleatory points/quadrant (Figure 1). For coral growth conditions, cores were extracted from *Orbicella faveolata.* Additionally, cyanobacteria samples were collected, stored (4% formaldehyde with sea water), and identified in the lab under an optic microscope, measuring samples with up to 1000 magnifications (Figure 2). Bacterial 16s DNA extraction was performed using commercial extraction kits. Bird monitoring through an exhaustive inventory was done during 10 days based on visual records, counts, population estimation and spatial distribution of the colonies. Reproductive state and environmental conditions in terms of structure was also evaluated, and a list of species of the main island, three cays and surrounding waters was obtained.

Six monitoring stations were evaluated for coral reef health, with an additional 20 rapid check stations, identifying very low coral (< 10%) and high macroalgae (> 85%) coverage in all stations. These results reflect Caribbean reef tendencies,

where coral cover is decreasing, and macroalgae is increasing (Gardner et al. 2003, Côté et al. 2005). Fourteen (14) species of scleractinean corals were identified, and 816 colonies were evaluated from the photoquadrants. The most abundant species was *Porites astreoides* with 97 colonies, while various species (such as *Orbicella faveolata* and *Diploria labyrinthiformis*) were only represented with one colony in the monitored stations. These results are similar to those found by Vega and collaborators (2015), who found dominance of macroalgae in Serranilla previously. Though many species showed a relative low abundance, and coral cover values were below average for the Caribbean and for the SBR (16.0 ± 0.4 % Schutte *et al.,* 2010), positive observations such as the presence of healthy colonies of *Acropora palmata* and *Gorgonia ventalina* (both endangered), show a recovery of these two species which had been widely declined in the 80's. Five coral cores where extracted from colonies of *Orbicella faveolata*, for though the species is one of the most common in the Caribbean, no more big healthy colonies of more than 1 m in height were found. Cores are still under analysis, and this data will be contrasted with further findings of other evaluated sites in the SBR.

Low coral disease was identified, though a constant presence of benthic cyanobacteria consortiums was registered in all reef areas, with some stations having more than 40% benthic coverage of cyanobacterial benthic mats. Samples of consortiums were collected to identify dominant species in the lab. Morphologically (Komárek and Anagnostidis 2005), 4 genera were identified: *Scytonema*, *Ulothrix*, *Dichtotrix* spp and *Phormidium* (Order: Oscillatoriales), being *Phormidium* the most abundant (species *P. cf. corium and P. cf. monile*). Further sequencing of these samples was not achieved given that, though DNA extraction was possible, samples inhibited PCR reaction.

An exhaustive inventory of birds was done, identifying 71 bird species, with 80% being migratory and 20% resident and marine species. No signs of reproduction or nesting was found, though habitat diversity and complexity in the emerged portion of the cays was observed. We attribute this to rodents (common rats) observed in the main island, probably arriving with food or supplies for the naval base; eradication of this species is required. Serranilla's avian richness is the highest registered up to date in any island of the SBR. These observations, linked to a high number of migratory species, strengthens previous knowledge of the high value of Caribbean oceanic islands for migratory species, who use these terrestrial habitats for feeding and resting during migrations. Hence, avian monitoring during migration peaks (such as September-October) are the only way to obtain complete information of bird diversity, and thus the importance of these islands in terms of biodiversity support.

Additionally, during terrestrial surveys the Gecko *Aristelliger georgeensis* was recorded, making this the first record for the species in Serranilla Cays. The Saint George Island Gecko known to occur in the Mexico in the Yucatan peninsula, in the coasts and islands of Belize and Honduras, has only been reported in Colombia in islands of the SBR (San Andres, Providence and Santa Catalina, and Roncador) (Lopez-Victoria and Daza 2015). Given its limited distribution, the species is considered endangered in Colombia (Castro-Herrera 2002), and this new locality represents an opportunity for its conservation.

In order to achieve conservation goals in the SBR, further management actions are required. For Serranilla, the eradication of rodents in order to assure bird nesting and reproduction is not affected in the main island is needed. High macroalgae and cyanobacteria cover is attributed to the lack of generalized herbivores, especially parrotfish. Further control and surveillance against illegal fishing needs to be enforced in order to maintain and/or regain coral reef cover and health.

