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Biodiversity OF THE SEVEN colors sea

Coralina
Corporación para el Desarrollo Sostenible del Archipiélago de San Andrés, Providencia y Santa Catalina

RBSF
RESERVA DE BIOSFERA SEAFLOWER

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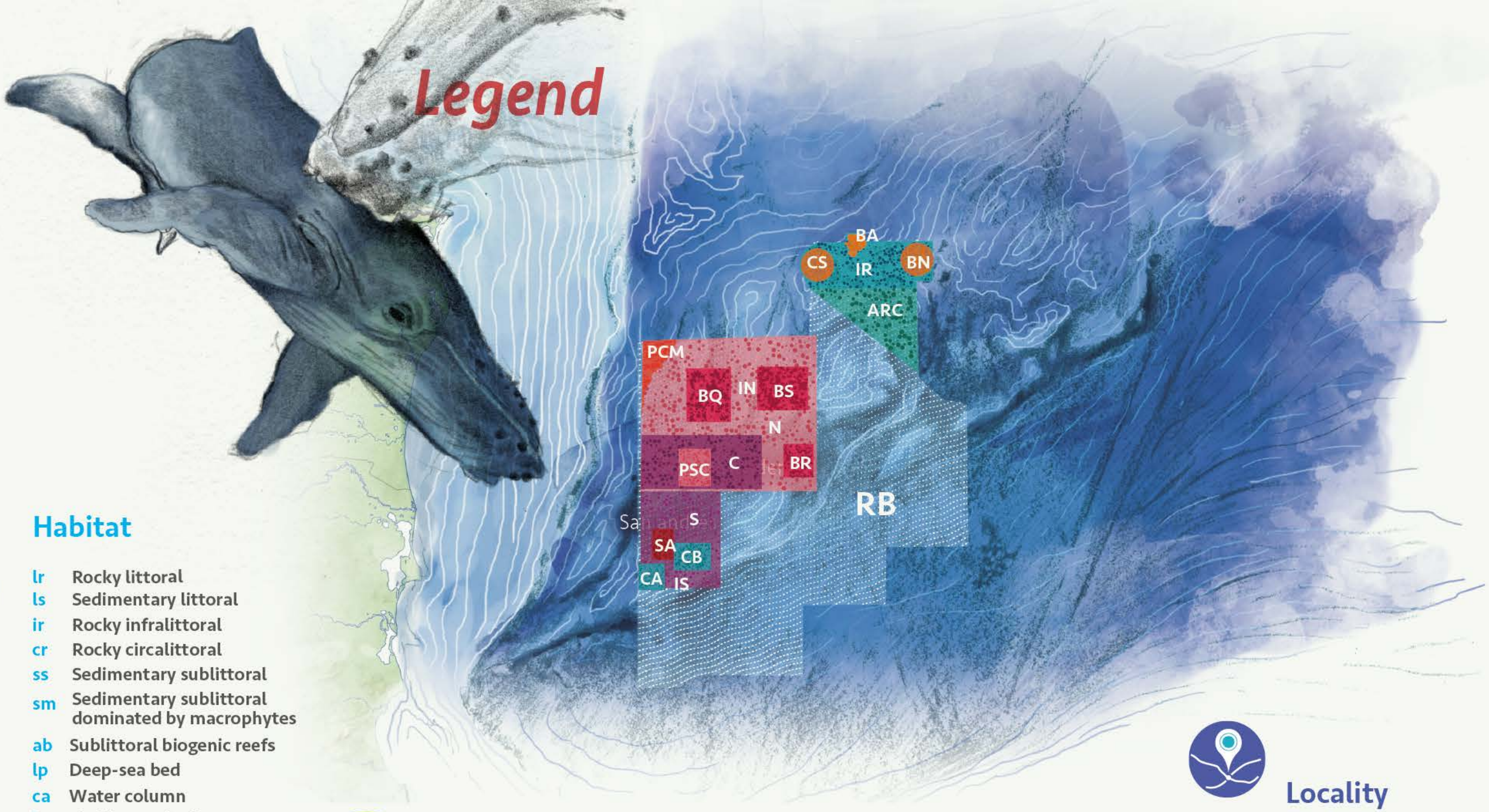
Legend



Environment

- P Pelagic
- B Benthic
- D Demersal
- L Planktonic
- A Aerial
- E Epiphytic
- N Neustonic
- C Coastal
- M Open Sea

Author

Reference

Habitat

- lr Rocky littoral
- ls Sedimentary littoral
- ir Rocky infralittoral
- cr Rocky circalittoral
- ss Sedimentary sublittoral
- sm Sedimentary sublittoral dominated by macrophytes
- ab Sublittoral biogenic reefs
- lp Deep-sea bed
- ca Water column
- ls Shallow seabed
- ac Coral terraces
- mg Mangrove swamp
- pl Beaches
- zt Transition zone
- pm seagrass *Thalassia testudinum*
- as Shallow water
- ap Deep water

C Class
Sc Subclass
O Order
Sf Superfamily
F Family
S Species

Life cycle

- H Holoplanktonic
- M Meroplanktonic

Behavior

- Mc Marine-coastal habits
- Cm Continental migratory

Locality

- IR Remote islands
- IN Northern islands
- PSC Providencia and Santa Catalina
- SA San Andrés island
- IS Southern islands
- ARC Joint Regime Area
- N Northern section
- C Central section
- S Southern section
- RB RB Seaflower
- PCM PCM-Esquina
- BN Bajo Nuevo Bank
- CS Serranilla Cay
- BA Alicia shoal
- BQ Quitasueño Bank
- BS Serrana Bank
- BR Roncador Bank
- CB Bolívar Cay
- CA Alburquerque Cay

CITES

- I Appendix I
- II Appendix II
- III Appendix III

SPAW

- I Annex I
- II Annex II
- III Annex III

Conservation status

- EX Extinct
- EW Extinct in the Wild
- DD Data Deficient
- CR Critically Endangered
- EN Endangered
- VU Vulnerable
- NT Near Threatened
- LC Least concern
- NE Not Evaluated

Corporación para el Desarrollo Sostenible del Archipiélago
de San Andrés, Providencia y Santa Catalina

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Biodiversity OF THE SEVEN colors sea

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Presentation

In 2000, the UNESCO's Man and the Biosphere Programme (MAB) declared the Archipelago of San Andrés, Providencia and Santa Catalina as Seaflower Biosphere Reserve, thus recognizing the importance of the natural biodiversity of this portion of the planet for mankind and particularly for the Colombians who inhabit the archipelago. Subsequently, in 2005, the Ministry of Environment and Sustainable Development (MADS) turned the Seaflower reserve into a Marine Protected Area (MPA), being at that time the largest marine conservation area in Colombia and one of the largest in the world. Thanks to this national decision, CORALINA was awarded the 2010 Countdown Award as recognition for the efforts made to protect biodiversity in the Seaflower reserve. The same year, as part of the Seventh Meeting of the Contracting Parties (COP7) to the Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region, Seaflower was officially included in the list of the first 18 marine protected areas of this protocol, highlighting its immense significance in terms of biodiversity for the entire planet.

This publication becomes the first inventory of marine biodiversity described for the Seaflower Biosphere Reserve. It is divided into the main biological groups studied by scientists of INVEMAR, CORALINA and other academic and research institutions during the last 40 years.

INVEMAR and CORALINA demonstrate with this publication that the country is committed to the conservation of marine biodiversity in the archipelago, as a result of the recommendations that have been formulated to comply with the international commitments to the Convention on Biological Diversity and the AICHI targets, as well as the national environmental policies for the management of marine, coastal and island zones (PNAOCI) and for the management of biodiversity and its ecosystem services (PNGBSE).

Thanks to the information gathered, it is possible to reinforce the hypothesis that the reserve is one of the sectors of the western Caribbean with highest values of marine biodiversity, considering it as a "hot spot" worldwide. The information recorded herein references about 1,500 species within 10 biological groups (macroalgae, angiosperms, annelids, echinoderms, crustaceans, molluscs, sponges, cnidarians, fish and tetrapods). This number rises to about 2,200 when the species and morphotypes identified in the groups of marine plankton are also considered. The digital format of this publication enables experts and the community in general to consult all the information included, in a simple and agile way and with a friendly visual environment.

We hope this publication will become a national and international reference on biodiversity values associated with this part of our country in which we exercise. sovereignty from June 23, 1822, when the communities of the archipelago joined the cause of the Colombian independence.nacional en el cual llevamos ejerciendo soberanía desde 23 de junio de 1822.

FRANCISCO A. ARIAS ISAZA

INVEMAR's Director-General

DURCEY ALISON STEPHENS LEVER

CORALINA's Director-General

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The authors wish to express their gratitude to the José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR) and the Autonomous Corporation for the Sustainable Development of the Archipelago of San Andrés, Providencia and Santa Catalina (CORALINA) for their leadership in getting this project off the ground. Special thanks to INVEMAR's Director-General, Francisco A. Arias Isaza, and CORALINA's Director-General, Durcey Alison Stephens Lever, for their constant support during the development of the book, as well as to all the administrative and financial dependencies of both entities for their support.

We want to gratefully acknowledge the project "Protection and conservation of resources, biodiversity and strategic ecosystems within the Seaflower Biosphere Reserve" (BIODIVERSIDAD) funded by the Environmental Compensation Fund (FCA), for the resources to cofinance this publication.

This publication is the result of years of effort in research carried out in the Seaflower Biosphere Reserve. Many researchers, students, interns and institutions were involved directly or indirectly in it, either as participants in the results or as selfless collaborators; to all of them, we want to express our sincere gratitude.

INTRODUCTION

Martha Patricia Vides Casado.[1] and David Alejandro Alonso Carvajal.[1]

In the current scenarios of global change, knowledge about biodiversity of a region is the basis for achieving, in an efficient and sustainable manner, the proper management of the natural resources that it sustains. The basic description of marine biodiversity evidences the extraordinary variety of forms, species and adaptations of marine organisms. Of approximately 1.5 million species of macroscopic organisms known on Earth, the modern ocean supports 15%, while the terrestrial environment holds approximately 80%, and the remaining 5% live in fresh water. Some groups of organisms have an exclusively marine or freshwater distribution, such as sponges, cnidarians, bryozoans, bivalve and cephalopod molluscs, and polychaeta worms. Echinoderms and tunicates are considered, to date, as purely marine inhabitants (Grosberg *et al.*, 2012). **) The constant discovery of new families, orders and even phyla of organisms all over the world predicts an enormous diversity yet to be discovered, particularly when inventories of deep-water species are included** (Woolley *et al.*, 2016).

One of the reasons why the area of the Archipelago of San Andrés, Providencia and Santa Catalina was declared as the Seaflower Biosphere Reserve was the recognition of a high concentration of biological diversity in a relatively small area. Island shelves, cays and shoals are occupied by beautiful coral systems, including barrier reefs in San Andrés, Providencia and Quitasueño, atolls in some of the cays, extensive seagrass beds and vast bottoms of sand and coral fragments in addition to small systems with mangrove trees, some sand beaches and rocky littorals **(CORALINA-INVEMAR, 2012).**

Even though the inventory of marine species inhabiting the Seaflower reserve is not yet close to be completed, in recent years a progressive increase in studies and efforts has been identified. Contributions of groups of researchers, expert taxonomists, people who practice water sports and sea lovers have increased awareness of this natural treasure. Moreover, some technological advances in the equipment of research platforms have allowed collecting biological samples from deep environments of the Joint Regime Area that Colombia shares with Jamaica. These lists, however, have focused on groups of animal organisms known as major taxa (kingdom Animalia), leaving behind the knowledge on marine plants, fungi, protozoa, bacteria and viruses present in this area, and in the Colombian sea in general.

Inventories of marine species in wide regions are extremely difficult to obtain, given the diverse sources of information, the different levels of uncertainty and the limited amount of expert taxonomists who devote to perform this task **(Costello *et al.*, 2010)**. Similarly, the taxonomic authorities that lead identification of some groups of organisms can be varied and change from previous works, giving rise to synonymies or double counts of species **(Costello *et al.*, 2013).** Although this situation occurs in all biodiversity monitoring works, the study of marine biodiversity becomes even more complicated due to the constant changes that research on molecular genetics displays during the identification of several species that were once considered the same (e.g. stony corals) **(Danwei *et al.*, 2011).** Similarly, species that have been considered rare may not belong to this group, if the vast expanse of marine habitats is taken into account, as well as the continuity of the processes caused by currents, tides and the chemical and stratified dynamics of the column water, in addition to the patchy nature of the seafloor.

This book is an additional effort to try to compile the inventory available to date on the biodiversity of the seven colors sea, named to the wide variety of shades ranging from deep blue to translucent aquamarine green, as a result of the sunlight spreading itself through the depth, over the white sandy seafloor, and blending with coral reefs. The present initiative does not only seek to add species to the reserve's accounts; it seeks to meet the need for a systematic analysis of the marine biodiversity in the area, based on the experience and qualities of a group of experts on marine biology, who have dedicated their time and expertise to describe and count groups of species of marine animals and plants.

1. José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR).

Approach

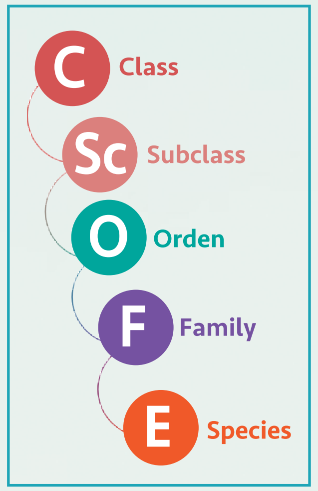
From the very conception of the idea of creating a book on the Seaflower Biosphere Reserve marine biodiversity, it was determined that the voluntary contribution of authors to the book should be restricted, so that collection, management and unification of parameters would be easier and the dimension of the work would be not only suitable for an audience of scientists and taxonomists, but accessible to a general public. With the exception of the last chapter, which provides a view of conservation of marine biodiversity as to its threat status within several management tools, the remaining chapters of the book give a phylogenetic treatment to the species groups (usually at the level of order, class or phylum).

Guidelines to the authors of each group were established for all chapters, through a standardized form that gathers taxonomic information of each species, as well as data regarding recognized features of the environment, habitat and geographical location where taxa have been observed or collected. This information is included as an embedded list of species or morphospecies that constitute the bulk of each chapter. In every case, the titles of the chapters define the taxonomic scope of the list of species or morphospecies, which may include all the phylum or any taxa component. The list is preceded by the references that defines them and provides some elements about its descriptive ecology, its behavior or its state of knowledge, through the review of works and monitoring processes on the area.

The first chapter of the book is dedicated to the description of a group of organisms known, in general, as plankton, integrated by a large community of organisms from almost all groups of marine invertebrates, whose displacement is modulated by the currents among different water masses.

As in subsequent chapters, there is a description of the characteristics of these communities or groups and their composition. In some cases, references to their state of knowledge, the relevance of the group, the life history and the particular ecology are also mentioned. Additionally, a list of species (and morphospecies in some groups) is also included, which reflects the state of knowledge of the group of organisms in the area of the Seaflower Reserve.

Species lists include an embedded structure from left to right, starting with the broadest taxonomic group, usually at the level of phylum, followed by the class (and/or subclass), order , family and, finally, the names of species in alphabetical order (morphospecies are included in some groups), with its author and date , maintaining consistency in style among chapters, but allowing certain flexibility to include special features within. Authors were asked to restrict the list as to those species documented inside the reserve, through publications, museum records or reported by environmental authorities based on evidence (e.g. sightings or photographs). They were also asked for the latest taxonomic authority, however, the adoption of the taxonomic treatment to resolve any possible dispute during the review of the reports of species was left to their judgment and experience.



Ideally, columns on the right-hand side of the taxon were successively arranged from the reference , used to describe the occurrence of the species in the reserve, environment type, habitat , risk of extinction (CITES), SPAW and locality.

Only in the description of the planktonic community, holoplanktonic or meroplanktonic organisms are identified, in accordance with their life cycle.

H - Holoplanktonic: refers to those organisms that complete all their life cycle as part of the planktonic community.

M - Meroplanktonic: identifies those organisms that develop only part of their life cycle in the plankton, then they grow and become part of another environment.

Similarly, the group of birds uses for its description a feature of its behavior:

Mc - Marine-coastal habits: species of birds that use cays or islands as feeding and breeding areas.

Cm - Continental migratory: species of birds that use the reserve as part of its migration corridor to and from the continent.

Environment

All taxonomic groups were categorized in terms of the environment in which they are presumable to remain or develop their adult life cycles. For purposes of classification of the environment , the following general definitions are adopted and a capital letter is used to classify each species according to the convention.

P - Pelágic: corresponding to the ocean's water column from its surface to great depths.

B - Benthic: corresponding to the ocean floor, which includes both the sediment surface and some subsoil layers.

D - Demersal: comprises the portion of the water column closest to the ocean floor or just above the benthic zone, and it is significantly affected by it.

Environments describing marine macrophytes implement two terms specific to them:

E - Epiphyte: refers to the plant that is used only as a support for the growth of another (non-parasitic).

N - Neustonic: refers to the interface between open water and the atmosphere.

Seabirds are classified within two environment types:

C - Coastal: section of seawater or estuarine water close to the shore. It includes the portion of land that is intermittently flooded.

M -Open sea: refers to the surface of the sea distant to the coast, where birds get their food.

When all species of a particular taxonomic group belong to the same environment, the information is included in each list as a footnote and not as a column within the table.

Hábitat

La definición de hábitat propuesta para categorizar los listados de especies sigue la jerarquía de tipificación de hábitats marinos descrita en Davies *et al.* (2004)**, la cual es usada en el sistema de información ambiental europeo (European Nature Information System-EUNIS). Las descripciones de los mismos fueron traducidas y modificadas en concordancia con los hábitats comúnmente reconocidos en el ambiente marino y fueron sugeridas a los autores para la clasificación de cada especie dentro de los grupos. Cada uno de los tipos de hábitat se describe a continuación.**

Lr - Litoral rocoso: incluye hábitats de lecho de roca, rocas y guijarros que se encuentran en la zona intermareal (la zona de la costa entre las mareas altas y bajas) y la zona de salpicadura. El límite superior está marcado por la parte superior de la zona de líquenes, y el límite inferior por la parte superior de la zona de algas laminarias. Abarca todas las condiciones de exposición al oleaje (suave, moderado y fuerte), salinidad, temperatura, emersión diurna e inmersión de la orilla.

Ir - Rocky infralittoral: includes habitats of bedrock, rocks and pebbles that are produced in the shallow subtidal zone and usually support communities of algae; areas of heterogeneous soil that lack stable rocks, as in estuaries and other zones of shallow turbid waters. The subtidal zone may be dominated by animal communities. Shores of medium and fine sand generally support a range of oligochaetes, polychaetes and cryptic crustaceans. The most stable banks of sand or mud support a variety of bivalves.

Cr - Rocky circalittoral: is characterized by the presence of a mosaic of species. It is composed of two subzones: upper and lower circalittoral, and circalittoral dependent on the presence of foliose algae. The depth at which the circalittoral zone begins is determined by the intensity of light reaching the seafloor. In very turbid conditions, circalittoral zone can start just below the water level. Biotopes can be assigned to one of these three categories: high, moderate or low energy. The nature of the fauna varies and is affected by wave action, tidal current strength, salinity, turbidity, leaching level of the rock and topography.

Sm - Sedimentary sublittoral dominated by macrophytes: includes rhodolith beds, mixed sediments dominated by (red and filamentous green) algae, seagrass beds and angiosperm communities. These communities are developed in a variety of exposed coasts and closed coastal lagoons, over different types of sediments and salinity regimes.

Lp - Deep seabed: covers the seabed beyond the limits of the continental shelf, whose break occurs at a variable depth; generally, more than 200 m. The upper limit of the high-seas zone is marked by the edge of the shelf.

Lm - Shallow seabed: acovers the seabed over the continental shelf at a variable depth; generally, less than 200 m. The lower limit is marked by the edge of the shelf.

Mg - Mangrove swamp: group of trees and shrubs living in the coastal intertidal zone of low energy and influenced by tides.

Pl - Beaches: type of relief along the coast of cays and islands, composed of loose particles of biological origin (mollusc shells or coralline algae).

Zt - Transition zone: landscape unit between the mangrove swamp and the terrestrial vegetation**(CORALINA - NVEMAR, 2012).**

Ls - Sedimentary littora: includes habitats of pebbles, gravel, sand and mud or any combination of them, which occur in the intertidal zone. It sustains communities tolerant to some degree of drainage at low tide, and are constantly subject to changes in air temperature and reductions of salinity in estuarine conditions. Coarse sediments tend to support few species of macrofauna, since they are mobile and are also subject to desiccation when exposed at low tides. Finer sediments tend to be more stable and to retain water at high tides, housing a greater diversity of species. Very fine and cohesive sediments (e.g. mud) usually house less diversity of species, because oxygen cannot penetrate far below the sediment surface.

Ss - Sedimentary sublittoral: near the shore (it covers the infralittoral and a portion of the circalittoral zone). It goes from the lower shore to the edge of the continental shelf (200 m). Sediments range from pebbles, gravel, coarse sands, sands, fine sands, sludge and mixed sediments.

Ab - Sublittoral biogenic reef: includes coral reefs (also those of cold water) and other biogenic formations (sponges and bryozoans). They thrive in a variety of exposed coasts in estuaries, coves or deep marine biotopes, over different types of sediments and salinity regimes.

Ca - Columna de agua: abarca desde las aguas costeras poco profundas hasta las aguas profundas o ambientes cerrados. Debido a la naturaleza temporal fuerte el medio ambiente pelágico en un lugar determinado se clasifica de forma diferente en diferentes momentos del año.

Ac - Coral terraces: landscape unit regarding the surfaces of the islands and cays of the reserve, formed mainly by calcareous sand, sometimes with vegetation of coconut trees and tall grasses **(CORALINA-INVEMAR, 2012).**

Pm - PThalassia testudinum seagrass: sedimentary sublittoral dominated by seagrass of which it gets its name and that shelters some microalgae.

As - Shallow water: body of brackish water in the interior of cays and islands, subject to desiccation and the action of tides.

Ap - Deep water: water body in cays and islands, variable in depth but permanent.

Risk of extinction

It refers to the red lists of threatened species **(IUCN, 2015)**, in which each species is assigned a threat category, through the evaluation of established criteria and based on the best scientific information available. Categories indicate the level of risk of extinction in the near future that wild populations of a determined species face in a given area (Critically Endangered - CR, Endangered - EN, Vulnerable - VU); CR implies a higher risk of extinction than EN, and thus higher than VU.

The risk classification system includes other categories, which do not imply that the species is threatened, such as Data Deficient (DD) and Near Threatened (NT). A species is categorized in DD when information is insufficient to make a proper assessment of its conservation status, but future researches could show a threat category. Finally, species are considered NT when evaluation does not meet the criteria to be included in a category of threat (i.e. CR, EN, VU), but is considered to be close to meet them in the near future.

- EX Extinct
- EW Extinct in the wild
- CR Critically endangered
- EN Endangered
- VU Vulnerable
- NT Near threatened
- LC Least concern
- NE Not evaluated
- DD Deficient data

CITES

Under this feature, authors of each group classified the species included in any of the three appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Only a few groups have been included in the appendices; therefore, this categorization is not described in all species lists.

SPAW

The Protocol concerning specially protected areas and wildlife in the Wider Caribbean Region (SPAW) has three annexes that include marine and coastal species selected by agreement under the criteria of requiring special protection measures. Different taxonomic groups have been included in the annexes: Annex I: flora; Annex II: fauna; and Annex III: marine flora and fauna susceptible to exploitation. They are highlighted under the title.

Locality

Some elements, such as the clear definition of the limits of the specific localities grouping the physical evidence records of collection of organisms or the presumption of their distribution within the Seaflower Reserve, was suggested by the editors and submitted to the authors for consideration. The established limit of the Seaflower Biosphere Reserve was determined by its declaration following the mandate of Law 99 of 1993, Article 37, paragraph 2, which states: "The Archipelago of San Andrés, Providencia and Santa Catalina becomes Biosphere Reserve, meaning that the total area of the department covers the territorial sea and the exclusive economic zone generated by the land portions of the archipelago".

The division of locality was performed in a hierarchical way, which allowed the authors to be specific to locate the report site for each species, or general enough to give a record of the species within the reserve when location was unknown or presumable for the whole area (e.g. some morphospecies of plankton). Each locality is identified by a number and is used in the tables where species are listed under the icon.

10	Seaflower Biosphere Reserve	10	Northern section	2	Southern islands	15	Quitasueño Bank
						16	Serrana Bank
						17	Roncador Bank
				11	Mesoamerican shelf - Esquina		
		8	Central section			3	Providencia and Santa Catalina Islands
		9	Southern section	6	Southern islands	18	Bolívar Cay
						19	Albuquerque Cay
				6	San Andrés Island		
		6	Joint Regime Area Jamaica – Colombia			12	Alicia Shoal
		1	Remote islands			13	Bajo Nuevo Bank
						14	Serranilla Cay

The footnotes in the species lists offer explanations regarding general aspects of the environment or habitat of the group, references to taxonomic authorities or sources of the taxonomic classification, and other information specific to the group.

It is worth mentioning that, considering the particular features of the chapters, some exceptions to the way of presenting them were permitted to the authors. One or more columns may have been deleted, since they were considered irrelevant or devoid of information sources to categorize some species in one or more characteristics. In any case, the absence of such information is explained in each chapter.

Although a great effort was made to standardize the parameters, it is undeniable that the authors have questioned the inclusion or exclusion of certain species, have adopted or incorporated systematic reviews, which may be considered controversial by some taxonomists, and have included references that may not be valid for some readers. These limitations have been accepted by the editors due to the peculiarities that may arise during the execution of any inventory of species; even more if we take into account the variety of specialties of the experts united in this effort and the haste to complete the work within the short time set from the beginning. Such haste has also limited the possibility to include new authors, who may have expanded the list with species of other groups sharing transitional environments in remote cays and islands; and has restricted the performance of the analysis of potentialities of the use and development of the biodiversity in the seven colors sea, regarding its current and future perspectives.

This omission does not attempt to belittle these subjects. On the contrary, it is meant to raise awareness not only to technological demand, but also to human and economic resources to make possible the development of new descriptive studies on the marine biodiversity of this region and for the whole immensity of the submerged territory of our country.

We hope this work will arouse interest on both authorities and the general public who can support and fund similar initiatives, towards unveiling the great biological richness that surrounds us.

Content overview

This book consists of nine chapters written by 48 contributing authors from 10 different entities, including national and international universities, research institutes and environmental organizations. It also counted on the contribution of authors from the Corporation for the Sustainable Development of the Archipelago of San Andrés, Providencia and Santa Catalina (CORALINA), who, along with people from the José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR), acted as editors of the work. These chapters provide an inventory of about 2,354 species recorded in the archipelago of the Seaflower Biosphere Reserve, among marine invertebrates, fish, birds, turtles and mammals, as well as 225 species of macroalgae, seagrasses and mangroves.

The term "about" means that this number does not include the species or morphospecies of kingdoms Chromista (Phylum Foraminifera, Ochrophyta, Myzozoa and Haptophyta) and Bacteria (Phylum Cyanobacteria) present in plankton, which could increase or reduce this amount if morphotypes were totally identified at the same level. It is estimated that the inventory covers a little more than 80% of the species of the animal groups known (described) in the area of the Biosphere Reserve; however, it is only possible to speculate on how many additional species of the remaining groups have not been discovered and described yet. There is a large number of nematodes, polychaetes, copepods and amphipods that have not been listed yet. Moreover, they would probably exceed the amount of species of macroinvertebrates, once its biodiversity is measured.

The intention of this book was to carry out an additional effort to compile the inventory available to date on the biodiversity of the sea of seven colors, so it is important to emphasize that it is a basis to consult about the richness of the reserve, but should not be used as a mechanism for comparison with other inventories, in order to determine the increase or reduction of biota. In fact, lists differ in the dates or periods used to report species, which may come from a single collection, from a particular expedition or from the records of monitoring processes carried out over the years. It is possible that certain records of species do not have complementary references that demonstrate the occurrence of the organism in the area, but, on the other hand, proving its absence is very difficult. References used in the lists can clarify the date or the evidence that gives rise to the report of the species in the area; however, they do not imply the absence of other species that may have been listed in other sources not consulted.

Taxonomic lists are the result of the cumulative report of species over the course of previous researches, studies and literature reviews across the different localities of the archipelago, without aiming to give a list of each and every one of the reports of occurrence of the species in the area. Lists also include invasive or introduced species that have been identified within a group, when the author of the chapter has considered it convenient. It is expected that the list grow thanks to the advantages of improved techniques of morphological identification and genetic analysis, thus increasing the biodiversity described herein.

Perspectives

In the development of this initiative, publishers decided to support the production of a printed copy, as well as a digital version of the work in order to reach a larger audience and allow readers to consult, in a more interactive way, the lists of species and their characteristics. This proposal also seeks to lay the foundations to enable access and participation of authorities and researchers for the updating of the lists contents, as new opportunities arise.

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PLANKTON

life in a drop of water.

Edgar Fernando Dorado-Roncancio[1], José Manuel Gutiérrez-Salcedo[1], Eugenia Escarria[1], María del Pilar Martínez-Barragán[1] and John Mauricio Beltran[1]

The pelagic ecosystem contains important communities of organisms that inhabit and define it. A particular group of organisms characterized by having members from almost all groups of marine invertebrates can be found within. Its size range is so wide that some of their organisms are less than one micron, while others are several meters long (e.g. some colonies of siphonophores reaching 40 m in length have been identified). Its displacement is modulated by the currents in different water masses. This group of organisms in general is called plankton n (Parsons *et al.*, 1984).

Plankton is regarded as one of the most relevant communities in the pelagic ecosystem, since it is responsible for controlling the flow of matter and energy between the environment and living organisms **(Raymont, 1983; Bathmann *et al.*, 2001).** It is also useful as a bioindicator of the ecological status of aquatic systems **(Daly y Smith, 1993; Pinel-Alloul, 1995),** because the different assemblages that make up plankton are highly sensitive to the physical, geomorphological and meteorological conditions of the system and respond to these changes by modifying its structure to adapt themselves to the new environmental conditions **(Parsons *et al.*, 1984; Angel, 1993).**

The role of plankton in nature does not end there. Recent studies have demonstrated that this community participates in macroscale events, such as climate change, capturing significant amounts of carbon dioxide from the atmosphere and depositing them on the ocean floor, thus reducing the effect of this greenhouse gas

Plankton is responsible for the smell we associate with the sea. This aroma is produced by the metabolism of organisms.

(Franco-Herrera *et al.*, 2006). Plankton also takes part in migration, displacement and colonization of larvae and juveniles, extending biogeographic zones through the movement produced by currents, tides and waves that transport them **(Mujica, 2006).**

1 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

Phytoplankton produces more than

75%

of the oxygen we breathe.

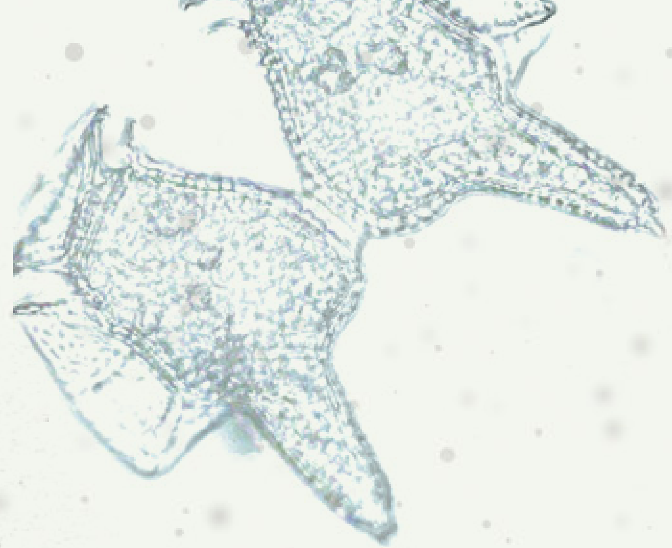
This community is divided into two groups: The first group is phytoplankton, consisting mainly of microalgae, which synthesize their own food like most terrestrial and aquatic plants, fixing the inorganic carbon and turning it into organic matter available for the higher trophic levels of pelagic and benthic ecosystems (Dawes, 1986). The second group is zooplankton, made up of heterotrophic organisms, i.e., organisms that cannot synthesize their food, so they obtain it from their environment, either by filtration of microalgae (herbivores) or ingestion of organic matter (detritivores or carnivores). Zooplankton consists mainly of marine invertebrates, which may develop their entire life cycle (holoplankton) or at least a part of it (meroplankton) inhabiting plankton. In the latter group, eggs and larvae of fish are included as representatives of marine vertebrates, known as Ichthyoplankton **(Boltovskoy, 1981b; Parsons , 1984).**

Methods to collect plankton vary according to the characteristics of the environment, groups to be studied, biological characteristics, among other aspects. Trawl nets are the most commonly used method from about 150 years ago, since this type of sampling has several advantages over other models, such as high effectiveness and efficiency, low negative impact, limited damage of the sample and easy construction, operation and maintenance of the tool **(Boltovskoy, 1981a).**

In the Colombian Caribbean, most studies on plankton have focused on the analysis of coastal zones and continental shelf and bays, collecting valuable information on the ecology and taxonomy of the group; however, little is known about the community inhabiting oceanic island areas, where these ecosystems are considered important means of production due to their oligotrophic waters **(Giraldo y Villalobos, 1983; Martínez Barragán, 2007).**

The Seaflower Biosphere Reserve has 18 scientific publications since 1980, whose main approach has been characterizing the plankton community and establishing taxonomic inventories. In total, 366 morphotypes have been identified in three kingdoms, of which 40% are microalgae, 30% zooplankton and 30% fish larvae. Ecologically, the information provided in each of the investigations on plankton agrees that, in the area of the reserve, the planktonic community is stable and highly diverse, typical of a tropical oligotrophic system.

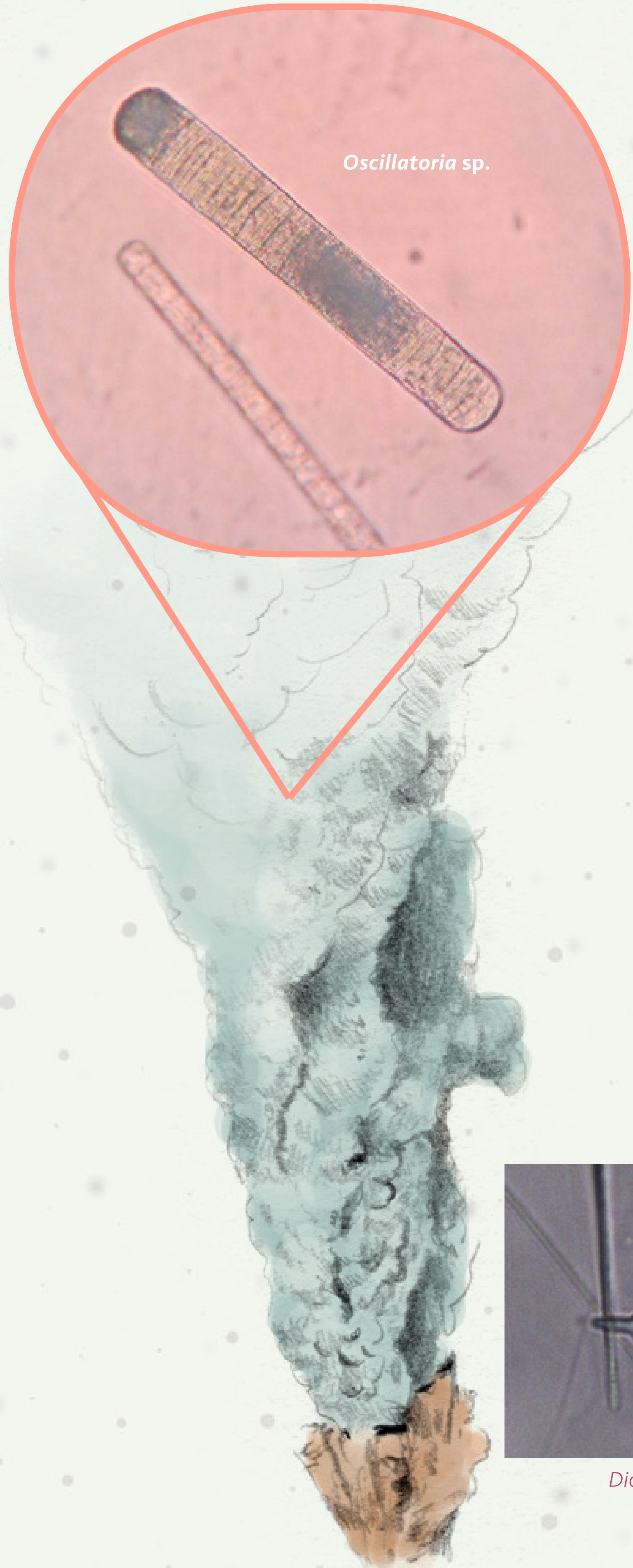
[Without plankton, marine life would not exist, because from small corals to giant whales feed on it.]



Phytoplankton

One of the closest figures to the total number of marine phytoplankton species is 5,000 (Round *et al.*, 2007)**;). Out of this number of species, around 1,800 diatoms and 400 dinoflagellates have been recorded for the Wider Caribbean Region** (Lozano Duque *et al.*, 2011)**.**

Both are the dominant groups in the marine phytoplankton community, in terms of number of species and abundance. However, depending on the environmental conditions, there are other groups that can significantly increase their numbers such as cyanobacteria. Additionally, added to this assemblage are the coccolithophorids and silicoflagellates, which have a more limited representation in terms of diversity and number of organisms **(Falowsky y Knowll, 2007)**. For the Archipelago of San Andrés, Providencia and Santa Catalina, 226 morphospecies in the groups mentioned above have been described.



Oscillatoria sp.

Cyanobacteria

Cyanobacteria are characterized by their lack of a defined nucleus; however, they differ from other bacteria in having chlorophylls, allowing them to produce oxygen through photosynthesis **(Whitton y Potts, 2002)**. In the archipelago, eight species were found; seven of them are free-living such as Synechococcus sp. (unicellular organism) and Trichodesmium hildebrandtii (filamentous organism). The eighth species, belonging to the genus Richelia, is an endosymbiont organism; it lives within another organism (the diatom Rhizosolenia sp. is its host).

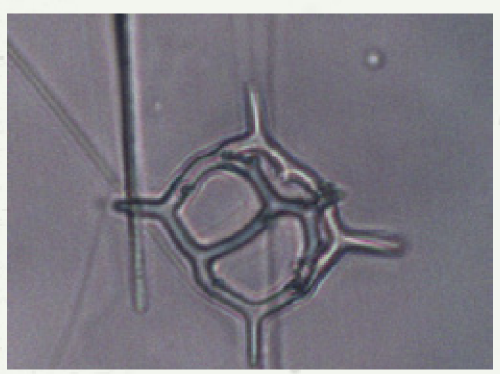
This group is well known for increasing their numbers under environmental conditions where nutrients are limited, achieving in some cases to represent 50% of the total biomass of phytoplankton **(Lemus *et al.*, 2003)**. This increase is due to the sum of various adaptations such as their ability to absorb from the atmosphere the missing nitrogen in the water, their ability to obtain extra energy from toxic substances such as sulfides and their high resistance to solar radiation and high temperatures.

These adaptations have allowed cyanobacteria to colonize inhospitable environments such as the deep sea vents **(Whitton y Pott, 2002)**. Their size enables them to increase the surface-area-to-volume ratio, which gives them greater efficiency in absorbing nutrients and improves their buoyancy and resistance in hostile environments **(Naselli Flores y Barone, 2011)**.

are groups having a low abundance and diversity,

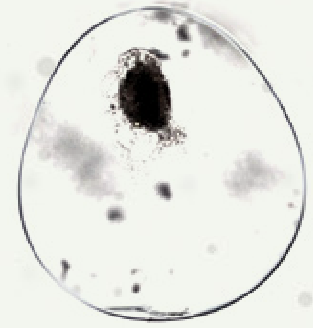
coccolithophorids and silicoflagellates

are groups having a low abundance and diversity, both belonging to the kingdom Chromista. Regarding the first group, only the species Emiliania huxleyi has been recorded at the archipelago. This species is characterized, as for the whole group, by a solid structure of calcium carbonate covering most of the cell. With respect to the second group, three morphospecies (Dictyocha fibula), whose most important characteristic is an internal skeleton composed of strands of silica, have been identified. Both groups live in warm and oligotrophic waters **(Falowsky y Knowll, 2007).**

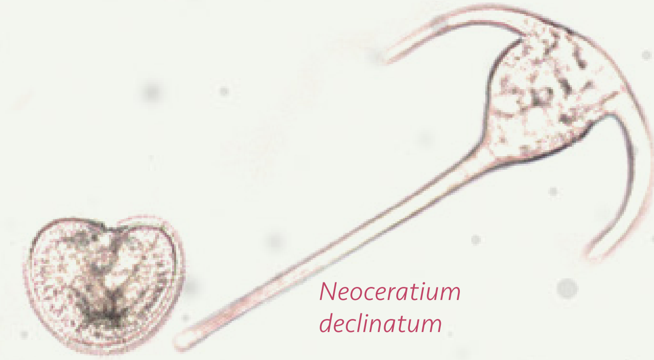


Dictyocha fibula

Scyphosphaera sp.



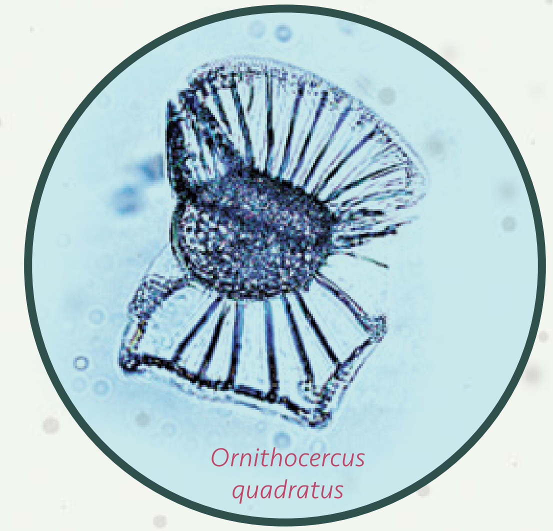
Pyrocystis noctiluca



Neoceratium declinatum

Dinoflagellates

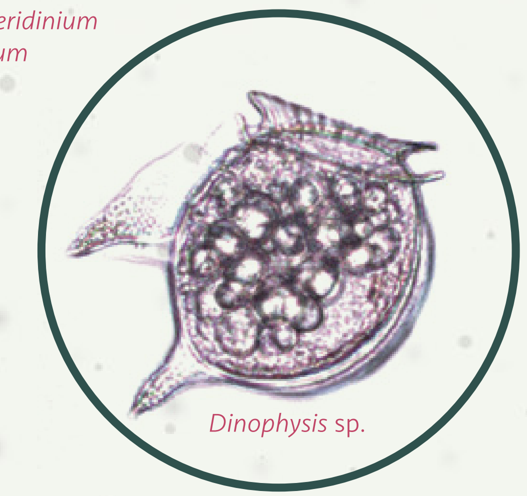
Dinoflagellates are microalgae that also belong to the kingdom Chromista given their ability to produce their own food; however, they have been linked to the kingdom Animalia because they can nourish themselves by eating other smaller organisms. This method of feeding is only used as a way of survival if nutrients are limited. When there are large blooms of dinoflagellates, this group produces a phenomenon known as "red tides", causing poisoning to organisms that consume them in high concentrations. Some members of the group of dinoflagellates serve as indicators to assess climate change. Moreover, this species has become a tourist attraction in some Caribbean islands given their ability to produce bioluminescence **(Gómez *et al.*, 2010).** In the archipelago, 104 morphospecies represented by voluminous forms such as *Dinophysis caudata*, *Ornithocercus magnificus* y *Pyrocytis* sp.



Ornithocercus quadratus

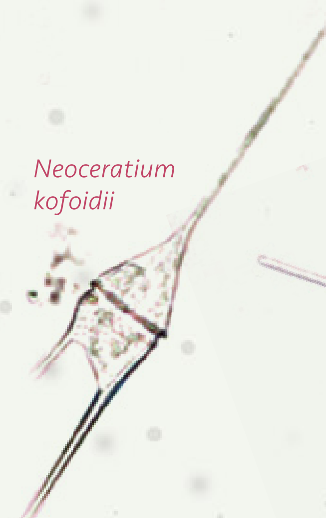
Protoperidinium depresum

Alexandrium sp.



Dinophysis sp.

Podolampas elegans



Neoceratium kofoidii

Amphisolenia bidentata

Gymnodinium sp.

Phytoplankton

Phylum Bacillariophyta

C: Bacillariophyceae
Sc: Bacillariophycidae
O: Bacillariales, Cocconeidales, Mastogloiales, Naviculales, Surirellales, Thalassiophysales
F: Bacillariaceae, Cocconeidaceae, Achnanthaceae, Mastogloiaceae, Diploneidaceae, Naviculaceae, Plagiotropidaceae, Pleurosigmataceae, Stauroneidaceae, Surirellaceae, Catenulaceae, Thalassiophysaceae

C: Coscinodiscophyceae
Sc: Corethrophycidae, Coscinodiscophycidae, Melosirophycidae
O: Bacillariales, Corethrales, Asterolamprales, Coscinodiscales, Melosirales, Coscinodiscales, Rhizosoleniales
F: Bacillariaceae, Corethraceae, Asterolampraceae, Coscinodiscaceae, Hemidiscaceae, Paraliaceae, Coscinodiscaceae, Rhizosoleniaceae

S			
Cylindrotheca sp	Rabenhorst, 1859	5	ARC, IR
Cylindrotheca closterium	(Ehrenberg) Reimann y Lewin, 1964	4	C, S, RB, BR
Nitzschia bicapitata	Cleve, 1901	4	RB
Nitzschia longissima	(Brébisson) Ralfs en Pritchard, 1861	4, 6	RB
Nitzschia sigma	(Kützing) Smith, 1853	4	C, S
Nitzschia sp	Hassall, 1845	4, 5, 14	RB
Pseudo-nitzschia pungens	(Grunow ex Cleve) Hasle, 1993	4, 6	ARC, S, RB
Pseudo-nitzschia seriata	(Cleve) Peragallo en Peragallo y Peragallo, 1899	4, 14	RB
Pseudo-nitzschia sp	Peragallo, 1900	5	ARC, CS, BA
Tryblionella kuetzingii	Álvarez-Blanco y Blanco, 2014	4	S, RB
Cocconeis sp	Ehrenberg, 1836	5	ARC, BA
Achnanthes sp	Bory de Saint-Vincent, 1822	5	BA
Mastogloia sp	Thwaites ex W.Smith, 1856	4, 5	RB
Diploneis sp	Ehrenberg ex Cleve, 1894	5	ARC
Haslea sp	Simonsen, 1974	5	ARC, CS, BA
Navicula cancellata	Donkin, 1872	4	ARC, N, C, BR
Navicula directa	(Smith) Ralfs, 1861	4	RB
Navicula sp	Bory de Saint-Vincent, 1822	4, 5, 6, 14	RB
Plagiotropis sp	Pfitzer, 1871	5	ARC
Pleurosigma sp	Smith, 1852	4, 5	RB
Stauroneis sp	Ehrenberg, 1843	5	ARC
Campylodiscus sp	Ehrenberg ex Kützing, 1844	5	ARC
Surirella sp	Turpin, 1828	5	ARC
Amphora ocellata	Donkin, 1861	5	BA
Amphora sp	Ehrenberg ex Kützing, 1844	4, 5	RB
Thalassiophysa sp	Conger, 1954	5	ARC
Pseudonitzschia delicatissima	(Cleve) Heiden en Heiden y Kolbe, 1928	4	ARC, S, RB
Corethron criophilum	Castracane, 1886	4	S
Asterolampra marylandica	Ehrenberg, 1844	4	S
Asterolampra sp	Ehrenberg, 1844	5	ARC, IR
Asteromphalus sp	Ehrenberg, 1844	5	ARC
Coscinodiscus centralis	Ehrenberg, 1844	5	ARC, IR
Coscinodiscus curvatulus	Grunow ex Schmidt, 1878	5	ARC, IR
Coscinodiscus granii	Gough, 1905	5	ARC, CS
Coscinodiscus marginatus	Ehrenberg, 1844	5	ARC, IR
Coscinodiscus radiatus	Ehrenberg, 1840	4	S
Coscinodiscus sp	Ehrenberg, 1839	4, 5, 6	RB
Actinocyclus sp	Ehrenberg, 1837	14	SA
Paralia sp	Heiberg, 1863	4	RB, BR
Paralia sulcata	(Ehrenberg) Cleve, 1873	5	ARC
Coscinodiscus wailesii	Gran y Angst, 1931	5	ARC
Dactyliosolen sp	Castracane, 1886	4	S
Dactyliosolen fragilissimus	(Bergon) Hasle en Hasle y Syvertsen, 1996	4	S, RB
Guinardia flaccida	(Castracane) Peragallo, 1892	4, 5, 6	ARC, CS, BA, S
Guinardia sp	Peragallo, 1892	6	ARC
Guinardia striata	(Stolterfoth) Hasle en Hasle y Syvertsen, 1996	5, 6	ARC, IR
Guinardia striata	(Stolterfoth) Hasle en Hasle y Syvertsen, 1996	4	C, S, RB, BR
Neocalyptrella robusta	(Norman ex Ralfs) Hernández-Becerril y Meave del Castillo, 1997	4	S
Proboscia alata	(Brightwell) Sundström, 1986	4, 5	RB
Proboscia sp	Sundström, 1986	6	ARC
Pseudosolenia calcar-avis	(Schultze) Sundström, 1986	4, 5, 6	ARC, IR, N, S
Rhizosolenia hebetata	Bailey, 1856)	4, 5	RB
Rhizosolenia hyalina	Ostenfeld en Ostenfeld y Schmidt, 1901	4	BR
Rhizosolenia imbricata	Brightwell, 1858	5, 6	ARC, IR
Rhizosolenia setigera	Brightwell, 1858	4, 5	RB
Rhizosolenia sp	Brightwell, 1858	4, 5, 6	ARC, S
Rhizosolenia styliformis	Brightwell, 1858	4	S

Interactive table

Phylum Bacillariophyta

C: Fragilariophyceae
O: Fragilariales, Licmophorales, Rhabdonematales, Striatellales, Tabellariales, Thalassionematales
F: Fragilariaceae, Licmophoraceae, Ulnariaceae, Grammatophoraceae, Rhaphoneidaceae, Striatellaceae, Tabellariaceae, Thalassionemataceae

C: Mediophyceae
Sc: Biddulphiophycidae, Chaetocerotophycidae, Thalassiosirophycidae
O: Biddulphiales, Toxariales, Anaulales, Chaetocerotales, Hemiaulales, Eupodiscales, Leptocylindrales, Thalassiosirales, Eupodiscales
F: Biddulphiaceae, Climacospheniaceae, Toxariaceae, Anaulaceae, Chaetocerotaceae, Hemiaulaceae, Eupodiscaceae, Leptocylindraceae, Lauderiaceae, Skeletonemataceae, Thalassiosiraceae, Eupodiscaceae

S			
Fragilaria sp	Lyngbye, 1819	5	ARC, IR
Podocystis sp	Bailey, 1854	5	ARC
Licmophora sp	Agardh, 1827	5, 14	ARC, SA
Bleakeleya sp	Round, 1990	5	ARC
Synedra sp	Ehrenberg, 1830	5	ARC
Synedra ulna	(Nitzsch) Ehrenberg, 1832	14	SA
Microtabella sp	Round, 1990	5	ARC
Asterionellopsis glacialis	(Castracane) Round en Round, Crawford y Mann, 1990	4	S
Asterionellopsis sp	Round, 1990	5	ARC
Striatella unipunctata	(Lyngbye) Agardh, 1832	5	ARC
Tabellaria sp	Ehrenberg ex Kützing, 1844	14	SA
Lioloma pacificum	(Cupp) Hasle en Hasle y Syvertsen, 1996	5	ARC, IR
Thalassionema bacillare	(Heiden) Kolbe, 1955	5, 6	ARC, IR
Thalassionema frauenfeldii	(Grunow) Tempère y Peragallo, 1910	4, 5	RB
Thalassionema nitzschioides	(Grunow) Mereschkowsky, 1902	4, 5, 6	RB
Thalassionema sp	Grunow ex Mereschkowsky, 1902	5	ARC, IR
Thalassiothrix sp	Cleve y Grunow, 1880	5	ARC
Biddulphia sp	Gray, 1821	5, 14	ARC, SA
Isthmia sp	Agardh, 1832	4, 5	ARC, CS, BR
Trigonium sp	Cleve, 1867	5	ARC
Climacosphenia moniligera	Ehrenberg, 1843	5	ARC
Toxarium undulatum	Bailey, 1854	5	ARC
Eunotogramma sp	Weisse, 1855	4, 5	RB
Bacteriastrum comosum	Pavillard, 1916	4	C, S, RB, BR
Bacteriastrum delicatulum	Cleve, 1897	4	S
Bacteriastrum elongatum	Cleve, 1897	4	C, S
Bacteriastrum furcatum	Shadbolt, 1854	5	ARC, IR
Bacteriastrum hyalinum	Lauder, 1864	4	S
Bacteriastrum sp	Shadbolt, 1854	4, 5, 6	ARC, CS, N
Chaetoceros affinis	Lauder, 1864	4, 5, 6	RB
Chaetoceros coarctatus	Lauder, 1864	4	RB
Chaetoceros compressus	Lauder, 1864	4	ARC, S, RB
Chaetoceros curvisetus	Cleve, 1889	4, 5	ARC, CS, RB
Chaetoceros decipiens	Cleve, 1873	5	CS
Chaetoceros dichaeta	Ehrenberg, 1844	4	S, RB
Chaetoceros didymus	Ehrenberg, 1845	4, 5, 6	RB
Chaetoceros diversus	Cleve, 1873	4, 5, 6	RB
Chaetoceros gracilis	Schütt, 1895	4	C, RB
Chaetoceros laciniosus	Schütt, 1895	4, 5, 6	ARC, CS, S, RB
Chaetoceros lauderi	Ralfs, 1864	5	ARC, CS
Chaetoceros lorenzianus	Grunow, 1863	4, 5, 6	RB
Chaetoceros peruvianus	Brightwell, 1856	4, 5, 6	ARC, IR, S
Chaetoceros radicans	Schütt, 1895	4	S
Chaetoceros seriacanthus	Gran	5	CS
Chaetoceros sp	Ehrenberg, 1844	4, 5, 6	RB
Chaetoceros willei	Gran, 1897	4	S, RB
Hemiaulus hauckii	Grunow ex Van Heurck, 1882	4, 5, 6	RB
Hemiaulus membranaceus	Cleve	4, 5	RB
Hemiaulus sinensis	Greville, 1865	4, 5, 6	RB
Eupodiscus sp	*Bailey, 1851*	14	SA
Trieres mobiliensis	(Bailey) Ashworth y Theriot en Ashworth et al., 2013	14	SA
Leptocylindrus danicus	Cleve, 1889	4	S, BR
Leptocylindrus sp	Cleve, 1889	5, 6	ARC, CS
Lauderia borealis	Gran, 1900	4	S
Skeletonema costatum	(Greville) Cleve, 1873	4, 5	CS, S
Thalassiosira sp	*Cleve, 1873*	5	ARC
Lampriscus sp	Schmidt, 1882	5	ARC

Phytoplankton

Phylum Cyanobacteria

C	Sc	O	F	S			
Cyanophyceae	Nostocophycideae	Nostocales	Nostocaceae	*Richelia intracellularis*	Schmidt en Ostenfeld y Schmidt, 1901	16	RB
				Richelia sp	Schmidt, 1901	5, 6	ARC, CS
	Oscillatoriophycideae	Oscillatoriales	Microcoleaceae	*Trichodesmium* sp	Ehrenberg ex Gomont, 1892	5, 6	ARC, IR
				Trichodesmium erythraeum	Ehrenberg ex Gomont, 1892	4	RB
				Trichodesmium hildebrandtii	Gomont, 1892	16, 17	RB
				Trichodesmium thiebautii	Gomont ex Gomont, 1890	4, 16, 17	RB
			Oscillatoriaceae	*Lyngbya* sp	Agardh ex Gomont, 1892	5	ARC, BA
	Synechococcophycideae	Synechococcales	Synechococcaceae	*Synechococcus* sp	Nägeli, 1849	5	ARC

Phylum Dinophyta

C	O	F	S			
Dinophyceae	Dinophysiales	Amphisoleniaceae	*Amphisolenia bispinosa*	Kofoid, 1907	17	RB
			Amphisolenia sp	Stein, 1883	4, 5	ARC, BN, RB
		Dinophysaceae	*Ornithocercus thurnii*	(Schmidt) Kofoid y Skogsberg, 1928	17	RB
			Citharistes sp	Stein, 1883	5	ARC
			Dinophysis acuminata	Claparède y Lachmann, 1859	6	ARC
			Dinophysis caudata	Saville-Kent, 1881	5, 17	RB
			Dinophysis schuettii	Murray y Whitting, 1899	17	RB
			Dinophysis sp	Ehrenberg, 1839	5, 17	RB
			Dinophysis tripos	Gourret, 1883	5	BN
			Histioneis sp	Stein, 1883	5	ARC
			Ornithocercus magnificus	Stein, 1883	4, 5, 16, 17	RB
			Ornithocercus quadratus	Schütt, 1900	4, 5, 17	ARC, BN, C
			Ornithocercus sp	Stein, 1883	5	ARC, BA
			Ornithocercus steinii	Schütt, 1900	5, 17	ARC, BA
		Oxyphysiaceae	*Ornithocercus thumii*	(Schmidt) Kofoid y Skogsberg, 1928	4	S
			Phalacroma doryphorum	Stein, 1883	5, 17	ARC, CS
			Phalacroma rapa	Jorgensen, 1923	5, 17	RB
			Phalacroma sp	Stein, 1883	5, 6	ARC, IR
	Gonyaulacales	Ceratiaceae	*Biceratium* sp	Vanhoeffen, 1896	4, 5, 6, 16, 17	RB
			Ceratium gravidum	Lemmermann, 1899	5	ARC, BA
			Ceratium inflatum	(Kofoid) Jørgensen 1911	17	RB
			Ceratium setaceum	Jørgensen, 1911	5	ARC, BA
			Tripos belone	(Cleve) Gómez, 2013	16, 17	N, C, S, RB
			Tripos boehmii	(Graham y Bronikovsky) Gómez, 2013	16, 17	RB
			Tripos candelabrus	(Ehrenberg) Gómez, 2013	5, 16, 17	RB
			Tripos contortus	(Gourret) Gómez, 2013	4, 5, 16, 17	RB
			Tripos declinatus	(Karsten) Gómez, 2013	4, 16, 17	RB
			Tripos euarcuatus	(Jörgenen) Gómez, 2013	16, 17	RB
			Tripos extensus	(Gourret) Gómez, 2013	16, 17	RB
			Tripos falcatiformis	(Jörgenen) Gómez, 2013	17	RB
			Tripos furca	(Ehrenberg) Gómez, 2013	4, 5, 6, 17	ARC, IR
			Tripos fusus	(Ehrenberg) Gómez, 2013	4, 5, 16, 17	RB
			Tripos geniculatus	(Lemmermann) Gómez, 2013	17	RB
			Tripos gibberus	(Gourret) Gómez, 1883	17	RB
			Tripos hexacanthus	(Gourret) Gómez, 2013	16, 17	RB
			Tripos horridus	(Cleve) Gómez, 2013	5	ARC, IR
			Tripos kofoidii	(Jörgenen) Gómez, 2013	5	ARC, CS
			Tripos limulus	(Pouchet) Gómez, 2013	5	ARC, CS
			Tripos lunula	(Schimper ex Karsten) Gómez, 2013	5	ARC, CS,
			Tripos macroceros	(Ehrenberg) Gómez, 2013	5, 16, 17	RB
			Tripos massiliensis	(Gourret) Gómez, 2013	16, 17	RB
			Tripos minutus	(Jörgensen) Gómez, 2013	5	ARC
			Tripos muelleri	Bory de Saint-Vincent en Lamouroux et al., 1824	5, 16, 17	RB
			Tripos paradoxides	(Cleve) Gómez, 2013	5	BN, BA
			Tripos pentagonus	(Gourret) Gómez, 2013	4, 6, 16, 17	RB
			Tripos pulchellus	(Schröder) Gómez, 2013	17	RB
			Tripos strictus	(Okamura y Nishikawa) Gómez, 2013	16, 17	ARC, RB, BS, BR
			Tripos symmetricus	(Pavillard) Gómez, 2013	5	ARC, IR
			Tripos tenuis	(Ostenfeld y Schmidt) Gómez, 2013	17	RB

Phylum Dinophyta

C	O	F	S			
Dinophyceae	Gonyaulacales	Ceratiaceae	*Tripos teres*	(Kofoid) Gómez, 2013	4, 5, 6, 16, 17	RB
			Tripos trichoceros	(Ehrenberg) Gómez, 2013	5, 16	RB
			Tripos vultur	(Cleve) Gómez, 2013	5, 17	ARC, BA
		Cladopyxidaceae	*Cladopyxis* sp	Stein, 1883	17	RB
		Goniodomataceae	*Alexandrium* sp	Halim, 1960	5	ARC, BN
			Goniodoma polyedricum	(Pouchet) Jørgensen, 1899	5, 16, 17	
			Goniodoma sp	Stein, 1883	5	ARC, CS, BA
			Gonyaulax milneri	(Murray y Whitting) Kofoid, 1911	4	ARC, S, RB
			Gonyaulax polygramma	Stein, 1883	4	N, S, RB
			Gonyaulax sp	Diesing, 1866	4, 5, 16, 17	RB
		Gonyaulacaceae	*Gonyaulax polyedra*	Stein, 1883	4	RB
			spiraulax kofoidii	Graham, 1942	5	ARC
			spiraulax sp	Kofoid, 1911	17	RB
		Protoceratiaceae	*Ceratocorys armata*	(Schütt) Kofoid, 1910	5	ARC
			Ceratocorys horrida	Stein, 1883	5, 16, 17	RB
			Ceratocorys sp	Stein, 1883	5	ARC
		Pyrophacaceae	*Pyrophacus* sp	Stein, 1883	5, 17	ARC, CS
	Gymnodiniales	Gymnodiniaceae	*Amphidinium* sp	Claperède y Lachmann, 1859	4	N, C, S, RB, BR
			Gymnodinium sp	Stein, 1878	6	ARC
			Gyrodinium fissum	(Levander) Kofoid y Swezy, 1921	4	S, RB, BR
			Gyrodinium sp	Kofoid y Swezy, 1921	6	ARC
		Tovelliaceae	*Katodinium* sp	Fott, 1957	6	ARC
	Peridiniales	Diplopsaliaceae	*Diplopsalis* sp	Bergh, 1881	4	RB
		Heterocapsaceae	*Heterocapsa* sp	Stein, 1883	5	ARC, IR
		Oxytoxaceae	*Oxytoxum elegans*	Pavillard, 1916	4	RB
			Oxytoxum parvum	Schiller, 1937	4	S
			Oxytoxum scolopax	Stein, 1883	4	RB
			Oxytoxum sp	Stein, 1883	4, 5, 6	RB
		Peridiniales incertae sedis	*Corythodinium* sp	Loeblich Jr. y Loeblich III, 1966	5	ARC, BA
		Podolampadaceae	*Podolampas bipes*	Stein, 1883	5, 17	ARC, IR
			Podolampas elegans	Schütt, 1895	5, 6	ARC, IR
			Podolampas palmipes	Stein, 1883	4	RB
			Podolampas sp	Stein, 1883	5	ARC, IR
			Podolampas spinifera	Okamura, 1912	6, 17	RB
		Protoperidiniaceae	*Protoperidinium conicum*	(Gran) Balech, 1974	4	RB
			Protoperidinium depressum	(Bailey) Balech, 1974	6	ARC
			Protoperidinium elegans	(Cleve) Balech, 1974	5, 17	ARC, CS
			Protoperidinium ovum	(Schiller) Balech, 1974	4	N, S
			Protoperidinium pellucidum	Bergh, 1881	4	N, S
			Protoperidinium sp	Bergh, 1881	5, 6, 16, 17	RB
			Protoperidinium sphaericum	(Murray y Whitting) Balech, 1974	4	ARC
			Protoperidinium steinii	(Jørgensen) Balech, 1974	4	ARC, C, S, BR
	Prorocentrales	Prorocentraceae	*Prorocentrum gracile*	Schütt, 1895	5	ARC
			Prorocentrum lima	(Ehrenberg) Stein, 1878	4	S
			Prorocentrum micans	Ehrenberg, 1834	4, 5	N, C, S, RB, BR
			Prorocentrum sp	Ehrenberg, 1834	5	ARC, BN
	Pyrocystales	Pyrocystaceae	*Pyrocystis fusiformis*	Thomson en Murray, 1876	5, 16, 17	RB
			Pyrocystis noctiluca	Murray ex Haeckel, 1890	16, 17	RB
			Pyrocystis robusta	Kofoid, 1907	6	ARC
			Pyrocystis sp	Wyville-Thompson, 1876	4, 5, 17	ARC, IR
	Thoracosphaerales	Thoracosphaeraceae	*Scrippsiella* sp	Balech ex Loeblich III, 1965	4, 5, 6	RB

Phylum Haptophyta

C	Sc	O	F	S			
Coccolithophyceae	Prymnesiophycidae	Isochrysidales	Noelaerhabdaceae	*Emiliania huxleyi*	(Lohmann) Hay y Mohler en Hay et al., 1967	4	ARC, C, S, RB

Phylum Ochrophyta

C	O	F	S			
Chrysophyceae	Isochrysidales	Rhizochrysidaceae	*Rhizochrysis* sp	Pascher, 1913	14	SA
Dictyochophyceae	Dictyochales	Dictyochaceae	*Dictyocha fibula*	Ehrenberg, 1839	4, 5	ARC, CS, BR
			Dictyocha navicula	Ehrenberg	4	ARC, N, C, RB

All species listed as ichthyoplankton have an holoplanktonic life cycle.

Interactive table

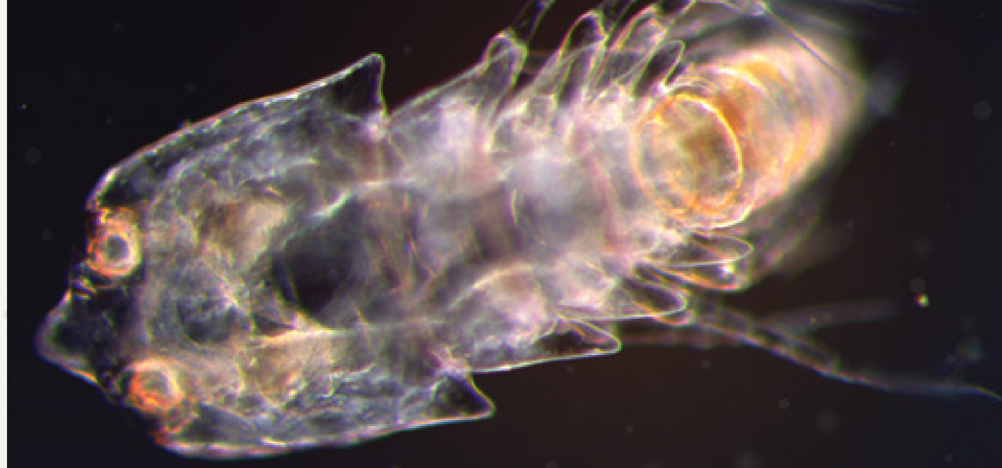
Diatoms

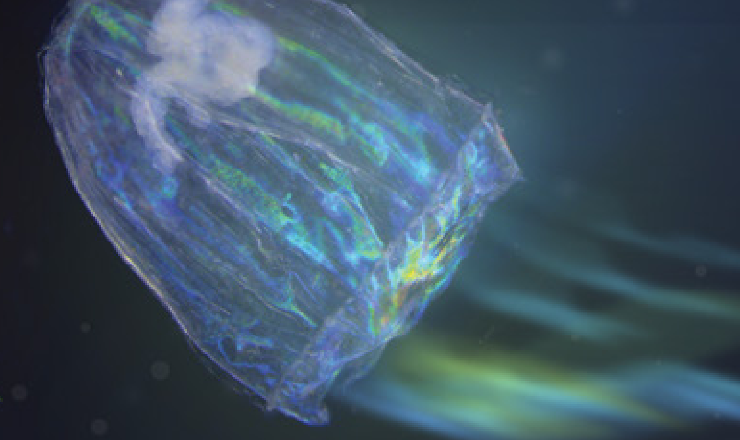
Diatoms are the last group comprising this assemblage in the archipelago. Some members of this group can be up to two millimeters long and they have an external structure made of silica called frustule, which is similar to a box with two covers (i.e. valves) fitting into each other. This frustule provides them with additional weight; therefore, diatoms have adapted using organelles such as the intracellular vesicle that they can inflate or deflate with air to regulate flotation **(Round *et al.*, 2007)**. In addition, thanks to their radial shape and their elaborate composition, they increase surface area-to-volume ratios, which offer them resistance to sinking **(Naselli Flores y Barone, 2011).** On marine biogeochemical cycles research, the importance of this group has been highlighted, especially for the importance of carbon and silica, using living as well as fossil samples to get information from the past history **(Falowsky y Knowll, 2007)**. Diatoms have also been used as indicators of pH water changes because ocean acidification (due to climate change) affects their valves and weakens them.

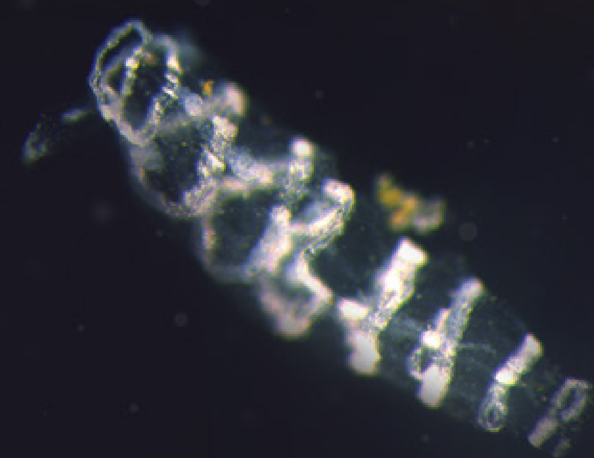
114
morphospecies

In the archipelago, 114 morphospecies have been recorded; among the most representative are *Actinocyclus* sp., *Bacteriastrum hyalinum* and *Chaetoceros affinis*.

In the industrial sector, the frustules of dead diatoms accumulated in sediments are used as a very fine abrasive in additives for polishing metals and in toothpastes and as very selective mineral filters, insulating materials and elements of slip-resistant compounds (Round *et al.*, 2007).







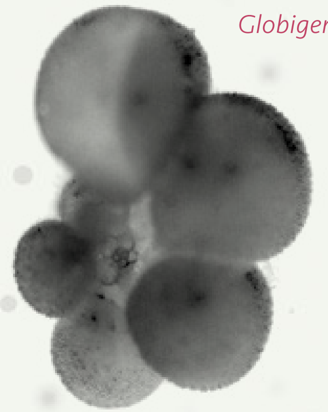
Zooplankton

In this assemblage, around 7,000 species have been described worldwide, but this figure may be larger since much of the information has been obtained from the first 1,000 m in depth, leaving a little over 60% of the ocean's depth to be explored (Wiebe *et al.*, 2010). **For the Colombian Caribbean, 715 species of planktonic copepods have been recorded, this being the most diverse group** (Razouls *et al.*, 2015). **In the archipelago, a total of 259 morphotypes have been described and classified in different taxonomic levels, where 135 managed to be identified to the species level; nonetheless, it is presumed that this number may be higher since most work done in the Seaflower Biosphere Reserve has focused in the characterization of higher taxonomic groups (class, order or family), masking the true diversity of this group.**

Zooplankton is dominated by crustaceans, mainly copepods described as the most numerous organisms on the planet **(Boxshall y Halsey, 2004)**. Like chaetognaths, amphipods, ostracods, hydromedusae and pteropods, among others, copepods are a holoplankton species, while the larvae of some invertebrates such as crabs, lobsters, sea snails, anemones and starfish are classified as meroplankton **(Boltovskoy, 1981a).**

These morphotypes are grouped

8 PHYLA



Globigerina sp

0,5 mm

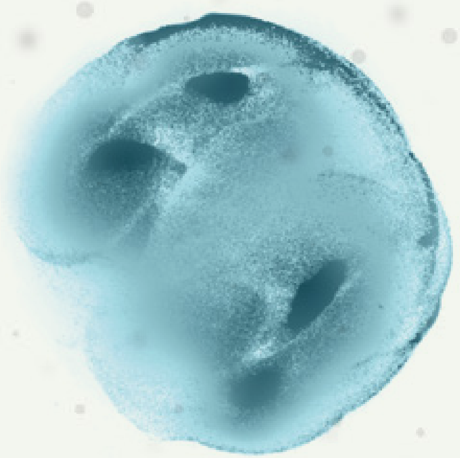
Globigerina sp.

1 mm

The first is the ***phylum Foraminifera***, a group of unicellular organisms that are part of the smallest animals in plankton. In the archipelago, four morphotypes (including Orbulina universa) were found. These organisms prefer clean waters far from continental shelves since coastal depths are not sufficient for their ontogenetic vertical migrations, necessary for their reproduction. Some of their most important adaptations to the planktonic life are weight reduction due to a decrease in their calcareous material, increased friction by producing spines, stripes and ridges on their shell and formation of floats in the last layer of their shells. Additionally, they help conducting climate studies because thanks to their variability and sensitivity, they are good indicators of geological ages, allowing to reconstruct the ecological conditions in the past **(Boltovskoy, 1981b; Sen Gupta *et al.*, 2009).**

[Although some have microscopic sizes, large blooms of plankton can be seen from space.]

With respect to the ***phylum Ctenophora*** three specimens (an organism belonging to the family Pleurobrachiidae and two species Bolinopsis *vítrea* y *Ocyropsis maculata*),while in the ***phylum Cnidaria*** the hydromedusa being its main representative, 23 morphotypes (including *Moerisia boulenger*, *Clytia hemisphaerica*, *Aglaura hemistoma*). have been recorded. These two phyla tend to have transparent bodies, water being their main component. Given their predatory nature, they are located at the top of the food web, including in their diet not only primary producers (phytoplankton) but also first-order and second-order carnivores (e.g., amphipods and fish larvae). The hunting methods of ctenophores are based on iridescent cells that allow them to produce light in order to attract their prey, while hydromedusae have tentacles containing modified cells called cnidocytes that, upon contact with the body of their prey, release toxins to capture their food **(Ramírez y Zamponi, 1983; Daly *et al.*, 2007).**



Ocyropsis maculata

The ***phylum Annelida*** comprises some planktonic polychaetes and benthic larvae. The members of this group are well known for being excellent predators that have developed several morphological modifications such as projection of the jaw, flattened appendages, tentacles and globular eyes. They are agile swimmers; therefore, they can pursue their prey until they catch them **(Fernández-Álamo, 2006)**. In the archipelago, 13 morphotypes belonging to different families (ej. *Tomopteridae* e *Iospilidae*), have been identified, of which most are larval stages of benthic worms *(ej. Nereidae, Amphinomidae)*.

The ***phylum Chaetognatha*** consists of arrow worms. In the archipelago, 15 morphotypes (including Sagitta enflata, Krohnitta subtilis, Eukrohnia fowleri). have been recorded. This is one of the few groups that are exclusively marine and, like the previous group, they are active, agile and ravenous. They are excellent hunters that take advantage of their spire-like teeth at the front of their head to get through or easily catch their prey **(Terazaki, 1995).**

Mesosagitta sp.

5 mm

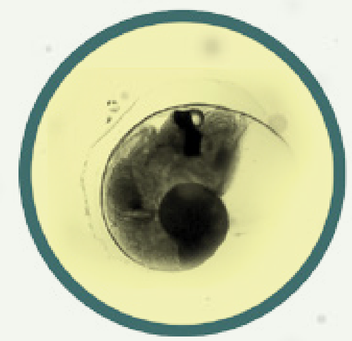
Mesosagitta sp.

1 mm

Eukrohnia sp.

5 mm

Atlanta sp.

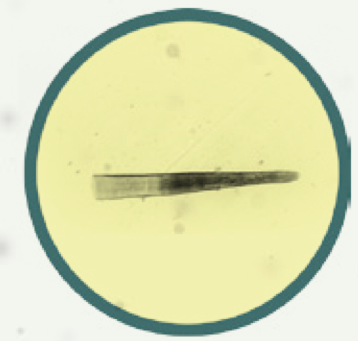


1 mm

Cavolinidae

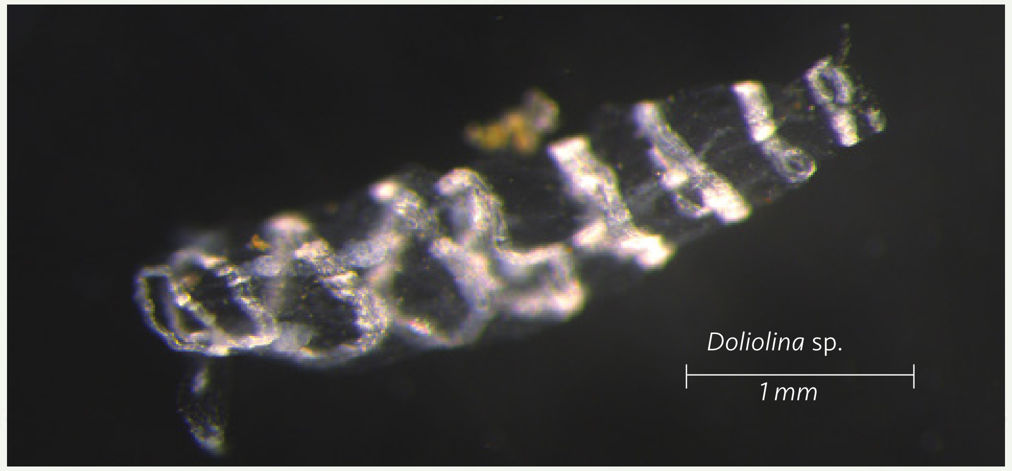
0,5 mm

Creseidae



1 mm

The sixth group belongs to the ***phylum Mollusca*** which are organisms that are characterized by an outer shell that protects their body. For the archipelago, 28 different morphotypes (18 species), of which most are holoplanktonic (ej. *Limacina inflata*, *Cavolinia longirostris* and *Atlanta peresi*) and a few are larvae of pelagic and benthic species (ej. family Ommastrephidae). Ehave been found. Most of the members of this group are hunters that use their entire body to wrap their prey and some use their feet like fins to swim **(Boltovskoy, 1981)**. They are also one of the most endangered groups due to climate change effects, as the calcium carbonate they use for their shells is not absorbed and begins to degrade in waters that have started to become acidified, turning them into indicators of these environmental conditions **(Tyrrella *et al.*, 2015).**



Oikopleura sp.

0,5 mm

With more complex morphological structures, there is the **Phylum Chordata**. This group is characterized by an embryonic structure called notochord, which is common to every vertebrate in at least one stage of its development **(Hopcroft *et al.*, 1998).** EIn the archipelago, nine holoplanktonic morphotypes were recorded, of which half were appendicularians (ej.*Oikopleura albicans*) and the other half, salps (ej.*Salpa fusiformis*). Appendicularians are able to produce a structure out of mucus that surrounds their body in order for them to better handle currents and to have a larger filtration area. When this structure is saturated, appendicularians change it, generating organic debris that fall to the bottom and serve as food for other organisms; salps, for their part, feed by generating currents through compression of the muscle bands around their body, thus succeeding in filtering the smallest plankton (**Riisgård y Larsen, 2010; Saveleva *et al.*, 2013).**

> **In the movie "Aliens" (1986), the character Alien was inspired by the amphipod Phronima, a voracious predator in the ocean's depth.**

Phronimidae

1 mm

Phylum Arthropoda

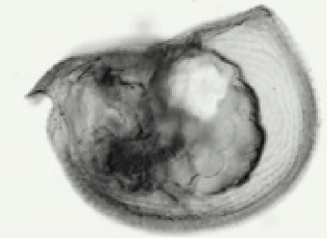
70%

of all abundance and biodiversity of zooplankton

In the archipelago, 162 morphotypes (13 órdenes, 74 familias), of which 72 were identified to the species level, have been described. This group is characterized by its great diversity, high adaptability to the environment and specialized structures like exoskeletons, segmented bodies and jointed appendages, which have enabled it to be the largest group on the planet and colonize every aquatic environment **(Boltovskoy, 1981a; Koenemann y Jenner, 2005).**

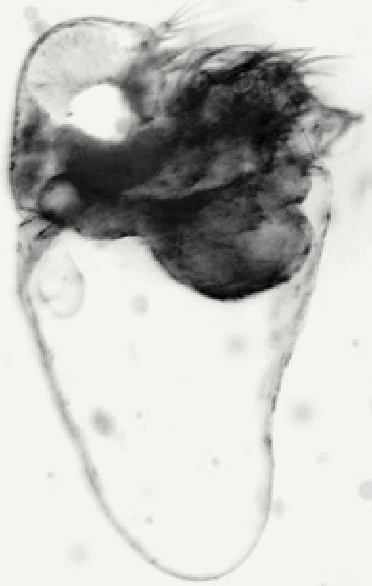
Oncaea sp.

1 mm



Ostracoda

1 mm



Polyphemidae

0,5 mm

Corycaeus sp.

1 mm

Isopoda

1 mm

*The phylum Arthropoda includes diverse organisms having all sizes and belonging to every trophic level and is divided into nine subgroups: Branchiopoda (family Podonidae), Ostracoda (families Cypridinidae and Halocyprididae), Amphipoda (familia Brachyscelidae), Euphausiacea (family Euphausiidae), Isopoda (family Cirolanidae), Mysida (familia Mysidae), Decapoda (families Sergestidae and Luciferidae) and Copepoda (families Calanidae, Acartidae and Eutepinidae).*The latter is the most diverse and representative group because its members are the most prolific primary consumers and because of its rapid response to adaptation and rapid growth rates compared to other organisms **(Bjornberg, 1984)**. AAmong some species of copepods found in the archipelago are *Acartia tonsa, Macrosetella gracilis, Corycaeus latus, Oncaea venusta, Oithona plumífera and Sapphirina nigromaculata.*

Among other physical features to which copepods owe their success are their oval-shaped body, which enables them to be efficient in water; their highly-modified antennae, which enables them to feel the vibrations of the water generated by other organisms and thus, capture their prey (mecanorecepción) and their muscles, which along with their exoskeleton, turn them into the animals with the quickest reaction, managing to move at distances of over 500 times their body size in less than a millisecond **(Kiørboe, 2011, 2013; Heuschele y Selander, 2014).**

Zooplankton

Phylum Annelida

C	O	F	S				
Polychaeta	Amphinomida	Amphinomidae	*Amphinomidae* spp.	Lamarck, 1818	2	M	RB
		Alciopidae	*Alciopidae* spp.	Ehlers, 1864	5, 6, 8, 2	H	ARC, PSC, RB
		Hesionidae	*Hesionidae* spp.	Grube, 1850	2	H	RB
		Iospilidae	*Iospilidae* spp.	Bergström, 1914	5, 8	H	ARC, PSC
		Lopadorrhynchidae	*Lopadorrhynchidae* spp.	Claparède, 1870	5, 6, 8	H	ARC, IR, PSC
		Nereidae	*Nereidae* spp.	Blainville, 1818	2	H	RB
		Polynoidae	*Polynoidae* spp.	Kinberg, 1856	5	H	BN
		Sigalionidae	*Sigalionidae* spp.	Malmgren, 1867	2	H	RB
		Syllidae	*Syllidae* spp.	Grube, 1850	2	H	RB
		Tomopteridae	*Tomopteridae* spp.	Grube, 1850	2, 5, 6	H	RB
		Typhloscolecidae	*Typhloscolecidae* spp.	Uljanin, 1878	6	H	ARC
		Sabellidae	*Sabellidae* spp.	Latreille, 1825	2	H	RB
		Spionidae	*Spionidae* spp.	Grube, 1850	2, 8	H	RB

Phylum Arthropoda

C	O	F	S				
Branchiopoda	Diplostraca	Podonidae	*Podonidae* spp.	Mordukhai-Boltovskoi, 1968	5, 6	H	ARC, IR
		Polyphemidae	*Polyphemidae* spp.	Baird, 1845	8	H	PSC
Malacostraca	Amphipoda	Ampithoidae	*Amphitoe* sp.	Leach, 1814	2	H	RB
		Brachyscelidae	*Brachyscelidae* spp.	Stephensen, 1923	6	H	ARC
			Brachyscelus sp.	Bate, 1861	2	H	RB
		Dairellidae	*Dairella* sp.	Bovallius, 1887	2	H	RB
		Hyperiidae	*Hyperia* sp.	Latreille, 1823	2	H	RB
			Hyperiella sp.	Bovallius, 1887	2	H	RB
			Hyperiidae spp.	Dana, 1852	5, 8	H	ARC, IR
		Lestrigonidae	*Lestrigonidae* spp.	Zeidler, 2004	6	H	ARC
		Lycaeidae	*Lycaea* sp.	Dana, 1852	2	H	RB
		Oxycephalidae	*Oxycephalidae* spp.	Bate, 1861	5	H	BA
		Parascelidae	*Thyropus* sp.	Dana, 1852	2	H	RB
		Phronimidae	*Phronimella* sp.	Claus, 1871	2	H	RB
		Phrosinidae	*Anchylomera* sp.	Milne Edwards, 1830	2	H	RB
		Pronoidae	*Eupronoe* sp.	Claus, 1879	2	H	RB
			Paralycaea sp.	Claus, 1879	2	H	RB
		Synopiidae	*Synopia* sp.	Dana, 1852	2	H	RB
	Decapoda	Alpheidae	*Alpheopsis labis*	Chace, 1972	2	H	RB
			Alpheopsis trigona	(Rathbun, 1901)	2	H	RB
		Anchistioididae	*Anchistioides antiguensis*	(Schmitt, 1924)	2	H	RB
		Callianassidae	*Callianassidae* spp.	Dana, 1852	6	M	ARC
		Cancridae	*Cancridae* spp.	Latreille, 1802	8	M	PSC
		Hippolytidae	*Hippolytidae* spp.	Spence Bate, 1888	8	M	PSC
			Latreutes fucorum	(Fabricius, 1798)	2	H	RB
		Luciferidae	*Lucifer faxoni*	Borradaile, 1915	2	H	RB
			Lucifer typus	H. Milne Edwards, 1837	2	H	RB
			Luciferidae spp.	De Haan, 1849	5, 6, 8	H	PSC
		Majidae	*Majidae* spp.	Samouelle, 1819	8	M	PSC
		Palaemonidae	*Palaemonetes intermedius*	Holthuis, 1949	2	H	RB
		Palinuridae	*Palinuridae* spp.	Latreille, 1802	8	M	PSC
		Parapaguridae	*Parapaguridae* spp.	Smith, 1882	8	M	PSC
		Pasiphaeidae	*Pasiphaeidae* spp.	Dana, 1852	8	H	PSC
		Porcellanidae	*Porcellanidae* spp.	Haworth, 1825	8	M	PSC
		Raninidae	*Raninidae* spp.	De Haan, 1839	8	M	PSC
		Sergestidae	*Acetes americanus*	Ortmann, 1893	2	H	RB
			Sergestidae spp.	Dana, 1852	5, 6, 8	H	ARC, CS, PSC

C	O	F	S				
Malacostraca	Euphausiacea	Bentheuphausiidae	*Bentheuphausia* sp.	G.O. Sars, 1885	2	H	RB
		Euphausiidae	*Euphausia* sp.	Dana, 1850	2	H	C, RB
			Euphausiidae spp.	Dana, 1852	5, 6, 8	H	BN, PSC
			Nematoscelis sp.	G.O. Sars, 1883	2	H	RB
	Isopoda	Cirolanidae	*Cirolana* sp.	Leach, 1818	2	H	RB
			Eurydice littoralis	(Moore, 1901)	2	H	RB
		Isopoda incertae sedis	*Bagatus* sp.	Richardson, 1902	2	H	RB
		Munnidae	*Munnidae* spp.	Sars, 1897	8	H	PSC
	Mysida	Mysidae	*Bowmaniella* sp.	Ortmann, 1893	2	H	RB
			Mysidae spp.	Haworth, 1825	5, 8	H	ARC, CS, PSC
			Siriella chierchiae	Coifmann, 1937	2	H	RB
			Siriella sp.	Dana, 1850	2	H	RB
Ostracoda	Halocyprida	Halocyprididae	*Halocyprididae* spp.	Dana, 1853	5, 6	H	ARC, CS
	Myodocopida	Cypridinidae	*Cypridinidae* spp.	Baird, 1850	8	H	PSC
	Calanoida	Acartiidae	*Acartia (Acanthacartia) tonsa*	Dana, 1849	8, 9	H	PSC
			Acartia lilljeborgii	Giesbrecht, 1889	10	H	PSC
			Acartiidae spp.	Sars G.O., 1903	5, 6	H	ARC, IR
		Aetideidae	*Aetideidae* spp.	Giesbrecht, 1892	5	H	ARC
			Aetideus acutus	Farran, 1929	10	H	PSC
			Aetideus armatus	(Boeck, 1872)	2	H	RB
			Euchirella rostrata	(Claus, 1866)	2	H	RB
			Gaetanus kruppii	Giesbrecht, 1903	2	H	RB
		Arietellidae	*Arietellidae* spp.	Sars G.O., 1902	5	H	ARC
		Augaptilidae	*Augaptilidae* spp.	Sars G.O., 1905	5, 6	H	ARC
		Calanidae	*Calanidae* spp.	Dana, 1849	5, 6	H	ARC, IR
			Calanus tenuicornis	(Dana, 1849)	2	H	RB
			Nannocalanus minor	(Claus, 1863)	2, 10	H	PSC
			Neocalanus gracilis	(Dana, 1852)	2	H	RB
			Undinula vulgaris	(Dana, 1849)	2, 8, 9	H	PSC
		Candaciidae	*Candacia pachydactyla*	(Dana, 1849)	2, 8, 9	H	PSC
			Candaciidae spp.	Giesbrecht, 1893	5, 6	H	ARC, IR
		Centropagidae	*Centropages bradyi*	Wheeler, 1900	8, 9	H	PSC
			Centropagidae spp.	Giesbrecht, 1893	5, 6	H	ARC, CS
		Clausocalanidae	*Clausocalanidae* spp.	Giesbrecht, 1893	5, 6	H	ARC, IR
			Clausocalanus arcuicornis	(Dana, 1849)	8, 9	H	PSC
			Clausocalanus furcatus	(Brady, 1883)	8, 9	H	PSC
		Epacteriscidae	*Epacteriscidae* spp.	Fosshagen,1973	5	H	ARC, IR
		Eucalanidae	*Eucalanidae* spp.	Giesbrecht, 1893	5, 6	H	ARC, IR
			Eucalanus attenuatus	(Dana, 1849)	2	H	RB
			Eucalanus sp.	Dana, 1852	2, 10	H	PSC
			Pareucalanus sewelli	(Fleminger, 1973)	8, 9	H	PSC
		Euchaetidae	*Euchaeta barbata*	(Brady, 1883)	2	H	RB
			Euchaeta marina	(Prestandrea, 1833)	8, 9	H	PSC
			Euchaeta sp.	Philippi, 1843	10	H	PSC
			Euchaeta tonsa	(Giesbrecht, 1895)	2	H	RB
			Euchaetidae spp.	Giesbrecht, 1893	5, 6	H	ARC, IR
		Heterorhabdidae	*Heterorhabdidae* spp.	Sars G.O., 1902	5	H	ARC, BN
		Lucicutiidae	*Lucicutia flavicornis*	(Claus, 1863)	8, 9	H	PSC
			Lucicutiidae spp.	Sars G.O., 1902	6	H	ARC
		Metridinidae	*Pleuromamma quadrungulata*	(Dahl F., 1893)	2	H	RB
		Nullosetigeridae	*Nullosetigeridae* spp.	Soh, Ohtsuka, Imabayashi y Suh, 1999	6	H	ARC
		Paracalanidae	*Acrocalanus longicornis*	Giesbrecht, 1888	8, 9, 10	H	PSC
			Calocalanus contractus	Farran, 1926	8, 9	H	PSC
			Calocalanus pavo	(Dana, 1852)	8, 9, 10	H	PSC
			Paracalanidae spp.	Giesbrecht, 1893	5, 6	H	ARC, IR
			Paracalanus aculeatus	Giesbrecht, 1888	2	H	RB
			Paracalanus quasimodo	Bowman, 1971	8, 9	H	PSC
		Phaennidae	*Xanthocalanus marlyae*	Campaner, 1978	10	H	PSC
			Labidocera acutifrons	(Dana, 1849)	2, 8, 9	H	PSC
			Labidocera aestiva	Wheeler, 1900	2	H	RB
			Labidocera nerii	(Krøyer, 1849)	2	H	RB
			Labidocera scotti	Giesbrecht, 1897	10	H	PSC
			Pontella atlantica	(Milne Edwards, 1840)	2	H	IR, IN, ARC, N, C
			Pontella mimocerami	Fleminger, 1957	2	H	RB
			Pontella securifer	Brady, 1883	8, 9	H	PSC