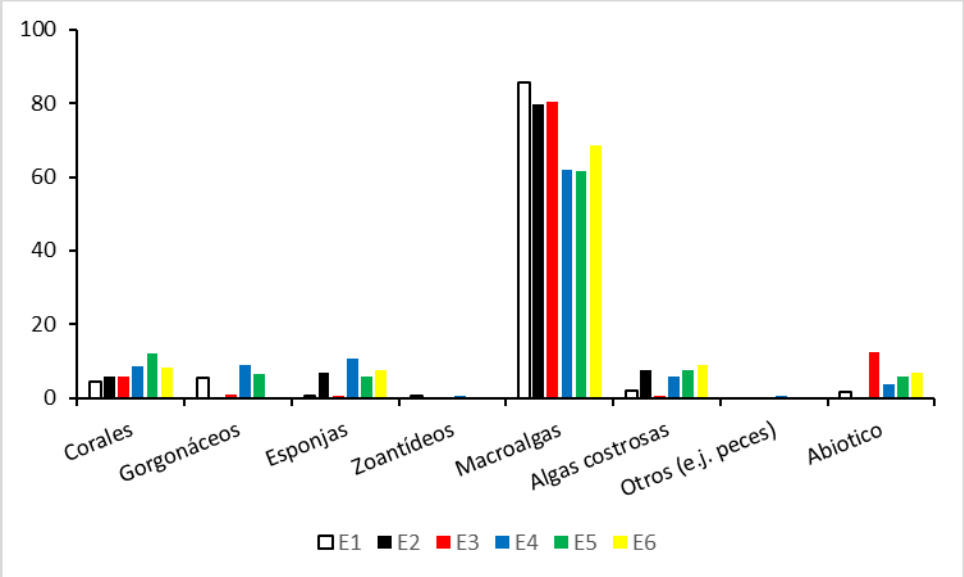

Figure 1. Benthic cover of shallow coral reefs of Serranilla Cays, Seaflower Biosphere Reserve in 2017.

KEYWORDS: Seaflower, coral reefs, ecological integrity

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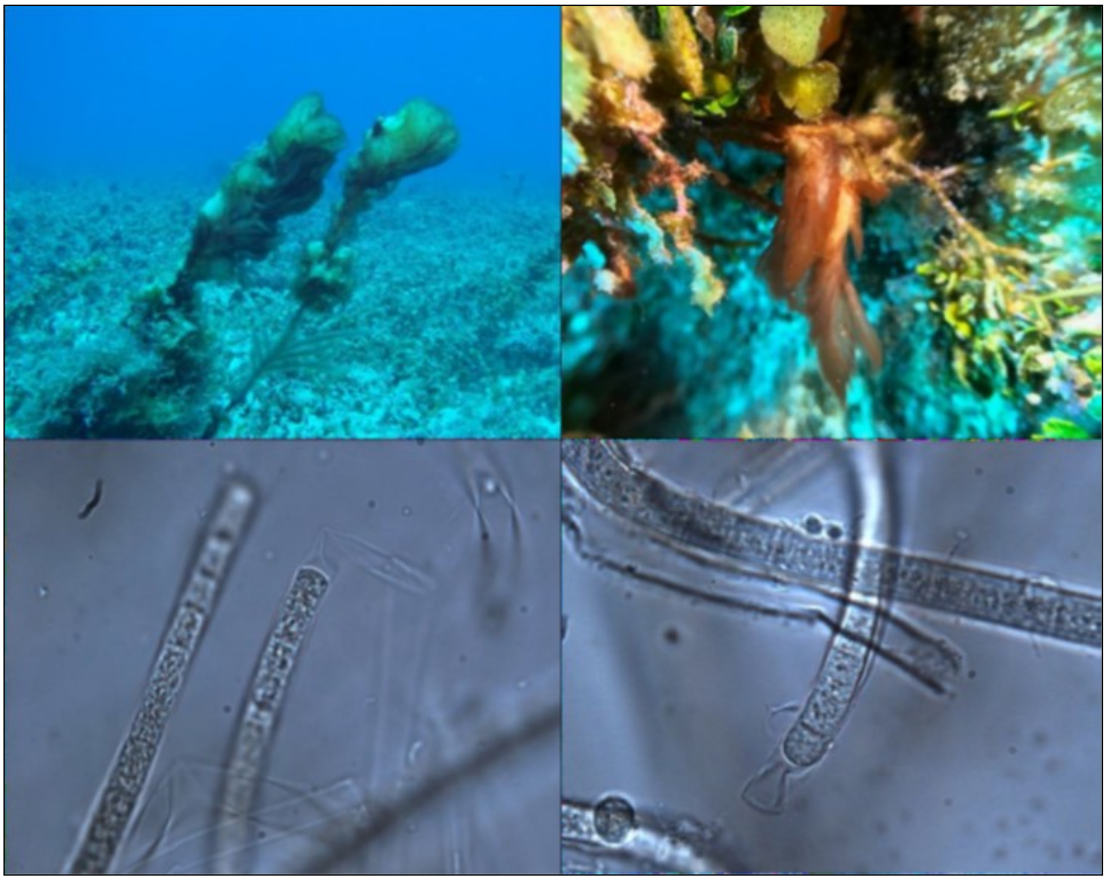

Figure 2. Top: benthic cyanobacteria of shallow coral reefs found in Serranilla Cays, Seaflower Biosphere Reserve in 2017. Bottom: Cyanobacteria filaments of the genera *Phormidium* observed under the microscope showing taxonomic identification characters (Photographs: authors).