O	F	S				
Calanoida	Pontellidae	*Pontella spinipes*	Giesbrecht, 1889	2	H	RB
		Pontellidae spp.	Dana, 1853	5	H	ARC, BA
		Pontellina plumata	(Dana, 1849)	2, 8, 9	H	PSC
		Pontellopsis sp.	Brady, 1883	10	H	PSC
	Pseudodiaptomidae	*Pseudodiaptomus acutus*	Dahl F., 1894	10	H	PSC
	Rhincalanidae	*Rhincalanidae* spp.	Geletin, 1976	5, 6	H	BN
		Rhincalanus cornutus	(Dana, 1849)	8, 9	H	PSC
	Scolecitrichidae	*Scolecithrix danae*	(Lubbock, 1856)	2	H	RB
	Spinocalanidae	*Monacilla typica*	Sars G.O., 1905	2	H	RB
		Spinocalanidae spp.	Vervoort, 1951	5	H	BA
		Subeucalanus mucronatus	(Giesbrecht, 1888)	8, 9	H	PSC
	Temoridae	*Temora stylifera*	(Dana, 1849)	2, 8, 9, 10	H	PSC
		Temora turbinata	Dana, 1849	10	H	PSC
		Temoridae spp.	Giesbrecht, 1893	5, 6	H	ARC, IR
		Tortanidae spp.	Sars G.O., 1902	5	H	ARC, CS
Cyclopoida	Cyclopoida incertae sedis	*Pachos punctatum*	(Claus, 1863)	2	H	RB
	Oithonidae	*Oithona setigera*	Dana, 1849	10	H	PSC
		Oithona sp.	Baird, 1843	8, 9	H	PSC
		Oithonidae spp.	Dana, 1853	5, 6	H	ARC, IR
Harpacticoida	Dactylopusiidae	*Dactylopusia tisboides*	(Claus, 1863)	2	H	RB
	Ectinosomatidae	*Microsetella rosea*	(Dana, 1847)	2	H	RB
	Euterpinidae	*Euterpina acutifrons*	Dana, 1847	10	H	PSC
		Euterpina sp.	Norman, 1903	8, 9	H	PSC
		Euterpinidae spp.	Brian, 1921	6	H	ARC
	Miraciidae	*Distioculus minor*	(Scott T., 1894)	8, 9	H	PSC
		Macrosetella gracilis	(Dana, 1847)	8, 9, 10	H	PSC
		Miracia efferata	Dana, 1849	10	H	PSC
		Miraciidae spp.	Dana, 1846	5, 6	H	ARC, IR
	Peltidiidae	*Clytemnestra scutellata*	Dana, 1847	8, 9	H	PSC
		Clytemnestra sp.	Dana, 1847	10	H	PSC
		Peltidiidae spp.	Claus, 1860	6	H	ARC
	Clytemnestridae	*Clytemnestridae* spp.	Scott, 1909	5	H	ARC, CS
Poecilostomatoida	Clausidiidae	*Saphirella* sp.	Embleton, 1901	8, 9	H	PSC
	Corycaeidae	*Corycaeidae* spp.	Dana, 1852	5, 6	H	ARC, IR
		Corycaeus clausi	Dahl F., 1894	10	H	PSC
		Corycaeus flaccus	(Giesbrecht, 1891)	2	H	RB
		Corycaeus latus	(Dana, 1849)	2	H	RB
		Corycaeus speciosus	Dana, 1849	2, 8, 9	H	RB
		Corycaeus speciosus	Dana, 1849	10	H	PSC
		Farranula gracilis	(Dana, 1849)	8, 9	H	PSC
		Onychocorycaeus latus	(Dana, 1849)	8, 9	H	PSC
		Urocorycaeus lautus	(Dana, 1849)	8, 9	H	PSC
	Lubbockiidae	*Lubbockia* sp.	Claus, 1863	8, 9	H	PSC
	Oncaeidae	*Oncaea mediterranea*	(Claus, 1863)	8, 9	H	PSC
		Oncaea sp.	Philippi, 1843	2, 10	H	PSC
		Oncaea venusta	Philippi, 1843	8, 9	H	PSC
		Oncaeidae spp.	Giesbrecht, 1893	5, 6	H	ARC, IR
	Sapphirinidae	*Copilia mirabilis*	Dana, 1852	8, 9, 10	H	PSC
		Copilia quadrata	Dana, 1849	2, 8, 9	H	RB
		Copilia vitrea	(Haeckel, 1864)	2	H	RB
		Sapphirina angusta	Dana, 1849	2	H	RB
		Sapphirina auronitens	Claus, 1863	10	H	PSC
		Sapphirina nigromaculata	Claus, 1863	2	H	RB
		Sapphirina ovatolanceolata	Dana, 1849	2	H	RB
		Sapphirina sp.	Thompson J., 1829	8, 9	H	PSC
		Sapphirina stellata	Giesbrecht, 1891	2	H	RB
		Sapphirinidae spp.	Thorell, 1859	5, 6	H	ARC, IR
Siphonostomatoida	Caligidae	*Caligidae* spp.	Burmeister, 1835	8, 9	H	PSC
		Caligus sp.	O.F. Müller, 1785	2	H	RB

Interactive table

Zooplankton

Phylum Chaetognatha

C	O	F	S				
Sagittoidea	Aphragmophora	Krohnittidae	*Krohnitta mutabbii*	(Aida, 1897)	12	H	RB
			Krohnitta subtilis	(Grassi, 1881)	2, 12	H	RB
			Krohnittidae spp.	Tokioka, 1965	5, 6	H	ARC, IR
		Pterosagittidae	*Pterosagitta draco*	(Krohn, 1853)	2, 12	H	RB
		Sagittidae	*Sagitta bipunctata*	Quoy y Gaimard, 1828	12	H	RB
			Sagitta enflata	(Grassi, 1881)	2, 12	H	RB
			Sagitta friderici	(Ritter-Záhony, 1911)	2	H	ARC, C, S
			Sagitta hexaptera	(d'Orbigny, 1836)	12	H	PSC
			Sagitta serratodentata	(Krohn, 1853)	12	H	RB
			Sagitta sp.	Quoy y Gaimard, 1827	8	H	PSC
			Sagitta tenuis	(Conant, 1896)	12	H	RB
			Sagitta zetezios	(Fowler, 1905)	2	H	RB
			Sagittidae spp.	Claus y Grobben, 1905	5, 6	H	ARC, IR
	Phragmophora	Eukrohniidae	*Eukrohnia fowleri*	Ritter-Záhony, 1909	2	H	RB
			Eukrohniidae spp.	Tokioka, 1965	5	H	ARC, IR

Phylum Chordata

C	O	F	S				
Appendicularia	Copelata	Fritillariidae	*Fritillariidae* spp.	Lohmann, 1915	5, 6	H	ARC, BN
		Oikopleuridae	*Oikopleura albicans*	(Leuckart, 1853)	2	H	RB
			Oikopleura parva	Lohmann, 1896	2	H	RB
			Oikopleura sp.	Mertens, 1830	2	H	ARC, RB
			Oikopleuridae spp.	Lohmann, 1915	5, 6, 8	H	ARC, IR, PSC
Leptocardii		Branchiostomatidae	*Branchiostomatidae* spp.	Bonaparte, 1846	6	H	ARC
Thaliacea	Doliolida	Doliolidae	*Doliolum muelleri*	(Krohn, 1852)	2	H	RB
	Salpida	Salpidae	*Salpa fusiformis*	Cuvier, 1804	2	H	RB
			Salpidae spp.	Lahille, 1888	5, 6, 8	H	ARC, IR, PSC
			Thalia democratica	(Forskål, 1775)	2	H	RB

Phylum Cnidaria

C	O	F	S				
Hydrozoa	Anthoathecata	Moerisiidae	*Moerisia boulenger*	Paltschikowa-Osroumowa, 1925	2	H	RB
		Rathkeidae	*Rathkea* sp.	Brandt, 1837	2	H	RB
	Leptothecata	Campanulariidae	*Clytia discoida*	(Mayer, 1900)	2	H	RB
			Clytia hemisphaerica	(Linnaeus, 1767)	2	H	RB
		Mitrocomidae	*Mitrocomella* sp.	Haeckel, 1879	2	H	RB
	Limnomedusae	Olindiidae	*Craspedacusta* sp.	Lankester, 1880	2	H	RB
	Narcomedusae	Aeginidae	*Aeginidae* spp.	Gegenbaur, 1857	6	H	ARC
		Cuninidae	*Cunina* sp.	Eschscholtz, 1829	2	H	RB
	Siphonophorae	Abylidae	*Abylidae* spp.	L. Agassiz, 1862	6	H	ARC
			Abylopsis sp.	Chun, 1888	8	H	PSC
			Abylopsis tetragona	(Otto, 1823)	2	H	RB
			Bassia bassensis	(Quoy y Gaimard, 1833)	2	H	RB
			Enneagonum hyalinum	Quoy y Gaimard, 1827	2	H	RB
		Diphyidae	*Chelophyes appendiculata*	(Eschscholtz, 1829)	2	H	RB
			Diphyes bojani	(Eschscholtz, 1825)	8	H	PSC
			Diphyes dispar	Chamisso y Eysenhardt, 1821	2	H	RB
			Diphyidae spp.	Quoy y Gaimard, 1827	6	H	ARC
			Lensia conoidea	(Keferstein y Ehlers, 1860)	2	H	RB
			Muggiaea atlantica	Cunningham, 1892	2	H	RB
			Muggiaea kochii	(Will, 1844)	2	H	RB
		Hippopodiidae	*Vogtia* sp.	Kölliker, 1853	2	H	PSC
	Trachymedusae	Geryoniidae	*Liriope tetraphylla*	(Chamisso y Eysenhardt, 1821)	2	H	RB
		Rhopalonematidae	*Aglaura hemistoma*	Péron y Lesueur, 1810	2	M	RB

Phylum Ctenophora

C	O	F	S				
Tentaculata	Cydippida	Pleurobrachiidae	*Pleurobrachiidae spp.*	Chun, 1880	6	H	ARC
	Lobata	Bolinopsidae	*Bolinopsis vitrea*	L. Agassiz, 1860	1	H	PSC
		Ocyropsidae	*Ocyropsis maculata*	Rang, 1828	11	H	SA

Phylum Mollusca

C	O	F	S				
Cephalopoda	Oegopsida	Ommastrephidae	*Ommastrephidae* spp.	Steenstrup, 1857	6	H	RB
Gastropoda	[unassigned]	Cerithiopsidae	*Cerithiopsis* sp.	Forbes y Hanley, 1850	2	H	RB
	Caenogastropoda	Litiopidae	*Litiopa melanostoma*	Rang, 1829	2	H	RB
	Gymnosomata	Clionidae	*Paraclione longicaudata*	(Souleyet, 1852)	2	H	RB
	Littorinimorpha	Assimineidae	*Assiminea* sp.	Fleming, 1828	2	H	RB
		Atlantidae	*Atlanta gaudichaudi*	J.E. Gray, 1850	2	H	RB
			Atlanta inclinata	J.E. Gray, 1850	2	H	RB
			Atlanta lesueurii	J.E. Gray, 1850	2	H	RB
			Atlanta peresi	Frontier, 1966	2	H	RB
			Atlanta quoyana	J.E. Gray, 1850	2	H	IN, N, C, S
			Oxygyrus keraudrenii	Lesueur, 1817	2	M	RB
		Calyptraeidae	*Trochilla* sp.	Schumacher, 1817	2	H	RB
		Rissoidae	*Benthonella* sp.	Dall, 1889	2	H	RB
	Thecosomata	Cavoliniidae	*Cavolinia longirostris*	(Blainville, 1821)	2	H	RB
			Cavoliniidae spp.	Gray, 1850 (1815)	5, 6	H	ARC, IR
			Diacria trispinosa	(Blainville, 1821)	2	H	RB
		Creseidae	*Creseidae* spp.	Rampal, 1973	6	H	ARC
			Creseis acicula	(Rang, 1828)	2	H	RB
			Creseis conica	Eschscholtz, 1829	2	H	RB
		Cuvierinidae	*Cuvierina columnella*	(Rang, 1827)	2	H	RB
		Limacinidae	*Limacina helicina*	(Phipps, 1774)	2	H	RB
			Limacina inflata	(d'Orbigny, 1834)	2	H	RB
			Limacina lesueurii	(d'Orbigny, 1835)	2	H	RB
			Limacina retroversa	(Fleming, 1823)	2	H	IN, IS, N, C, RB
			Limacina sp.	Bosc, 1817	8	H	PSC
			Limacina trochiformis	(d'Orbigny, 1834)	2	H	RB
			Limacinidae spp.	Gray, 1840	5, 6	H	RB
		Turbinidae	*Astraea phoebia*	(Röding, 1798)	2	H	RB

Phylum Foraminifera

C	O	F	S				
Globothalamea	Rotaliida	Globigerinidae	*Globigerinella adamsi*	(Banner y Blow, 1959)	2	H	RB
			Globigerinidae spp.	Carpenter et al., 1862	6	H	ARC
			Globigerinoides ruber	(d'Orbigny, 1839)	2, 8	H	PSC
			Globigerinoides sacculifer	(Brady, 1877)	2	H	RB
			Orbulina universa	d'Orbigny, 1839	2	H	RB

Interactive table

Ichthyoplankton

This assemblage consists of eggs, larvae, post-larvae of fish and, in some cases, juvenile fish, which are part of the planktonic community until they reach sufficient size and are no longer passive drifters and begin to move independently, becoming pelagic or demersal organisms. This stage of life is very important for the study of fish in any region since it allows to complete the natural history (Richards, 2006) and to define information on the composition, diversity and productive potential of an area (Navarro Rodríguez et al., 2006). It also constitutes an important factor in elucidating the phylogenetic relationships and taxonomy of fish. In addition, it allows identifying physiological, ethological and biological problems in the critical stages of development of fish (Fagetti, 1975).

Fish larvae exhibit a great diversity and they are identified taking into account the shape of their body, their spines, their pigmentation, their size, the number and position of melanophores, the position and size of fins and rays, the myomere and vertebra counts, among others, because larval stages have very different morphological characteristics compared to adult fish **(Matsuura y Olivar, 1999).**

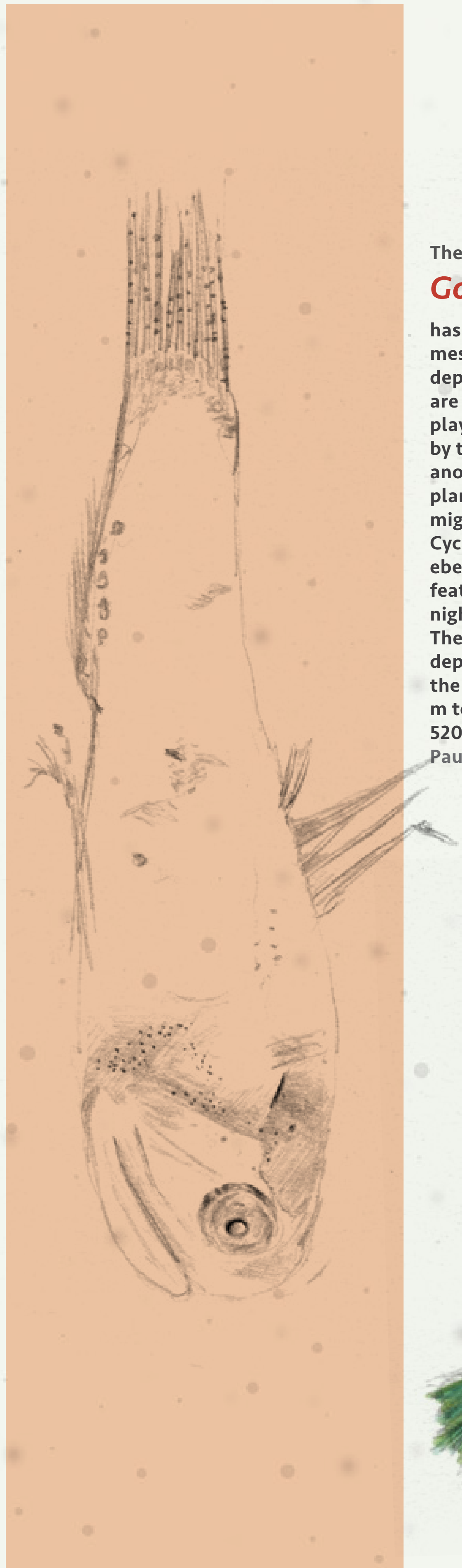
For the archipelago were found

169
morphotypes

For the archipelago, 169 morphotypes belonging to 74 families were found, having identified 84 species so far. When contrasting this with the information obtained for adult fish, where 143 families and 731 species have been recorded, it can be observed that there are still gaps in information on ichthyoplankton, since only 12% of the species match up. In turn, deep-water species have mainly been found, so, for studies of adult fish, there is no doubt that the taxonomic inventory may continue to increase.

The families **Bregmacerotidae and Gonostomatidae**
ccomprise the group of the most important deep-water fish larvae due to their abyssal habits in ocean waters with a wide distribution both in tropical and in subtropical areas. The family Bregmacerotidae is among the ten most common and abundant families in organisms collected in samples of ichthyoplankton **(Houde y Schekter, 1978)**, the species Bregmaceros atlanticus being the most common and abundant in the Caribbean. This species is a first-order carnivore and feeds mainly on copepods and cladocerans **(Zavala García y Flores Coto, 1994).** Its spawning season has not been described, but it might take place throughout the year and it reaches sexual maturity few days after hatching **(Fahay, 2007).** It can be found at depths of around 300 m and its ecological role in the marine environment is very important since it is considered a link in the food web and energy flow due to its extensive vertical migrations **(Zabala García y Flores Coto, 1994).**

In plankton, there are species in many colors; those living near the surface are bluish or transparent, others are reddish or have a metallic color, even many emit luminescence.

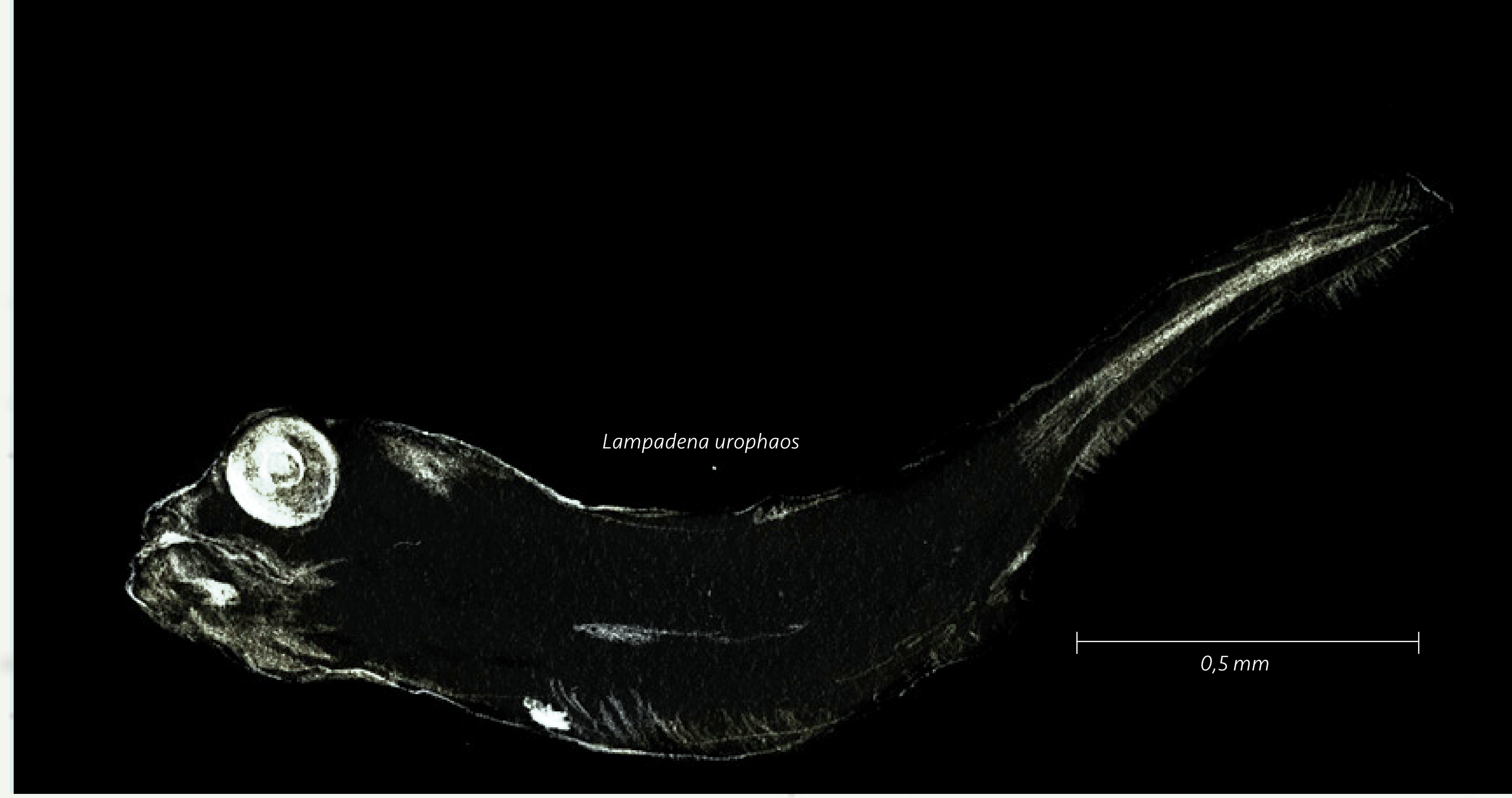


The family
Gonostomatidae

has a wide geographical distribution with meso- and bathypelagic habits, occupying depths of up to 2,000 m. Although they are not commercially important, they do play an important role in the food web, by transferring energy from one level to another (Beltrán & Ríos, 2000). It has a plantonik diet with possible diurnal vertical migrations. In the archipelago, the species Cyclothone acclinidens and Gonostoma ebelingi were recorded. One of the main features of this family is that it feeds at night, mainly on copepods (Fahay, 2007). The species C. acclinidens is found at depths of between 300 m and 1,200 m; and the species G. ebelingi goes up around 125 m to 300 m at night and descends between 520 m and 700 m during the day (Froese y Pauly, 2015).

A family that was particularly special was found, and despite being very abundant and dominant in the adult stage, it is rare to find it in its larval stage in the archipelago. This is the family Labridae; only one genus for larvae was recorded, while, for adults, 31 species were found. This occurs probably due to the type of trawling that is traditionally performed to capture icthyoplankton, which does not allow capturing larvae in areas of high complexity, and due to the depth and spatial heterogeneity of reef systems, seagrass beds and mangrove swamps **(Riley & Holt, 1993; Rooker *et al.*, 1996; Hickford y Schiel, 1999; Fisher & Bellwood, 2002; Sponaugle *et al.*, 2003).**

Gonostoma ebelingi



Lampadena urophaos

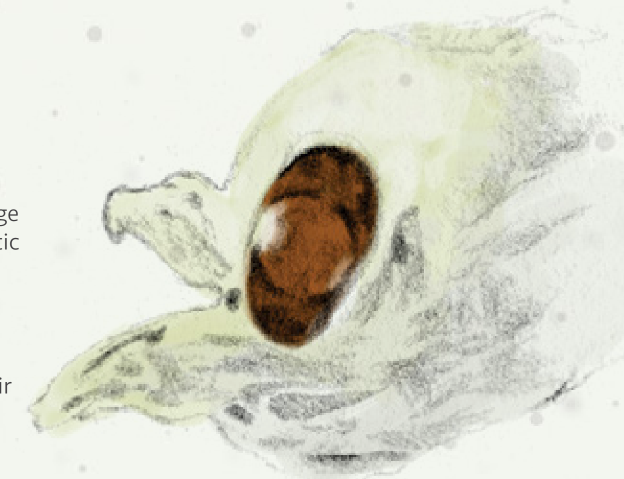
These ecosystems are typical in the Seaflower Biosphere Reserve, mainly made up of coral reefs, cays, mangrove swamps and seagrass. However, the sampling techniques used in the various studies conducted did not allow evaluating these areas, so some species of certain families do not appear in this study, such as the case of the family Labridae. Therefore and despite its low density, it is important to highlight certain features of this family; for instance, it is the largest and most diverse family, with around 500 species in 60 genera. It also has a very particular feature: all its specimens are born as females, but as they grow, they gradually turn into males (Bussing, 1983). Wrasses have a long planktonic larval life and some species spawn in small groups on the surface (Landaeta & Castro, 2004).

The family
Myctophidae

was the family with the largest number of species recorded, which is common because myctophid larvae constitute a high percentage when collecting samples of oceanic and neritic ichthyoplankton. The species *Diogenichthys atlanticus*, *Lampadena luminosa*, *Lampadena uraphaos*, *Diaphus metopoclampus* y *Hygophum hygomii.* stand out. This family also comprises deep-water larvae due to their location in the water column ranging from 100 m to 300 m; however, thanks to their diurnal migrations, it is common to obtain a maximum abundance at depths between 300 m and 1,200 m during the day and between 10 m and 100 m at night **(Froese y Pauly, 2015).** From the point of view of ontogeny, the family Myctophidae is the most varied of the Teleostei since no larvae of any other group of fish have experienced such diverse evolutionary ways like these have.

Myctophid larvae exhibit different body shapes and sizes of mouth, intestinal tracts with different lengths, a great diversity and patterns in melanophores, as well as variations in the length and shape of their dorsal and pectoral fins **(Moser, 1984)**. In terms of their reproductive life, myctophids are characterized by early sexual maturity with short periods of spawning **(Childress *et al.*, 1980; Gjfsaeter & Kawaguchi, 1980).**

Fish larvae have very different taxonomic characteristics compared to adult species and, in some cases, these changes are strongly marked, as in the case of Pleuronectiformes, consisting mainly of the families Cynoglossidae, Bothidae, Achiridae and Paralichthyidae, which have a complex metamorphosis that involves changes in the skull bones, nerves, blood vessels and muscles. Since they are pelagic larvae, they are bilaterally symmetrical and swim vertically, but, at the end of their early development, they turn into asymmetrical juvenile fish swimming on one side. The most visible changes are the migration of one eye through the skull and different pigmentation patterns between the sides of the body **(Beltrán y Ríos, 2000).**



Hygophum hygomii

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Ichthyoplankton

Phylum Chordata

F	S			
Acanthuridae	*Acanthurus* sp.	Forsskål, 1775	15	PSC, C
Achiridae	*Trinectes maculatus*	(Bloch y Schneider, 1801)	7	ARC
Antennariidae	*Antennariidae* spp.	Jarocki, 1822	15	PSC, C
	Histrio histrio	(Linnaeus, 1758)	3, 7	ARC, S
Apogonidae	*Apogonidae* spp.	Günther, 1859	15	PSC, C
Astronesthidae	*Astronesthidae* spp.	Günther, 1864	15	IN, N, BS
Atherinidae	*Atherinidae* spp.	Risso, 1827	13	ARC, BR
	Craterocephalus sp.	McCulloch, 1912	7	RB
Aulopidae	*Aulopidae* spp.	Bonaparte, 1831	6	ARC
Balistidae	*Balistes capriscus*	Gmelin, 1789	7	IR, N
	Balistes vetula	Linnaeus, 1758	3, 7	N, S
	Canthidermis maculata	(Bloch, 1786)	15	IN, N, BS
Belonidae	*Platybelone argulus*	(Lesueur, 1821)	7	RB
	Tylosurus acus	(Lacepède, 1803)	3, 7	IR, RB
Blenniidae	*Hypsoblennius* sp.	Gill, 1861	3	RB
Bothidae	*Bothidae* spp.	Smitt, 1892	13	BN
	Bothus ocellatus	(Agassiz, 1831)	3, 7	ARC, IR
Bramidae	*Taractichthys longipinnis*	(Lowe, 1843)	7	BA
Bregmacerotidae	*Bregmaceros atlanticus*	Goode y Bean, 1886	15	N
	Bregmaceros sp.	Thompson, 1840	15	PSC, C
	Bregmacerotidae spp.	Gill, 1872	6	ARC
Callionymidae	*Diplogrammus* sp.	Gill, 1865	15	N
Carangidae	*Alectis ciliaris*	(Bloch, 1787)	3	IS, S
	Carangidae spp.	Rafinesque, 1815	6	ARC
	Caranx bartholomaei	Cuvier, 1833	3, 7	RB
	Caranx crysos	(Mitchill, 1815)	3, 7	RB
	Caranx sp.	Lacepède, 1801	6, 7	ARC, S
	Chloroscombrus chrysurus	(Linnaeus, 1766)	7	RB
	Decapterus punctatus	(Cuvier, 1829)	7	IN, N, BR
	Elagatis bipinnulata	(Quoy y Gaimard, 1825)	3	RB
	Seriola rivoliana	Valenciennes, 1833	7	N, S
	Seriola sp.	Cuvier, 1816	15	PSC, C
Ceratiidae	*Ceratiidae* spp.	Gill, 1861	15	IN, N, BS
Chaetodontidae	*Chaetodon* sp.	Linnaeus, 1758	7	BA
Clupeidae	*Alosa* sp.	Linck, 1790	7	RB
	Brevoortia sp.	Gill, 1861	7	RB
Congridae	*Ariosoma* sp.	Swainson, 1838	15	IN, N, BS
Coryphaenidae	*Coryphaena equiselis*	Linnaeus, 1758	3, 7	IR, N, S
	Coryphaena hippurus	Linnaeus, 1758	7, 15	RB
	Coryphaena sp.	Linnaeus, 1758	15	PSC, C
Cynoglossidae	*Symphurus plagiusa*	(Linnaeus, 1766)	3, 7	ARC, RB
	Symphurus sp.	Rafinesque, 1810	15	IN, N, BS
Dactylopteridae	*Dactylopterus volitans*	(Linnaeus, 1758)	3, 7	ARC, IR
Diodontidae	*Diodon histrix*	(Linnaeus, 1758)	7	ARC
	Diodontidae spp.	Bonaparte, 1835	13	ARC
Echeneidae	*Remora* sp.	Gill, 1862	7	BA
Exocoetidae	*Cheilopogon cyanopterus*	(Valenciennes, 1847)	7	RB
	Cheilopogon heterurus	(Rafinesque, 1810)	3, 7	RB
	Cheilopogon melanurus	(Valenciennes, 1847)	7	RB
	Cheilopogon sp.	Lowe, 1841	3, 7	RB
	Exocoetidae spp.	Risso, 1827	13	ARC, BN
	Exocoetus sp.	Linnaeus, 1758	15	IN, N, BS
	Exocoetus volitans	Linnaeus, 1758	3, 7	IN, N, RB
	Hirundichthys affinis	(Günther, 1866)	3, 7	IR, RB
	Hirundichthys rondeletii	(Valenciennes, 1847)	7	RB
	Parexocoetus brachypterus	(Richardson, 1846)	3, 7	IR, RB, RB

F	S			
Exocoetidae	*Parexocoetus* sp.	Bleeker, 1865	7	RB
	Prognichthys gibbifrons	(Valenciennes, 1847)	7	RB
Gempylidae	*Diplospinus multistriatus*	Maul, 1948	7	BA
	Gempylidae spp.	Gill, 1862	6, 15	C, ARC
	Gempylus serpens	Cuvier, 1829	3, 7, 15	RB
	Nesiarchus nasutus	Johnson, 1862	15	IN, N, BS
Gerreidae	*Gerreidae* spp.	Bleeker, 1859	15	IN, N, BQ
Gobiesocidae	*Gobiesox* sp.	Lacepède, 1800	15	PSC, C
Gobiidae	*Gobiidae* spp.	Cuvier, 1816	15	C, BQ, BR, N
Gonostomatidae	*Cyclothone acclinidens*	Garman, 1899	6	ARC
	Cyclothone sp.	Goode y Bean, 1883	15	IN, N, BS, BR
	Diplophos sp.	Günther, 1873	7	RB
	Gonostoma ebelingi	Grey, 1960	6	ARC
	Gonostomatidae spp.	Cocco, 1838	6	ARC
Haemulidae	*Emmelichthyops atlanticus*	Schultz, 1945	3, 7	BA, RB
Hemiramphidae	*Hemiramphus brasiliensis*	(Linnaeus, 1758)	3, 7	RB
	Oxyporhamphus sp.	Gill, 1864	7	RB
Holocentridae	*Sargocentron vexillarium*	(Poey, 1860)	3, 7	RB
Howellidae	*Howella* sp.	Ogilby, 1899	15	IN, N
Istiophoridae	*Istiophoridae* spp	Rafinesque, 1815	15	IN, N, BQ
	Istiophorus platypterus	(Shaw, 1792)	7	RB
	Makaira nigricans	Lacepède, 1802	3, 7	RB
Kyphosidae	*Kyphosus incisor*	(Cuvier, 1831)	7	IN, N, BS
Labridae	*Halichoeres* sp.	Rüppell, 1835	7, 15	BA, BR, C, N
Labrisomidae	*Labrisomidae* spp	Clark Hubbs, 1952	15	IN, N, C, BQ
Lobotidae	*Lobotes surinamensis*	(Bloch, 1790)	3	IN, N
Lophiidae	*Lophius americanus*	Valenciennes, 1837	7	ARC
Lutjanidae	*Lutjanus* sp.	Bloch, 1790	7	BA
	Lutjanus synagris	(Linnaeus, 1758)	7	IR
Malacanthidae	*Caulolatilus* sp.	Gill, 1862	7	RB
Melamphaidae	*Melamphaes* sp.	Günther, 1864	15	IN, N, C, BR
Melanocetidae	*Melanocetus* sp.	Günther, 1864	15	IN, N, BS
Monacanthidae	*Monacanthus ciliatus*	(Mitchill, 1818)	7	ARC
	Stephanolepis setifer	(Bennett, 1831)	3, 7	ARC, SA, IS, S
	Stephanolepis sp.	Gill, 1861	15	IN, N, BQ
Mugilidae	*Agonostomus monticola*	(Bancroft, 1834)	7	BA
	Mugil curema	Valenciennes, 1836	3, 7	RB
	Mugil sp.	Linnaeus, 1758	15	IN, N, BQ
Mullidae	*Mullus auratus*	Jordan y Gilbert, 1882	7	BS, BR, CA, CS, N, S
	Upeneus parvus	Poey, 1852	7	BA
Myctophidae	*Centrobranchus nigroocellatus*	(Günther, 1873)	3, 7	IN, N, RB
	Ceratoscopelus sp.	Günther, 1864	15	IN, N, BQ, BS
	Diaphus metopoclampus	(Cocco, 1829)	15	IN, N, BS
	Diaphus sp.	Eigenmann y Eigenmann, 1890	6, 15	ARC, IN, C
	Diogenichthys atlanticus	(Tåning, 1928)	6	ARC
	Hygophum hygomii	(Lütken, 1892)	15	IN, N, BQ
	Hygophum sp.	Bolin, 1939	6	ARC
	Lampadena luminosa	(Garman, 1899)	15	IN, N, BQ, BS
	Lampadena sp.	Goode y Bean, 1893	15	IN,C
	Lampadena uraphaos	Paxton, 1963	15	IN, N, BQ, BS
	Lampanyctus sp	Bonaparte, 1840	6, 15	ARC, C, BQ, BR, N
	Myctophidae spp	(Gill, 1893)	6, 15	ARC, BS, N, C
	Myctophum asperum	Richardson, 1845	7	RB
	Myctophum nitidulum	Garman, 1899	6, 7	RB, ARC
	Myctophum obtusirostre	Tåning, 1928	6, 7	ARC, RB
	Myctophum sp.	Rafinesque, 1810	3, 6, 15	RB

Interactive table

Ichthyoplankton

Phylum Chordata

F	S			
Nomeidae	*Psenes sp.*	Valenciennes, 1833	15	IN, N, C, BR
Oneirodidae	*Oneirodidae spp.*	Gill, 1878	15	IN, N, BS
Ophichthidae	*Ahlia egmontis*	(Jordan, 1884)	3, 7	IN, N, RB
	Myrichthys ocellatus	(Lesueur, 1825)	7	RB
	Myrophis punctatus	Lütken, 1852	3, 7	IN, N, RB
Ophidiidae	*Lepophidium sp.*	Gill, 1895	6	ARC
	Ophidiidae spp.	Rafinesque, 1810	6	ARC
Paralepididae	*Lestidiops affinis*	(Ege 1930)	6	ARC
	Lestidiops sp.	Hubbs, 1916	15	IN, N, BQ
Paralichthyidae	*Citharichthys sp.*	Bleeker, 1862	15	PSC, C
	Syacium papillosum	(Linnaeus, 1758)	7	ARC
	Syacium sp.	Ranzani, 1842	15	PSC, C
Phosichthyidae	*Phosichthyidae spp.*	Weitzman, 1974	6	ARC
	Pollichthys mauli	(Poll, 1953)	6	ARC
	Vinciguerria sp.	Jordan y Evermann, 1896	6	ARC
Polynemidae	*Polydactylus virginicus*	(Linnaeus, 1758)	3, 7	RB
Pomacentridae	*Abudefduf saxatilis*	(Linnaeus, 1758)	3, 7	RB
	Stegastes partitus	(Poey, 1868)	7	BA
Pomatomidae	*Pomatomus saltatrix*	(Linnaeus, 1766)	7	RB
Priacanthidae	*Priacanthidae spp.*	Günther, 1859	15	IN, N, BQ, BS
	Pristigenys alta	(Gill, 1862)	7	RB
Sciaenidae	*Menticirrhus sp.*	Gill, 1861	6	ARC
Scombridae	*Euthynnus alletteratus*	(Rafinesque, 1810)	7	RB
	Katsuwonus pelamis	(Linnaeus, 1758)	3	IR
	Scomberomorus sp.	Lacepède, 1801	6, 7	ARC, BA
	Scombridae spp.	Rafinesque, 1815	6, 13, 15	ARC, BQ, N, C
	Thunnus albacares	(Bonnaterre, 1788)	6	ARC
	Thunnus obesus	(Lowe 1839)	15	IN, N, BR
	Thunnus sp.	South, 1845	7, 15	IN, N, BQ, BA
Scorpaenidaet	*Pontinus sp.*	Poey, 1860	15	IN, N, BS
	Scorpaenodes caribbaeus	Meek y Hildebrand, 1928	7	ARC
Sebastidae	*Helicolenus dactylopterus*	(Delaroche, 1809)	7	ARC
Serranidae	*Mycteroperca sp.*	Gill, 1862	7	RB
	Serranidae spp.	Swainson, 1839	15	IN, N, BR
	Serranus sp.	Cuvier, 1816	6, 15	ARC, BS, N, C
Sparidae	*Diplodus holbrookii*	(Bean, 1878)	3	IS, S, RB, CA
Sphyraenidae	*Sphyraena borealis*	DeKay, 1842	15	IN, N, BS
	Sphyraena guachancho	Cuvier, 1829	15	PSC, C
	Sphyraena sp.	Artedi, 1793	15	IN, N, BQ
	Sphyraenidae spp.	Rafinesque, 1815	15	PSC, C
Sternoptychidae	*Sternoptychidae spp.*	Duméril, 1805	6	ARC
Sternoptychidae	*Sternoptyx sp.*	Hermann, 1781	6	ARC
Stomiidae	*Stomiidae spp.*	Bleeker, 1859	6, 15	ARC, IN, N, BS
Syngnathidae	*Doryrhamphus sp.*	Kaup, 1856	3, 7	IR, RB
	Syngnathidae spp.	Bonaparte, 1831	13, 15	PSC, C, BR
	Syngnathus pelagicus	Linnaeus, 1758	7	RB
	Syngnathus sp.	Linnaeus, 1758	3	IN, N, RB
	Trachinocephalus myops	(Forster, 1801)	3, 7	IR, IN, N, BR, RB
Tetraodontidae	*Sphoeroides sp.*	Anonymous [Lacepède], 1798	15	IN, N, BS
	Sphoeroides spengleri	(Bloch, 1785)	3, 7	RB
Trachipteridae	*Trachipteridae spp.*	Swainson, 1839	15	IN, N, BS
Tripterygiidae	*Enneanectes sp.*	Jordan y Evermann, 1895	15	IN, N, BS
	Tripterygiidae spp.	Whitley, 1931	15	PSC, C
Xiphiidae	*Xiphias gladius*	Linnaeus, 1758	3, 7	RB

Interactive table

References

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All species listed as ichthyoplankton have an meroplanktonic life cycle.

MARINE MACROALGAE

the productive universe of the seaflower biosphere reserve

Martha Natalia Rincón Díaz[1] and Francisco Ramos

Marine macroalgae are a diverse group of autotrophic organisms grouped into non-vascular plants, meaning that they do not hold a nutrient transport channel system compared to the most common land plants or large trees. They are an important component in the structure and dynamics of marine and coastal ecosystems because they are at the base of the food web. They, along with microalgae, are the primary producers of the oceans (Gavio *et al.*, 2013). Moreover, macroalgae are important in the formation of reefs and beaches and are part of the mosaic of marine diversity that houses the coastal areas of the Archipelago of San Andrés, Providencia and Santa Catalina. Nonetheless, it has been considered that the biodiversity of algae is very large but difficult to determine, mainly due to the limited information on marine flora inventories around the world (Norton *et al.*, 1996).

Marine algae are an underexplored resource, important in the formation of coral reefs. They are the base of the oceanic food web, the source of food and shelter for many species of ecological and commercial interest. Moreover, they are raw material for the extraction of products for human consumption.

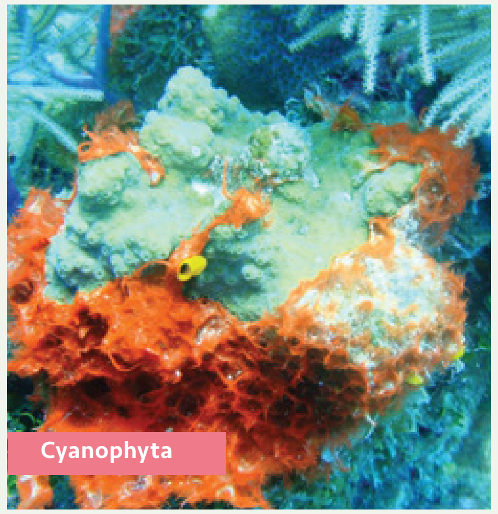
According to the environmental conditions and biotic factors such as grazing, algae can exhibit different types of growth and composition. Some have crustose, foliose or filamentous forms; others can grow with a firm thallus, simple or complex ramifications, varying sizes and specialized structures for capturing light, and thus complete their reproductive cycles, attach to different substrates and, in some cases, float **(Díaz Pulido y McCook, 2008).**

Acknowledgments

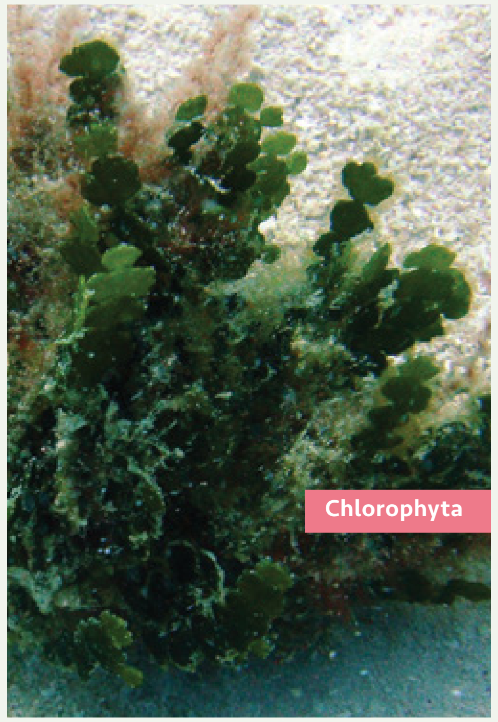
The authors thank Brigitte Gavio for her multiple contributions in obtaining the information for the preparation of this chapter and in consolidating the updated list of species of macroalgae for the Archipelago of San Andrés, Providencia and Santa Catalina.

1 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

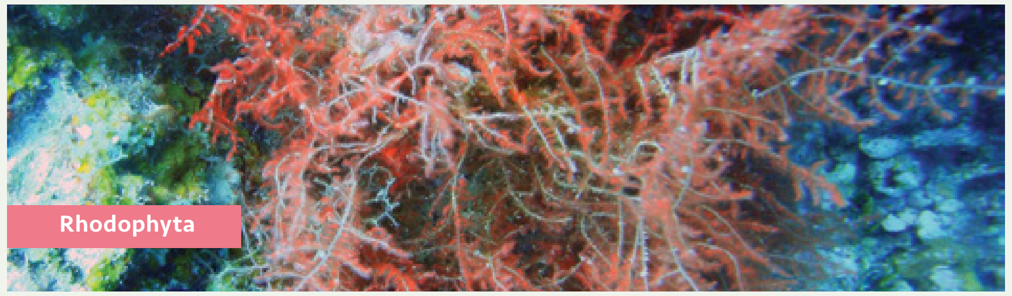
Historical review of the study of marine macroalgae in the Seaflower Biosphere Reserve



Cyanophyta



Chlorophyta



Rhodophyta

Historically, there have been several publications on records of macroalgae in the Colombian Caribbean (Taylor, 1960; Schnetter & Schnetter, 1967; Schnetter, 1976; 1977; 1978; Bula Meyer, 1982; 1983; Kapraun *et al.*, 1983; Hörnig *et al.*, 1992; Díaz Pulido & Bula Meyer, 1997; Littler & Littler, 2000; Bula Meyer & Norris 2001). **Particularly for the Seaflower Biosphere Reserve (SBR), the studies conducted on this matter have been a valuable tool to collect information on biodiversity of marine macroalgae, from species of large sizes such as those grouped in the genera Halimeda, Dictyota, Padina, Lobophora, and Avrainvillea to small epiphytes growing in large quantities upon larger algae, or forming the so-called algal turfs. Algae reported for the SBR are all grouped in the phylum Cyanophyta (blue-green algae or cyanobacteria), Rhodophyta (red algae), Chlorophyta (green algae) according to the classification of Van den Hoek et al. (1995), and brown algae (Ochrophyta) according to Cavalier and Chao (1996).**

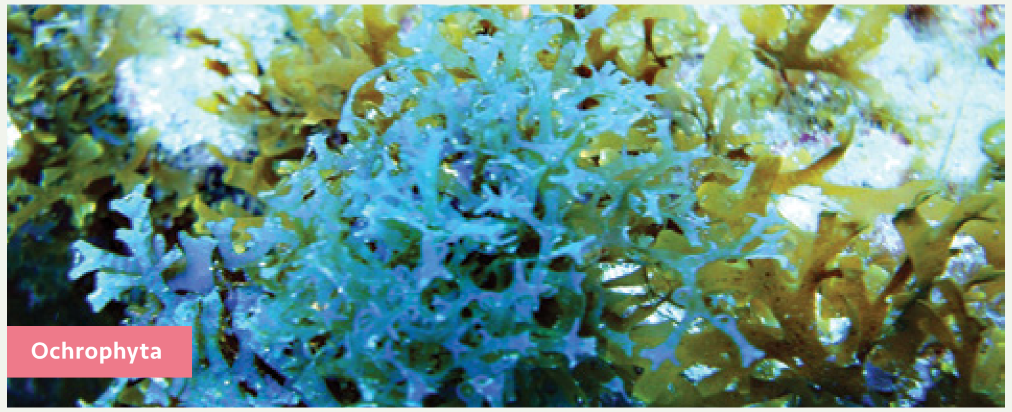
Generally speaking, research on marine algae in the Colombian Caribbean has been a little more thorough than research conducted in the Pacific. **Bula Meyer (1989),** documented 472 species of macroalgae for the Caribbean and included historical information on phycology in Colombia, documenting herbaria and reference collections including Colombian specimens. **Díaz Pulido y Díaz Ruiz (2003),** presented an updated list of macroalgae that includes a total of 565 taxa of benthic algae for the Caribbean, of which 201 were reported for the Archipelago of San Andrés, Providencia and Santa Catalina, and concluded that flora in the Colombian Caribbean includes nearly half of the species identified in the Tropical and Subtropical Western Atlantic. This suggests that the Colombian Caribbean is highly diverse, especially when considering that it constitutes less than 5% of the coastline ranging from North Carolina to southern Brazil.

Beginning in 2011, the study of the diversity of macroalgae in the reserve was taken up again, where six new records of species of red algae *Thalassia testudinum* **(Albis Salas & Gavio, 2011). Later, Ortíz y Gavio (2012)** reported 23 species described as new records: 17 for the archipelago and 6 for Colombia. These algae were collected in four beaches of the San Andrés Island and were part of the biological material that was adrift at sea and came as seaweeds washed ashore.

Reyes Gómez y colaboradores (2013), in samples taken from the Archipelago of San Andrés, Providencia and Santa Catalina, reported seven species of cyanobacteria, of which five were new records for Colombia. Additionally, **Gavio y colaboradores (2013),** described a new species for science, Crouania pumila, which was found in samples taken from different coastal ecosystems of the archipelago, including coral reefs, seagrass beds, rocky and sandy substrates at different depths, from the intertidal zone up to 37 m deep. The alga recorded was found growing as an epiphyte of other larger algae.

Rincón Díaz y colaboradores (2014), reported a new record of red alga for the San Andrés Island, *Ceramium bisporum*, which exhibited variation in reproductive structures from the original description. The alga was found growing as an epiphyte of *Halimeda tuna* in the reef platforms in the western part of the island.

Vega Sequeda y colaboradores (2015), eon a research study conducted in 2011 in the oceanic reef systems of the north end of the Colombian Caribbean: Bajo Nuevo Bank, Alicia Shoal (Joint Regime Area between Colombia and Jamaica) and Serranilla Bank, conducted rapid environmental assessments in order to determine the composition and relative abundance of the most representative species and groups of marine biota. As for the group of algae, 16 species of brown algae, 22 species of green algae and 23 species of red algae were recorded, plus several records of cyanobacterial morphotypes. These results showed seven new records for Colombia and the reserve: *Caulerpa lanuginosa, Caulerpa paspaloides* var. *laxa, Jania cubensis, Hydropuntia cornea, Chamaedoris peniculum, Cladophora prolifera and Fosliella chamaedoris.*



Ochrophyta

Gavio y colaboradores (2015a), published a list of species collected in the northern cays of the archipelago, specifically in the Quitasueño Bank. A total of 75 macroalgae were listed; 10 were cyanobacteria; 14 were new records for Colombia and 9 were new records for the archipelago. In this same year, **Albis Salas y Gavio (2015),** reported nine species as new records for the reserve, all found growing as *Thalassia testudinum,* at depths less than 1 m.

The list of species of marine algae, which increases the numbers of this group in the archipelago, has been increasing as on-going research studies have been conducted (Albis Salas y Gavio, 2015)**, which, to date, show a total of 276 species published. Most of these species correspond to small filamentous algae, epiphytes of large algae on seagrasses and rocky substrates. These findings indicate the great variety of life forms this group of macroalgae hosts in coastal ecosystems and reveals the need to continue to explore them.**

Ceramium bisporum

Caulerpa

Ecological importance of macroalgae and their role in the ecosystems of the archipelago

According to the morphological and ecological variations and the type of growth of marine macroalgae, they have been classified into functional groups alternately with their conventional taxonomic classification. These functional groups have helped understand the distribution of algal communities and their response to environmental variations; moreover, they help characterize communities in ecological studies conducted on coral reefs and coastal ecosystems (Díaz Pulido & McCook, 2008). This classification tool is used when it is not possible to identify algae to the species level on site, mainly filamentous algae that make up algal turfs.

The particularities of each functional group are described below according to classification by **Díaz Pulido and McCook (2008),** adapted to the groups present in the Archipelago of San Andrés, Providencia and Santa Catalina.

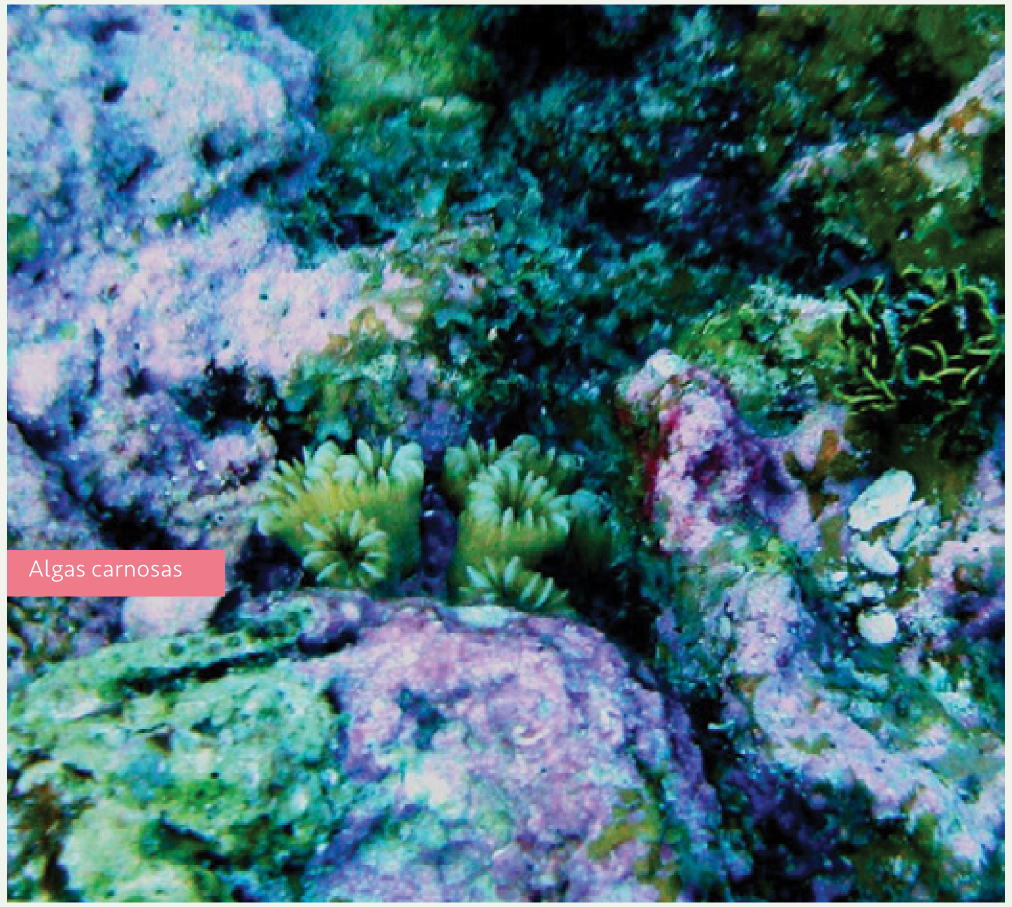
Classification of functional groups of marine macroalgae according to Díaz-Pulido and McCook (2008), considering genera recorded in the Caribbean and the Seaflower.

Algal categories	Functional groups			Examples of genera of algae in the Caribbean
Césped algal o "Turfs" (10 mm de height)	Filamentous algae			*Gayliella, Ceramium, Polysiphonia, Aglaothamnion, Heterosiphonia, Lyngbya*
Upright algae (10 mm de height)	Fleshy	Foliose	Membranous	*Ulva*
			Globose	*Valonia*
			Corticated	*Dictyota, Lobophora*
		Corticadas		*Chondria, Laurencia*
		Coriaceas		*Sargassum, Turbinaria*
	Calcareous	Calcareous articulated		*Jania, Amphiroa*
Crustose algae	Crustose	Fleshy		*Lobophora* (una forma), *Peyssonnelia*
		Calcareous		*Hydrolithon*


Mats algales "turfs"

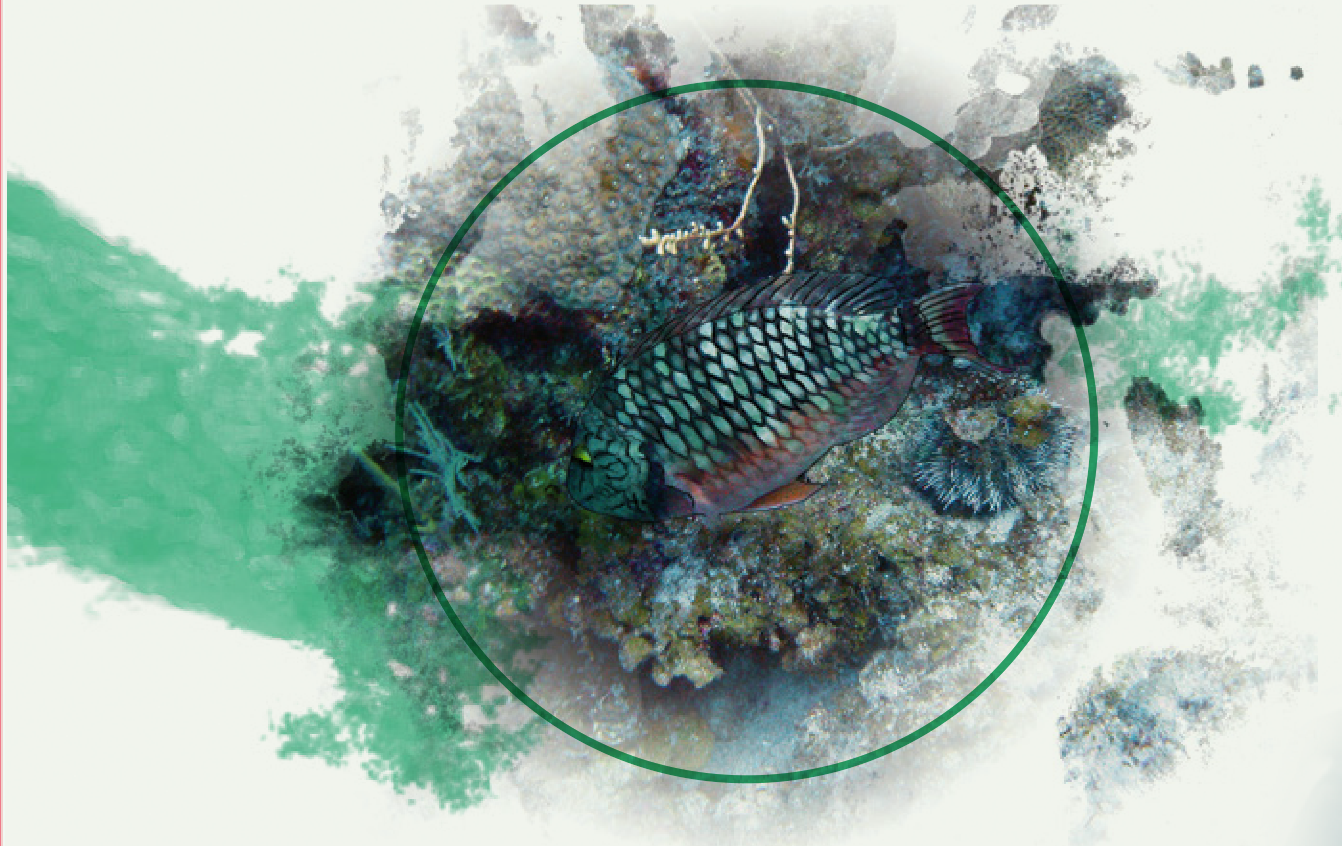
The mats algales turfs Turfs are well known for grouping different species of small algae having fast growth, high productivity and high rates of colonization. Despite having a strong pressure due to herbivory, they dominate in reef ecosystems.

Fleshy and leafy algae include species having a slightly slower growth, a rigid and/or foliose structure and allelochemicals **(Rasher y Hay, 2010)** anti-herbivory and anti-coral chemicals; therefore, they are usually found in areas with low rates of grazing by fish and invertebrates. Lastly, crustose algae are considered a very important group due to their participation in the consolidation of coral reefs. They have a hard texture and form crusts of calcium carbonate. Their growth rate is slow and they are mainly found in areas where coral reefs are healthy. The coverage of foliose algae is low.


Algas carnosas


Algas foliosas

All the functional groups mentioned above can be found in the archipelago, exalting their attributes for the benefit of the existing communities and contributing to the balance of ecosystems. One of their functions is primary production. Like higher plants, algae absorb energy from sunlight through photosynthesis, resulting in the production of organic matter, the base of food webs in marine ecosystems since they serve as food for various species such as fish, crustaceans and sea urchins, among others. Moreover, much of this organic matter can be transported by currents from coral reefs to mangrove ecosystems or seagrass beds typical of the islands making up the archipelago, being an available resource for species that live there. Marine algae provide energy resources to fish and invertebrates; their distribution and abundance are defined by the effects of



grazing and competence, as well as by abiotic interactions, such as physical disturbances and environmental oscillations (Littler & Littler, 1984; Steneck & Dethier, 1994)**. However, researchers have agreed on the fact that herbivory is essential in the variation of the composition and coverage of macroalgae** (Lessios, 1988; Morrison, 1988; Hughes, 1994; Hixon & Brostoff, 1996; Rasher & Hay, 2010; Ferrari et al., 2012, Rincón Díaz, 2014)**. It has been demonstrated that, in high topographic complexity reefs, herbivores can reach an herbivory rate of 20,000 to 150,000 bites/m2/day** (Hatcher & Larkum, 1983; Carpenter, 1986-1988; Klumpp & Polunin, 1989)**, which accentuates the importance of this activity in the balance of coral reef ecosystems, where corals keep their dominance status over fleshy algae.**

Reports show that, during 2013 in San Andrés Island, herbivorous fish grouped in the families Scaridae (parrotfish) and Acanthuridae (surgeonfish) and the species *Canthigaster rostrata* of the family Tetraodontidae foraged mainly on the turf substrate, in coral formations of the western zone of the island (leeward). Furthermore, the highest herbivory rate was recorded in July (5,964.05 bites/m2/day); and the lowest, in May (157.92 bites/m2/day) **(Rincón Díaz, 2014)**. These results evidenced a low influence of the herbivory activity, supported by a non-significant correlation between the abundance of herbivorous fish and the percentage of coverage of macroalgae in both climatic periods, as well as between the herbivory rate and the coverage of macroalgae in the sampled months. **Schmitt (1997)** also observed this same low-influence pattern in the herbivory activity in Florida Keys.

The resulting outlook can suggest that the levels of grazing are insufficient to counteract algae growth and avoid their colonization in the studied reefs. It is likely that the composition, abundance and sizes of herbivorous fish have low levels in the reef systems, which may be damaging their well-being and health **(Rincón Díaz, 2014)**. It is worth emphasizing that these approaches on the dynamics of the herbivory activity should be deeply evaluated and studied to determine the herbivory interactions in the archipelago in a more complete way, widening the area and time of study, as well as the influence of other groups of herbivores.

Wrangelia

Uses of marine macroalgae in the Seaflower Biosphere Reserve

As a historical review, marine algae were used as food during the 4th century in Japan and during the 6th century in China. Nowadays, the use of algae for human consumption has expanded around the world, being the Korean peninsula, Japan and China the greatest consumers (Kılınç et al., 2013)**. In several developing countries, the informal market of algae has grown in coastal zones, where they are used mainly in culinary preparations.**

In the global context, commercialization of macroalgae has increased with the demand for consumption of this resource. According to FAO, great quantity of food, pharmaceutical, agricultural and cosmetic products derives from the algae industry, which reaches an estimated value of US$ 5.5-6 billion per year of which food products for human consumption represent US$ 5 billion **(McHugh, 2003).** Both wild algae and cultivated algae species have been used in the production of macroalgae. More and more countries produce and commercialize algae; for 2003, they were 35, located in coastal zones of cold and temperate waters, and even in tropical zones **(Kılınç *et al.*, 2013).**

In Colombia, the use of macroalgae for consumption has been restricted to certain regions and it has been poorly documented. A good example is the case of algae locally known in the Archipelago of San Andrés, Providencia and Santa Catalina as *Seaweed* (género *Gracilaria*). Traditionally, local fishers have collected the algae from which they obtain a beverage to which they confer aphrodisiac and manhood effects, and they have commercialized it in the local market as a food product at a low scale.

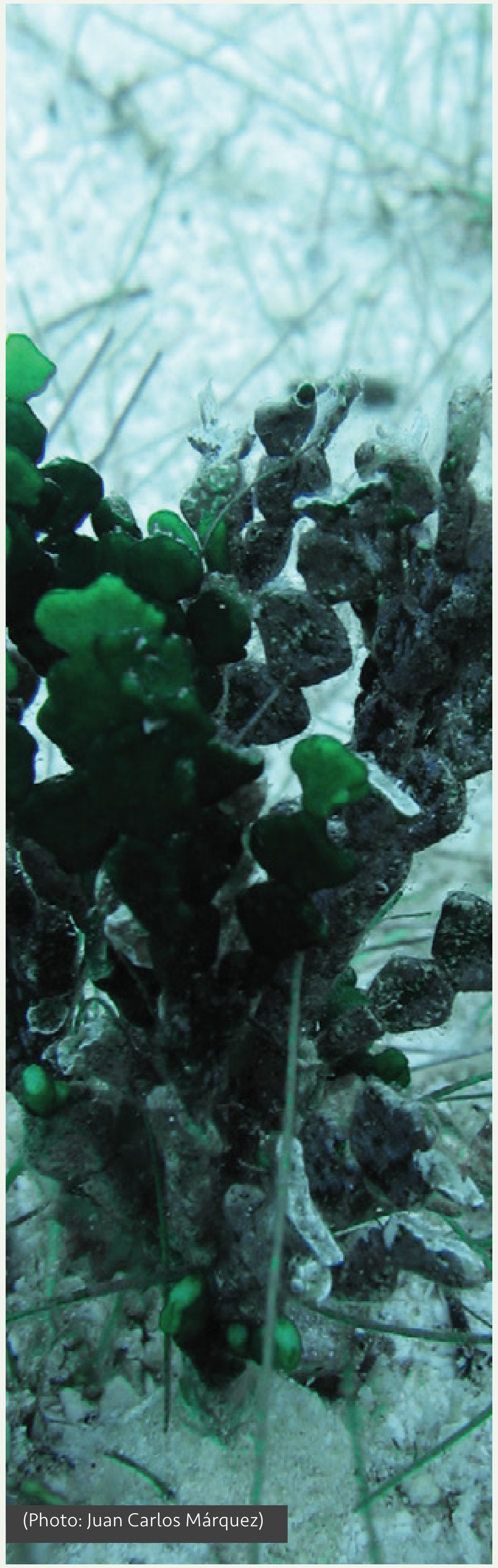
Sargassum

The potential of some species that grow naturally stands out in the archipelago. **Bula (2004)**, considered the use of brown alga *Sargassum* spp., as a feasible resource to improve crops in San Andrés Island, since one of the main properties of algae in soils is the addition of alginic acid, contained in a third part of the plant's carbohydrate **(Quastel y Webley, 1947)**. the genus *Sargassum* comprises around 335 species taxonomically accepted, of which eight have been recorded in the Archipelago of San Andrés, Providencia and Santa Catalina.

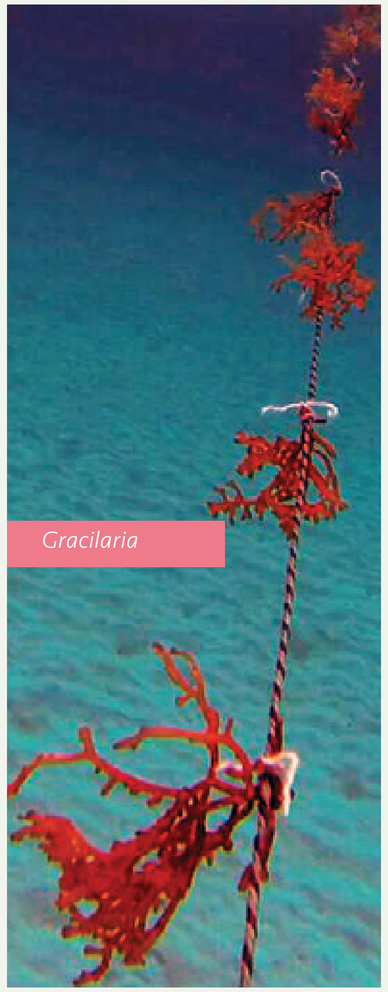
Likewise, the importance of establishing projects for cultivating algae grown in the islands naturally but in low quantities has been accentuated. These projects would aim to include the cultivation of algae in the economic development of the islands, with the purpose of generating employment and food for inhabitants and food for tourists **(Bula Meyer & Newball, 1983).**

The poor use the Colombian Caribbean has given to the phycological resources is not necessarily due to the lack of investment, but to the low abundance of species, as **Bula Meyer (1989)**, indicated, when referring to the macroalgae diversity potential in Colombia. Therefore, he stated that establishing an extraction industry is not profitable and he suggested carrying out biocelogical studies on subjects such as life cycles and seasonal variations in algae production.

For several years, traditional fishers of the archipelago have collected and commercialized seaweed locally. It has been exploited especially in the Serrana cay, and nowadays its abundance and distribution have decreased. Such situation has caused the creation of projects that have strengthened both the knowledge of algae and the feasibility in the establishment of crops, mainly of genus *Gracilaria* spp., and species *Eucheuma isiforme*.



(Photo: Juan Carlos Márquez)



Gracilaria

One of the pilot projects that have been developed in the archipelago was Experiences of Mariculture in the Archipelago - Training for Growing and Using Marine Algae with the Fisher Community in Providencia Island. -Agreement 021, 2005, by the Regional Autonomous Corporation of the Archipelago, abbreviated CORALINA in Spanish, in agreement with **(INVEMAR-CORALINA, 2007)**. In one of the workshops, fishermen expressed that there are species with a high potential to be cultivated, mainly Seaweed, stating that the natural banks are abundant and their biomass is much larger than the *Gracilaria* spp., biomass, used for the trials carried out that date in the crop workshops.

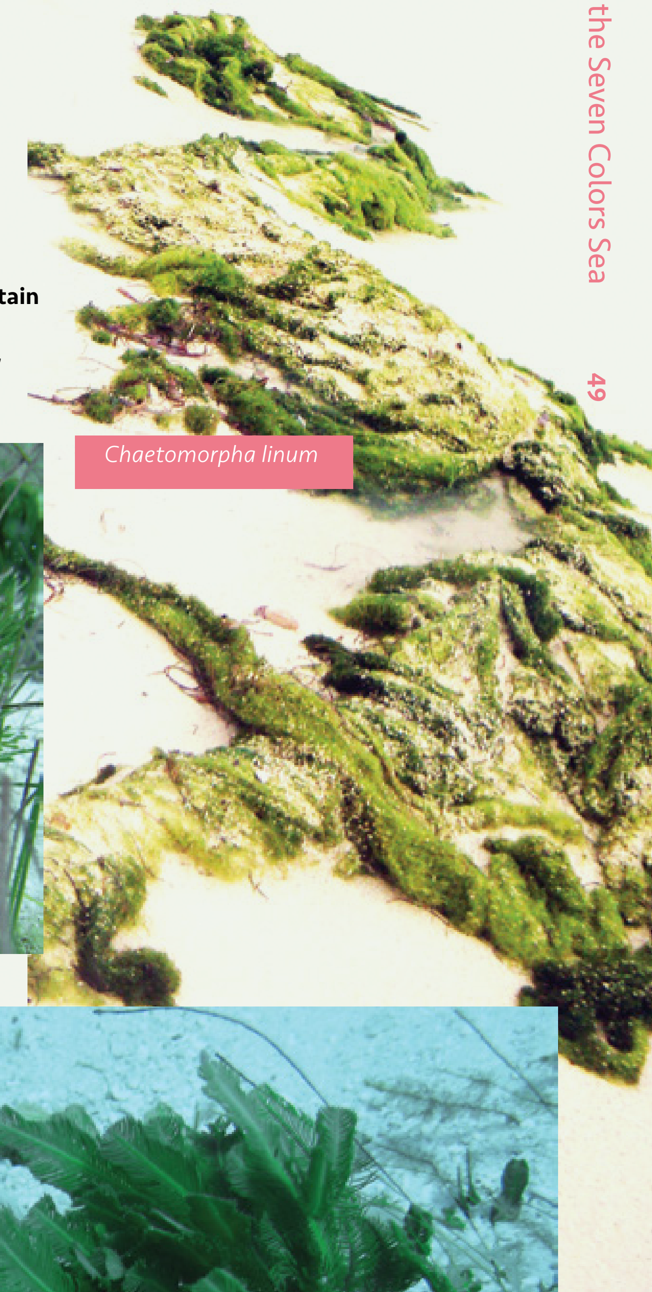
Furthermore, as part of the mariculture project started in 2013b in Providencia Island, funded by the National Unit for Disaster Risk Management **(UNGRD)** developed by the Fish & Farm Cooperative, jointly with universities and the Secretary of Agriculture and Fishing, and supervised by CORALINA, the feasibility of producing the mentioned red algae also stood out, considering that, during the experimental activities, it was possible to triplicate the weight of *Gracilaria* spp. in 46 days under conditions of herbivore and epiphyte exclusion. In the same way, the use of algae in the preparation of typical milkshakes as food for local communities and the big economic potential, if continuity of crops pre-established in the island is provided, were highly taken into account.

The search for new alternatives for the sustainable use of resources in the archipelago may give way to the formulation of projects that involve cultivating local species of macroalgae, which would allow the encouragement and development of the mariculture industry with new and convenient proposals for the island's communities. In this sense, CORALINA, together with the Old Providence and Santa Catalina Fishing and Farming Cooperative Enterprise of traditional fishers, Universidad Nacional de Colombia-Caribe campus, McBean Lagoon National Natural Park and SENA, designed the second phase of the mariculture project for Providencia Island (previously referenced), which, once approved, will be developed between 2016-17 and 2018-19.

Some potential uses of macroalgae and seagrasses, and even of gorgonians, have been described in numerous scientific papers. These studies show their role as fertilizers, raw materials in composting processes and raw materials to obtain subproducts and/or chemicals for pharmaceutical and cosmetic products, which could be implemented in the department in the future.

Massive blooms and beds of some notable species of macroalgae in San Andrés Island

Marine algae perform important roles in marine and fresh water coastal ecosystems. However, environmental and biotic alternations may generate an excessive increase of certain species, generally as response to changes in the levels of concentration of nitrogen and phosphorous in the water. Algae blooms may exhaust oxygen and block sunlight entrance, affecting the survival of other organisms (NCEH, 2012).



Chaetomorpha linum

Marine macroalgae blooms are generally made up of opportunistic species that are part of natural communities present in marine ecosystems **(Fletcher, 1996).** LEffects of excessive increase of macroalgae affect social, economic and ecological dimensions. Likewise, proliferation of macroalgae interferes with the esthetics of coastal zones, and toxins released by macroalgae decomposition may become a risk for humans' and domestic animals' health **(Chrisafis, 2009; Samuel, 2011).**
In that way, blooms may negatively affect the economic income generated by tourism; therefore, it is necessary to fund programs to remove algae and control their growth **(Lyons *et al.*, 2012).** Ephemeral bloom events of macroalgae have been documented in several occasions worldwide and have been generally represented by opportunistic algae of early succession of genus *Ulva, Chaaetomorpha ó Cladophora* **(Smith *et al.*, 2005).**

The species *Chaetomorpha linum*, linum has been showing continuous bloom events in the Caribbean, especially in Jamaica and Florida Keys **(Lapointe *et al.*, 2004).** This increase of *C. linum*, covering the area may be attributed to the enrichment of nitrogen from the coastal zones' dumping water, derived from numerous human activities, such as agriculture and housekeeping **(Linton y Warner, 2003; Lapointe *et al.*, 2004; Thomsen y Wernberg, 2009).**

In San Andrés Island, the serious issue of overpopulation, estimated to exceed 70,069 inhabitants **(DANE, 2011),** as well as a high influx of tourists all year long, may affect certain algae's blooms. One of these cases occurred between the months of February and May of 2013, when an unusual event of *C. linum*, massive bloom was reported. It was recorded because of its magnitude and possible impacts on coastal ecosystems, mainly seagrass beds **(Gavio y Macera, 2015).**

(Photo: Juan Carlos Márquez)

(Photo: Juan Carlos Márquez)

Sargassum fluitans y S. natans

The increase of anthropogenic pressure on the coastal ecosystems of San Andrés Island by the local population and the influence of tourists could generate the occurrence of algae blooms through eutrophication of shallow water. These blooms would alter the balance of seagrass beds, entailing a possible change of dominance of perennial beds and algae, and algae formations with ephemeral blooms **(McGlathery *et al.*, 2007). Gavio y Mancera (2015)**,suggested that, in order to avoid such occurrences in the future and their negative impacts on the coastal zones of the island, the management of wastewater dumping should be improved, and the entrance of nutrients to the coastal zones should be reduced urgently.

Other macroalgae species, such as gulfweed and leaves detached from seagrass beds, frequently reach the beaches of the archipelago's islands. The large quantities accumulated are buried in most cases, partly as final disposal and because of a popular belief that they produce and hold sand. In spite of the aforementioned, in 2014, a large-impact case occurred with the massive beds of *Sargassum* spp. brought to the beaches, mostly from the north of the island. These golden tides, as the beds of these brown algae are called, are common in the Wider Caribbean and the Gulf of Mexico; however, over the last years, they have increased both in volume and in frequency. It has been considered that the Sargasso Sea, located in the northern Atlantic, is the source of biomass of the algae that drift until the coasts of the islands in the Antilles and the Gulf of Mexico through trade winds **(Moreira y Alfonso, 2013; Gavio *et al.*, 2015b)**. Golden tides have increased since the 80's, possibly because of nitrification **(Lapointe, 1995; Smetacek y Zingone, 2013).**

From September 17 to 20 of 2014, massive beds of *Sargassum fluitans* and *S. natans* were washed ashore in San Andrés **(Gavio *et al.*, 2015b)** covering around 32,520 m2 (data taken by CORALINA). This situation had not occurred in decades in the island; however, it warns possible situations in the future, since the periodic occurrence of such events, added to the continuous discharges of nutrients from the coast, would strongly affect local communities, tourism, traditional fishing and other economic activities **(Gavio *et al.*, 2015b).**). Even though the cause of the massive event in 2014 is not known with certainty, the algae were washed ashore shortly after hurricane Edouard **(Sosnowski, 2014)**, suggesting that currents produced by this natural event could have dragged them to the island **(Gavio *et al.*, 2015b).**

Keeping this in mind and knowing that the issue of massive beds of macroalgae

(Photo: Juan Carlos Márquez)

being washed ashore is happening more frequently all around the Wider Caribbean and considering the magnitude of the event that took place in San Andrés Island, CORALINA not only evaluated and documented the event, but also calculated the biomass of macroalgae in impacted beaches and areas and, subsequently, generated maps. Additionally, the corporation made the international queries in the scientific information networks (e.g. the Gulf and Caribbean Fishery Institute-GCFI-) and prepared the corresponding international reports in a website created for that purpose, called Caribbean Sargassum. This matter had great international relevance and currently the French government and its delegates in the Antilles lead actions to manage these events as part of scientific findings, such as the ones previously mentioned; as for Colombia, the Ministry of Environment and Sustainable Development is in charge of this matter.

Even though the Biosphere Reserve is not a toxic algae *(blooms)*, zone, as in other areas of the Wider Caribbean, there have been some isolated cases associated with ciguatera, a disease caused by the consumption of fish that have accumulated liposoluble ciguatoxins produced by dinoflagellates of genera *Gambierdiscus, Ostreopsis, Coolia and Prorocentrum* **(Celis y Mancera 2015)**, which are toxic microalgae that can generate the called red tides. Some ciguatera outbreaks have been reported in San Andrés Island, two of them in 1997, affecting 16 tourists and 9 locals **(Arencibia *et al.*, 2009).**

Rodríguez *et al.* (2010), determined the presence of toxic epiphyte dinoflagellates in seagrass beds of the northern and eastern sectors of the island in coastal waters and found seven toxicogenic species belonging to genera *Prorocentrum* and *Ostreopsis*. Cell densities found in these dinoflagellates were low, compared to studies in other sites of the Caribbean. It is worth noting that such microalgae may grow in different types of substrates, as well as in seagrass beds; one of them is the drifting organic matter that represents, perhaps, the most important vector for the spreading of these toxicity agents in the island **(Mancera *et al.*, 2014).**

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Marine macroalgae

Phylum Chlorophyta

C: Ulvophyceae — O: Bryopsidales

F	S	Author				
Bryopsidaceae	*Bryopsis pennata*	J.V. Lamouroux C	3	B	ab	SA
Codiaceae	*Codium intertextum*	Collins & Hervey	3	E	ab	SA
Codiaceae	*Codium isthmocladum*	Vickers	3	E	ab	SA
Codiaceae	*Codium isthmocladum var. clavatum*	(Collins & Hervey) P.C.Silva	3	E	ab	SA
Codiaceae	*Codium repens*	P.L.Crouan & H.M.Crouan	3	B	ab	SA
Codiaceae	*Codium taylorii*	P.C.Silva	3	B	ab	SA
Derbesiaceae	*Derbesia vaucheriaeformis*	(Harvey) J. Agardh	3	B	ab	SA
Dichotomosiphonaceae	*Avrainvillea asarifolia*	Børgesen	3	B	ab	SA
Dichotomosiphonaceae	*Avrainvillea asarifolia f. asarifolia*	D.S.Littler & M.M.Littler	3	B	ab	SA
Dichotomosiphonaceae	*Avrainvillea asarifolia f. olivacea*	D.S.Littler & M.M.Littler	3	B	ab	SA
Dichotomosiphonaceae	*Avrainvillea digitata*	D.S.Littler & M.M.Littler	3	B	ab	SA
Dichotomosiphonaceae	*Avrainvillea levis f. translucens*	D.S.Littler & M.M.Littler	3	B	ab	SA
Dichotomosiphonaceae	*Avrainvillea longicaulis*	(Kützing) G.Murray & Boodle	3	B	ab	SA
Dichotomosiphonaceae	*Avrainvillea silvana*	D.S.Littler & M.M.Littler	3	B	ab	SA
Halimedaceae	*Halimeda copiosa*	Goreau & E.A.Graham	3	B	ab	SA
Halimedaceae	*Halimeda discoidea*	Decaisne	3	B	ab	SA
Halimedaceae	*Halimeda goreauii*	W.R.Taylor	3	B	ab	SA
Halimedaceae	*Halimeda incrassata*	(J.Ellis) J.V.Lamouroux	3	B	ab	SA
Halimedaceae	*Halimeda monile*	(J.Ellis & Solander) J.V.Lamouroux	3	B	ab	SA
Halimedaceae	*Halimeda opuntia*	(Linnaeus) J.V.Lamouroux	3	B	ab	SA
Halimedaceae	*Halimeda simulans*	Howe	3	B	ab	SA
Halimedaceae	*Halimeda tuna*	(J.Ellis & Solander) J.V.Lamouroux	3	B	ab	SA
Ostreobiaceae	*Ostreobium quekettii*	Bornet & Flahault	3	E	ab	SA
Rhipilaceae	*Rhipiliopsis stri*	(Earle & J.R.Young) Farghaly & Denizot	3	B	ab	SA
Udoteaceae	*Avrainvillea rawsoni*	(Dickie) Howe	3	B	ab	SA
Udoteaceae	*Penicillus lamourouxii*	Decaisne	3	B	ab	SA
Udoteaceae	*Penicillus capitatus*	Lamarck	3	B	ab	SA
Udoteaceae	*Penicillus dumetosus*	(J.V.Lamouroux) Blainville	3	B	ab	SA
Udoteaceae	*Penicillus pyriformis*	A.Gepp & E.S.Gepp	3	B	ab	SA
Udoteaceae	*Rhipocephalus phoenix*	(J.Ellis & Solander) Kützing	3	B	ab	SA
Udoteaceae	*Rhipocephalus phoenix f. brevifolius*	A.Gepp & E.S.Gepp	3	B	ab	SA
Udoteaceae	*Rhipocephalus phoenix f. longifolius*	A.Gepp & E. Gepp	3	B	ab	SA
Udoteaceae	*Udotea caribaea*	D.S.Littler & M.M.Littler	3	B	ab	SA
Udoteaceae	*Udotea conglutinata*	(Solander) Lamouroux	3	B	ab	SA
Udoteaceae	*Udotea cyathiformis*	Decaisne	3	B	ab	SA
Udoteaceae	*Udotea cyathiformis* var. *C.f. Infundibulum*	J.Agardh	3	B	ab	SA
Udoteaceae	*Udotea dixonii*	D.S.Littler &M.M.Litter	3	B	ab	SA
Udoteaceae	*Udotea flabellum*	J. Ellis y Solander	3	B	ab	SA
Udoteaceae	*Udotea looensis*	D.S.Littler & M.M.Littler	3	B	ab	SA
Udoteaceae	*Udotea luna*	D.S.Littler & M.M.Littler	3	B	ab	SA
Udoteaceae	*Udotea wilsonii*	A.Gepp, E.S.Gepp & M.A.Howe	3	B	ab	SA
Ulvellaceae	*Ulvella lens*	P.L: Crouan y H.M. Crouan (F)	3	B	ab	SA
Bryopsidaceae	*Bryopsis pennata* var. *leprieurii*	(Kützing) Collins & Hervey	3	E	ab	SA
Bryopsidaceae	*Bryopsis pennata* var. *pennata*	(Lamouroux) Børgesen	3	E	ab	SA
Bryopsidaceae	*Bryopsis plumosa*	(Hudson) C.Agardh	3	E	ab	SA
Caulerpaceae	*Caulerpa ambigua*	Okamura	3	B	ab	SA
Caulerpaceae	*Caulerpa cupressoides*	(Vahl) C.Agardh	3	B	ab	SA
Caulerpaceae	*Caulerpa cupressoides* var. *cupressoides*	(West) C. Agardh	3	B	ab	SA
Caulerpaceae	*Caulerpa cupressoides* var. *mamillosa*	(Montagne) Weber-van Bosse	3	B	ab	SA
Caulerpaceae	*Caulerpa cupressoides* var. *turneri*	Weber-van Bosse	3	B	ab	SA
Caulerpaceae	*Caulerpa lanuginosa*	J.Agardh	9	E	ls	SA
Caulerpaceae	*Caulerpa mexicana*	Sonder ex Kützing	3	B	ab	SA
Caulerpaceae	*Caulerpa microphysa*	(Weber-van Bosse) Feldmann	3	B	ab	SA
Caulerpaceae	*Caulerpa paspaloides* var. *laxa*	Weber-van Bosse	9	E	ls	SA
Caulerpaceae	*Caulerpa prolifera*	J.V.Lamouroux	3	B	ab	SA

C: Ulvophyceae

O	F	S	Author				
Bryopsidales	Caulerpaceae	*Caulerpa racemosa var. lamourouxii*	(Turner) Weber-van-Bosse	5	B	ab	BQ
Bryopsidales	Caulerpaceae	*Caulerpa racemosa var. occidentalis*	(J.Agardh) Børgesen,	3	B	ab	SA
Bryopsidales	Caulerpaceae	*Caulerpa racemosa var. peltata*	J.V.Lamouroux) Eubank	3	B	ab	SA
Bryopsidales	Caulerpaceae	*Caulerpa racemosa var. racemosa*	J.V.Lamouroux)	3	B	ab	SA
Bryopsidales	Caulerpaceae	*Caulerpa serrulata*	(Forsskål) J.Agardh	3	B	ab	SA
Bryopsidales	Caulerpaceae	*Caulerpa sertularioides*	(S.G.Gmelin) M.A.Howe, 1905	3	B	ab	SA
Bryopsidales	Caulerpaceae	*Caulerpa verticillata*	J.Agardh	3	B	ab	SA
Bryopsidales	Caulerpaceae	*Caulerpa webbiana*	Montagne	3	B	ab	SA
Cladophorales	Anadyomenaceae	*Anadyomene saldanhae*	A.B.Joly & E.C.Oliveira	3	E	ab	SA
Cladophorales	Anadyomenaceae	*Anadyomene stellata*	(Wulfen) C.Agardh	3	B	ab	SA
Cladophorales	Cladophoraceae	*Chaetomorpha linum*	(O.F.Mueller) Kuetzing	6	B	ls	SA
Cladophorales	Cladophoraceae	*Chaetomorpha minima*	(C. Agardh) Montagne	2	E	pm	SA
Cladophorales	Cladophoraceae	*Chaetomorpha brachygona*	Harvey	3	B	ab	SA
Cladophorales	Cladophoraceae	*Chaetomorpha clavata*	Kützing	6	E	ls	SA
Cladophorales	Cladophoraceae	*Chaetomorpha crassa*	(C.Agardh) Kützing	3	B	ab	SA
Cladophorales	Cladophoraceae	*Chaetomorpha gracilis*	Kützing	3	B	ab	SA
Cladophorales	Cladophoraceae	*Cladophora albida*	(Ness) Kuetzing	5	E	ab	BQ
Cladophorales	Cladophoraceae	*Cladophora catenata*	(L.) Kützing	6	E	ls	SA
Cladophorales	Cladophoraceae	*Cladophora dalmatica*	Kützing	3	B	ab	SA
Cladophorales	Cladophoraceae	*Cladophora laetevirens*	(Dillwyn) Kuetzing (F)	6	E	ls	SA
Cladophorales	Cladophoraceae	*Cladophora liniformis*	Kützing	2	E	pm	SA
Cladophorales	Cladophoraceae	*Cladophora prolifera*	(Roth) Kützing	9	E	ls	SA
Cladophorales	Cladophoraceae	*Cladophora vagabunda*	(Linnaeus) Hoek (F)	3	E	ab	SA
Cladophorales	Siphonocladaceae	*Dictyosphaeria versluysii*	Weber-van Bosse	3	B	ab	SA
Cladophorales	Valoniaceae	*Ernodesmis verticillata*	(Kuetzing) Boergesen	3	B	ab	SA
Dasycladales	Dasycladaceae	*Neomeris annulata*	Dickie	3	E	ab	SA
Dasycladales	Dasycladaceae	*Neomeris mucosa*	M.A.Howe	3	E	ab	SA
Dasycladales	Polyphysaceae	*Acetabularia crenulata*	J.V. Lamouroux, 1816	3	E	ab	SA
Dasycladales	Polyphysaceae	*Parvocaulis polyphysoides*	(P.L.Crouan & H.M.Crouan) S.Berger, U. Fettweiss, S. Gleissberg, L.B. Liddle, U. Richter, H. Sawitzky & G.C. Zuccarello	3	B	ab	SA
Siphonocladales	Boodleaceae	*Cladophoropsis macromeres*	W.R. Taylor	6	E	ls	SA
Siphonocladales	Boodleaceae	*Cladophoropsis membranaceae*	(Hofman Bang ex C.Agardh) Børgesen	3	E	ab	SA
Siphonocladales	Boodleaceae	*Phyllodictyon pulcherrimum*	J.E.Gray	3	B	ab	SA
Siphonocladales	Siphonocladaceae	*Chamaedoris peniculum*	(J.Ellis & Solander) Kuntze	9	E	ls	SA
Siphonocladales	Siphonocladaceae	*Dictyosphaeria cavernosa*	(Forsskål) Børgesen	3	B	ab	SA
Siphonocladales	Siphonocladaceae	*Dictyosphaeria ocellata*	(M.A.Howe) Olsen-Stojkovich	3	B	ab	SA
Siphonocladales	Valoniaceae	*Valonia ventricosa*	J. Agardh	3	B	ab	SA
Siphonocladales	Valoniaceae	*Valonia macrophysa*	Kützing	3	B	ab	SA
Ulotrichales	Ulotrichaceae	*Ulothrix sp.*	Kützing	2	E	pm	SA
Ulvales	Phaeophilaceae	*Phaeophila dendroides*	(P.L. Crouan y H. M. Crouan) Batters (FE)	2	E	pm	SA
Ulvales	Ulvaceae	*Ulva clathrata*	(Roth) C.Agardh	3	B	ab	SA
Ulvales	Ulvaceae	*Ulva flexuosa*	Wulfen	3	B	ab	SA
Ulvales	Ulvaceae	*Ulva flexuosa subsp. paradoxa*	(C.Agardh) M.J.Wynne	2	E	pm	SA
Ulvales	Ulvaceae	*Ulva lactuca*	Linnaeus	3	B	ab	SA
Ulvales	Ulvaceae	*Ulva linza*	Linnaeus	3	B	ab	SA
Ulvales	Ulvaceae	*Ulva rigida*	C.Agardh	3	B	ab	SA
Ulvales	Ulvaceae	*Enteromorpha lingulata*	J.Agardh	3	B	ab	SA

Phylum Cyanobacteria

C: Cyanophyceae

Sc	O	F	S	Author				
Synechococcophycideae	Synechococcales	Heteroleibleiniaceae	*Heteroleibleinia epiphytica*	Komárek in Anagnostidis	5	E	ab	BQ
Synechococcophycideae	Synechococcales	Scytonemataceae	*Scytonematopsis crustacea*	(Thuret ex Bornet & Flahault) Koválik & Komárek	3	E	ab	SA
Nostocophycideae	Nostocales	Symphyonemataceae	*Brachytrichia quoyi*	(C. Agardh) Bornet & Flahault	7	E	ls	PSC, SA
Nostocophycideae	Nostocales	Symphyonemataceae	*Calothrix confervicola*	C. Agardh ex Bornet & Flahault	7	E	ls	PSC, SA
Nostocophycideae	Nostocales	Oscillatoriaceae	*Phormidium corallyticum*	Rützler & Santavy	3	E	ab	SA
Nostocophycideae	Nostocales	Oscillatoriaceae	*Phormidium crassior*	(Behr) Anagnostidis	5	E	ab	BQ
Nostocophycideae	Nostocales	Oscillatoriaceae	*Phormidium dimorphum*	Lemmermann	7	E	ls	PSC, SA
Nostocophycideae	Nostocales	Oscillatoriaceae	*Phormidium roseum*	(P.L. Crouan & H.M. Crouan ex Gomont) Anagnostidis	7	E	ls	PSC, SA
Oscillatoriophycidae	Oscillatoriales	Phormidiaceae	*Phormidium submembranaceum*	Gomont	3	E	ab	SA
Oscillatoriophycidae	Oscillatoriales	Phormidiaceae	*Symploca hydnoides*	Kützing ex Gomont	5	E	ab	BQ
Oscillatoriophycidae	Oscillatoriales	Schizotrichaceae	*Schizothrix calcicola*	Gomont	3	E	ab	SA
Oscillatoriophycidae	Oscillatoriales	Schizotrichaceae	*Schizothrix mexicana*	Gomont	3	E	ab	SA
Oscillatoriophycidae	Oscillatoriales	Oscillatoriaceae	*Lyngbya confervoides*	C.A. Agardh	3	E	ab	SA
Oscillatoriophycidae	Oscillatoriales	Oscillatoriaceae	*Lyngbya lutea*	(C. Agardh)	3	E	ab	SA
Oscillatoriophycidae	Oscillatoriales	Oscillatoriaceae	*Lyngbya majuscula*	(Dillwyn) Harvey	3	E	ab	SA
Oscillatoriophycidae	Oscillatoriales	Oscillatoriaceae	*Lyngbya penicilliformis*	P. Silva in Silva et al.	7	E	ls	PSC, SA
Oscillatoriophycidae	Oscillatoriales	Phormidiaceae	*Oxynema acuminatum*	(Gomont) Chatchawan et al.	5	E	ab	BQ
Oscillatoriophycidae	Oscillatoriales	Phormidiaceae	*Leibleinia epiphytica*	(Hieronymus) Compère	5	E	ab	BQ
Synechococcophycideae	Pseudanabaenales	Pseudanabaenaceae	*Leptolyngbya hendersonii*	(Howe) Anagnostidis & Komárek	3	E	ab	SA
Synechococcophycideae	Pseudanabaenales	Pseudanabaenaceae	*Spirulina meneghiniana*	Zanardini ex Gomont	5	E	ab	BQ

Phylum Ochrophyta

C: Phaeophyceae

Sc	O	F	S	Author				
Fucophycidae	Ectocarpales	Acinetosporaceae	*Hincksia mitchelliae*	(Harvey) P.C. Silva (F)	3	B	ab	SA
Fucophycidae	Ectocarpales	Chordariaceae	*Cladosiphon occidentalis*	Kylin	2	E	pm	SA
Fucophycidae	Fucales	Sargassaceae	*Sargassum filipendula*	C. Agardh	3	B	ab	SA
Fucophycidae	Fucales	Sargassaceae	*Sargassum bermudense*	Grunow	3	B	ab	SA
Fucophycidae	Fucales	Sargassaceae	*Sargassum acinarium*	(Linnaeus) Setchel	5	P	ab	BQ
Fucophycidae	Fucales	Sargassaceae	*Sargassum buxifolium*	(Chauvin) M.J.Wynne	6	E	ls	SA
Fucophycidae	Fucales	Sargassaceae	*Sargassum fluitans*	(Børgesen) Børgesen	3	N	ab	SA
Fucophycidae	Fucales	Sargassaceae	*Sargassum hystrix*	J.Agardh	3	N	ab	SA
Fucophycidae	Fucales	Sargassaceae	*Sargassum natans*	(Linnaeus) Caillon	3	N	ab	SA
Fucophycidae	Fucales	Sargassaceae	*Sargassum polyceratium*	Montagne	3	B	ab	SA
Fucophycidae	Fucales	Sargassaceae	*Sargassum polyceratium var. ovatum*	(F.S.Collins) W.R.Taylor	3	B	ab	SA
Fucophycidae	Fucales	Sargassaceae	*Sargassum vulgare*	C.Agardh	3	B	ab	SA
Fucophycidae	Fucales	Sargassaceae	*Turbinaria tricostata*	E.S.Barton	3	B	ab	SA
Fucophycidae	Fucales	Sargassaceae	*Turbinaria turbinata*	(Linnaeus) Kuntze	3	B	ab	SA
Fucophycidae	Scytothamnales	Scytosiphonaceae	*Hydroclathrus clathratus*	(C.Agardh) M.A.Howe	3	E	ab	SA
Fucophycidae	Scytothamnales	Asteronemataceae	*Asteronema breviarticulatum*	(J.Agardh) Ouriques & Bouzon	3	E	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Lobophora variegata*	(J.V.Lamouroux) Womersley ex E.C.Oliveira	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Padina borgesenii*	Allender & Kraft	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Padina gymnospora*	(Kützing) Sonder	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Padina haitiensis*	Thivy	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Padina pavonica*	(L.) Thivy in W.R. Taylor	6	E	ls	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Padina sanctae-crucis*	Børgesen	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Spatoglossum schroederi*	(C.Agardh) Kützing	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Stypopodium zonale*	(J.V.Lamouroux) Papenfuss	3	E	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Canistrocarpus cervicornis*	(Kützing) De Paula & De Clerck	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyopteris delicatula*	Lamouroux	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyopteris justii*	J.V.Lamouroux	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota bartayresiana*	J.V.Lamouroux	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota caribaea*	Hoerning & Schnetter	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota ciliolata*	Lamouroux	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota crenulata*	J.Agardh	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota crispata*	J.V.Lamouroux	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota guineensis*	P.L.Crouan & H.M.Crouan	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota hamifera*	Setchell	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota menstrualis*	(Hoyt) Schnetter, Hörning & Weber-Peukert	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota mertensii*	Kützing	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota pfaffii*	Schnetter	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota pinnatifida*	Kützing	3	B	ab	SA
Dictyotophycidae	Dictyotales	Dictyotaceae	*Dictyota pulchella*	Horning y Schnetter	3	B	ab	SA

Interactive table

Marine macroalgae

Phylum Rhodophyta

C	Sc	O	F	S					
Florideophyceae	Corallinophycidae	Corallinales	Corallinaceae	*Amphiroa fragilissima*	Linnaeus (J.V. Lamouroux)	3	B	ab	SA
				Hydrolithon farinosum	(J.V: Lamouroux) Penrose y Y.M. Chamberlain	3	B	ab	SA
				Jania capillacea	Harvey	3	E	ab	SA
				Lithophyllum prototypum	(Foslie) Foslie	3	B	ab	SA
				Lithophyllum stictaeforme	(J.E. Areschoug) Hauck	3	E	ab	SA
				Neogoniolithon strictum	(Foslie) Setchell & L.R.Mason	3	E	ab	SA
				Porolithon onkodes	(Heydrich) Foslie	3	B	ab	SA
				Amphiroa rigida	J.V.Lamouroux	3	B	ab	SA
				Lithophyllum congestum	(Foslie) Foslie	3	E	ab	SA
		Rhodogorgonales	Rhodogorgonaceae	*Rhodogorgon ramosissima*	J.N.Norris & Bucher	3	E	ab	SA
		Corallinales	Corallinaceae	*Amphiroa hancockii*	W.R.Taylor	3	B	ab	SA
				Amphiroa tribulus	(J. Ellis & Solander) J. V. Lamourux	3	B	ab	SA
				Fosliella chamaedoris	(Foslie & M.Howe) M.Howe	9	E	ls	SA
				Jania adherens	J.V. Lamouroux	3	E	ab	SA
				Pneophyllum fragile	Kuetzing (C)	3	E	ab	SA
				Haliptilon cubense	(Montagne ex Kützing) Garbary & H.W.Johansen	3	B	ab	SA
				Hydrolithon boergesenii	(Foslie) Foslie	3	E	ab	SA
				Jania cubensis	Montagne ex Kützing	9	E	ls	SA
				Jania subulata	(Ellis & Solander) Sonder	3	E	ab	SA
	Nemaliophycidae	Colaconematales	Colaconemataceae	*Colaconema dasyae*	(Collinis) Stegenga, I. Mol, Prud´homme van Reine et Lokhorst	1	E	pm	SA
				Colaconema hallandicum	(Kylin) Alfonso-Carillo, Sanson, Sangil et Diaz-Villa	1	E	pm	SA
				Colaconema hypneae	(Borgensen) A.A. Santos et C.W.N. Moura	1	E	pm	SA
		Nemaliales	Galaxauraceae	*Dichotomaria obtusata*	(J.Ellis & Solander) Lamarck	3	B	ab	SA
				Galaxaura subverticillata	Kjellman	3	E	ab	SA
			Liagoraceae	*Ganonema farinosum*	(J.V.Lamouroux) K.C.Fan & Yung C.Wang	6	E	ls	SA
				Ganonema norrisiae	(I.A.Abbott) Huisman, I.A.Abbott & A.R.Sherwood	3	E	ab	SA
				Liagora ceranoides	Lamouroux	3	B	ab	SA
				Liagora valida	Harvey	3	B	ab	SA
			Galaxauraceae	*Galaxaura rugosa*	(J. Ellis & Solander) J.V.Lamouroux Bonnemaisoniaceae	3	B	ab	SA
	Rhodymeniophycidae	Bonnemaisoniales		*Asparagopsis taxiformis*	(Delile) Trevisan de Saint-León	5	E	ab	BQ
		Ceramiales	Callithamniaceae	*Crouania attenuata*	(C.Agardh) J.Agardh	3	E	ab	SA
				Crouania pumila	B. Gavio, V.P. Reyes-Gomez & M.J.Wynne	4	E	lp	PSC
			Ceramiaceae	*Anotrichium tenue*	(C.Agardh) Naegeli	3	B	ab	SA
				Antithamnion decipiens	(J. Agardh) Athanasiadis	3	B	ab	SA
				Antithamnionella breviramosa	(E.Y. Dawson) Wollaston	3	B	ab	SA
				Centroceras clavulatum	Montagne	3	E	ab	SA
				Centroceras gasparrini	(Meneghini) Kuetzing	6	E	ls	SA
				Centroceras micracanthum	Kuetzing R (F)	6	E	ls	SA
				Ceramium bisporum	D.L. Ballantine	8	E	ls	SA
				Ceramium deslongchampii	Chauvin ex Duby	3	E	ab	SA
				Ceramium nitens	(C.Agardh) J.Agardh	3	E	ab	SA
				Ceramium virgatum	J.D.Hooker & Harvey	3	E	ab	SA
				Gayliella transversalis	(F.S.Collins & Hervey) T.O. Cho et Fredericq	5	E	ab	BQ
				Griffithsia globulifera	Harvery ex Kuetzing	5	E	ab	BQ
				Griffithsia heteromorpha	Kuetzing	3	E	ab	SA
				Gymnothamnion elegans	(Schousboe ex C.Agardh) J.Agardh	3	E	ab	SA
				Palisada corallopsis	(Montagne) Sentíez, Fujii & Díaz	3	E	ab	SA
				Perikladosporon percurrens	(E.Y.Dawson) Athanasiadis	3	E	ab	SA
				Wrangelia argus	(Montagne) Montagne	3	E	ab	SA
				Acrothamnion butlerae	(F.S.Collins) Kylin	3	E	ab	SA
				Balliella pseudocorticata	(E.Y.Dawson) D.N.Young	3	E	ab	SA
			Dasyaceae	*Dasya collinsiana*	M. Howe	6	E	ls	SA
				Dasya mollis	Harvey	3	E	ab	SA
				Dasya rigidula	(Kuetzing) Ardissone	5	E	ab	BQ
				Hypoglossum caloglossoides	M.J.Wynne & C.W.Schneider	3	E	ab	SA
				Nitophyllum adhaerens	M.J.Wynne	5	E	ab	BQ
			Rhodomelaceae	*Acanthophora spicifera*	(M.Vahl) Børgesen	3	E	ab	SA
				Bryothamnion triquetrum	(S.G.Gmelin) M.A. Howe	3	B	ab	SA
				Chondria baileyana	(Montagne) Harvey	5	E	ab	BQ

C	Sc	O	F	S					
Florideophyceae	Rhodymeniophycidae	Ceramiales	Rhodomelaceae	*Chondria cnicophylla*	(Mellvil) De Toni	6	E	ls	SA
				Chondria dasyphylla	(Woodward) C. Agardh C (MC)	6	E	ls	SA
				Chondria floridana	(F.S.Collins) M.A. Howe	5	E	ab	BQ
				Chondria leptacremon	(Mellvil) De Toni	6	E	ls	SA
				Chondria platyramea	A.B.Joly & Ugadim,	3	E	ab	SA
				Digenea simplex	(Wulfen) C.Agardh	3	E	ab	SA
				Herposiphonia parca	Setchell	1	E	pm	SA
				Laurencia filiformis	(C.Agardh) Montagne	6	E	ls	SA
				Laurencia intricata	J.V.Lamouroux	3	E	ab	SA
				Laurencia microcladia	Kützing	3	E	ab	SA
				Laurencia obtusa	(Hudson) J.V.Lamouroux	3	E	ab	SA
				Lophocladia trichoclados	(C. Agardh) F. Schmitz	5	E	ab	BQ
				Lophosiphonia cristata	Falkenberg	3	E	ab	SA
				Neosiphonia sertularioides	(Grateloup) K.W.Nam & P.J.Kang	2	E	pm	SA
				Neosiphonia sphaerocarpa	(Boergesen) M.S.Kim & I.K.Lee	2	E	pm	SA
				Neosiphonia tongatensis	(Harvery ex Kuetzing) M.S. Kim & I.K.Lee	5	E	ab	BQ
				Palisada perforata	(Bory de Saint-Vincent) K.W.Nam,	3	E	ab	SA
				Polysiphonia flaccidissima	Hollemberg (F)	6	E	ls	SA
				Polysiphonia howei	Hollenberg in W.R. Taylor	6	E	ls	SA
				Polysiphonia schneideri	B. Stuercke & D.W.Freshwater	2	E	pm	SA
				Yuzurua poiteaui var. gemmifera	(Harvey) M.J.Wynne	6	E	ls	SA
			Spyridiaceae	*Spyridia filamentosa*	Harvey	3	E	ab	SA
				Spyridia hypnoides	(Bory de Saint-Vincent) Papenfuss	3	E	ab	SA
			Wrangeliaceae	*Griffithsia schousboei*	Montagne	3	E	ab	SA
				Lejolisia mediterranea	Bornet	3	B	ab	SA
				Wrangelia bicuspidata	Borgesen	5	E	ab	BQ
				Wrangelia penicillata	(C.Agardh) C.Agardh	3	E	ab	SA
			Ceramiaceae	*Antithamnion antillanum*	Børgesen	3	E	ab	SA
			Dasyaceae	*Heterosiphonia crispella*	(C.Agardh) M.J.Wynne	3	E	ab	SA
				Heterosiphonia crispella var. laxa	(Borgesen) Wynne	5	E	ab	BQ
			Delesseriaceae	*Hypoglossum hipoglossoides*	(Stackhouse) F.S.Collins & Hervey	3	E	ab	SA
				Hypoglossum simulans	M.J.Wynne I.R.Price & D.L.Ballantine	5	E	ab	BQ
				Hypoglossum subsimplex	M.J.Wynne	3	E	ab	SA
				Hypoglossum tenuifolium	(Harvey) J.Agardh	3	E	ab	SA
				Martensia fragilis	Harvey	3	E	ab	SA
			Wrangeliaceae	*Haloplegma duperreyi*	Montagne	3	E	ab	SA
		Gelidiales	Gelidiaceae	*Gelidium americanum*	(W.R. Taylor) Santelices	3	E	ab	SA
				Gelidium crinale	(Hare ex Turner) Gaillon	3	E	ab	SA
				Parviphycus setaceus	(Feldmann) J. Agonso-Carrillo, M. Sanson, C. Sangil & T. Diaz-Villa.	5	E	ab	BQ
				Gelidium pusillum	(Stackhouse) Le Jolis	3	E	ab	SA
		Gigartinales	Cystocloniaceae	*Hypnea cervicornis*	J. Agardh	6	E	ls	SA
			Solieriaceae	*Meristotheca gelidium*	(J.Agardh) E.J.Faye & M.Masuda	3	B	ab	SA
			Gracilariaceae	*Gracilaria damaecornis*	J. Agardh	6	E	ls	SA
				Gracilaria domingensis	(Kützing) Sonder	6	E	ls	SA
		Halymeniales	Halimedaceae	*Cryptonemia crenulata*	(J.Agardh) J.Agardh, 1851	3	B	ab	SA
				Grateloupia filicina	(J.V.Lamouroux) C.Agardh	3	E	ab	SA
		Rhodymeniales	Champiaceae	*Champia parvula var. prostrata*	"L.G.Williams"	5	E	ab	BQ
				Coelothrix irregularis	Boergesen	3	E	ab	SA
			Rhodymeniaceae	*Botryocladia pyriformis*	(Børgesen) Kylin	3	E	ab	SA
			Champiaceae	*Champia salicornioides*	Harvey	6	E	ls	SA
				Champia vieillardii	Kützing	3	E	ab	SA
		Gigartinales	Cystocloniaceae	*Hypnea musciformis*	(Wulfen) J.V.Lamouroux	3	E	ab	SA
				Hypnea spinella	(C.Agardh) Kützing	3	E	ab	SA
		Gracilariales	Gracilariaceae	*Hydropuntia cornea*	(J.Agardh) M.J.Wynne	9	E	ls	SA
		Rhodymeniales	Rhodomelaceae	*Yuzurua poiteaui*	J.V.Lamouroux Martin-Lescanne	6	E	ls	SA
Stylonematophyceae	Rhodellophytina	Stylonematales	Stylonemataceae	*Stylonema alsidii*	(Zanardini) K. M. Drew	1	E	pm	SA
				Chroodactylon ornatum	(C. Agardh) Basson	1	E	pm	SA

Interactive table

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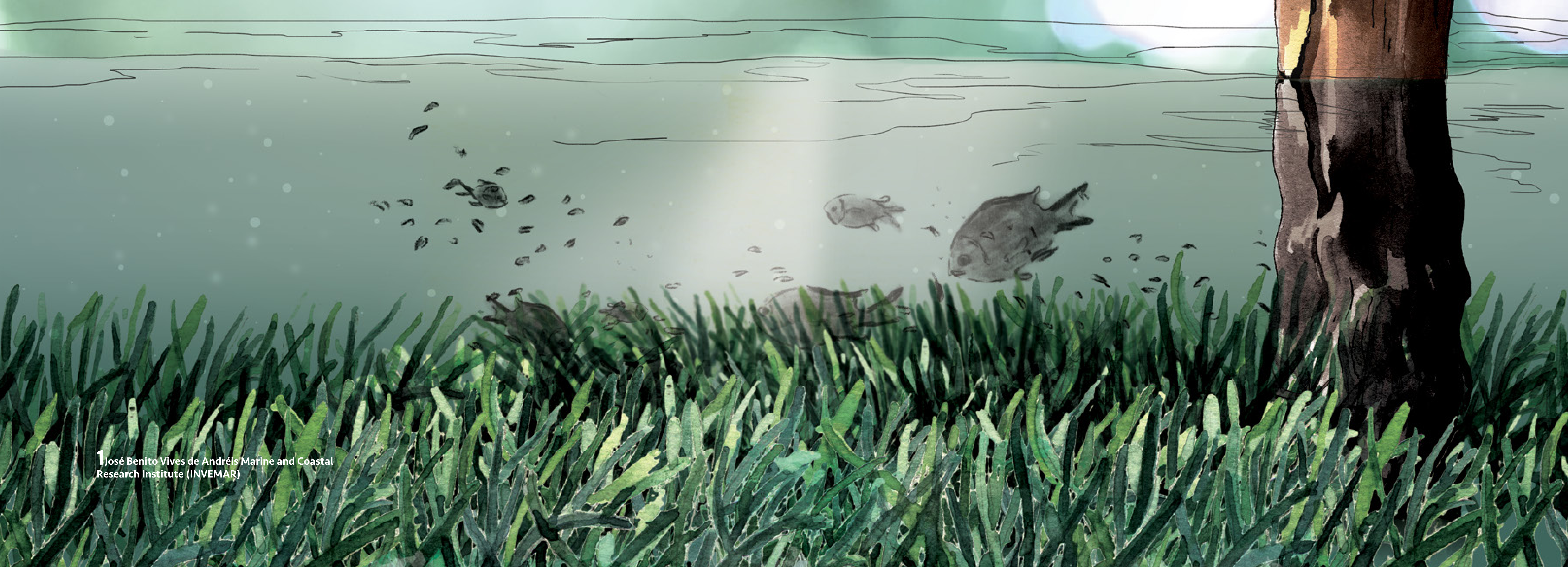
MARINE ANGIOSPERMS

Of the San Andrés, Providencia and Santa Catalina Islands

Diana Isabel Gómez López[1], Jenny Alexandra Rodríguez Rodríguez[1]

Plants are all those living organisms that have the ability to photosynthesize, do not determine their moves autonomously and whose cell walls are formed especially by cellulose. Nowadays, angiosperms, also called vascular plants, make up the most important group of plants, considering their number of lineages, their abundance and the diverse types of life and habitats they occupy in the planet. Although the presence of flowers has usually been considered the most important characteristic of this group of plants, other important characteristics that differentiate them from the other groups include production of protected seeds; conductor vessels through which water, nutrients and different minerals circulate into the plant; and quick reproduction and pollination. This chapter addresses marine angiosperms that are present in marine coastal zones of the San Andrés, Providencia and Santa Catalina Islands, specifically mangrove swamps and seagrass beds.



[1] José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

Mangrove swamps

In the coastal zone
41%
of the land area is colonized by forests

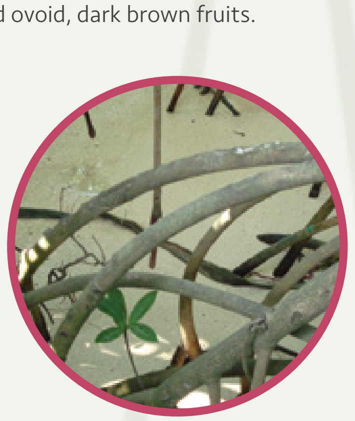
Mangrove swamps are plant associations typical of coastal strips in tropical and subtropical zones of the world, which have morphological, physiological and reproductive specializations that allow them to develop in unstable and anoxic soils with high temperatures, content of organic matter and saline influence **(Tomlinson, 1986; Hutchings y Saenger, 1987)**. Around 55 species belonging to 17 families that cohabit in transition environments are recorded worldwide **(Field, 1995)**; nevertheless, only some of them are true mangroves **(Wang *et al.*, 2010)**. In Colombia, there are nine true species, two of them distributed exclusively in the Pacific coast and only five of them are related to the continental Caribbean **(Spalding *et al.*, 2010).**

In general, in the coastal zone of the Archipelago of San Andrés, Providencia and Santa Catalina, 41% of the land area is colonized by forests (monospecific or of several species corresponding to the families Rhizophoraceae, Avicenniaceae and Combretaceae) of which around 80% is in San Andrés Island and 20% between Providencia and Santa Catalina. They are characterized by their short stature and stunted growth, except for the forest located in the Smith Channel sector in San Andrés Island, where the influence of aquifers and runoffs that generate the low levels of salinity on the soil enable the existence of mangrove organisms with a large structural development **(Rodríguez Rodríguez, 2011; Gómez Cubillos, *et al.*, 2014)**.

Four true species make up the mangrove forests of the Archipelago of San Andrés, Providencia and Santa Catalina: Red mangrove (*Rhizophora mangle*), Black mangrove (*Avicennia germinans*), White mangrove (*Laguncularia racemosa*) and Button wood mangrove (*Conocarpus erecta*) **(Sánchez Páez *et al.*, 1997 a y b; CORALINA-INVEMAR, 2012; Machacón *et al.*, 2012)**; which host great diversity of invertebrates, reptiles, birds and mammalians **(Londoño Mesa *et al.*, 2002; Vilardy y Polanía, 2002, Romero Murillo y Polanía, 2008)**, the swanka turtle (*Kinosternon scorploides*),endemic of San Andrés Island, stands out **(CORALINA, 2014)**. Among the mangrove swamps, the following are the most important ones.

Rhizophora mangle or red mangrove

It is the most common species of the archipelago and it tolerates salinities from zero to 45 psu. It requires longer flooding times and greater circulation waters. It roots well in very soft and unstable soils, which become steady and stable after it grows and develops prop stilt-shaped roots; this allows the colonization of other species, such as the black and white mangroves, as well as the withholding of sediment contributing to soil accretion. It has extended pencil-shaped propagules and ovoid, dark brown fruits.



Avicennia germinans or black mangrove

It is the second species in terms of abundance in the archipelago and the most tolerant to salinity (up to 90 psu). In hypersaline soils, it can modify its physiognomic structure, forming bushes or scrubs; it has pneumatophores that allow it to exchange gases; it also reinforces soils **(Twilley *et al.*, 1986)**. It has an elliptical lime-color fruit.

Laguncularia racemosa or white mangrove

It can be found between the two previously mentioned species. It tolerates salinities from zero to 70 psu and requires a flood frequency lower than the red mangrove and higher than the black mangrove, as well as a more stable substrate (soil). It takes advantage of high densities of solar irradiation to grow quickly and, for that reason, it is considered an innovating species; however, it is not very tolerant to shades **(Rivera Monroy *et al.*, 2001)**. It has no visible air roots, even though in long anoxic conditions it can get to develop short pneumatophores. It produces small white flowers in ears and small heart-shaped lime-color fruits.

Conocarpus erectus or buttonwood mangrove

It is often found in transition zones with more elevated and dry lands with terrestrial vegetation. It has a gray or brown, rough and cracked bark. Its flowers are grouped in the shape of buttons growing in ramified bunches, forming a purple or brown cone-shaped fruit.

Conocarpus erectus

Since the different mangrove species transform their substrates and create, in that way, habitats for other species, succession gives rise to a sequence of species from the marine front to mainland (Spalding ***et al.***, 2010), that generally starts with *R. mangle*, continues with *L. racemosa*, *A. germinans* , and ends with *C. erectus* .

Among the associated fauna, there are many generalist and wide-spreading species; however, species such as the raccoon and some species of crustaceans, birds and reptiles are typical of these environments (REF: Figure 9). Moreover, each part of the plants is of specific interest for different types of organisms. For instance, the fiddler crab Uca sp. and some molluscs, such as snails, prefer the fallen leaves, while defoliating insects in larval stage, deer and howler monkeys prefer to take the leaves directly from the branches. On the branches, it is common to see birds such as pelicans, herons, common kingfishers, hawks, migratory birds and even termites, whose role as decomposers is important in this type of environments. Around the roots, the presence of fish and bivalve molluscs, such as oysters, snails, barnacles, sponges, worms and echinoderms, are only a small list of the living organisms that use these plants in a specific way. Likewise, bees are the pollinators of the mangrove species *Avicennia* y *Laguncularia*.

The following are some of the benefits these ecosystems provide:

They host a diverse group of aquatic, terrestrial and amphibian organisms (in total more than 15 groups including fish, reptiles, molluscs, macroalgae and crustaceans, among others).

They protect coasts from wind and wave erosion, as well as from storms and swells.

They play a vital role in coastal fisheries and the continental shelf, favoring large-scale fishing and traditional family fishing.

They represent an invaluable resource for the wood industry, as well as for tannins employed in tanneries and dry cleaners.

They work as the environment's lungs because they produce oxygen and sequester carbon dioxide from the air **(Pendleton *et al.*, 2012)**,therefore, they are one of the biggest natural sewers of the coastal marine zones in the tropics, storing carbon dioxide mainly at the level of the subsoil **(Donato *et al.* 2011)**,and, in that way, contributing to mitigate climate change.

They are areas for passive recreation, water sports and tourism activities.

They increase the biodiversity favoring nesting and resting zones for (native and migratory) birds

The causes of deterioration and loss of vegetation of mangrove swamps in Providencia and Santa Catalina Islands are related to the expansion of the rural and tourist boundary, the high exposure to the coastal dynamics and the passage of tropical storms. Regarding San Andrés Island, the most recurring and impacting issues are those derived from the expansion of the urban, tourism and rural infrastructure, as well as the construction of the surrounding road, the high exposure to the coastal dynamics, the effects of the passage of tropical storms, the attack of plagues and diseases and the occasional pollution with chemicals and hydrocarbons **(Gómez Cubillos *et al.*, 2014).**

The study of the associated threats and risks in the islands is important to establish mitigation and adaptation measures. In the particular case of the mangrove forest of the Smith Channel sector, **Guerra Vargas (2013)**,after studying the associated threats, suggests adopting conservation measures in the short term, due to the high values of sensitivity regarding urban development, infrastructure and land reclamation that is just starting to affect it and that may be solved more easily than those found in the Old Point regional park.

Seagrasses

Seagrasses are species of land vascular plants that migrated to the sea around 100 million years ago, living there during all their life cycle. They have a hydrophilic pollination and an internal gas transport system; they can live in anoxic environments during short periods and they get nutrients dissolved in water and sediments, through leaves and roots. Their leaves absorb CO_2 and other forms of organic carbon dissolved, mainly carbonate ions **(den Hartog & Phillips, 2001; Díaz *et al.*, 2003; den Hartog & Kuo, 2006).**

Their general structure consists of a root system that is buried in the substrate, and an exposed leaf system that is present in a perpendicular linear construction; the leaf structure emerges vertically from the stolons at regular intervals. Fossil records of current genera and species such as *Thalassia testudinum* Banks ex König, have been found and dated back to the Eocene, around 56 million years ago **(den Hartog y Kuo, 2006).**

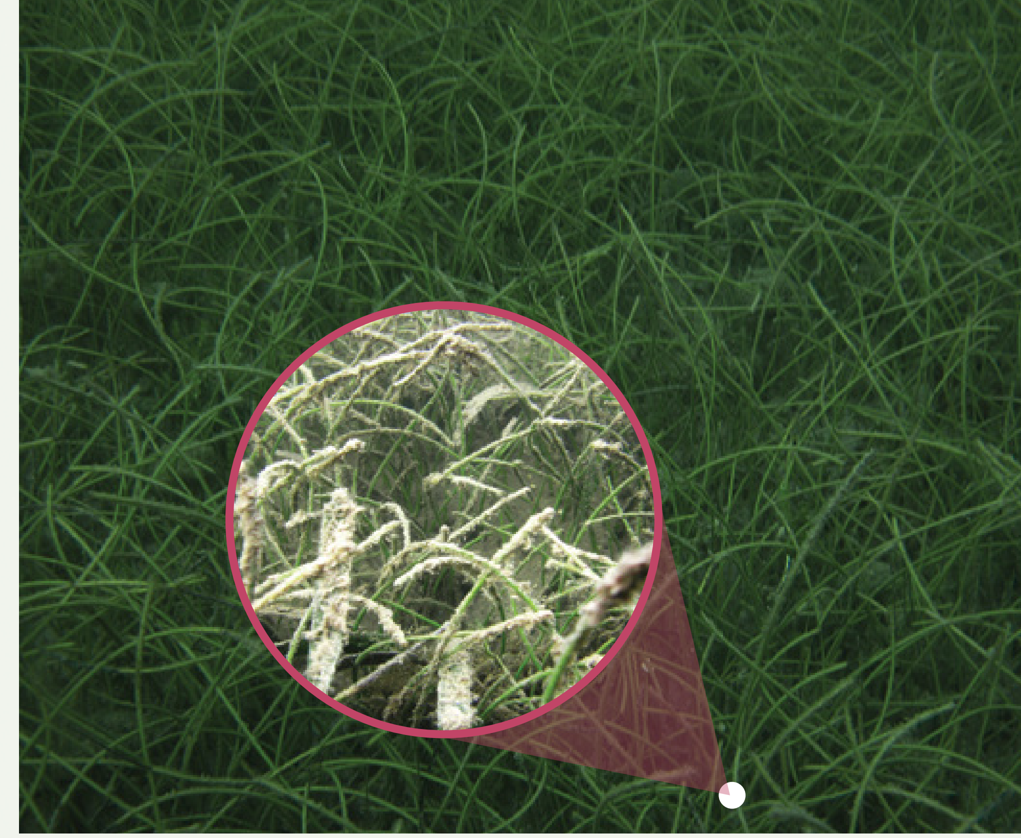
Around the world, there are approximately 60 species belonging to three families: Hydrocharitaceae, Cymodoceaceae and Ruppiaceae **(Green *et al.*, 2003)**. Of the total recognized species, 10 are already in the lists of threatened species worldwide, especially due to degradation and loss of their habitats **(Short et al, 2011).**
In Colombia, Six seagrass species (*Thalassia testudinum, Syringodium filiforme, Halodule wrightii, Halophila decipiens, Halophila baillonis* y *Ruppia maritima*), d) of the nine recorded in the Wider Caribbean are recorded in Colombia. Regarding the archipelago, until 2007, studies by Lasso (2007 a y b) ronly recorded two notable species in the island (*Thalassia testudinum* and *Syringodium filiforme*), However, after the updating studies of the marine flora and fauna inventory carried out in 2008, the number of species became four, namely *Thalassia testudinum, Syringodium filiforme, Halodule wrightii* y *Halophila decipiens* **(Mejía-Ladino *et al.*, 2008).**

Thalassia testudinum or turttlegrass

It has flat, broad (±2cm) ribbon-shaped leaves that, in the islands, can reach up to 50 cm long. It has a strong and thick rhizome provided with knots. Each stem (group of leaves) has from three to seven leaves. Its reproduction is sexual and asexual. It is the main producer of grass around the islands.

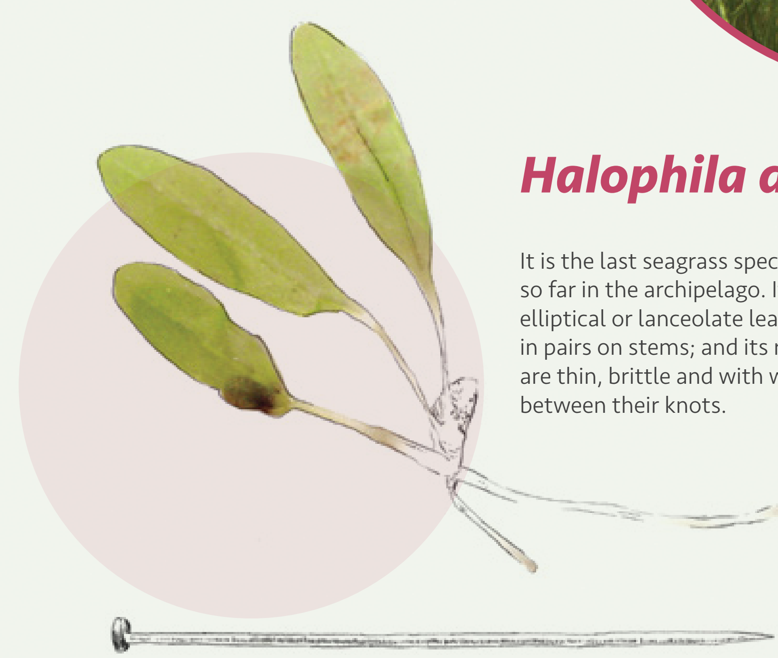
Syringodium filiforme or manatee grass

It has thin brittle cylindrical leaves, with an average length of 10 cm in the islands. Branches holding the leaves emerge from the rhizome nodes at regular intervals. There are not many records of flowers. It is the second producer of seagrass in the archipelago.



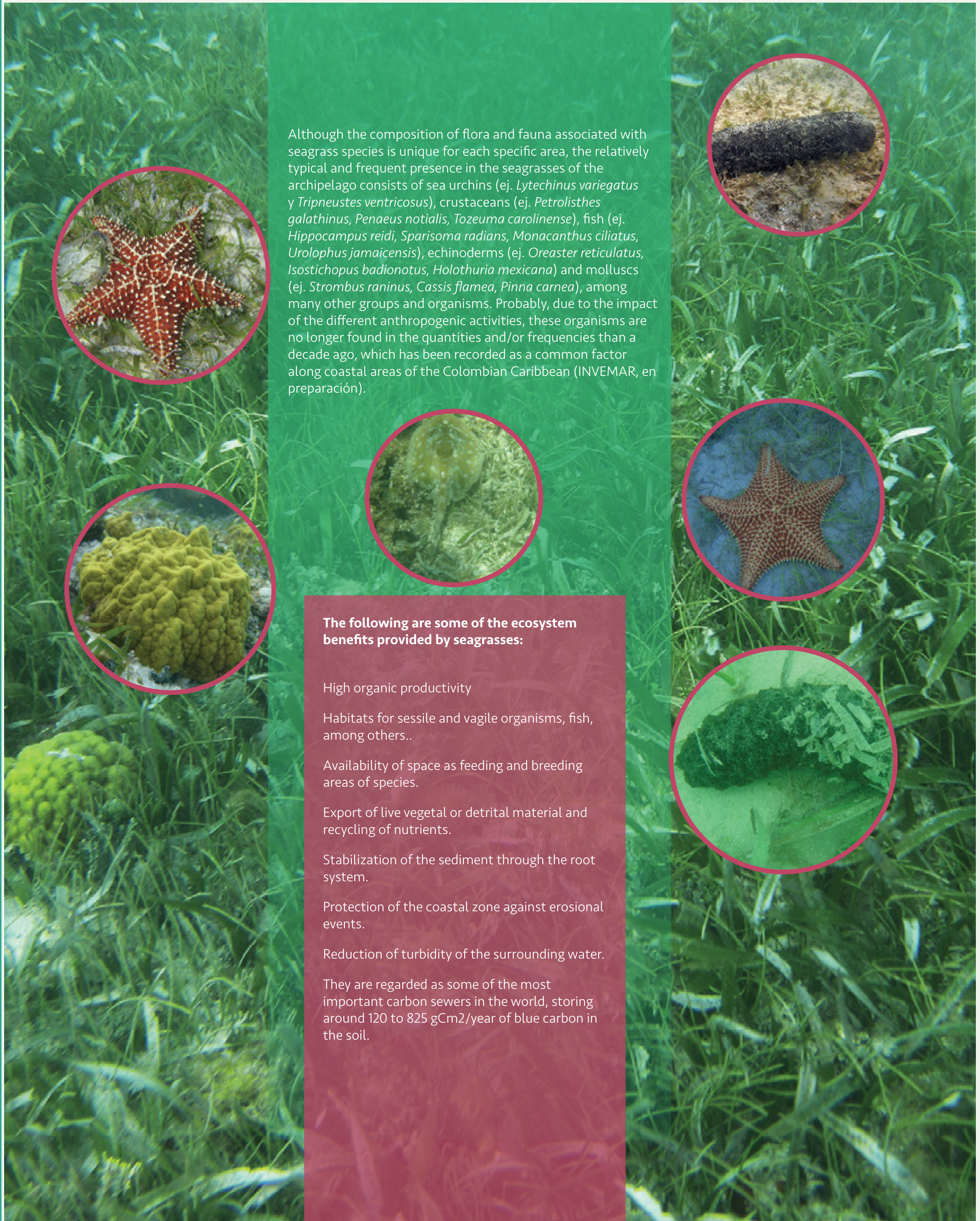
Halodule wrightii

It is one of the smallest species of this group (not higher than 7 cm long) and has stems of erect branches with two to four very thin flat leaves. The apex of its leaves ends irregularly, creating points in the ends. It has thin rhizomes knotted at regular intervals and it is generally associated with fine sand substrates near mangrove swamps, or forming small patches among the *Thalassia*.



Halophila decipiens

It is the last seagrass species recorded so far in the archipelago. It has oblong, elliptical or lanceolate leaves, arranged in pairs on stems; and its rhizomes are thin, brittle and with wide spaces between their knots.



Although the composition of flora and fauna associated with seagrass species is unique for each specific area, the relatively typical and frequent presence in the seagrasses of the archipelago consists of sea urchins (ej. *Lytechinus variegatus* y *Tripneustes ventricosus*), crustaceans (ej. *Petrolisthes galathinus, Penaeus notialis, Tozeuma carolinense*), fish (ej. *Hippocampus reidi, Sparisoma radians, Monacanthus ciliatus, Urolophus jamaicensis*), echinoderms (ej. *Oreaster reticulatus, Isostichopus badionotus, Holothuria mexicana*) and molluscs (ej. *Strombus raninus, Cassis flamea, Pinna carnea*), among many other groups and organisms. Probably, due to the impact of the different anthropogenic activities, these organisms are no longer found in the quantities and/or frequencies than a decade ago, which has been recorded as a common factor along coastal areas of the Colombian Caribbean (INVEMAR, en preparación).

The following are some of the ecosystem benefits provided by seagrasses:

High organic productivity

Habitats for sessile and vagile organisms, fish, among others..

Availability of space as feeding and breeding areas of species.

Export of live vegetal or detrital material and recycling of nutrients.

Stabilization of the sediment through the root system.

Protection of the coastal zone against erosional events.

Reduction of turbidity of the surrounding water.

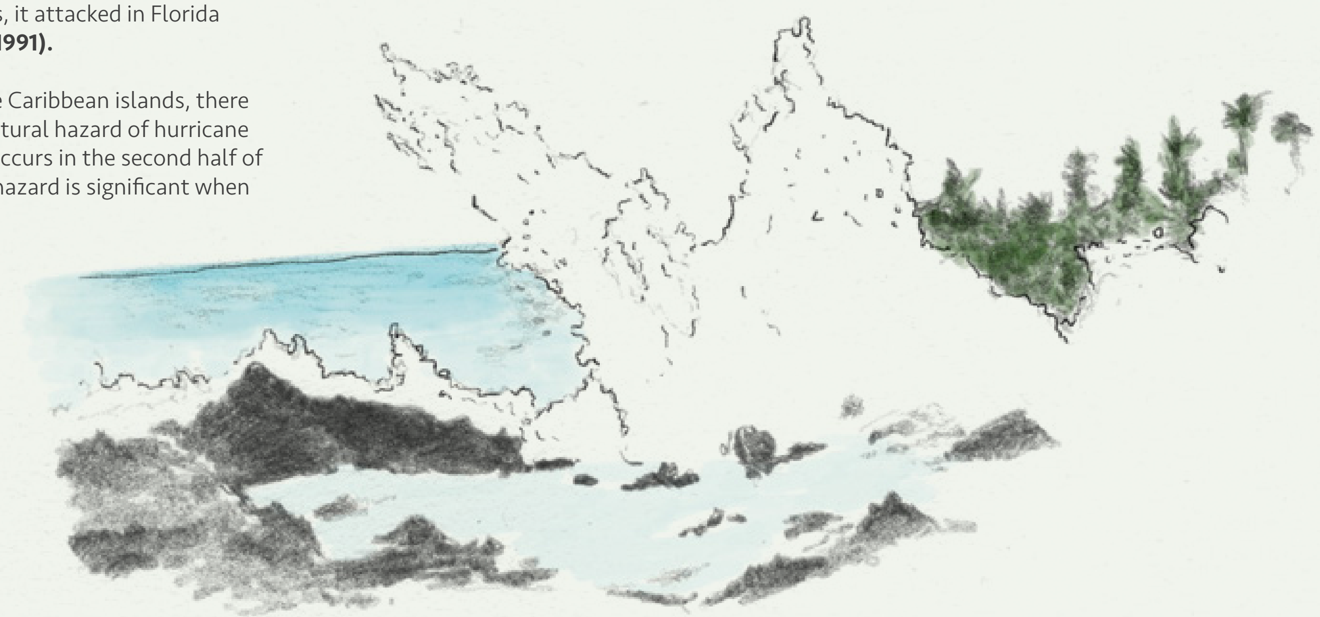
They are regarded as some of the most important carbon sewers in the world, storing around 120 to 825 gCm2/year of blue carbon in the soil.

Trampling and crushing, caused by tourism in coastal areas; manual or mechanic physical extraction, caused by tourism or coastal development activities; habitat degradation, caused by solid and liquid waste pollution; unchecked boating activities —anchorage and docking causing scars due to outboard motors—; and both selective and nonselective extraction of fauna related to the ecosystems, are recognized as anthropic threats to which these species are exposed **(Gómez Cubillos *et al.*, 2014).** All these causes are very similar to those recorded for its degradation and loss worldwide.

Thepresence of a disease caused by a fungus called *Labyrinthula* sp. has been detected in both Thalassia and Syringodium, and it has affected seagrass leaves in the archipelago (Mejia Ladino *et al.*, 2008) **it could also affect macroalgae and phytoplankton** (Sullivan *et al.*, 2013).

As of today, however, there have been no massive or partial mortalities caused by this fungus at a local level; and its disappearance has been shown to occur in infested areas at the Old Providence McBean Lagoon National Natural Park. In historical records from the 30's, in North America and Europe, it is said that this fungus caused a dieback of more than 90% of the population of *Zostera sp.* **(den Hartog, 1987; Short *et al.*, 1987)**,and later, in the 80's, it attacked in Florida **(Roblee *et al.*, 1991).**

Especially in the Caribbean islands, there is a recurring natural hazard of hurricane season, which occurs in the second half of each year. This hazard is significant when tropical storms and hurricanes in the Caribbean are petering out and reach the archipelago, causing, in many cases, plants and sediment to be ripped out, which mainly affects the restoration of grasslands and its role as sediment compactors and coastline protectors.



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Mangrove swamps

Phylum Tracheophyta

O	F	S			
Malpighiales	Rhizophoraceae	*Rhizophora mangle*	(L.)	1,2	PSC, SA
Lamiales	Acanthaceae	*Avicennia germinans*	(L.) L.	1,2	PSC, SA
Myrtales	Combretaceae	*Laguncularia racemosa*	(L.) C.F. Gaertn.	1,2	PSC, SA
		Conocarpus erectus	Linnaeus, 1753	1,2	PSC, SA

LC The conservation status of all species listed as mangrove swamp is classified under the category of Least Concern.

SPAW Anexo III SPAW All species listed as mangrove swamp are included in Annex III of the SPAW Protocol.

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Interactive table

Seagrass

Phylum Tracheophyta

C	O	F	S					
Magnoliopsida	Alismatales	Hydrocharitaceae	*Thalassia testudinum*	K.D.Koenig, 1805	1	B	sm	PSC, SA, BQ, BS
		Cymodoceaceae	*Syringodium filiforme*	Kützing, 1860	1	B	sm	PSC, SA, CS
			Halodule wrightii	Ascherson, 1868	1	B	sm	PSC, SA
		Hydrocharitaceae	*Halophila decipiens*	Ostenfeld, 1902	1	B	sm	PSC, SA

LC The conservation status of all seagrass species is classified under the category of Least Concern.

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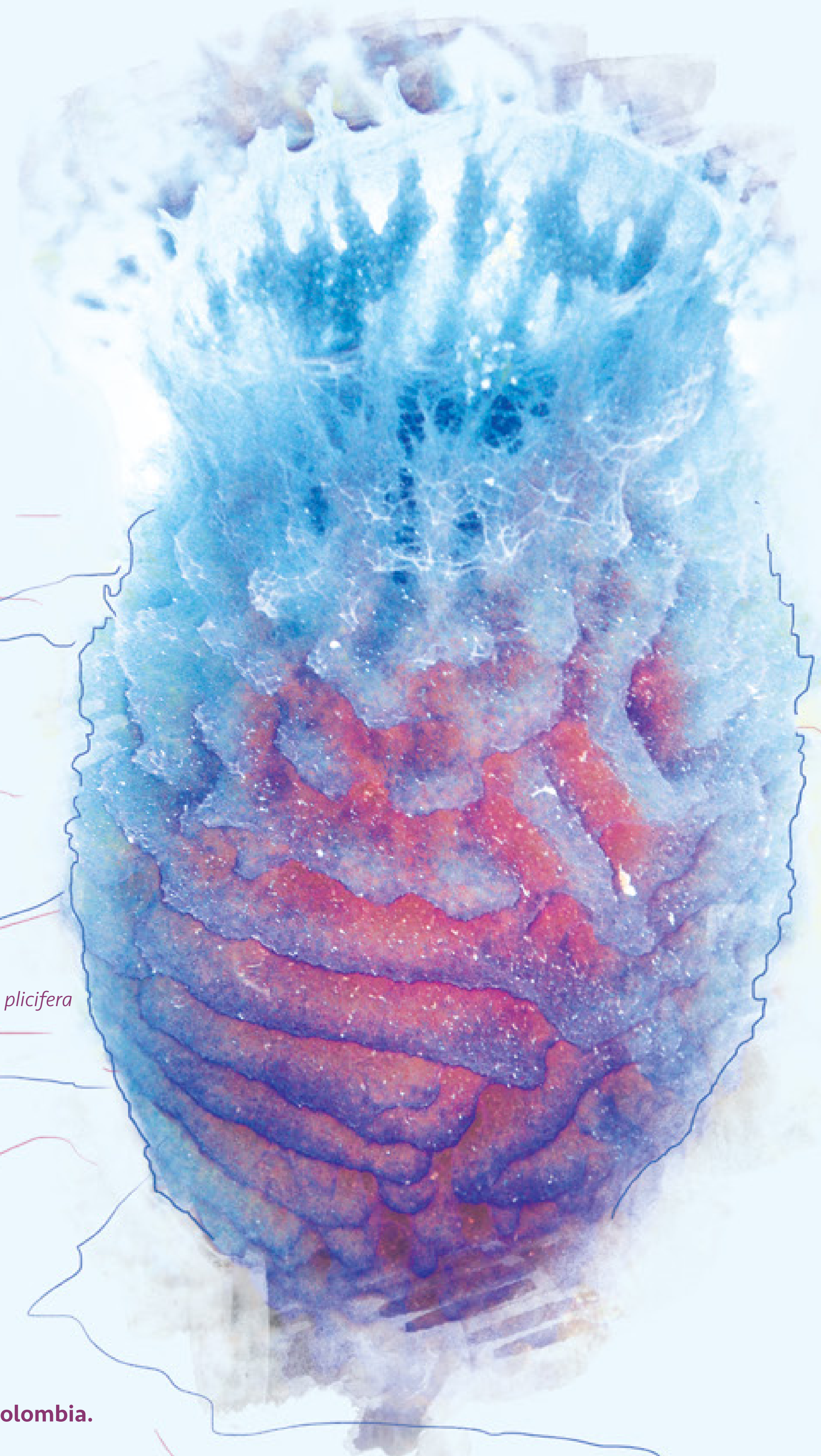
Interactive table

SPONGES (*Porifera*)

Of the Seaflower Biosphere Reserve

Christian M. Díaz-Sanchez[1] and Sven Zea[2]

Callyspongia plicifera



Poriferans or sponges are the most primitive multicellular animals. They live attached to the bottom and come in a variety of shapes and dazzling colors. Their relative external simplicity contrasts with its internal complexity, full of biochemical and microscopic interactions that are imperceptible to the human eye. This group has prompted high-impact research, primarily, regarding the origin of multicellular animal characteristics. Nevertheless, few divers and amateurs can distinguish species by their particular growth forms underwater. For instance, forms of tubes, glasses, fans, and branches are commonly documented as erect sponges; and those forms covering irregular-shaped rocks and living substrates are called encrusting sponges. Fortunately, visual guides, databases, and an increasing number of people considering the group of sponges in their research are currently available with the aim of identifying porifera (Zea *et al.*, 2014).

Sponges are an important group of organisms in marine communities as they are part of biodiversity maintenance, seascape scaffold, and ecosystem services provision. Most species of sponges live in the sea and a few in fresh water. As they do not move, they must filter the surrounding water to extract their food and oxygen. To do this, they have an aquifer system consisting in intake pores in the skin and a network of inhalant canals, feeding chambers where particles are filtered and water is actively pumped through specialized cells with a collar and a flagellum, and networks of exhalant canals that converge to large holes (oscula), through which water carrying waste is expelled **(De Voes *et al.*, 1991).** The particulate material they filter are tiny algae and bacteria; to illustrate its capacity, a 1-kg specimen is capable of filtering 24 m3 of water per day **(Hentschel *et al.*, 2002).** In addition —and as an interesting fact—, evidence of carnivorous habits sponges that passively hunt small invertebrates, as carnivorous plants do, has been registered **(Vacelet y Boury-Esnault, 1995).**

The body of the sponge is supported by an internal skeleton formed by mineral spicules (generally made of silica or calcium carbonate for another group), cemented in a greater or lesser extent by collagen (spongin). The inner matrix is a type of connective tissue with multifunctional cells, many of them movable **(Müller y Müller, 2003).** Like other animals, they reproduce sexually, even though they do not have permanent sexual organs but groups of cells that differentiate themselves to form eggs or sperm during the breeding season. Whether it is developed in the water or inside the mother sponge, the fertilized egg develops into a swimmer larva that scatters and looks for a new substrate to attach itself **(Custódio *et al.*, 2007).** These living strategies have successfully helped sponges inhabit all seas, for, at least, 500 million years now **(Ehrlich *et al.*, 2013).**

1 Marine and Coastal Research Institute (INVEMAR), Santa Marta, Colombia.

2 Universidad Nacional de Colombia - Caribe Campus-, Institute of Studies on Marine Sciences (CECIMAR) c/o INVEMAR, Santa Marta, Colombia.

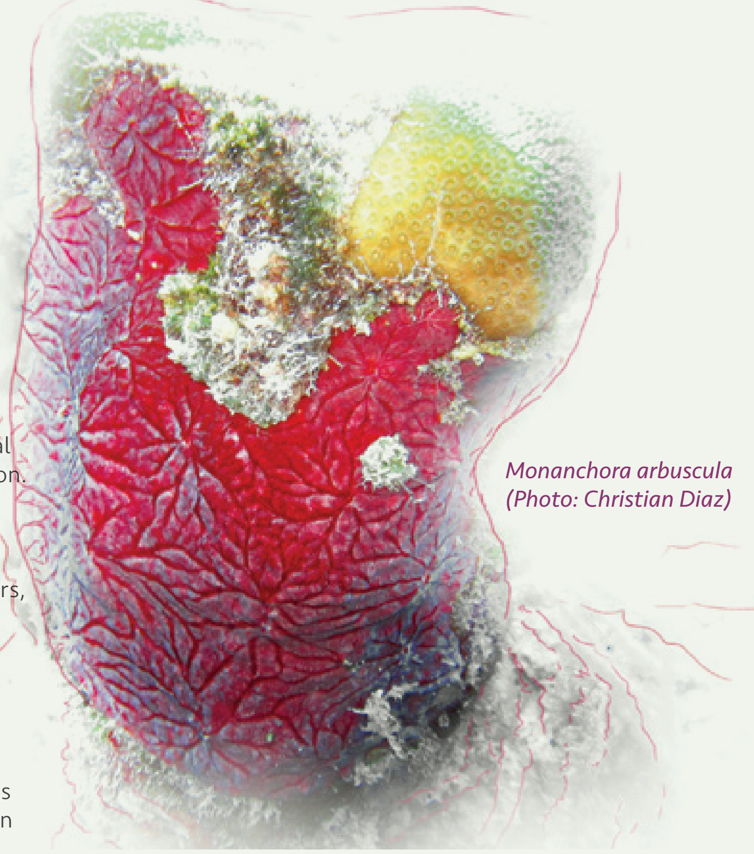
Classification

The ***Phylum Porífera*** is classified into four classes: Calcarea, Hexactinellida, Homoscleromorpha and Demospongiae (Erpenberck y Wörheide, 2007). Nowadays, Porifera is an abundant group in the oceans of the earth, with about 8,637 valid species (Van Soest *et al.*, 2015), and its biodiversity is distributed across all known latitudes and hemispheres. Class Demospongiae gathers about 81% of current species, with about 7,000 valid species, and an average of 50 new species described to science per year (Morrow Cárdenas, 2015). This scenario of global taxonomy for sponges is indexed in the World Porifera DataBase www.marinespecies.org/porifera (Hooper y van Soest, 2002).


Photo: Juan Carlos Marquez

According to Van Soest and (2012), 945 species, grouped in 281 genera, have been recorded in the Western Tropical Atlantic. Among these, 676 species, grouped in 239 genera, are known to be in the marine province of the Wider Caribbean Region. However, only 34 genera have been recorded in the Southwestern Caribbean, marine ecoregion where Colombia is located.

Sponges are classified based on internal morphological characteristics such as the shape of spicules and the three-dimensional architecture and organization of the skeleton. As for species, physical characteristics of shape, color, consistency, surface, and osculum organization are also used. They have different shapes and, sometimes, colors, depending on the habitat and geography they inhabit and it is often reflected in the genetic variability among populations **(Solé - Cava y Boury - Esnault, 1999).** However, in a given geographical area, each species is usually unique and, with a certain experience, the most common ones can be distinguished; besides, although assigning them a scientific name is generally difficult, online and printed regional guides are facilitating this process.


Monanchora arbuscula (Photo: Christian Diaz)

Ecological aspects of marine sponges

Ecological functions attributed to sponges can be summarized into three broad categories (Moraes, 2011):

1 They act as a link between the seafloor and the surrounding water column, by biochemically filtering and processing large amounts of water.

2 They provide shelter and protection to other organisms through multiple ecological associations.

3 They compete for space on the seafloor, and help both erode and settle it. lidarlo.

Sponges also benefit primary production recycling oxygen, carbon, silica and nitrogen and remineralizing dissolved organic matter **(de Goeij *et al.*, 2013)**, with significant differences among species depending on the food webs they are part of **(Maldonado, 2015).**

Biological associations in sponges are multiple and, thanks to modern research techniques, different types of symbiotic microorganisms such as algae, dinoflagellates, fungi, bacteria, and viruses have been found inside them **(Müller y Müller, 2003)**. It is common to find relationships of mutualism, commensalism and parasitism with worms, shrimp, crabs, snails, bivalves, sea urchins, and brittle stars, and even with small fish. These relationships demonstrate phylum Porifera involvement and importance in the construction of the ecological structure on the seafloor **(Pawlik, 2011).**

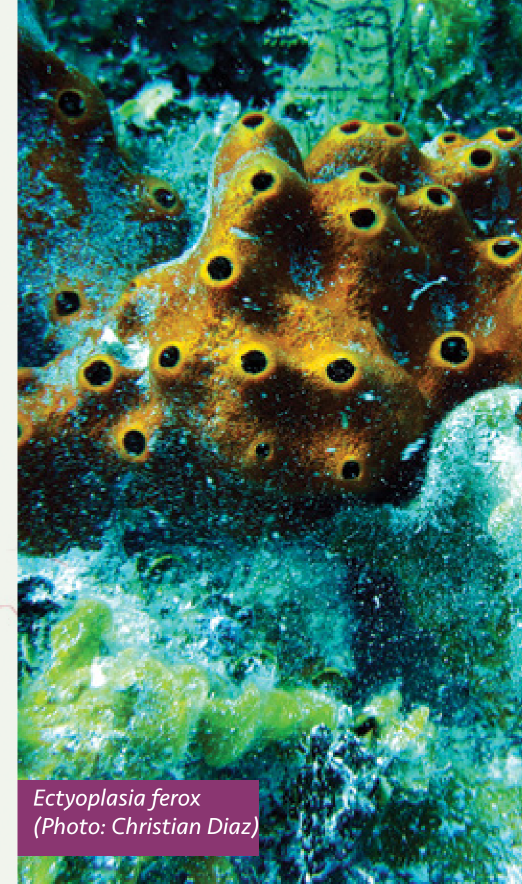
Approximately 98% of all species of sponges live in the marine environment, in warm and cold water, in tropical and polar latitudes, from the intertidal zone to the abyssal depths. Although there are some species that inhabit soft sand and mud bottoms, these organisms are more easily found settled on hard substrates in shallow ecosystems ((<30 m in depth) as reefs, mangrove roots, seagrass beds, rocky walls, and artificial structures, where their biomass can exceed other organisms which are closely associated to the seafloor **(Díaz & Rützler, 2009; Díaz, 2012).**

Sponge communities can also be conspicuous in mesophytic environments **(30-100m de profundidad)** d), where the availability of sunlight is poor, as well as in shallow cryptic habitats like caves, crevices, and coral rubble; and there, discoveries that serve as a reference point for future studies are made every year **(Rützler *et al.*, 2014).** DSimilarly, studies in deepwater **>100m in depth** are finding unique aggregations in sponges that resemble reefs **(Maldonado *et al.*, 2015)**. Apparently, the greatest riches are found in places where substrates are more consolidated, or in areas with greater structural complexity, and are usually found in inclined areas, such as slopes, canyons, and seamounts **(Hajdu *et al.*, 2011).**

Sponges can be used to determine the relative level of biodiversity in marine environments; and distribution patterns of certain species and families can be used to detect areas of endemism, barriers, and biogeographic transition zones **(Rocha, 2003; Worheide *et al.*, 2005).**

Nowadays, due to the decline of scleractinian or hard corals found in shallow waters of the Caribbean province, the marine setting is dominated by macroalgae, gorgonian-type soft corals, and sponges, depending on the prevailing ecological conditions. According to **Pawlik (2013)**, in the coral reefs of Florida and the Bahamas, a change in the dominant organisms responsible for forming the three-dimensional structure of the habitat has been occurring —corals for sponges—, as a result of the growing mortality of hard corals due to extreme climate events, diseases, loss of herbivorous fish, and pollution. In addition, the recent report on change trends of Caribbean coral reefs between 1970 and 2012 indicate that this ecosystem could have better ecological conditions in its southern portion, including Colombia **(Jackson *et al.*, 2014).** According to these regional trends, questions about the current ecological role of sponges in the country's reefs remain unanswered **(Zea y Díaz Sánchez, 2011).**

Ecological studies on sponges have been focused on their distribution in the Colombian Caribbean, mainly in shallow waters of rocky littorals ecosystems and coral reefs of San Andrés, Providencia and northern islands **(Zea, 2001)**; Cartagena and the Archipelagos of Rosario-San Bernardo **(Zea & Díaz Sánchez, 2011)**; Urabá-Capurganá **(Valderrama & Zea, 2003)**; Tayrona and Santa Marta **(Parra Velandia & Zea , 2003)**;); and the carbonate seafloor in Guajira, up to 50 m in depth **(Díaz y Zea, 2008)**. For deep waters of the country, there are taxonomic studies on marine sponges collected at depths of over 1,000 m **(INVEMAR-ANH, 2012)**; however, there are still unidentified sponges that have been collected in even deeper waters of Colombia, kept, for instance, in the Museum of Natural Marine History of Colombia.


Ectyoplasia ferox (Photo: Christian Diaz)


Agelas clathrodes (Photo:Christian Diaz)


Agelas sventres (Photo: Sven Zea)


Scopalina ruetzleri (Photo: Christian Diaz)

Uses and facts of marine sponges

Sponges are the most ancient animals on the planet. There are written references to sponges from the VIII century BC (Hooper y Van Soest, 2002). In ancient Greece, and in Homer's Odyssey and Iliad, sponges were referred to as treasures and everyday tools for body cleaning and fragrance. Other records indicate that, for the Egyptians, they were important elements in the human body embalming process. Meanwhile, in ancient Rome, they were used as hygiene elements, and even for therapeutic purposes in certain diseases (Voultsaiadou, 2007). Bath sponges, in particular, have been used for cosmetic and clothing applications, thanks to its skeleton of collagen networks. Every civilization has used marine sponges for natural purposes, as a source of inspiration for art, for competing and recognizing them through free diving, and for trading in the well-known sponge industries of the 19th century, which caused many divers to fall seriously sick because of the use of diving suits.

Due to the fact that they are attached to the bottom, sponges defend themselves from predators and competitors by regularly using chemical compounds with substances that have different biological activities —many of them useful to man— and bear the name of marine natural products. Their discovery has increased over the past two decades, between 20 and 200 new compounds per year. Marine sponges are known, among the marine organisms that have been studied, for being highly rich in new marine natural products, with about 4,851 compounds known as of the early 21st century. This contributed 30% of the compounds of all marine natural products discovered. It is noteworthy that 1,499 of the compounds derived from marine sponges were isolated between 2008 and 2012, which makes them the group of aquatic animals with more than 200 new compounds recorded each year over the last decade. Applications cover a wide range of biological activities for these compounds, including anti-cancer, antiviral, antibacterial, antifungal, antiprotozoal, anti-inflammatory, immunosuppressive, neurosupressive, neuroprotective and antifouling properties, among others **(Mehbub *et al.*, 2014).**

For instance, the sponge *Niphates* olemda contains Kapakanina-type metabolites, which are toxic for leukemic cells in mice. *Theonella swinhoei*, a sponge that lives in coral reefs of the Western Indo-Pacific in the Andaman and Palau Islands, as well as in the Philippines and Indonesia, has benzoic acid derivatives with the same anti-leukemic activity **(Tabares *et al.*, 2012; Mehbub *et al.*, 2014)**. Another case is the sponge *Polymastia tenax*, Found in the Seaflower Biosphere Reserve and whose metabolites are able to kill cancer cells in humans; therefore, it could become an effective form of treatment. In fact, diseases such as dementia and HIV (human immunodeficiency virus) are finding direct adversaries in the compounds of certain sponges **(Mehbub *et al.*, 2014).**

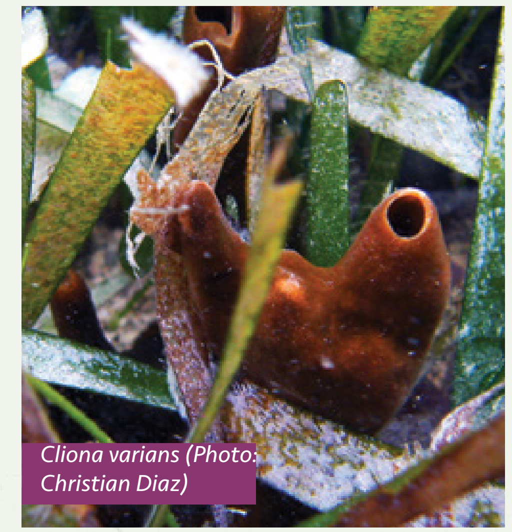
Scientists at the Harbor Branch Oceanographic Institution isolated a potent biological agent, a polyketide called discodermolide, taken from the marine sponge Discodermia dissoluta. It has immunosuppressive and cytotoxic characteristics and has reached human clinical trials for the treatment of solid tumors **(Smith *et al.*, 2011)**. This species is normally found in waters of more than 30 m deep; however, **Ruiz et al. (2013)** discovered that in Colombia, particularly in Santa Marta, this species is found at shallower depths, which is allowing the development of cultivation techniques in order to meet the potential demand. This sponge is found in the Seaflower Biosphere Reserve, although very little is known about its local distribution and ecology.

An interesting case is that of the giant barrel sponge, *Xestospongia muta*, known as the redwood of the reef. This sponge is common throughout the Caribbean province, including shallow waters of the Seaflower. This species has been monitored and it has been found that its population increased by 46% between 2000 and 2006 in the Florida Keys **(McMurray *et al.*, 2010)**, where bleaching events that remain unexplained were also documented **(McMurray *et al.*, 2011).** This sponge is becoming one of the most important habitat-forming elements on coral reefs, since individuals can be long-lived and giants, with a estimated lifespan of hundreds to thousands of years **(McMurray *et al.*, 2008).**


Xestospongia muta (Photo Christian Diaz)


Cliona delitrix (Photo Christian Diaz)

Another group of sponges, mainly from the genus Cliona, is able to erode the calcium carbonate skeletons of corals and molluscs, by digging tunnels and galleries that weaken them. Several species are capable of killing the coral tissue, by undermining them and taking them off the surface of the reef. For example, the species *Cliona delitrix*, which is common throughout the Caribbean province, including shallow waters of the Seaflower Biosphere Reserve, is a widespread and very aggressive competitor and excavator of corals. It has taken advantage of coral deterioration to dramatically increase their presence in some places, especially those with organic pollution due to wastewater **(Chavez Fonnegra *et al.*, 2015).**


Cliona varians (Photo: Christian Diaz)


Cliona aprica (Photo: Christian DIaz)

History of sponges in the Seaflower Biosphere Reserve

Sponge communities in the Archipelago of San Andrés, Providencia and Santa Catalina have been studied, mainly, in coral reefs characterized by its location in the ocean and good biophysical development (Díaz Pulido *et al.*, 2004; Díaz, 2005). In these insular areas, it is common to find from sponges of lush shapes and sizes, to tiny, colorful species of sponges. Studies on Porifera were conducted by Professor Sven Zea, at the Universidad Nacional de Colombia, with samples collected in Providencia and Santa Catalina at first (Zea, 1987), He later studied the distribution patterns of sponges in Albuquerque, Serrana, and Roncador (Zea, 2001), His observation works were concurrently included in the Atlas of Colombian marine areas (Díaz *et al.*, 2000); among other several publications. Since then, a growing generation of researchers, led by Professor Zea, has been solving scientific questions with sponges as reference points; for example, the phylogenetic divergence of the genus Cliona (Chavez Fonnegra *et al.*, 2015; Escobar *et al.*, 2012); ethe origin and evolutionary status of tropical sponges of the genus Agelas (Parra Velandia *et al.*, 2014) and the conspicuous diversity of the genus Clathria (Zea *et al.*, 2014). All of this is based on direct observation work in different parts of the reserve, which are comparable with other areas of the province of the Caribbean Sea, and even the Atlantic Ocean.

Some shallow-water sponges have also been identified, along with other organisms associated with seagrass ecosystems **(Montoya Maya, 2002)**. Moreover, during scientific expeditions in some little explored areas of the reserve **(Abril Howard *et al.*, 2011; Vega Sequeda *et al.*, 2015)**, and in general literature reviews **(CORALINA-INVEMAR, 2012)**, figures on Porifera richness and diversity are determined, although they do not detail aspects of the community structure. Something even more remarkable happens with communities of sponges in deep waters of the reserve, which are virtually unexplored, although there are some records for the Joint Regime Area of Jamaica-Colombia, northern Seaflower Biosphere Reserve **(INVEMAR-ANH, 2012; Diaz Sanchez *et al.*, 2013)**.

The information contained in this chapter is the result of reviewing the field forms of the Coral Areas of Colombia project by INVEMAR, which characterized the coral formations of the Colombian Caribbean between 1994 and 1999. In these forms, the second author wrote down the names of species of sponges observed within plots located in the main coral formations of the archipelago. Subsequently, a database was designed with those results and, finally, information was described emphasizing the environment of the coral formations of the reserve. In order to complement the current list of species of sponges, the Information System on Marine Biodiversity (SIBM) was consulted, as well as the available literature and the database of material collected by Professor Zea during sampling and observation journeys at the area dating from the 80´s.

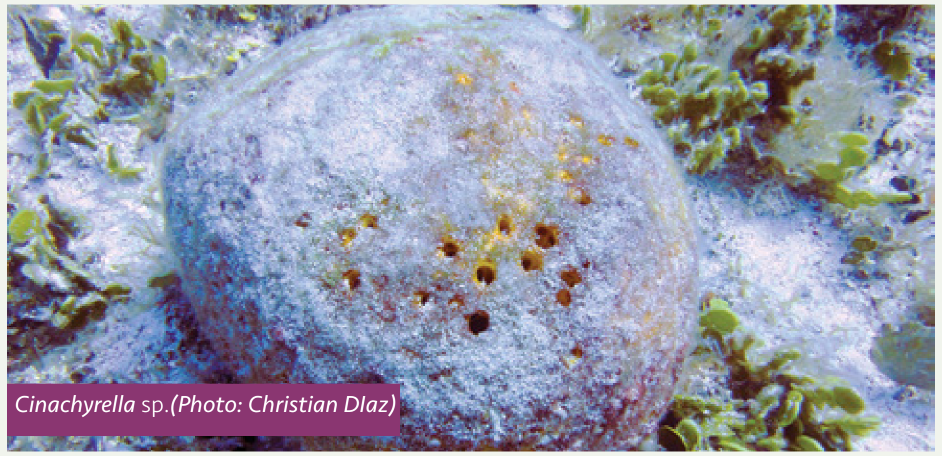
Porifera inventory

164

species-morphotypes

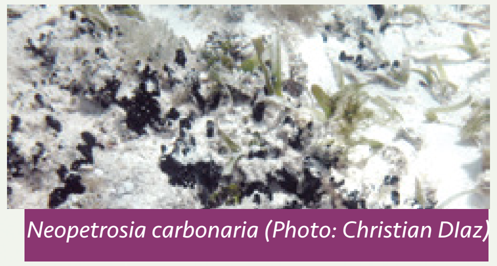
The updated Porifera inventory covers 164 species-morphotypes, of which 136 have been completely identified to species. There are, at least, 28 records of genera-groups of sponges, including *Aaptos* spp., *Amphimedon* spp., *Jaspis* spp., *Ircinia* spp., Astrophorida, Calcarea and Lithistida, which could comprise species not described for science. Undoubtedly, this inventory will keep growing in the future.

Sponges known in the Seaflower Biosphere Reserve have two types of evidence. Some of them have been collected and others have simply been observed and identified based on experience. Although they can be found colonizing soft bottoms, seagrass beds, mangrove roots and even in rocky littorals, the main environment of sponges is coral reefs **(CORALINA-INVEMAR, 2012)**. This is where the greatest diversity of sponges is hold, with more than 90% of known species. In fact, only three species have been recorded exclusively in seagrass beds, and only 7% of the sponges have been identified in the deep seabed **(Díaz Sánchez *et al.*, 2013)**. Additionally, 93% of known sponges have been recorded in shallow waters up to 30 m deep **(Zea, 2001; Zea obs. pers.),** which is a clear signal of the boundaries yet to be explored in mesophotic environments and deep waters.



Cinachyrella sp.*(Photo: Christian DIaz)*

Callyspongia vaginalis (photo: Christian Diaz).



Neopetrosia carbonaria (Photo: Christian DIaz)

Geodia neptuni (Photo: Christian DIaz)

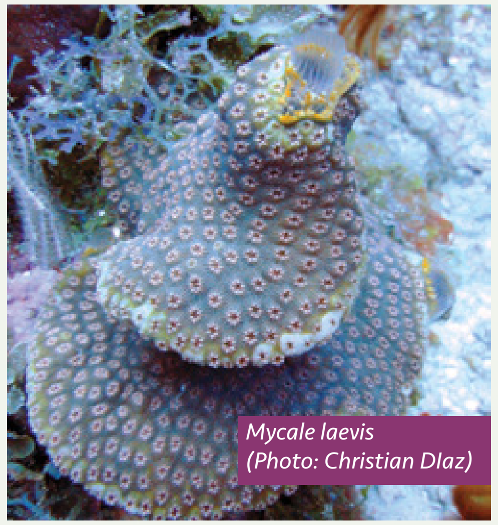
The diversity of sponges in the reserve demonstrates the importance of this environment. Among all species recorded in shallow waters, the most common are *Niphates erecta*, *Geodia neptuni and Xestospongia muta*. The most abundant sponge in the Caribbean province, and even in the Biosphere Reserve, is N. *erecta*, with individuals that usually grow anywhere in the bottom in the shape of thin branches; as opposed to individuals of *G, neptuni* and *X. muta*, which can reach 1 m or more in height and diameter. Other sponges with important populations are *Agelas* spp. *Aplysina fulva-cauliformis*, *Aiolochroia crassa*, *Cliona delitrix*, *Ectyoplasia ferox*, *Callyspongia vaginalis*, *Cinachyrella* spp., *Lotrochota birotulata*, *Ircinia felix*, *Mycale laevis*, *Neopetrosia carbonaria and Scopalina ruetzleri*. These sponges can be found, sometimes aggregated and sometimes dispersed, growing in habitats dominated by mixed corals, octocorals, ancient formations of Acropora cervicornis and sands or macroalgae on dead coral debris.

Based on the records verified up to 30 m deep, for the ten major reef systems of the reserve, 60 different sponges have been identified in the area of San Andrés Island and 67 in Providencia and Santa Catalina. As for Bolívar and Albuquerque cays, there are 65 and 68 species known so far, respectively. Additionally, 68 sponges have been recorded in the Roncador bank, 80 in the Serrana bank and 30 in the Quitasueño bank. The aforementioned data contrast with the records of the coral formations located in the northeastern side of the reserve, in the Joint Regime Area Jamaica–Colombia, since 50 different sponges have been identified at Bajo Nuevo bank, 50 at Serranilla cay and 20 on the Alicia shoal.

Distribution of populations of sponges in shallow waters of the reserve represents the scene of the benthic community of ocean reefs of the Colombian Caribbean described by Díaz Pulido and contributors s **(2004)**. Considering that the reefs of the reserve have been shaped by the same evolutionary and climate processes, reef complexes share a series of geomorphological features, such as the presence of life zones classified as fore-reef terraces, lagoons and fringing reefs **(Díaz, 2005).** In these zones there are habitats where different species of sponges grow, which can be found in one or several of the main reef systems, generating certain similarity among places in terms of presence or absence of different sponges. With this criterion and based on the inventory prepared in this paper, similarities among Bajo Nuevo, Serranilla, Bolívar, Providencia and San Andrés are observed. Roncador and Albuquerque can be considered a similar group, whereas Serrana, Alicia and Quitasueño are reef complexes that differ from the others, since their composition of identified species of sponges is not similar to any.

According to the relative composition of shallow-water sponges recorded in this paper, there are similarities among, at least, seven of the main reef complexes of the Seaflower Biosphere Reserve, suggesting an important environmental connectivity, on which population flow schemes should be studied so that they can be considered when taking steps for conservation and management in national and international settings. Further advance state of knowledge on the biodiversity of marine sponges, is expected to strengthen future researches in order to include this group of marine fauna within conservation targets.

Aiolochroia crassa (Photo: Christian DIaz)



Mycale laevis (Photo: Christian DIaz)

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Sponges

Phylum Porifera

C Calcarea — **Sc** Calcinea

O	F	S			
Clathrinida	Clathrinidae	*Clathrina* sp. Gray, 1867	8	ac	PSC, C, RB

C Demospongiae — **Sc** Heteroscleromorpha

O	F	S			
Agelasida	Agelasidae	*Agelas citrina* Gotera & Alcolado, 1987	10	ac	RB
		Agelas clathrodes (Schmidt, 1870)	12, 13, 10, 11	ac	RB
		Agelas conifera (Schmidt, 1870)	12, 13, 10, 11	ac	RB
		Agelas dispar Duchassaing & Michelotti, 1864	12, 10	ac	RB
		Agelas sceptrum (Lamarck, 1815)	12, 10	ac	RB
		Agelas schmidti Wilson, 1902	10	ac	RB
		Agelas sventres Lehnert & van Soest, 1996	13, 10	ac	RB
		Agelas tubulata Lehnert & van Soest, 1996	10	ac	RB
		Agelas wiedenmayeri Alcolado, 1984	13, 10	ac	RB
		Ceratoporella nicholsoni (Hickson, 1911)	14	ac	RB
	Hymerhabdiidae	*Prosuberites laughlini* (Diaz, Alvarez & van Soest, 1987)	13	ac	N, RB, BS
Axinellida	Axinellidae	*Dragmacidon lunaecharta* (Ridley & Dendy, 1886)	12	ac	PSC, S, RB
		Dragmaxia undata Alvarez, van Soest & Rützler, 1998	14	ac	RB
		Ptilocaulis marquezii (Duchassaing & Michelotti, 1864)	13, 18	ac	RB, BR
		Ptilocaulis walpersi (Duchassaing & Michelotti, 1864)	12, 13	ac	RB
	Heteroxyidae	*Didiscus oxeata* Hechtel, 1983	18	ac	RB
		Myrmekioderma gyroderma (Alcolado, 1984)	13	ac	N, RB, BR
		Myrmekioderma rea (de Laubenfels, 1934)	14	ac	RB
	Raspailiidae	*Ectyoplasia ferox* (Duchassaing & Michelotti, 1864)	12, 13, 11	ac	RB
Biemnida	Biemnidae	*Biemna caribea* Pulitzer-Finali, 1986	14	ac	RB
		Neofibularia nolitangere (Duchassaing & Michelotti, 1864)	12, 13, 11	ac	RB
Bubarida	Dictyonellidae	*Dictyonella arenosa* (Rützler, 1981)	7	ac	IR, ARC, RB
		Dictyonella funicularis (Rützler, 1981)	12, 13, 18	ac	RB
Clionaida	Clionaidae	*Cervicornia cuspidifera* (Lamarck, 1815)	14	ac	RB
		Cliona aprica Pang, 1973	13, 15	ac	RB
		Cliona caribbaea Carter, 1882	13, 15, 11	ac	RB
		Cliona delitrix Pang, 1973	13, 1, 11	ac	RB
		Cliona laticavicola Pang, 1973	4	ac	S, RB, CB
		Cliona peponaca Pang, 1973	14	ac	RB
		Cliona tenuis Zea & Weil, 2003	13, 15, 11	ac	RB
		Cliona varians (Duchassaing & Michelotti, 1864)	13, 11	ac	RB
	Clionidae	*Spheciospongia vesparium* (Lamarck, 1815)	13	ac	IN, N, RB, BS
	Placospongiidae	*Placospongia intermedia* Sollas, 1888	19	ac	RB
		Placospherastra micraster (Lehnert & Heimler, 2001)	14	ac	RB
	Spirastrellidae	*Diplastrella megastellata* Hechtel, 1965	13	ac	IN, N, RB, BR
		Spirastrella coccinea (Duchassaing & Michelotti, 1864)	13	ac	RB
		Spirastrella hartmani Boury-Esnault, Klautau, Bézac, Wulff & Solé-Cava, 1999	13	ac	RB
Dictyoceratida	Thorectidae	*Hyrtios proteus* Duchassaing & Michelotti, 1864	12, 13	ac	RB
		Smenospongia aurea (Hyatt, 1875)	14	ac	RB
		Smenospongia cerebriformis (Duchassaing & Michelotti, 1864)	13	ac	IS, S, RB, CA
		Smenospongia conulosa Pulitzer-Finali, 1986	14	ac	RB
		Smenospongia sp.	14	ac	RB
		Tectitethya crypta (de Laubenfels, 1949)	13, 11	ac	RB
Haplosclerida	Callyspongiidae	*Callyspongia armigera* (Duchassaing & Michelotti, 1864)	13	ac	IN, N, RB, BS
		Callyspongia fallax Duchassaing & Michelotti, 1864	12	ac	RB
		Callyspongia plicifera (Lamarck, 1814)	12, 13, 11	ac	IN, N, RB, BS
		Callyspongia strongylophora Hartman, 1955	14	ac	RB
		Callyspongia vaginalis (Lamarck, 1814)	12, 13, 11	ac	RB
	Chalinidae	*Chalinula molitba* (de Laubenfels, 1949)	13	ac	RB
		Chalinula zeae de Weerdt, 2000	13	ac	N, RB, BR
		Haliclona implexiformis (Hechtel, 1965)	12, 13	ac	RB

C Demospongiae — **Sc** Heteroscleromorpha

O	F	S			
Haplosclerida	Chalinidae	*Haliclona mucifibrosa* de Weerdt, Rützler & Smith, 1991	14	ac	RB
		Haliclona ruetzleri de Weerdt, 2000	14	ac	RB
		Haliclona spp.	14	ac	N, RB, BQ
		Haliclona tubifera (George & Wilson, 1919)	12	ac	C, RB
		Haliclona walentinae Díaz, Thacker, Rützler & Piantoni, 2007	14	ac	RB
	Niphatidae	*Amphimedon compressa* Duchassaing & Michelotti, 1864	12, 13, 11	ac	RB
		Amphimedon viridis Duchassaing & Michelotti, 1864	12, 13	ac	RB
		Amphimedon? sp.-"branching morphotype" van Soest, 1980	14	ac	IN, N, RB, BS
		Amphimedon? sp.-"castle morphotype" van Soest, 1980	13, 18	ac	IN, N, RB, BS
		Amphimedon? sp.-"tubular morphotype" van Soest, 1980	13, 18	ac	IN, N, RB, BS
		Cribrochalina vasculum (Lamarck, 1814)	13, 11	ac	RB
		Niphates alba van Soest, 1980	12	ac	C, RB
		Niphates digitalis (Lamarck, 1814)	12, 13, 11	ac	RB
		Niphates erecta Duchassaing & Michelotti, 1864	12	ac	RB
		Niphates sp.	14	ac	N, RB, BQ
	Petrosiidae	*Neopetrosia carbonaria* (Lamarck, 1814)	13, 18	ac	RB
		Neopetrosia proxima (Duchassaing & Michelotti, 1864)	14	ac	S, RB, CB
		Neopetrosia rosariensis (Zea & Rützler, 1983)	13, 18	ac	RB
		Neopetrosia sp. "soft" de Laubenfels, 1949	13, 18	ac	N, RB, BS
		Neopetrosia subtriangularis (Duchassaing, 1850)	16, 12	ac	RB
		Petrosia davilai (Alcolado, 1980)	13	ac	RB
		Petrosia pellasarca (de Laubenfels, 1934)	13	ac	RB
		Petrosia weinbergi van Soest, 1980	13	ac	IN, N, RB, BS
		Xestospongia muta (Schmidt, 1870)	12, 13, 11	ac	RB
		Xestospongia sp. "flabelada" de Laubenfels, 1932	14	ac	S, RB, CB
	Phloeodictyidae	*Calyx podatypa* (de Laubenfels, 1934)	9	ac	SA, RB
		Oceanapia bartschi (de Laubenfels, 1934)	13	ac	RB
		Siphonodictyon brevitubulatum Pang, 1973	13	ac	RB
		Siphonodictyon coralliphagum Rützler, 1971	13	ac	RB
Heteroscleromorpha incertae sedis	Lithistida incertae sedis	*Lithistida incertae sedis* Pisera & Levi, 2002	7	lp	ARC, RB
Lithistida	Theonellidae	*Discodermia dissoluta* Schmidt, 1880	14	ac	RB
Poecilosclerida	Acarnidae	*Acarnus innominatus* Gray, 1867	14	ac	N, RB, BQ
	Coeslosphaeridae	*Lissodendoryx colombiensis* Zea & van Soest, 1986	14	ac	N, RB, BR
		Lissodendoryx isodictyalis (Carter, 1882)	14	ac	RB
	Crambeidae	*Monanchora arbuscula* (Duchassaing & Michelotti, 1864)	13, 11	ac	RB
		Monanchora sp.	14	ac	RB
	Desmacididae	*Desmapsamma anchorata* (Carter, 1882)	12, 13, 9, 11	ac	IRB
	Hymedesmiidae	*Phorbas amaranthus* Duchassaing & Michelotti, 1864	13	ac	RB
	Iotrochotidae	*Iotrochota birotulata* (Higgin, 1877)	12, 13, 11	ac	RB
	Microcionidae	*Artemisina melana* van Soest, 1984	12, 13	ac	RB
		Clathria bulbotoxa van Soest, 1984	13	ac	RB
		Clathria calla (de Laubenfels, 1934)	12	ac	C, RB
		Clathria curacaoensis Arndt, 1927	13	ac	IS, S, RB, CA
		Clathria echinata (Alcolado, 1984)	14	ac	N, RB, BQ
		Clathria spinosa (Wilson, 1902)	13	ac	RB
		Clathria virgultosa (Lamarck, 1814)	17	ac	RB
		Pandaros acanthifolium Duchassaing & Michelotti, 1864	12, 13, 11	ac	RBA
	Mycalidae	*Mycale laevis* (Carter, 1882)	13, 11	ac	RB
		Mycale laxissima (Duchassaing & Michelotti, 1864)	13	ac	RB
		Mycale microsigmatosa Arndt, 1927	9	ac	SA, S, RB
	Tedaniidae	*Tedania ignis* (Duchassaing & Michelotti, 1864)	12	ac	RB
	Polymastiidae	*Polymastia tenax* Pulitzer-Finali, 1986	13	ac	RB

Interactive table

Sponges
Phylum
Porifera

C / Sc	O	F	S	Author			
Demospongiae / Heteroscleromorpha	Scopalinida	Scopalinidae	*Scopalina ruetzleri*	(Wiedenmayer, 1977)	12, 9, 11	ac	RB
			Svenzea cristinae	Alvarez, van Soest & Rutzler, 2002	13, 18	ac	IN, N, RB, BS
			Svenzea flava	(Lehnert & van Soest, 1999)	18	ac	RB
			Svenzea tubulosa	(Alcolado & Gotera, 1986)	13, 18	ac	IN, N, RB, BS
			Svenzea zeai	(Alvarez, van Soest & Rützler, 1998)	13, 18	ac	RB
	Suberitida	Halichondriidae	*Halichondria magniconulosa*	Hechtel, 1965	14	ac	RB
			Halichondria melanodocia	de Laubenfels, 1936	12	ac	PSC, C, RB
			Hymeniacidon caerulea	Pulitzer-Finali, 1986	11	ac	RB
			Topsentia ophiraphidites	(de Laubenfels, 1934)	13	ac	RB
		Suberitidae	*Aaptos* sp.		14	ac	RB
			Terpios fugax	Duchassaing & Michelotti, 1864	14	ac	RB
	Tetractinellida	Ancorinidae	*Jaspis* sp.		13	ac	IN, N, RB, BS
Keratosa	Dictyoceratida	Dysideidae	*Dysidea etheria*	de Laubenfels, 1936	6	ac	SA, S, RB
			Dysidea janiae	(Duchassaing & Michelotti, 1864)	9	ac	SA, S, RB
		Ircinidae	*Ircinia campana*	(Lamarck, 1814)	12, 13, 11	ac	RB
			Ircinia felix	(Duchassaing & Michelotti, 1864)	12, 13, 11	ac	RB
			Ircinia spp.		14	ac	N, RB, BQ
			Ircinia strobilina	(Lamarck, 1816)	12, 13, 9, 11	ac	RB
		Spongiidae	*Hyattella cavernosa*	(Pallas, 1766)	14	ac	N, RB, BQ
			Spongia obscura	Hyatt, 1877	12	ac	PSC, C, RB
			Spongia pertusa	Hyatt, 1877	14	ac	N, RB, BQ
Tetractinellida	Astrophorida	Ancorinidae	*Penares* sp.		3	lp	ARC, RB
			Stelleta sp.		3	lp	ARC, RB
		Calthropellidae	*Calthropella* sp.		3	lp	ARC, RB
		Geodiidae	*Caminus* sp.		3	lp	ARC, RB
			Erylus formosus	Sollas, 1886	13	ac	RB
			Erylus sp.		3	lp	ARC, RB
			Geodia gibberosa	Lamarck, 1815	14	ac	RB
			Geodia neptuni	(Sollas, 1886)	13, 18	ac	RB
			Geodia sp.		7	lp	ARC, RB
		Pachastrellidae	*Pachastrella* sp.		3	lp	ARC, RB
		Vulcanellidae	*Poecillastra* sp.	Sollas, 1888	3	lp	ARC, RB
			Vulcanella sp.	Sollas, 1886	3	lp	ARC, RB
	Spirophorida	Tetillidae	*Cinachyrella* spp.	Wilson, 1925	11	ac	RB
Verongimorpha	Chondrillida	Chondrillidae	*Chondrilla caribensis*	Rützler, Duran & Piantoni, 2007	13, 9, 11	ac	RB
		Halisarcidae	*Halisarca caerulea*	Vacelet & Donadey, 1987	13	ac	IN, N, RB, BS
	Chondrosiida	Chondrosiidae	*Chondrosia collectrix*	(Schmidt, 1870)	14	ac	RB
			Chondrosia reniformis	Nardo, 1847	14	ac	RB
	Verongiida	Aplysinidae	*Aiolochroia crassa*	(Hyatt, 1875)	12, 13	ac	RB
			Aplysina archeri	(Higgin, 1875)	12, 13	ac	RB
			Aplysina cauliformis	(Carter, 1882)	12, 13, 9, 11	ac	RB
			Aplysina fistularis	(Pallas, 1766)	13	ac	RB
			Aplysina fulva	(Pallas, 1766)	12, 13, 11	ac	RB
			Aplysina insularis	(Duchassaing & Michelotti, 1864)	11	ac	IR, ARC, RB, BN
			Aplysina lacunosa	(Lamarck, 1814)	12, 13	ac	RB
			Verongula gigantea	(Hyatt, 1875)	13, 11	ac	RB
			Verongula reiswigi	Alcolado, 1984	7	ac	RB
			Verongula rigida	(Esper, 1794)	13, 11	ac	RB
Homoscleromorpha	Homosclerophorida	Plakinidae	*Plakinastrella onkodes*	Uliczka, 1929	13	ac	RB
			Plakortis angulospiculatus	(Carter, 1879)	12, 13	ac	RB
			Plakortis halichondrioides	(Wilson, 1902)	12, 13	ac	RB
			Plakortis halichondrioides -"light brown morphotype"	Schulze, 1880	14	ac	RB, CB
			Plakina jamaicensis	Lehnert & van Soest, 1998	14	ac	N, RB, BQ

Interactive table

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CNIDARIANS

Of The Seaflower Biosphere Reserve

Alberto Acosta[1], Cristina Cedeño-Posso[2], Javier Montenegro[3], Raúl Navas-Camacho[2], Valeria Pizarro[4], Juan Armando Sánchez[5] and Fernando Zapata[6]

1 Pontificia Universidad Javeriana, Faculty of Sciences, Department of Biology, UNESIS.

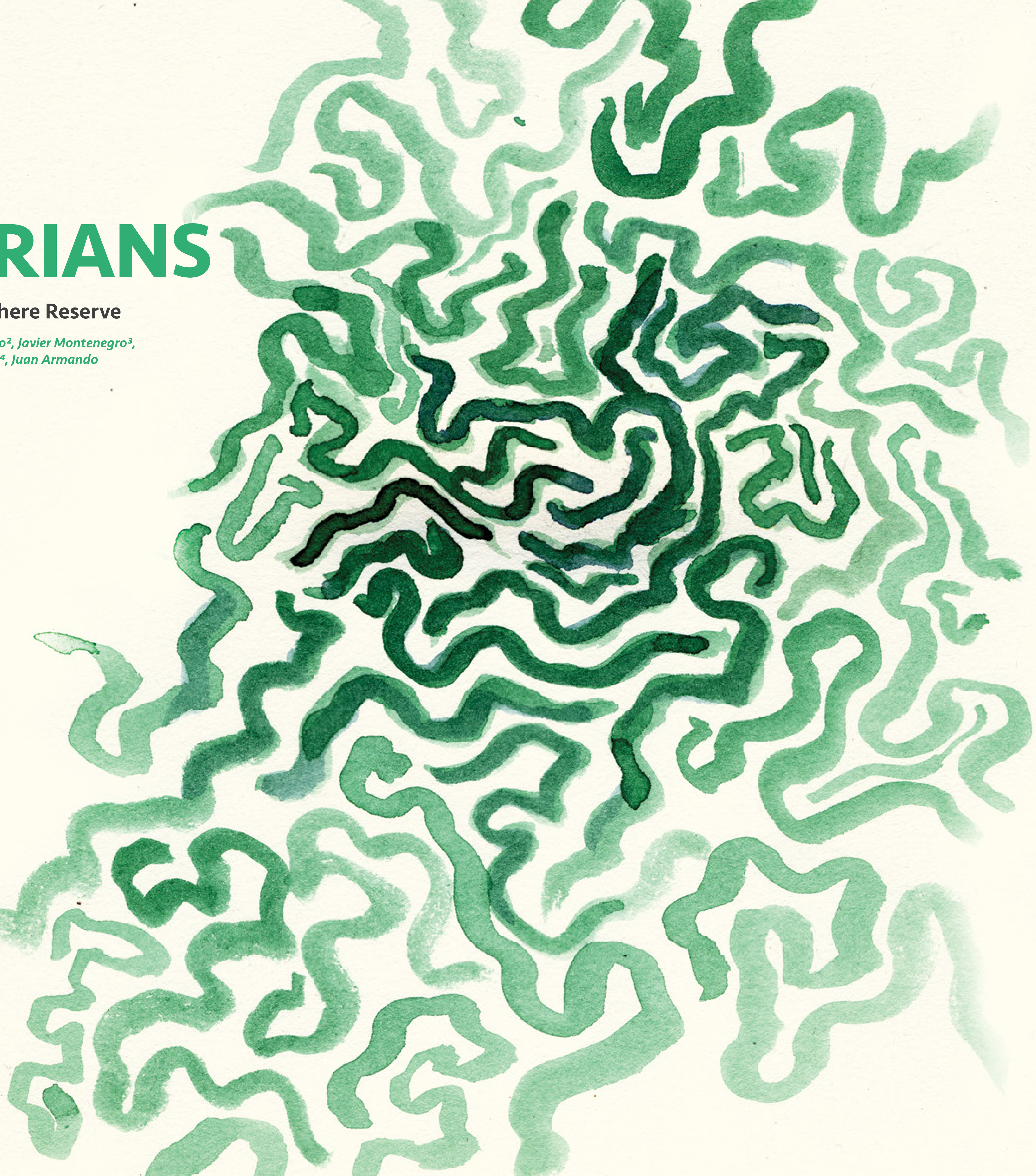
2 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR).

3 Tropical Biosphere Research Center (Yamahira Lab.) & Molecular Invertebrate Systematics and Ecology (MISE, Reimer Lab.), Faculty of Science, University of the Ryukyus, Okinawa, Japan

4 Ecomares Foundation.

5 Laboratory of Marine Molecular Biology (BIOMMAR), Department of Biological Sciences, Faculty of Sciences, Universidad de los Andes.

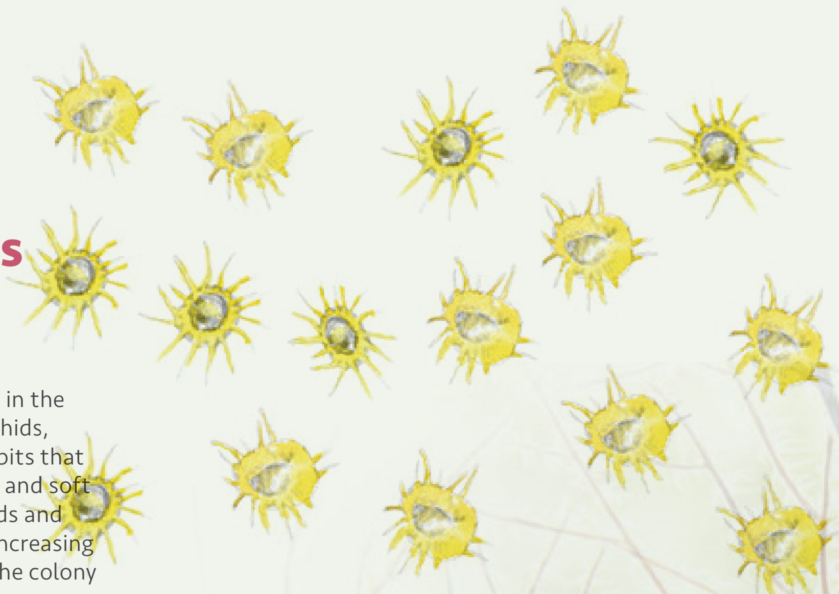
6 Department of Biology, Universidad del Valle.



ZOANTHIDS, ANEMONES, TUBE ANEMONES, SUN ANEMONES, BLACK CORALS, HARD CORALS, GORGONIANS AND SEA PENS

The phylum Cnidaria is an ancient, simple and diverse group of marine animals having cells, called cnidocytes, with adhesion, defense and prey immobilization functions. Some cnidarians form colonies by means of asexual reproduction, and others have a dimorphic life cycle: a polyp stage (bentónica) and a medusa stage (planctónica) **(Daly *et al.*, 2007).** The polyp has a cylindrical body and its mouth is surrounded by tentacles in radial symmetry.

Currently, the phylum Cnidaria consists of five classes: Anthozoa ***(zoanthids, anemones, tube anemones, sun anemones, black corals, hard corals, gorgonians and sea pens)***; Cubozoa (sea wasps); Hydrozoa (hydrocorals, hydroids and hydromedusae); Scyphozoa (verdaderas medusas) and Staurozoa (stalked jellyfish) **(Kayal *et al.*, 2013).** In the Archipelago of San Andrés, Providencia and Santa Catalina, 201 species of cnidarians have been identified so far, belonging to three of the aforementioned classes (Anthozoa, Hydrozoa and Scyphozoa),) and represented by the orders: Zoantharia (11 spp), Actiniaria (9 spp), Corallimorpharia (3 spp), Antipatharia (11 spp), Scleractinia (89 spp), Alcyonacea (68 spp), Anthoathecata (6 spp) Siphonophorae (2 spp) Rhizostomeae (1 spp) and Semaeostomeae (1 spp) which will be listed in the general table of species of this chapter and described below.



Corals with six tentacled polyps

Zoanthids

The first group of hexacorals present in the Seaflower Biosphere Reserve is zoanthids, which are cnidarians with benthic habits that use to form colonies of clonal polyps and soft body. Some of them incorporate sands and other particles in their tissues, thus increasing the structural strength of polyps in the colony **(Shiroma y Reimer, 2010).** Polyps have rows of tentacles arranged in two lines **(Daly *et al.*, 2007).** and their mouths are located in the middle of their bodies, are surrounded by tentacles and tend to be elongated instead of round (como otros *anthozoos*). Most of zoanthids are carnivorous, although many tropical and subtropical species have symbiotic associations with *zooxantelas* **(Trench 1974; Haddon Shackleton, 1981; Sinniger *et al.*, 2005; Reimer, 2006).**

They have the ability to reproduce sexually or asexually. In sexual reproduction, the most part of zoanthids, with the exception of Isozoanthus giganteus, releases eggs and sperm into the water column **(Ryland, 1997)**. Asexual reproduction occurs generally by fission or fragmentation of an adult colony of zoanthids and its further settlement in neighboring substrates **(Acosta, 2007)**. In the Seaflower Biosphere Reserve there are 11 species of zoanthids, belonging to the genera *Epizoathus, Isaurus, Palythoa, Parazoanthus, Umimayanthus and Zoanthus*, a widely distributed genus in San Andrés and the remote islands (Bajo Nuevo). Recently, the genus Bergia was restored as valid and currently comprises three species: *Bergia catenularis y Bergia puertoricense* transferred from the genus *Parazoanthus- y Bergia cutressi* -transferred from the genus *Epizoanthus-* **(Montenegro *et al.*, 2015).**

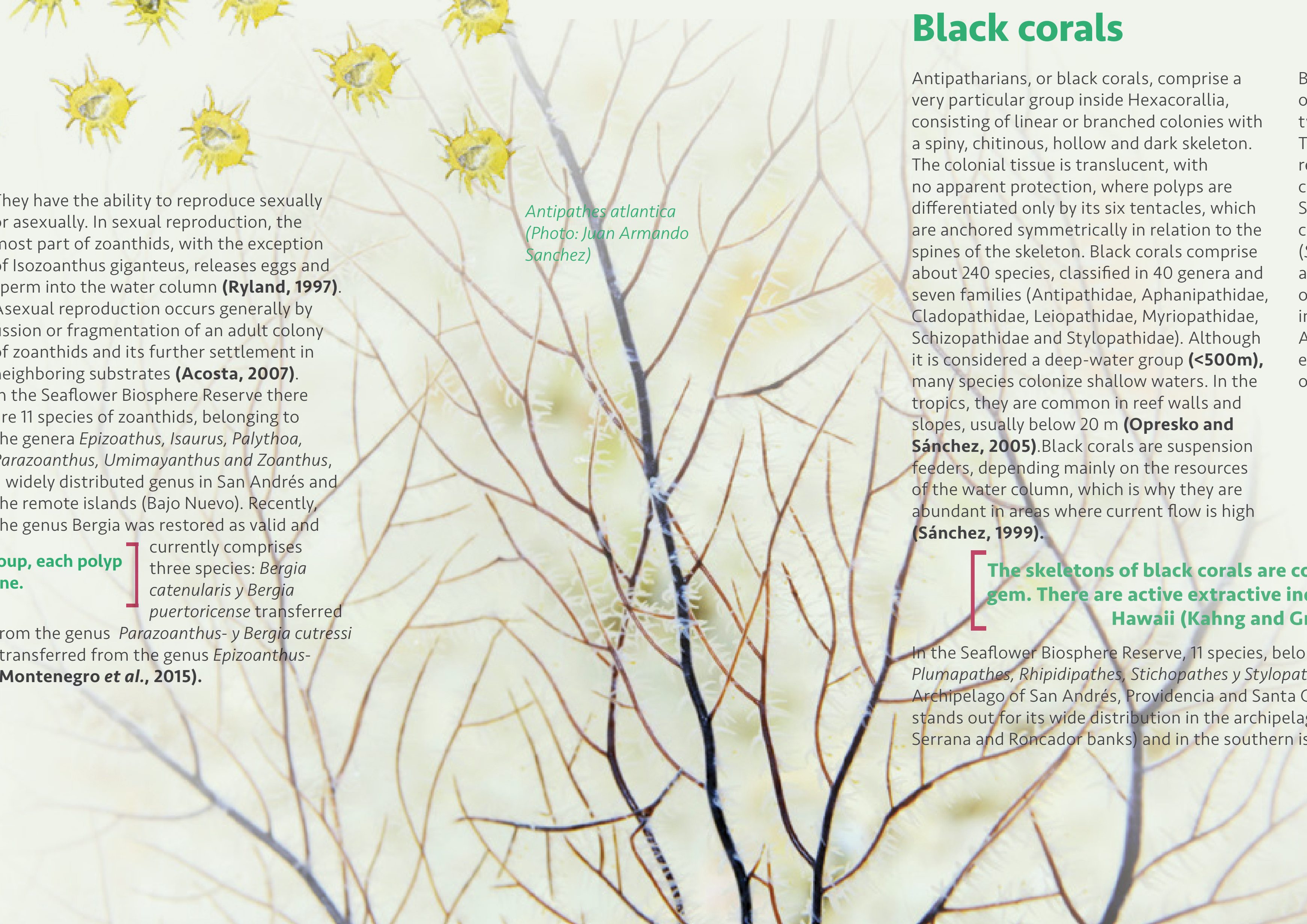
[In some species of this group, each polyp resembles a small anemone.]

Parazoanthus catenularis

Anemones

Anemones are one of the most diverse groups of anthozoa Hexacorallia. They are solitary polyps with soft body and different-sized tentacles. They live in all marine depths, latitudes and habitats; even in estuaries **(Daly *et al.*, 2007- 2008)**. since they have adapted their bodies to survive in different types of substrates and to compete for their area with corals and algae. Some species have also the ability to move to nearby places in order to evade predators **(Barrios *et al.*, 2002)**. Its reproduction method varies depending on whether it is sexual (type of fertilization, habits and nutrition of the larva), asexual (four different ways), or among species from different populations **(Chia, 1976)**. Of the 1,200 species of anemones described worldwide, nine can be found in the Seaflower Biosphere Reserve, which belong to the genera *Aiptasia, Bartholomea, Bunodeopsis, Bunodosoma, Condilactis, Lebrunia, Phymathus and Stichodactyla,* all of them distributed throughout the archipelago.

Condilactis gigantea
(Foto: Fernando Mancera)



Antipathes atlantica
(Photo: Juan Armando Sanchez)

Black corals

Antipatharians, or black corals, comprise a very particular group inside Hexacorallia, consisting of linear or branched colonies with a spiny, chitinous, hollow and dark skeleton. The colonial tissue is translucent, with no apparent protection, where polyps are differentiated only by its six tentacles, which are anchored symmetrically in relation to the spines of the skeleton. Black corals comprise about 240 species, classified in 40 genera and seven families (Antipathidae, Aphanipathidae, Cladopathidae, Leiopathidae, Myriopathidae, Schizopathidae and Stylopathidae). Although it is considered a deep-water group **(<500m),** many species colonize shallow waters. In the tropics, they are common in reef walls and slopes, usually below 20 m **(Opresko and Sánchez, 2005)**.Black corals are suspension feeders, depending mainly on the resources of the water column, which is why they are abundant in areas where current flow is high **(Sánchez, 1999).**

Black corals are slow-growing and long-lived organisms, with living colonies more than two thousand years old **(Roark *et al.*, 2006)**. Their protein skeletons leave an accurate record of the prevailing ecological conditions, climate and pollution **(Williams *et al.*, 2006)**. Some time ago, it was believed that black corals had no symbiosis with zooxanthellae (*Symbiodinium*), but it has been found that almost all species from shallow waters of the Indo-Pacific present zooxanthellae in lower densities **(Wagner *et al.*, 2011).** Apparently, the species of the Atlantic do not establish symbiosis with zooxanthellae (J.A.S., observación personal).

[The skeletons of black corals are considered a semiprecious gem. There are active extractive industries in places such as Hawaii (Kahng and Grigg, 2005).]

In the Seaflower Biosphere Reserve, 11 species, belonging to the genera *Anthipathes, Elatopathes, Plumapathes, Rhipidipathes, Stichopathes y Stylopathes*, can be found on the slopes of the Archipelago of San Andrés, Providencia and Santa Catalina. The species Stylopathes columnaris stands out for its wide distribution in the archipelago and the northern islands (Quitasueño, Serrana and Roncador banks) and in the southern islands (Albuquerque and Bolívar cays).

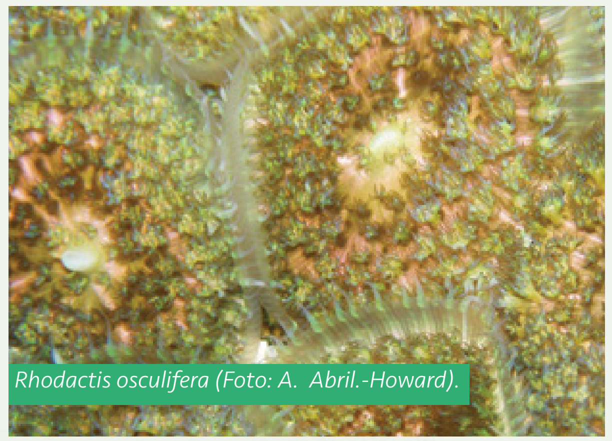
Coral anemones

Corallimorpharians are small hexacorals that live fixed to the sea bottom and are widely distributed in tropical zones. Usually, they have a disc-shaped body with marginal tentacles, although it can vary so that in some species the disc is completely covered with tentacles, which play an important role in the competition with other benthic organisms (**Langmead y Chadwick-Furman, 1999).** Besides having zooxanthellae, corallimorpharians are also carnivores; some species can feed on larger animals, such as starfish (**Bos *et al.*, 2011**), which also have zooxanthellae.

Though their common name is corallimorpharians, they are also called coral anemones due to their physical likeness to sea anemones; or false corals because of the similarity between their internal structures. However, unlike hard corals, corallimorpharians lack a skeleton.

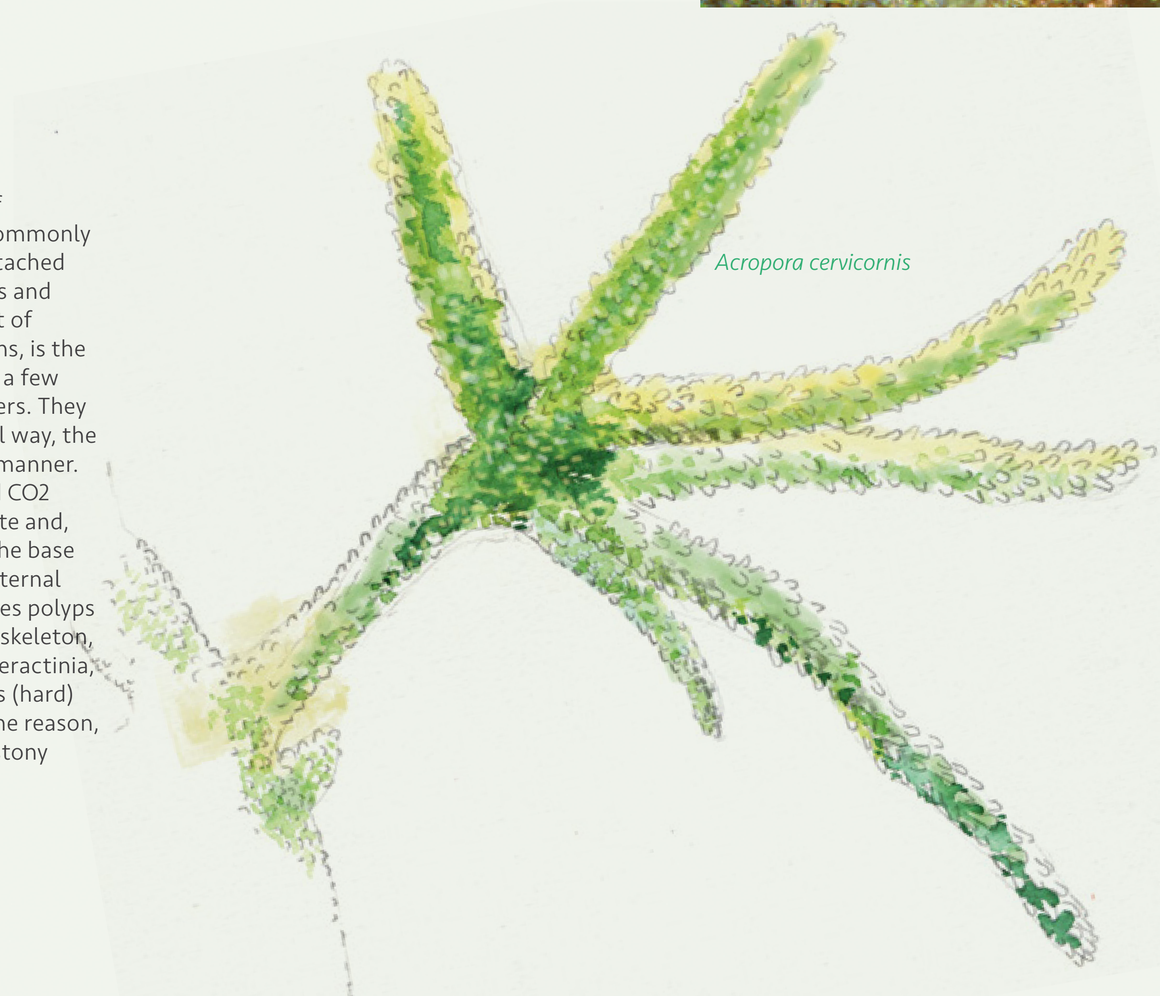
They can be found living individually (one polyp) or in a gregarious manner, forming mats on the seafloor. The size of the individual or polyp varies among species and can reach up to 30 cm in diameter. Corallimorpharians also have the ability to reproduce sexually and asexually. In some species, it has been observed that larvae settle gregariously and may present sexual segregation with central female and marginal male polyps (**Chadwick Furman *et al.*, 2000).** Asexual reproduction occurs with the division of an adult individual into two or more parts (**Chadwick Furman y Spiegel, 2000).** The genera *Discosoma*, *Ricordea* and Rhodactis are present in the reserve; *Discosoma* has only been observed in the area of Bajo Nuevo, while *Ricordea* and *Rhodactis* can be found in San Andrés Island.


Ricordea sp. (Foto: A. Abril-Howard)


Rhodactis osculifera (Foto: A. Abril.-Howard).

Hard corals

Finally, the best known group of Hexacorallia is scleractinians, commonly called hard corals, which live attached to hard substrates, such as rocks and other dead corals. The basic unit of these animals, as in all Cnidarians, is the polyp, whose size can vary from a few millimeters to several centimeters. They can grow in a solitary or colonial way, the latter being the most common manner. Corals transform carbonate and CO2 molecules into calcium carbonate and, subsequently, agglutinate it in the base of the polyps, forming a hard external skeleton that protects and shapes polyps and colonies. Thanks to this exoskeleton, the group receives the name Scleractinia, which comes from Greek skleros (hard) and aktis (rays), and, for the same reason, they are also known as hard or stony corals.


Acropora cervicornis


Phacelocyathus flos


Stylaster roseus

The oldest coral fossils known so far are from the Triassic period-250 million years ago, approximately- **(Veron, 2000)**, although it is believed that the first fossils appeared 425 million years ago. Since its origin, they have survived many environmental changes that have caused mass extinctions. Their survival is attributed to the way they reproduce and disperse and to their characteristic longevity. Currently, about 1,400 species of hard corals live in the oceans and seas of the world and are divided into two groups, depending on whether they are associated or not with zooxanthellae. Given that algae require light to carry out photosynthesis, the zooxanthellate corals must live in areas exposed to sunlight, so they are generally found in the first 50 m deep.

On the other hand, azooxanthellate corals, those without zooxanthellae, do not depend on sunlight and, therefore, can grow thousands of meters deep. Both zooxanthellate and azooxanthellate corals can grow on colonies of other dead corals and, over hundreds or thousands of years, are able to create huge structures of several kilometers long and up to thousands of meters thick that are even visible from space, such as the Australia's Great Barrier Reef, or the Providencia and Santa Catalina barrier (32 km). These structures, known as coral reefs, take up 6% of the world's seabed and represent one of the most diverse and productive ecosystems on the planet.

89
species

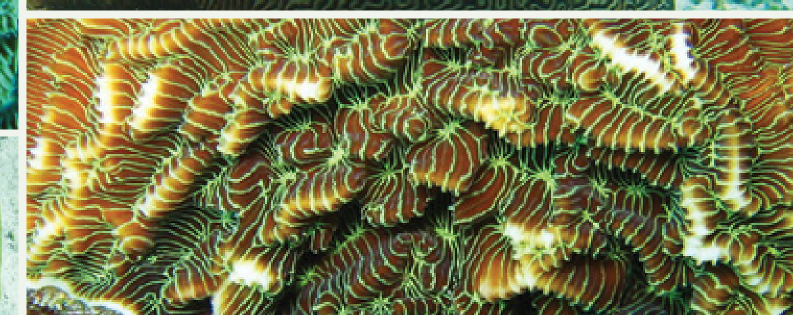
Corals and coral reefs of the Seaflower Biosphere Reserve make up the Colombia's largest shallow coral area (<50 m), that is, 70% of reefs. Zooxanthellate corals diversity (amount of species) is similar to that found in most reefs of the Caribbean region, with about 89 species. Species *Colpophyllia natans, Dichocoenia stokesii, Diploria laberinthiformis, Eusmilia fastigiata, Helioseris cucullata, Isophyllia rigida, Madracis decactis, Meandrina meandrites, Montastraea cavernosa, Mycetophyllia lamarckiana, Orbicella faveolata, Porites astreoides, Porites porites, Pseudodiploria strigosa, Siderastrea sidérea and Stephanocoenia intercepta, stand out due to their wide distribution in the Archipelago of San Andrés, Providencia and Santa Catalina; as well as in the northern islands* (bancos Quitasueño, Serrana and Roncador) and the southern islands (cayos Albuquerque y Bolívar). Unfortunately, and like other areas of the Caribbean region, corals, and consequently reefs, are at risk of disappearing due to natural events and human actions.

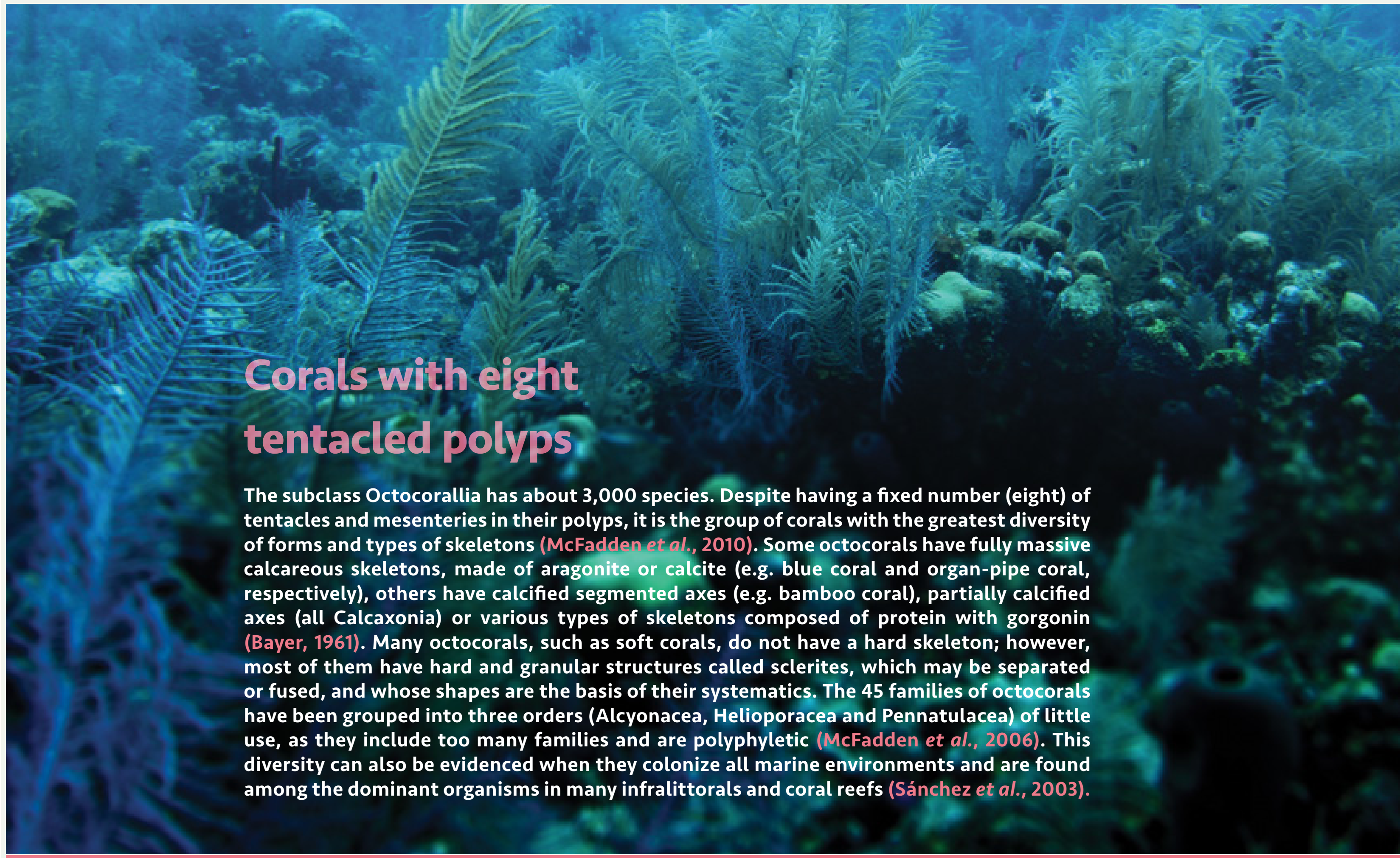

Meandrina meandrites (Photo: Archivo SIMAC)


Pseudodiploria strigosa (Photo: Archivo SIMAC)


Mycetophyllia lamarckiana


Diploria labyrinthiformis


Helioseris cucullata (Photo: Archivo SIMAC)



Corals with eight tentacled polyps

The subclass Octocorallia has about 3,000 species. Despite having a fixed number (eight) of tentacles and mesenteries in their polyps, it is the group of corals with the greatest diversity of forms and types of skeletons (McFadden *et al.*, 2010). Some octocorals have fully massive calcareous skeletons, made of aragonite or calcite (e.g. blue coral and organ-pipe coral, respectively), others have calcified segmented axes (e.g. bamboo coral), partially calcified axes (all Calcaxonia) or various types of skeletons composed of protein with gorgonin (Bayer, 1961). Many octocorals, such as soft corals, do not have a hard skeleton; however, most of them have hard and granular structures called sclerites, which may be separated or fused, and whose shapes are the basis of their systematics. The 45 families of octocorals have been grouped into three orders (Alcyonacea, Helioporacea and Pennatulacea) of little use, as they include too many families and are polyphyletic (McFadden *et al.*, 2006). This diversity can also be evidenced when they colonize all marine environments and are found among the dominant organisms in many infralittorals and coral reefs (Sánchez *et al.*, 2003).

Branched octocorals

Arborescent octocorals are a prominent component of all the coral reefs of the Seaflower Biosphere Reserve and the Caribbean Sea **(Sánchez *et al.*, 1998b)**. Between 4 and 10 species of the families Gorgoniidae and Plexauridae (gorgoninan branched octocorals, all of them having a symbiotic relationship with zooxanthellae) are found in shallow waters, reaching average densities of four colonies per m2. Species *Gorgonia ventalina, Antillogorgia bipinnata, Eunicea* sp. and *Plexaura* sp. stand out due to their wide distribution within the reserve.

Soft corals, *Briareum* y *Erythropodium*, also in symbiosis with zooxanthellae, may cover more than 2% in some environments. The density of the family Ellisellidae, which do not have zooxanthellae, stands out in slope areas of the reef. They are branched octocorals with a semi-calcified axis, whose red and white colonies may have densities similar to those of shallow waters, including species of *Ellisella barbadensis, Ellisella schmitti, Riisea paniculata y Viminella* sp.

Pseudopterogorgia spp y Pterogoria spp (Photo: Juan Armando Sánchez)

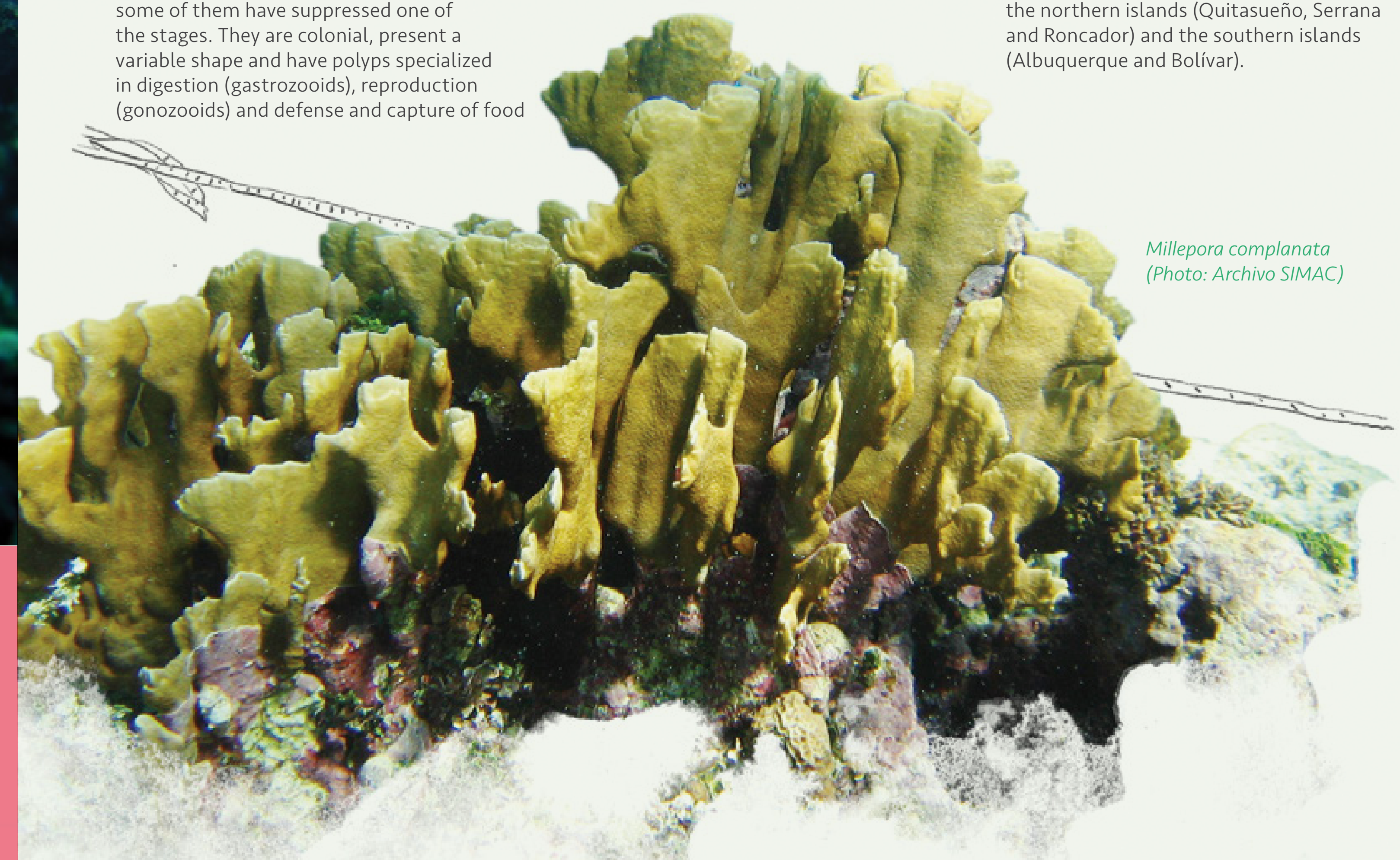
Gorgonia ventalina (Photo: Archivo SIMAC)

Plexaura sp. (Photo: Archivo MEDUSOZOA)

Gorgonaceo (Photo: Juan Carlos Marquez)

Hydrozoans

The next class is Hydrozoa, represented by hydrocorals, hydroids and hydromedusae. The class is divided into seven orders **(Daly *et al.*, 2007)** (Anthoathecata, Leptothecata, Siphonophorae, Actinulida, Limnomedusae, Narcomedusae y Trachymedusae), of which two have been recorded in the Seaflower Biosphere Reserve. Hydrozoans usually have a life cycle in which the polyp stage alternates with the medusa stage, although some of them have suppressed one of the stages. They are colonial, present a variable shape and have polyps specialized in digestion (gastrozooids), reproduction (gonozooids) and defense and capture of food (dactilozooids). Their exoskeleton is made of chitin or calcium carbonate (hydrocorals). The order Anthoathecata is characterized by solitary or colonial polyps that do not have a protective cover, with the exception of the genera Millepora and Stylaster (present in the Archipelago of San Andrés, Providencia and Santa Catalina), which form colonies with massive calcareous exoskeletons **(Daly *et al.*, 2007)**. *). Millepora, also known as fire coral due to the severe burns produced on contact with it, is a genus widely distributed in tropical waters and commonly found in any coral reef up to 50 m deep, with its robust paddle- or plate-shaped colonies* **(Lewis, 1989)**. Similarly, Stylaster occurs in dense colonies of purple or pink colorations. This order is widely distributed in the Archipelago of San Andrés, Providencia and Santa Catalina, as well as in the remote islands (Serranilla, Bajo Nuevo and Bajo Alicia), the northern islands (Quitasueño, Serrana and Roncador) and the southern islands (Albuquerque and Bolívar).



Millepora complanata (Photo: Archivo SIMAC)

Siphonophorae, or modified jellyfish, is the other order registered within the class Hydrozoa. It comprises mainly oceanic and free-swimming organisms of the water column. They are characterized by their floating colonial organization, their varied functional morphology and their specialized polyps to perform the functions of locomotion, feeding, defense, excretion and reproduction. They have a wide distribution and are among the longest organisms on the planet, given that some of them can exceed 40 m long **(Dunn *et al.*, 2005)**.

The Portuguese man o' war *Physalia physalis* has been found in the surrounding area of San Andrés Island. It is characterized by a horizontal violet float (pneumatophore) that reaches 30 cm long and is used to move by the effect of the wind. Its blue tentacles can exceed 10 m long. It is one of the most easily identifiable siphonophores because it is responsible for most stings during the dry season (Daly et al., 2007) **(Daly *et al.*, 2007).**

The colonial siphonophore *Agalma* sp., has also been observed in the surroundings of San Andrés. It receives its name due to its resemblance to a translucent red-banded neck ornament **(Fewkes, 1880)**; The colony can measure 1.20 m; it is cosmopolitan and occurs in deep waters, but when found in shallow waters, it indicates upwellings of ocean waters to the continental slope **(Kirkpatrick and Pugh, 1984).**

True jellyfish

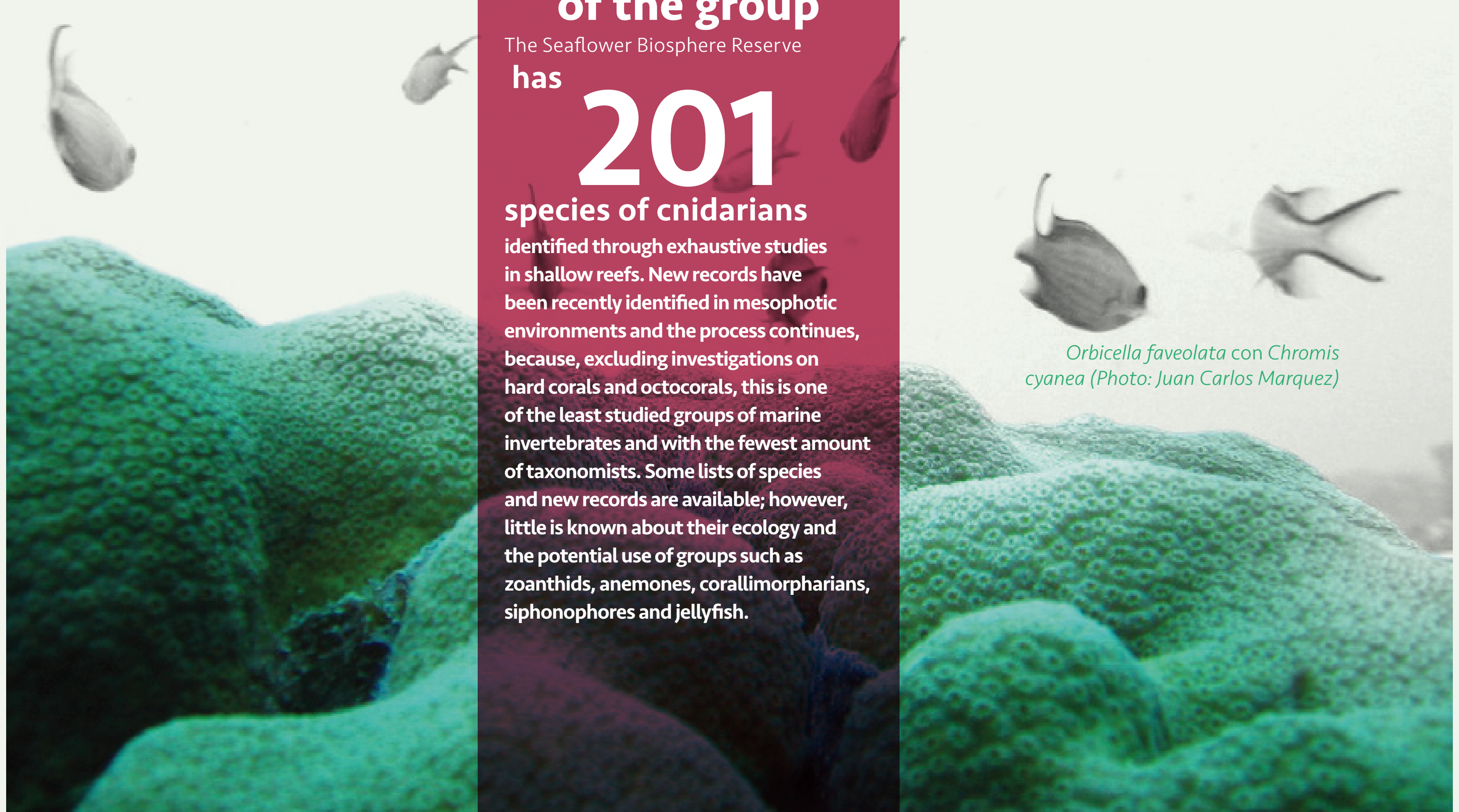
Finally, Scyphozoa, or true jellyfish, have a solid hemispherical (order Rhizostomeae) or discoidal (order Semaeostomeae) bell, and are characterized by long tentacles covered with cnidocytes. They have a dominant planktonic stage (jellyfish) that alternates with a benthic stage (polyp). The latter can reproduce asexually, allowing jellyfish population to preserve and spread, even if sexual reproduction from adult jellyfish does not occur. These attributes favor a quick growth of jellyfish populations in the world, affecting social and economic conditions of some countries where this phenomenon takes place **(Russell, 1970; Daly *et al.*, 2007).**

Aurelia sp.

Rhizostomeae, unlike other groups, have no marginal tentacles or a central mouth, instead they have eight oral arms with many tiny mouths; except for *Stomolophus meleagris*, which has a single oral cavity **(Daly *et al.*, 2007)**. They have a gelatinous consistency, firmer than the rest of true jellyfish, and exhibit the largest sizes. They are tropically distributed and most of them are recorded in the Indo-Pacific Ocean waters **(Mayer, 1910).**

In San Andrés Island, the genus *Cassiopea*, has been found associated with mangrove roots in the Old Point Regional Mangrove Park and Hooker Bay. *Cassiopea* establishes a symbiotic relationship with zooxanthellae and that is the reason of its greenish and brown colors. Usually, it is found semi-sessil inhabiting muddy bottoms of tropical areas, with its oral arms pointing at the surface, allowing zooxanthellae to use sunlight. On the other hand, Semaeostomeae jellyfish are different from the others because they have a central mouth, long oral arms, scalloped-edge bells and marginal tentacles **(Daly *et al.*, 2007).**

The genus *Aurelia*, or moon jellyfish, has also been found on the island, near the outfall and its surroundings. It is a cosmopolitan and widely studied jellyfish. Their diet is based on ciliates, zooplankton and fish larvae. It is a plate-shaped jellyfish with short marginal tentacles and four circular gonads.



Perspectives of the group

The Seaflower Biosphere Reserve **has 201 species of cnidarians**

identified through exhaustive studies in shallow reefs. New records have been recently identified in mesophotic environments and the process continues, because, excluding investigations on hard corals and octocorals, this is one of the least studied groups of marine invertebrates and with the fewest amount of taxonomists. Some lists of species and new records are available; however, little is known about their ecology and the potential use of groups such as zoanthids, anemones, corallimorpharians, siphonophores and jellyfish.

Orbicella faveolata con *Chromis cyanea* (Photo: Juan Carlos Marquez)

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Cnidarians

Phylum Cnidaria

Class (C): Anthozoa — Subclass (Sc): Hexacorallia

Order (O)	F	S				
Actiniaria	Actiniidae	*Bunodosoma granuliferum*	(Le Sueur, 1817)	18	PSC	
Actiniaria	Actiniidae	*Condylactis gigantea*	(Weinland, 1860)	13	PSC, SA	
Actiniaria	Aiptasidae	*Aiptasia* sp.	Gosse, 1858	13	SA	
Actiniaria	Aiptasidae	*Bartholomea annulata*	(Lesueur, 1817)	13	PSC, SA	
Actiniaria	Aliciidae	*Lebrunia coralligens*	(Wilson, 1890)	13	PSC	
Actiniaria	Aliciidae	*Lebrunia neglecta*	(Duchassaing & Michelotti, 1860)	13	PSC, SA	
Actiniaria	Boloceroididae	*Bunodeopsis* sp.	Andres, 1881	13	PSC, SA	
Actiniaria	Phymanthidae	*Phymanthus crucifer*	(Lesueur, 1817)	13	PSC, SA	
Actiniaria	Stichodactylidae	*Stichodactyla helianthus*	(Ellis, 1768)	18	PSC	
Antipatharia	Antipathidae	*Antipathes atlantica*	Gray, 1857	12	SA	Appendix II
Antipatharia	Antipathidae	*Antipathes caribbeana*	Opresko, 1996	12	PSC	Appendix II
Antipatharia	Antipathidae	*Antipathes furcata*	Gray, 1857	12	SA	Appendix II
Antipatharia	Antipathidae	*Antipathes* sp.	Pallas, 1766	13	BN	Appendix II
Antipatharia	Antipathidae	*Stichopathes lutkeni*	Brook, 1889	12	SA	Appendix II
Antipatharia	Antipathidae	*Stichopathes occidentalis*	Brook, 1889	12	SA	Appendix II
Antipatharia	Antipathidae	*Stichopathes* sp.	Brook, 1889	13	BN	Appendix II
Antipatharia	Aphanipathidae	*Elatopathes abietina*	(Pourtalés, 1874)	13	BN	Appendix II
Antipatharia	Aphanipathidae	*Rhipidipathes colombiana*	(Opresko & Sánchez, 1997)	12	SA	Appendix II
Antipatharia	Myriopathidae	*Plumapathes pennacea*	(Pallas, 1766)	12	SA	Appendix II
Antipatharia	Stylopathidae	*Stylopathes columnaris*	(Duchassaing, 1870)	13	IN, PSC, IS, S	Appendix II
Corallimorpharia	Discosomatidae	*Discosoma carlgreni*	(Watzl, 1922)	13	BN	
Corallimorpharia	Discosomatidae	*Rhodactis osculifera*	(Le Sueur, 1817)	18	PSC	
Corallimorpharia	Ricordeidae	*Ricordea* sp.	-	13	PSC	
Scleractinia	Acroporidae	*Acropora cervicornis*	(Lamarck, 1816)	4	PSC, SA, IR, BQ	Appendix II
Scleractinia	Acroporidae	*Acropora palmata*	(Lamarck, 1816)	4	IR, N, S, IN, CB, CA	Appendix II
Scleractinia	Acroporidae	*Acropora prolifera*	(Lamarck, 1816)	7	PSC, SA, BQ	Appendix II
Scleractinia	Agariciidae	*Agaricia agaricites*	(Linnaeus, 1758)	1	PSC, SA, ARC, IR, BA, BQ	Appendix II
Scleractinia	Agariciidae	*Agaricia fragilis*	Dana, 1848	1	PSC, SA, IR, BQ, CB	Appendix II
Scleractinia	Agariciidae	*Agaricia grahamae*	Wells, 1973	16	PSC, SA, BQ	Appendix II
Scleractinia	Agariciidae	*Agaricia humilis*	Verrill, 1901	1	IN, PSC, SA, CB	Appendix II
Scleractinia	Agariciidae	*Agaricia lamarcki*	Milne Edwards & Haime, 1851	1	PSC, SA, BN, BQ, CA	Appendix II
Scleractinia	Agariciidae	*Agaricia* sp.	Lamarck, 1801	13	IN, PSC, IS, S,	Appendix II
Scleractinia	Agariciidae	*Agaricia tenuifolia*	Dana, 1848	14	PSC, SA, IR, BA, BR, CB	Appendix II
Scleractinia	Agariciidae	*Agaricia undata*	(Ellis &Solander, 1786)	7	IN, PSC, IS, S	Appendix II
Scleractinia	Agariciidae	*Helioseris cucullata*	(Ellis &Solander, 1786)	1	IR, IN, PSC, IS, S, BA,	Appendix II
Scleractinia	Agariciidae	*Leptoseris* sp.	Milne Edwards & Haime, 1849	13	PSC, SA, BN	Appendix II
Scleractinia	Astrocoeniidae	*Stephanocoenia intersepta*	(Lamarck, 1836)	1	IR, IN, PSC, IS, S, BA	Appendix II
Scleractinia	Caryophylliidae	*Anomocora fecunda*	(Pourtalés, 1871)	13	BN	Appendix II
Scleractinia	Caryophylliidae	*Anomocora prolifera*	(Pourtalés, 1871)	13	PSC, SA	Appendix II
Scleractinia	Caryophylliidae	*Caryophyllia ambrosia caribbeana*	Cairns, 1979	8	BN	Appendix II
Scleractinia	Caryophylliidae	*Caryophyllia berteriana*	Duchassaing, 1850	13	BN	Appendix II
Scleractinia	Caryophylliidae	*Caryophyllia* sp.	Lamarck, 1801	13	BQ	Appendix II
Scleractinia	Caryophylliidae	*Coenosmilia* sp.	Pourtalés, 1874	13	BN	Appendix II
Scleractinia	Caryophylliidae	*Coesnosmilia arbuscula*	Pourtalés, 1874	13	PCM	Appendix II
Scleractinia	Caryophylliidae	*Oxysmilia rotundifolia*	Milne Edwards & Haime, 1848	8	BN	Appendix II
Scleractinia	Caryophylliidae	*Paracyathus pulchellus*	Philippi, 1842	13	SA	Appendix II
Scleractinia	Caryophylliidae	*Phacelocyathus flos*	(Pourtalés, 1878)	9	IN	Appendix II
Scleractinia	Caryophylliidae	*Phyllangia* sp.	Milne Edwards & Haime, 1848	9	SA	Appendix II
Scleractinia	Caryophylliidae	*Stephanocyathus (Odontocyathus) coronatus*	(Pourtalés, 1867)	9	PSC, SA	Appendix II
Scleractinia	Caryophylliidae	*Stephanocyathus (Stephanocyathus) paliferus*	Cairns, 1977	9	SA	Appendix II
Scleractinia	Caryophylliidae	*Thalamophyllia riisei*	(Duchassaing & Michelotti, 1864)	13	BN	Appendix II
Scleractinia	Deltocyathidae	*Deltocyathus calcar*	Pourtalés, 1874	13	BN	Appendix II
Scleractinia	Dendrophylliidae	*Balanophyllia (Balanophyllia) cyathoides*	(Pourtalès, 1871)	12	SA	Appendix II
Scleractinia	Dendrophylliidae	*Balanophyllia bayeri*	Cairns, 1979	13	PSC	Appendix II
Scleractinia	Dendrophylliidae	*Balanophyllia hadros*	Cairns, 1979	9	SA	Appendix II
Scleractinia	Dendrophylliidae	*Balanophyllia* sp.	Wood, 1844	13	BN	Appendix II
Scleractinia	Dendrophylliidae	*Flabellum (Ulocyathus) moseleyi*	Pourtalés, 1880	9	SA	Appendix II
Scleractinia	Dendrophylliidae	*Tubastraea coccinea*	Lesson, 1829	7	PSC, SA, BN, BQ	Appendix II
Scleractinia	Flabellidae	*Javania cailleti*	(Duchassaing & Michelotti, 1864)	8	BN	Appendix II
Scleractinia	Flabellidae	*Javania* sp.	Duncan, 1876	13	SA	Appendix II
Scleractinia	Flabellidae	*Polymyces fragilis*	(Pourtalés, 1868)	13	PSC, SA, BN, BS	Appendix II
Scleractinia	Flabellidae	*Polymyces wellsi*	Cairns, 1991	9	SA	Appendix II
Scleractinia	Fungiacyathidae	*Fungiacyathus symmetricus*	(Pourtalés, 1871)	9	SA	Appendix II
Scleractinia	Guyniidae	*Guynia annulata*	Duncan, 1872	9	SA	Appendix II
Scleractinia	Meandrinidae	*Dendrogyra cylindrus*	Ehrenberg, 1834	1	PSC, SA, IR, BA, BQ, CA	Appendix II
Scleractinia	Meandrinidae	*Dichocoenia stellaris*	Milne Edwards &Haime, 1849	7	SA	Appendix II
Scleractinia	Meandrinidae	*Dichocoenia stokesii*	Milne Edwards &Haime, 1848	1	IR, IN, PSC, IS, S, BA	Appendix II
Scleractinia	Meandrinidae	*Eusmilia fastigiata*	(Pallas, 1766)	1	IR, IN, PSC, IS, S, BA	Appendix II
Scleractinia	Meandrinidae	*Meandrina meandrites*	(Linnaeus, 1758)	1	IR, IN, PSC, IS, S, BA	Appendix II

Interactive table

Class (C): Anthozoa — Subclasses (Sc): Hexacorallia, Octocorallia

Subclass	Order (O)	F	S				
Hexacorallia	Scleractinia	Merulinidae	*Orbicella annularis*	(Ellis & Solander, 1786)	1	IR, IN, PSC, IS, S	Appendix II
Hexacorallia	Scleractinia	Merulinidae	*Orbicella faveolata*	(Ellis &Solander, 1786)	1	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Merulinidae	*Orbicella franksi*	(Gregory, 1895)	1	IR, IN, PSC, IS, S	Appendix II
Hexacorallia	Scleractinia	Montastraeidae	*Montastraea cavernosa*	(Linnaeus, 1767)	1	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Colpophyllia breviserialis*	Milne Edwards & Haime, 1849	13	PSC, SA, BQ	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Colpophyllia natans*	(Houttuyn, 1772)	5	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Diploria laberinthiformis*	(Linnaeus, 1758)	4	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Favia fragum*	(Esper, 1795)	1	PSC, IS, S, BN, BA, BQ, BR	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Isophyllia rigida*	(Dana, 1848)	1	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Isophyllia sinuosa*	(Ellis & Solander, 1786)	1	PSC, SA, IR, BA, BQ, BS	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Manicina areolata*	(Linnaeus, 1758)	14	PSC, SA, IR, BA, BQ	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Mussa angulosa*	(Pallas, 1766)	9	PSC, SA, IR, BQ, CA	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Mycetophyllia aliciae*	Wells, 1973	14	PSC, SA, BN, BQ, BR, CB	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Mycetophyllia dannana*	Milne Edwards & Haime, 1849	13	PSC, SA, BQ, CA	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Mycetophyllia ferox*	Wells, 1973	1	IR, PSC, IS, S, BS, BR	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Mycetophyllia lamarckiana*	Milne Edwards & Haime, 1848	1	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Mycetophyllia reesi*	Wells, 1973	9	PSC, SA, BQ, BR	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Pseudodiploria clivosa*	(Ellis & Solander, 1786)	5	IR, IN, PSC, IS, S	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Pseudodiploria strigosa*	(Dana, 1846)	4	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Scolymia cubensis*	Milne Edwards & Haime, 1849	1	IR, PSC, IS, S, BQ	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Scolymia lacera*	(Pallas, 1766)	7	PSC, SA, BQ, CB	Appendix II
Hexacorallia	Scleractinia	Mussidae	*Scolymia wellsii*	Laborel, 1967	13	PSC, SA	Appendix II
Hexacorallia	Scleractinia	Oculinidae	*Madrepora carolina*	(Pourtalés, 1871)	9	SA	Appendix II
Hexacorallia	Scleractinia	Oculinidae	*Oculina diffusa*	Lamarck, 1816	9	PSC, SA	Appendix II
Hexacorallia	Scleractinia	Pocilloporidae	*Madracis auretenra*	Locke, Weil Coates, 2007	9	PSC, SA, BQ	Appendix II
Hexacorallia	Scleractinia	Pocilloporidae	*Madracis decactis*	(Lyman, 1859)	9	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Pocilloporidae	*Madracis formosa*	Wells, 1973	9	PSC, SA, BQ	Appendix II
Hexacorallia	Scleractinia	Pocilloporidae	*Madracis myriaster*	Milne Edwards & Haime, 1850	1	PSC, SA, IR, BA, BQ	Appendix II
Hexacorallia	Scleractinia	Pocilloporidae	*Madracis pharensis*	(Heller, 1868)	9	PSC, SA	Appendix II
Hexacorallia	Scleractinia	Pocilloporidae	*Madracis senaria*	Wells, 1973	12	SA	Appendix II
Hexacorallia	Scleractinia	Pocilloporidae	*Madracis* sp.	Milne Edwards & Haime, 1849	13	IN, PSC, IS, S	Appendix II
Hexacorallia	Scleractinia	Poritidae	*Porites astreoides*	Lamarck, 1816	4	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Poritidae	*Porites branneri*	Rathbun, 1887	15	PSC, SA	Appendix II
Hexacorallia	Scleractinia	Poritidae	*Porites colonensis*	Zlatarski, 1990	15	PSC, SA	Appendix II
Hexacorallia	Scleractinia	Poritidae	*Porites divaricata*	Lesueur, 1820	14	PSC, SA, IR, BA	Appendix II
Hexacorallia	Scleractinia	Poritidae	*Porites furcata*	Lamarck, 1816	1	PSC, SA, IR, BA, BQ	Appendix II
Hexacorallia	Scleractinia	Poritidae	*Porites porites*	(Pallas, 1766)	14	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Scleractinia	Rhizangiidae	*Astrangia californica*	Durharn & Barnard, 1952	9	SA	Appendix II
Hexacorallia	Scleractinia	Rhizangiidae	*Astrangia solitaria*	(Lesueur, 1817)	17	PSC, SA	Appendix II
Hexacorallia	Scleractinia	Scleractinia incertae sedis	*Cladocora arbuscula*	Leseur, 1821	9	SA	Appendix II
Hexacorallia	Scleractinia	Scleractinia incertae sedis	*Solenastrea bournoni*	Milne Edwards & Haime, 1849	14	PSC, SA, CS, BQ	Appendix II
Hexacorallia	Scleractinia	Siderastreidae	*Siderastrea radians*	(Pallas, 1766)	1	PSC, SA, IR, BA, BQ, CA	Appendix II
Hexacorallia	Scleractinia	Siderastreidae	*Siderastrea siderea*	(Ellis & Solander, 1768)	1	IR, IN, PSC, IS, S, BA	Appendix II
Hexacorallia	Zoantharia	Epizoanthidae	*Epizoanthus cutressi*	West, 1979	2	SA	
Hexacorallia	Zoantharia	Epizoanthidae	*Epizoanthus* sp.	Gray, 1867	13	IR, SA	
Hexacorallia	Zoantharia	Parazoanthidae	*Parazoanthus catenularis*	(Duchasing de Fonbressin & Micheloti, 1860)	2	SA	
Hexacorallia	Zoantharia	Parazoanthidae	*Parazoanthus puertoricense*	West, 1979	2	SA	
Hexacorallia	Zoantharia	Parazoanthidae	*Parazoanthus swiftii*	(Duchasing de Fonbressin & Micheloti, 1860)	2	SA	
Hexacorallia	Zoantharia	Parazoanthidae	*Umimayanthus parasiticus*	(Duchasing de Fonbressin & Micheloti, 1860)	2	SA	
Hexacorallia	Zoantharia	Zoanthidae	*Isaurus tuberculatus*	Gray, 1828	13	SA	
Hexacorallia	Zoantharia	Zoanthidae	*Palythoa caribaeorum*	(Duchassaing & Michelotti, 1860)	13	PSC, SA	
Hexacorallia	Zoantharia	Zoanthidae	*Palythoa mammillosa*	(Ellis & Solander, 1786)	13	SA	
Hexacorallia	Zoantharia	Zoanthidae	*Zoanthus pulchellus*	(Duchassaing & Michelotti, 1860)	13	SA	
Hexacorallia	Zoantharia	Zoanthidae	*Zoanthus sociatus*	(Ellis, 1768)	13	SA	
Octocorallia	Alcyonacea	Anthothelidae	*Erythropodium caribaeorum*	(Duchassaing & Michelotti, 1860)	14	IR	
Octocorallia	Alcyonacea	Anthothelidae	*Erythropodium* sp.	-	13	SA	
Octocorallia	Alcyonacea	Anthothelidae	*Iciligorgia* sp.	Duchassaing, 1870	13	PSC, SA	
Octocorallia	Alcyonacea	Briareidae	*Briareum asbestinum*	(Pallas, 1766)	14	PSC, IS, IR, CB, CA	
Octocorallia	Alcyonacea	Briareidae	*Briareum* sp.	Blainville, 1834	13	SA	
Octocorallia	Alcyonacea	Chrysogorgiidae	*Chrysogorgia desbonni*	Duchassaing & Michelotti, 1864	13	BN	
Octocorallia	Alcyonacea	Chrysogorgiidae	*Chrysogorgia* sp.	Duchassaing & Michelotti, 1864	13	PSC, BN	
Octocorallia	Alcyonacea	Ellisellidae	*Ellisella barbadensis*	(Duchassaing & Michelotti, 1864)	12	PSC, SA	
Octocorallia	Alcyonacea	Ellisellidae	*Ellisella elongata*	(Pallas, 1766)	12	SA	
Octocorallia	Alcyonacea	Ellisellidae	*Ellisella nivea*	(Bayer & Grasshoff, 1995)	12	SA	
Octocorallia	Alcyonacea	Ellisellidae	*Ellisella rosea*	(Bayer & Grasshoff, 1995)	12	SA	
Octocorallia	Alcyonacea	Ellisellidae	*Ellisella schmitti*	(Bayer, 1961)	12	PSC, BN	
Octocorallia	Alcyonacea	Ellisellidae	*Nicella goreaui*	Bayer, 1973	12	SA	
Octocorallia	Alcyonacea	Ellisellidae	*Nicella* sp.	Gray, 1870	13	SA	
Octocorallia	Alcyonacea	Ellisellidae	*Nicella toeplitzae*	Viada & Cairns, 2007	12	SA	
Octocorallia	Alcyonacea	Ellisellidae	*Riisea paniculata*	Duchassaing & Michelotti, 1860	13	PSC, SA, BN	
Octocorallia	Alcyonacea	Ellisellidae	*Viminella* sp.	Gray, 1870	13	PSC, SA	

Phylum Cnidaria

Class	Subclass	Order	Family	S				
C Anthozoa	Sc Octocorallia	O Alcyonacea	Gorgoniidae	*Antillogorgia acerosa*	(Pallas, 1766)	12	PSC, IS, CB, CA	
				Antillogorgia albatrossae	Bayer, 1961	12	PSC	
				Antillogorgia americana	(Gmelin, 1791)	14	PSC, IS, BN, CB, CA	
				Antillogorgia bipinnata	(Verrill, 1864)	14	IR, PSC, IS, BA, CB, CA	
				Antillogorgia elisabethae	Bayer, 1961	12	PSC, IS, CB, CA	
				Antillogorgia histrix	Bayer, 1961	12	PSC, SA, IS, S, CB, CA	
				Antillogorgia kallos	(Bielschowsky, 1918)	12	PSC, IS, CB, CA	
				Antillogorgia rigida	(Bielschowsky, 1929)	12	PSC, IS, CB, CA	
				Gorgonia mariae	Bayer, 1961	12	PSC	
				Gorgonia sp.	Linnaeus, 1757	14	BN, CS, BA	
				Gorgonia ventalina	Linnaeus, 1758	11	IR, PSC, IS, S, BA,	
				Leptogorgia virgulata	(Lamarck, 1815)	13	PSC, SA	
				Pseudopterogorgia sp.	Kükenthal, 1919	14	SA, BN, CS, BA	
				Pterogorgia anceps	(Pallas, 1766)	14	IS, BA, CB, CA	
				Pterogorgia citrina	(Esper, 1792)	14	IR, IS, CB, CA	
				Pterogorgia sp.	Ehrenberg, 1834	14	IR, PSC, SA, BA	
			Keroeididae	*Thelogorgia studeri*	Bayer, 1991	12	SA	
			Nephtheidae	*Stereonephthya portoricensis*	(Hargitt, 1901)	13	SA	
			Plexauridae	*Eunicea calyculata*	(Ellis & Solander, 1786)	12	PSC	
				Eunicea flexuosa	(Lamouroux, 1821)	14	PSC, IS, S, BN,	
				Eunicea fusca	Duchassaing & Michelotti, 1860	11	IS, CB, CA	
				Eunicea knighti	Bayer, 1961	11	IS, CB, CA	
				Eunicea laciniata	Duchassaing & Michelotti, 1860	12	PSC	
				Eunicea laxispica	(Lamarck, 1815)	12	PSC	
				Eunicea mammosa	Lamouroux, 1816	12	PSC, IS, CB, CA	
				Eunicea pinta	Bayer & Deichmann, 1958	12	SA	
				Eunicea sp.	Lamouroux, 1816	14	IR, PSC, IS, S, BA	
				Eunicea succinea	(Pallas, 1766)	12	PSC, IS, CB, CA	
				Eunicea tourneforti	Milne Edwards & Haime, 1857	12	PSC, IS, CB, CA	
				Hypnogorgia pendula	Duchassaing & Michelotti, 1864	13	SA	
				Muricea laxa	Verrill, 1864	12	SA	
				Muricea muricata	(Pallas, 1766)	13	PSC, SA	
				Muricea sp.	Lamouroux, 1821	14	IR, BA	
				Muriceopsis flavida	(Lamarck, 1815)	12	PSC, IS, CB, CA	
				Muriceopsis sp.	Aurivillius, 1931	14	IR	
				Plexaura homomalla	(Esper, 1792)	14	PSC, IS, S, BN	
				Plexaura kuna	Lasker, Kim & Coffroth, 1996	12	PSC	
				Plexaura sp.	Lamouroux, 1812	11	IR, PSC, IS, S, BA	
				Plexaurella dichotoma	(Esper, 1791)	12	PSC, IS, CB, CA	
				Plexaurella grisea	Kunze, 1916	12	PSC, IS, CB, CA	
				Plexaurella nutans	(Duchassaing & Michelotti, 1860)	14	IR, BA	
				Plexaurella sp.	Kölliker, 1865	14	IR, BA	
				Pseudoplexaura crucis	Bayer, 1961	12	PSC, IS, CB, CA	
				Pseudoplexaura flagellosa	(Houttuyn, 1772)	12	PSC	
				Pseudoplexaura porosa	(Houttuyn, 1772)	12	PSC, IS, CB, CA	
				Pseudoplexaura sp.	Wright & Studer, 1889	11	IS, BN, CB, CA	
				Scleracis guadalupensis	(Duchassaing & Michelotti, 1860)	13	PSC, SA, BN	
				Swiftia exerta	(Ellis & Solander, 1786)	12	SA	
				Thesea nutans	Duchassaing & Michelotti, 1864	12	SA	
				Villogorgia nigrescens	Duchassaing & Michelotti, 1860	12	SA	
			Primnoidae	*Calyptrophora* sp.	Gray, 1866	13	PSC, SA, BN	
Hydrozoa	Hydroidolin	Anthoathecata	Milleporidae	*Millepora alcicornis*	Linnaeus, 1758	4	IR, IN, PSC, IS, S, BA	Appendix II
				Millepora complanata	Lamarck, 1816	4	IR, IN, PSC, IS, S, BA	Appendix II
				Millepora squarrosa	Lamarck, 1817	7	PSC, SA, BN	Appendix II
			Stylasteridae	*Stylaster duchassaingi*	Pourtalès, 1867	12	SA	Appendix II
				Stylaster roseus	(Pallas, 1766)	1	IR, PSC, SA, BN, CS, BA	Appendix II
				Stylaster sp.	Gray, 1831	13	PSC, SA, BQ, CB	
		Siphonophorae	Agalmatidae	*Agalma* sp.	Eschscholtz, 1825	3	SA	
			Physaliidae	*Physalia physalis*	Lamarck, 1801	6	SA	
Scyphozoa	Discomedusae	Rhizostomeae	Cassiopeidae	*Cassiopea* sp.	(Pallas, 1774)	6	SA	
		Semaeostomeae	Ulmaridae	*Aurelia* sp.	Lamarck , 1816	3	SA	

Interactive table

Cnidarians

Conservation status

LC	
Agaricia agaricites	**VU**
Agaricia grahamae	*Acropora prolifera*
Agaricia humilis	*Agaricia lamarcki*
Agaricia tenuifolia	*Dendrogyra cylindrus*
Helioseris cucullata	*Dichocoenia stokesii*
Stephanocoenia intersepta	*Mussa angulosa*
Eusmilia fastigiata	*Mycetophyllia ferox*
Montastraea cavernosa	*Gorgonia ventalina*
Colpophyllia natans	
Favia fragum	
Isophyllia sinuosa	**DD**
Manicina areolata	*Agaricia fragilis*
Mycetophyllia aliciae	*Dichocoenia stellaris*
Mycetophyllia lamarckiana	*Mycetophyllia reesi*
Scolymia cubensis	*Porites colonensis*
Scolymia lacera	
Oculina diffusa	
Madracis auretenra	**EN**
Madracis decactis	*Acropora palmata*
Madracis formosa	
Madracis pharensis	
Madracis senaria	**CR**
Porites astreoides	*Acropora cervicornis*
Porites divaricata	
Porites furcata	**NT**
Porites porites	*Agaricia undata*
Solenastrea bournoni	*Porites branneri*
Siderastrea radians	
Siderastrea siderea	
Millepora alcicornis	
Millepora complanata	
Millepora squarrosa	

All cnidarian species are associated with the benthic environment, with the exception of *Agalma* sp., *Physalia physalis* and *Aurelia* sp., which are associated with the pelagic environment.

All cnidarian species are associated with the habitat of sublittoral biogenic reefs, with the exception of *Agalma* sp., *Physalia physalis* and *Aurelia* sp., which are associated with the habitat of the water column.

SPAW *Acropora cervicornis* and *Acropora palmate* are included in Annex II of the SPAW Protocol

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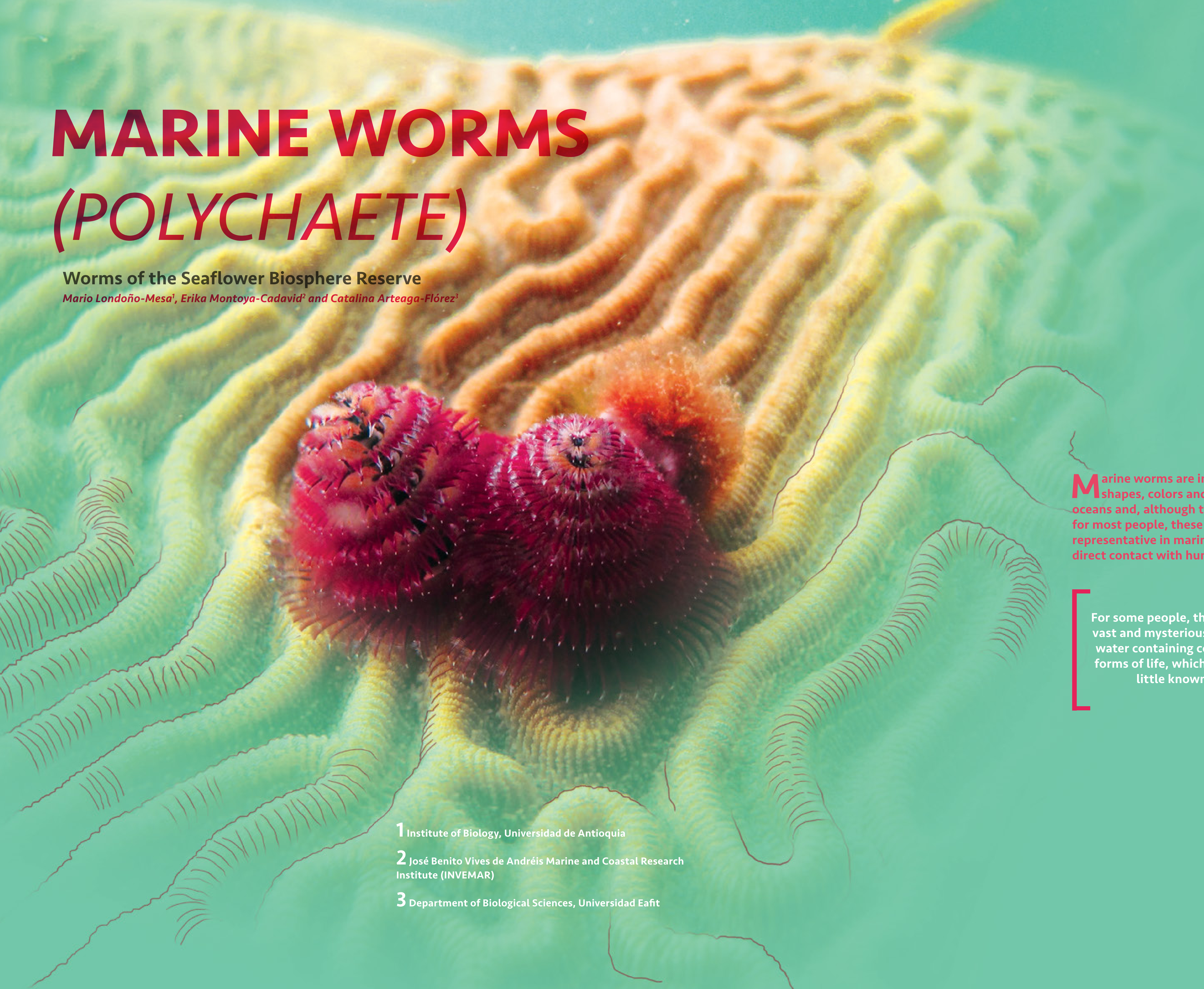


MARINE WORMS *(POLYCHAETE)*

Worms of the Seaflower Biosphere Reserve

Mario Londoño-Mesa[1], Erika Montoya-Cadavid[2] and Catalina Arteaga-Flórez[3]

Marine worms are invertebrates with a wide variety of shapes, colors and sizes, which can be found in the oceans and, although the term polychaete is unknown for most people, these organisms are common and very representative in marine environments, being easily found in direct contact with humans.

> For some people, the sea is a vast and mysterious body of water containing countless forms of life, which are still little known.

1 Institute of Biology, Universidad de Antioquia

2 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

3 Department of Biological Sciences, Universidad Eafit

Figura 1. Variety of marine worms Borstenwurmer des Meeres. Schematized cover by the German biologist Matthias Jakob Schleiden, in his catalog of seas "Das Meer" (1804 -1881).

Anatomy and biology

The word Polychaeta refers to organisms with many setas (poly: many, chaeta: seta, bristle or hair), whose body is composed of few or many segments. All segments have always the same organs, a feature known as metamerization. Generally, when observing an animal of this group, three regions can be distinguished: the head, the body and a terminal post-segmental region (Figure 2). The head, or anterior region, is divided into two sections: the first segment, called prostomium (pro: in front of, stoma: mouth); and the second segment, named peristomium (peri: around). Both sections are highly important for the identification of species. The mouth is located in ventral position between these two sections. The prostomium is usually located in dorsal position, above the mouth, and it contains the external sensory organs such as the eyes, the antennae and the palps. The peristomium may have other structures with sensory and feeding functions, such as cirri and palps, which exhibit different shapes and sizes. The body, or middle region, is composed of paired structures, similar to small legs, called parapodia (para: similar to; podos: feet), which are laterally arranged and are used in locomotion. Setas are inserted in parapodia, they have different shapes and are one of the most important characteristics to identify families, genera and species. Finally, there is a terminal region or posterior segment known as pygidium, which contains the anus.

Figure 2. An individual of the species Nereis sp., showing the general morphology of a polychaete (Photograph by C. Arteaga Flórez).

Polychaetes can reproduce both sexually and asexually, and have a wide variety of methods of reproduction and types of development, including external fertilization and incubation and encapsulation of larvae. **(Báez y Ardila, 2003)**. In most species, there are separate sexes, that is, there are male and female individuals (dioecious organisms). For sexual reproduction, mature adults release both eggs and sperm and fertilization occurs in the water, although the males of some species have adapted parts of their body for copulation (e.g. parapodia, bristles and anus). After fertilization, a free-living larva appears; the most common is called trochophore and is characterized by not having segments. It looks like a more or less elongated sphere, surrounded by bands of cilia with feeding and locomotion functions. There are also metatrochophore larvae, which have an initial segmentation and may be free swimmers **(Méndez, 2012)**. The larva stage can last from days to months, and ends with the metamorphosis into an adult organism **(Viéitez *et al.*, 2004)**.
Furthermore, regarding asexual reproduction, which is quite common in the group, the body divides into two or more parts, and from them, the missing parts are regenerated, resulting in an organism identical to the original. This process is known as schizotomy **(Rouse y Pleijel, 2001)**. Some polychaetes exhibit both types of reproduction, as in the case of the gregarious sabellid *Bispira brunnea* **(Tovar Hernández y Pineda Vera, 2007)** (Figura 3).

An extraordinary phenomenon among polychaetes is epitoky. It occurs in times of sexual maturity and is triggered mainly by the moonlight. During this phenomenon, polychaetes exhibit changes in behavior and internal and external physical modifications. It is sometimes considered a combination between sexual and asexual reproduction. This process involves generating new individuals from a parent, and their sole purpose is to transport the sexual products (eggs and sperm) of both sexes to the water column. Then, a few meters deep, such products are released, conveyors die and fertilization occurs. Although not all groups of worms carry out this process, this is a strategy to improve the chances of reproduction and it has been demonstrated and studied in great detail in the families Eunicidae, Nereididae and Syllidae.

Worms play an essential ecological role in the removal and movement of marine sediments, which is vital for the structure, production, dynamics and health of the environment, especially for benthic communities. For this reason, they are a vital link in the food web, as they are both, a source of food and consumers (Orensanz & Ramírez, 1973; Báez & Ardila, 2003). **Some tube organisms (e.g., sabellids and serpulids) form dense groups that alter the flow of water, favoring sedimentation of fine particles and encouraging the recruitment of other species of polychaetes and invertebrates; while others, such as nereids and syllids, are responsible for bioerosion of coral substrates because they perforate and destroy them** (Díaz, 2003).

Classification

Polychaetes, along with earthworms (class Oligochaeta) and leeches (class Hirudinea), make up the phylum Annelida and share the characteristic of having a ring-shaped body. The class Polychaeta is the most diverse and complex class and is divided into two large groups called subclasses. The subclass Errantia includes the most active groups capable of moving freely and living on soft substrates (sand, mud and gravel) or hard substrates (rocks and corals), digging or walking on the seafloor, or swimming in the water column. The subclass Sedentaria includes polychaetes that are less active and limited in their movement and that live in passages or burrows between rocks, on the seafloor, or in calcareous or sand tubes that they build and that, in some cases, may form three-dimensional structures or reefs, as the members of the families Sabellariidae and Serpulidae do. Both subclasses can also be differentiated by the type of food they eat; while errant polychaetes tend to be carnivores, scavengers or omnivores, sedentary polychaetes are often filter feeders and detritivores **(Fauchald y Jumars, 1979; Gambi y Giangrande, 1985; Blake y Hilbig, 1994).**

Distribution

Despite being mainly marine, polychaetes may be found, with low representation, in freshwater environments or terrestrial environments with high humidity. In the oceans, they can be found from the intertidal zone to the oceanic trenches, mainly inhabiting the seafloor or benthic zone where they are one of the most important groups of invertebrates in the infauna (organisms living within the sediment). There are also species that live in the water column (pelagic); some remain there throughout their lives, while most only stay in it during temporary reproductive stages or due to changes in diet and predator pressure **(Amaral &H Nonato, 1981; Halanych *et al.*, 2007).**

Figure 3. Aggregations of the sabellid Bispira brunnea settled on coral rubble (Photograph by Lizette Quan).

For the Seaflower Biosphere Reserve, it is not actually clear which and how many polychaete species have been recorded. Therefore, as a starting point to make progress in understanding this group, the available research studies and the material included in the biological collections and related to this area was reviewed. As a result of this task, we found that, at present, there are twelve studies, including scientific articles, grade papers, technical reports of projects and databases, that prove the existence of these animals, either through observation or capture of specimens that served as physical evidence for identifications **(Southward, 1972; Dueñas, 1981; Bastida Zavala *et al.*, 2001; Moreno Núñez, 2002; Londoño Mesa *et al.*, 2002; Báez & Ardila, 2003; Romero Murillo & Polanía, 2008; Londoño Mesa, 2011; Invemar—ANH, 2012; Arteaga Flórez & Londoño Mesa, 2015; SIBM—Invemar, 2015).**

340 Records of polychaetes — **131** Species — **66** Genera — **49** families

In these studies, there are 340 records of polychaetes, corresponding to 131 species of 66 genera and 49 families. These records are mostly from the Archipelago of San Andrés, Providencia and Santa Catalina, sectors in which research has been focused. As for their habitats, we found that studies have mainly evaluated organisms living in mangrove swamps, sedimentary bottoms (shallow) and the rocky littoral; to a lesser extent, the inhabitants of seagrass beds and the deep seabed; and poorly, those living in coral areas. It should be noted that some records were obtained during assessments of zooplankton, but, of them, only five families are unique to that environment, according to **Halanych *et al.* (2007)**. And are as follows: Alciopidae, Iospilidae, Lopadorhynchidae, Tomopteridae and Typhloscolecidae; the others correspond to transient stages of plankton.

In mangrove swamps, most of the studies conducted have targeted worms that live in the roots of the red mangrove Rizopohora mangle **(Londoño Mesa *et al.*, 2002; Moreno Nuñez, 2002; Romero Murillo y Polania, 2008; Arteaga Flórez y Londoño Mesa, 2015)**. In these habitats, nereids are one of the most representative groups. They have, among their most striking characteristics and visible to every observer, a short proboscis that can be everted or extended outward; it is adorned with small denticles that look like dark spots and has a pair of strong jaws similar to curved hooks (Figure 4). The invasive species *Alita succinea*, belongs to this group and its presence has been documented in various sectors of the archipelago, where it can reach high densities **(Herrera *et al.* 2011).**

Figure 4. Head or anterior region of a specimen of the species Neanthes sp. (nereid) with its pharynx or proboscis everted: A. Jaws and denticles (black dots), B. Detail of the jaws (Photographs by C. Arteaga Flórez).

In the shallow sedimentary bottoms, syllids were reported to have the highest number of records (Figure 6). These small organisms, which are between 2 and 3 mm in length, are one of the most diverse families among polychaetes and are extremely abundant in benthic habitats in shallow waters. They usually represent over 50% of the species of worms living in every substrate, but, due to their small size, they are often ignored **(Góngora Garza, 2009; San Martín y Worsfold, 2015).** In this family, some very interesting associations with species from other animal groups occur, such as that between Branchiosyllis exilis and the brittle star Ophiocoma echinata. This syllid lives among the spines of the arms of the star and has some cirrus or dark elongated sensory structures that are easily mistaken for such spines. The family Terebellidae was also frequently found in these environments. They have many thin tentacles in their anterior region, which gives them a particular aspect and, thus, they are known as spaghetti worms. These curious animals live on or within the sediment in tubes they build using materials that are in the seafloor such as sand grains, shells and remains of algae, among others **(Londoño Mesa, 2009).**

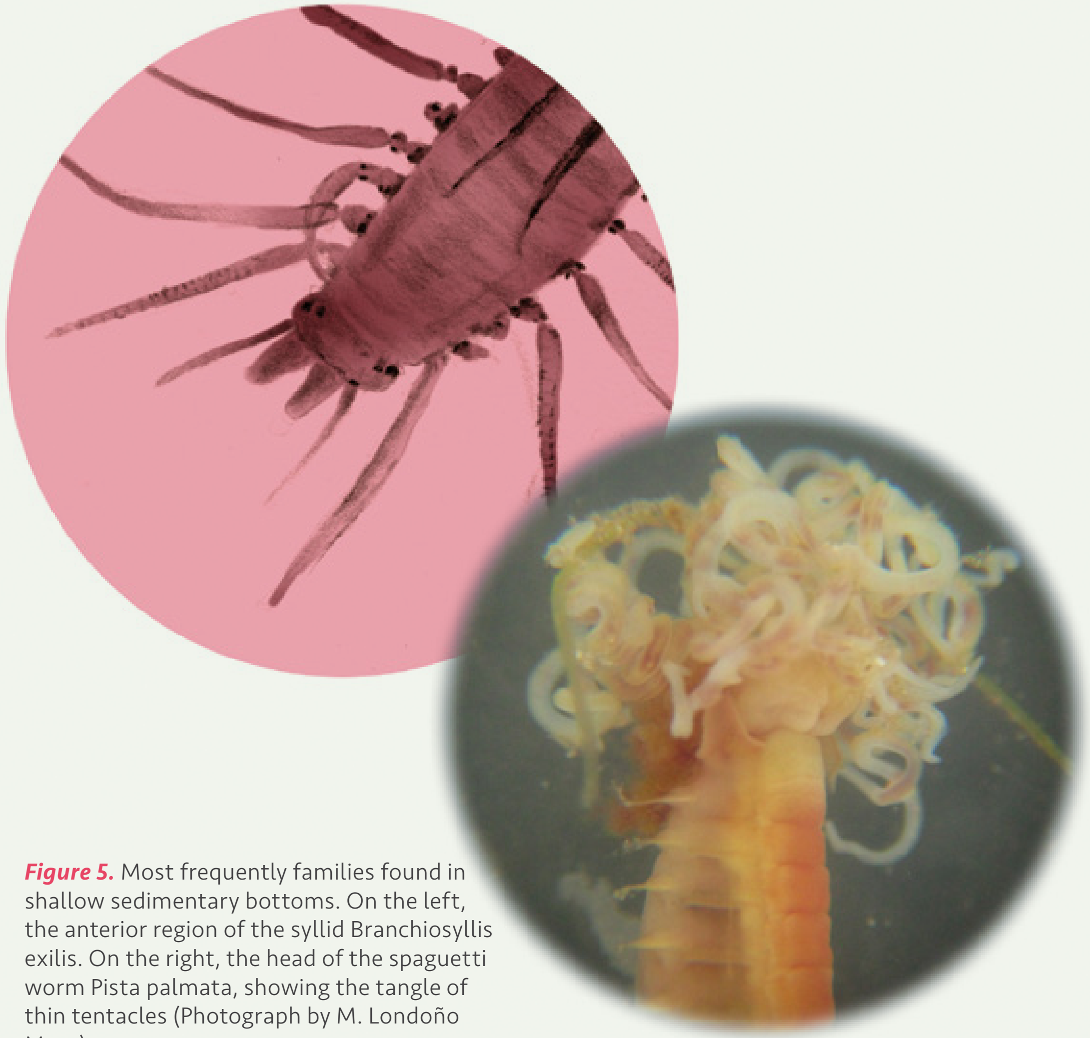
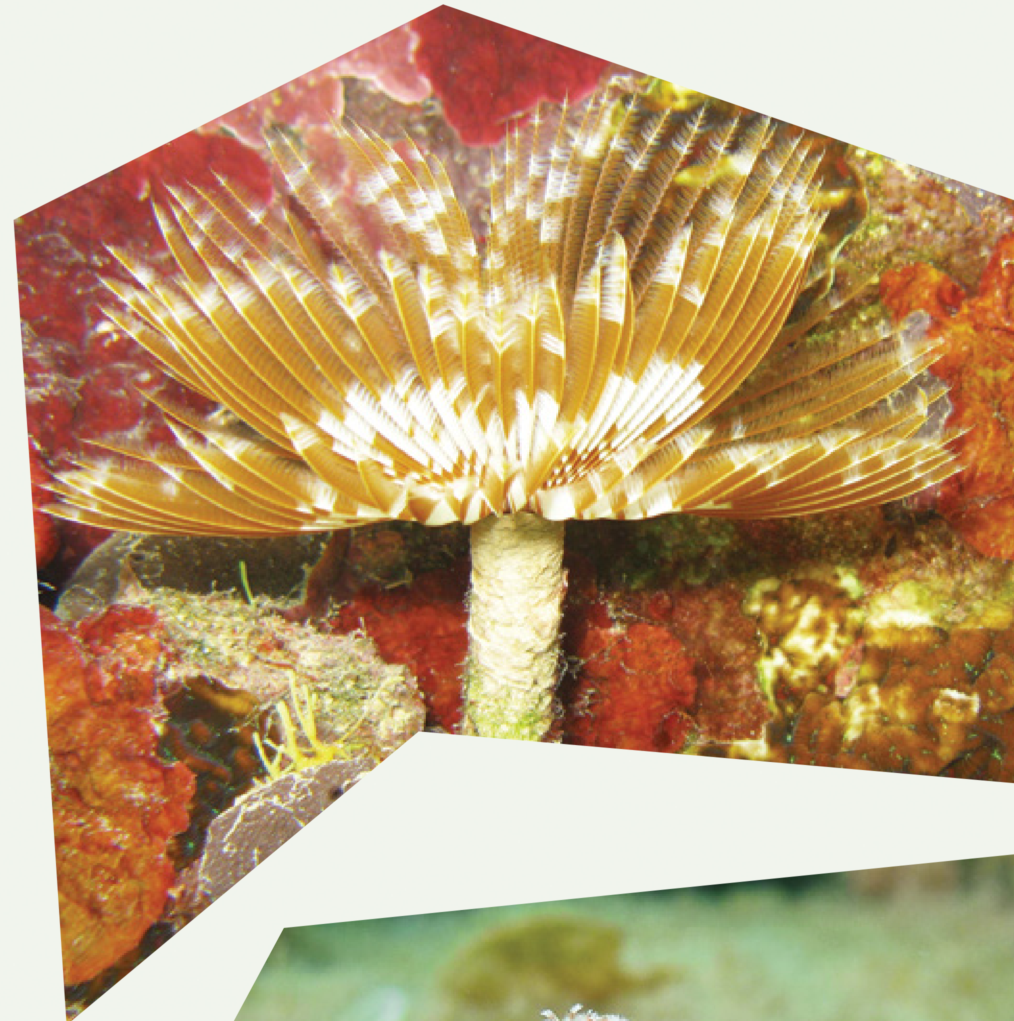


Figure 5. Most frequently families found in shallow sedimentary bottoms. On the left, the anterior region of the syllid Branchiosyllis exilis. On the right, the head of the spaguetti worm Pista palmata, showing the tangle of thin tentacles (Photograph by M. Londoño Mesa).

In the rocky environments of the littoral, the family Eunicidae stands out. It includes, among its members, some of the largest and most colorful marine worms in the phylum Annelida. Eunicids are characterized by strong and complex jaws that are useful to them in their carnivorous and digging habits. They are easy to recognize because they have one or more structures similar to "little antennae" and a pair of eyes in their head (Figura 6).

Figure 6. Specimen of an eunicid. In the anterior region, its antennae and eye can be observed (Photograph by M. Londoño Mesa).



Sabellids are another important group due to their diversity and number of representatives in this habitat. These striking sedentary worms build tubes between sand, rubble, or rock and coral fissures and live there partially buried leaving their head exposed. Their head is surrounded by feather-like, usually colorful structures that are actually their gills. This appearance is the reason why they are known as sea flowers or feather-duster worms (Figure 7).

Figure 7. Feather-duster worm, Sabellastarte magnifica, with gills extended (Photograph by E. Mancera).

Serpulidae also deserve to be mentioned. They are the calcareous tube-building family par excellence, a characteristic that allows them to create reefs. They are usually found in natural and artificial hard bottoms and are commonly known as Christmas tree worms because of the appearance of their colorful gills when exposed outside the tube (Bastida Zavala & Salazar Vallejo, 2000) (Figure 8).

Figure 8. Specimens of Christmas tree worms, Spirobranchus giganteus, — Serpulidae (Photograph by Lizette Quan).

The records from the deep seabed are few. However, it is important to mention the family Siboglinidae, a controversial group since it is not clear whether or not they belong to the phylum Annelida because although they share some characteristics that make them similar evolutionarily speaking, there is also evidence proving that they might belong to an independent phylum called Pogonophora (Smirnov, 2014). Nevertheless and despite this debate that still requires further studies to be solved, it is interesting to mention that these animals, known as beard worms, live in very special places where high concentrations of hydrogen sulfide can be found, such as volcanic hydrothermal vents on the seabed, cold seeps and on decaying whale bones (Tovar Hernández & Salazar Vallejo, 2009). From these places, they get their food through symbiosis with bacteria living inside their bodies and transforming the sulfides into the energy worms use for nourishment. Since feeding is internal and falls on bacteria, siboglinids have no mouth or digestive tract.

In general, families mentioned above are just some of the most diverse and frequent so far documented for the Seaflower Biosphere Reserve, where a total of 49 families, corresponding to 60% of families known in polychaetes, have been found. The information gathered showed that there is significant uncertainty as to the identification of many specimens that were only identified to their genus or family levels (65 and 67 records, respectively). This may be due to different reasons, including the fact that the available material is in a preparation and preservation stage, which do not allow determining the identity of species in order to conduct a taxonomic work with the group. Moreover, the lack of adequate, timely and regional information has been another reason for such uncertainty. Usually, for unknown groups in a region, information on other regions and taxonomic tools used there-which can be very different ecologically and geographically speaking-are used or reviewed, which has led to inadequately consider species from other regions as endemic, without considering the real biodiversity that happens to be underestimated during this process.

Moreover, the problems encountered are more constant when, due to the interests of the study, the presence of the specimen was merely recorded, but the specimen was not collected, making it impossible to verify and even identify it. Therefore, these reports were classified as presumable (Table ANNELIDS), giving them their importance as indicators of the potential existence of a taxon (e.g., genus, family) in an area, but not as conclusive information. They should be considered with caution in the inventory until they can be supported with physical evidence. A further aspect of uncertainty has to do with incomplete identifications that do not allow determining if specimens named equally by different researchers actually correspond to the same species or genus.
For instance, the species Lysidice sp., found by **Londoño Mesa *et al.* (2002)**, may be different from that named equally by **Romero Murillo y Polanía (2008)**; However, this information could only be verified having the individuals of both studies in order to make a comparative review to determine their full identity. Since the taxonomic work with many polychaetes requires evaluating very specific morphological structures that due to their size and complexity are not easily identifiable to an untrained eye, it is very important to have scientific collections that include an appropriate process involving relaxation, fixation and preservation of specimens in order to properly identify and document them and their associated data. This will not only allow future verifications, but it also contributes to strengthening the knowledge related to distribution patterns, ecology and biology of species..

Use and exploitation

Polychaetes have been used in studies of environmental monitoring because, since they are not able to escape quickly from contaminants as fish do, they react directly to disturbances and, depending on the species and its adaptability or resistance, they can proliferate in contaminated environments or, on the contrary, have negative changes in density and increased mortality rates. Therefore, they are used as indicators to determine the acute and chronic effects of lethal contamination **(Salazar Vallejo *et al.*, 1989)**. Additionally, they can be used for monitoring climate change, particularly in temperate and cold seas **(Mikac y Musco, 2010)**. Economically speaking, the industry uses them as bait for sport fishing and as food in aquaculture of fish and crustaceans, as they have high nutritional value due to their high concentrations of polyunsaturated fatty acids that are essential for the maturation of organisms **(Díaz, 2003)**.
Humans have also started to directly consider including polychaetes in their diet. Even though the generic name "worm" initially involves a rejection by almost anyone because it is associated with unpleasant organisms that generally are intestinal parasites of humans and domestic animals, as well as with organisms covered by smooth and sticky secretions, this prejudice has been overcome in some regions around the world and these animals have become a very important delicacy in the local markets. This happens with certain species of the genus Palola (family Eunicidae); they reproduce by epitoky and when its population increases excessively in the shallow coastal areas of the islands of the Indo-Pacific Ocean, they are exploited as food for the people of these islands. The advantage of this exotic diet is that annelids have hemoglobin in their blood, which uses iron as the oxygen carrier, as happens with our blood; thus, consumption of these worms can meet, to some extent, the need of our body for some vitamins and amino acids, turning polychaetes into an alternative source of nutrition from the sea.

Perspectives

Despite being one of the most outstanding groups of marine invertebrates for its abundance and diversity, colorfulness, high adaptability to different environments, as well as for their ecological role and relevance in monitoring environmental conditions, polychaetes have been little studied in the seas of many regions around the world (Laverde Castillo & Rodríguez Gómez, 1987). Likewise, in the Caribbean region, the state of knowledge in polychaetes is poor, with less than 50% of the species described (Miloslavich et al., 2010). Especially in Colombia, there is no real estimate of the biodiversity of this group. Currently, around twelve thousand species of worms-most of them found from intertidal zones to shallow waters-are known. Research conducted in these areas is relatively wide when considering the large number of environments, forms of reproduction and feeding strategies described. For Colombia, more than 300 species have been recorded by various authors; however, the lists made by Dueñas (1999) and Báez and Ardila (2003) emphasize how important it is to gain more knowledge about this group, mainly on the Caribbean region of Colombia, where the Ciénaga Grande de Santa Marta, the bay of Cartagena de Indias (Laverde Castillo & Rodríguez Gómez, 1987), the Gulf of Morrosquillo (Dueñas, 1999) and the Gulf of Urabá (Arteaga Flórez et al., 2014).

This inventory represents an important step towards understanding polychaetes in the Seaflower Biosphere Reserve. It aims to compile, for those interested and enthusiastic in studying this group, scattered information and, in many cases, inaccessible information because it has not been published, believing it will be useful to more clearly channel the research efforts. In this beautiful and biologically-unknown area of the country, it is urgent to conduct studies aimed at understanding these species, as this basic information is the one that constitutes the main input for those who take environmental decisions regarding measures of planning, use and conservation of resources at the local, regional and national levels.

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Phylum Annelida

C Polychaeta

Sc Errantia

O	F	S				
Amphinomida	Amphinomidae	*Eurythoe complanata*	(Pallas, 1766)	4, 2	ls	PSC
		Hermodice carunculata	(Pallas, 1766)	4,2,11, 15	ls, ir	PSC, IN, SA
		Notopygos crinita	(Grube, 1855)		ss	PSC
				3, 15, 12, 5	ss, ir, sm, ca	SA
Eunicida	Dorvilleidae	*Dorvillea sociabilis*	(Webster, 1879)		ls	SA
					ss	SA
	Eunicidae	*Cheilonereis* sp.			ls	SA
		Eunice atlantica	Kingberg, 1865	8, 2	ls	SA
		Eunice biannulata	Moore, 1904	4, 2	ls	PSC
		Eunice binominata	Quatrefages, 1866	4, 2	ls	PSC
		Eunice denticulata	Webster, 1884	8, 2	ir, ls	PSC
		Eunice filamentosa	Grube y Örsted en Grube, 1856	4, 8, 2	ls	PSC, SA
		Eunice guanica	(Treadwell, 1921)	4, 2	ls	PSC
		Eunice schemacephala	Schmarda, 1861	4, 2	ls	PSC
		Eunice sp.			ls	SA
		Eunice tridentata	Ehlers, 1905	8, 2	ls	PSC
		Eunice vittata	(delle Chiaje, 1828)	4, 2	ls	PSC
		Leodice antennata	Savigny en Lamarck, 1818	8, 2	ir, lp	SA
		Lysidice collaris	Grube, 1870	4, 2	ir, ls	PSC
		Lysidice ninetta	Audouin & Milne-Edwards, 1833	8, 13, 2, 15	ls, mg	PSC, SA
		Lysidice sp.		8, 14	ls, mg	SA
		Lysidice unicornis	(Grube, 1840)	8, 2	ls	PSC
		Marphysa aransensis	Treadwell, 1939	8, 2	ls	PSC, SA
		Marphysa longula	(Ehlers, 1887)	8, 2	ir	SA
		Marphysa regalis	Verrill, 1900	4, 2	mg, ls	SA, PSC
		Marphysa spp.		8, 14, 15	ls, mg	PSC, SA
		Nicidion cariboea	(Grube, 1856)	4, 8, 2	ls	SA
		Nicidion mutilata	(Webster, 1884)	4, 2	ss, ir	SA, PSC
		Palola siciliensis	(Grube, 1840)	4, 2	ls	PSC
		Palola sp.			ls	SA
				13, 3, 15, 12	ls, ss, ir, sm	SA
	Lumbrineridae	*Lumbrinereis inflata*	Moore, 1911		ls	SA
		Lumbrinereis sp.			ls	SA
				8, 15, 12	ss, mg, sm	SA
	Oenonidae			15, 12	ir, sm	SA
	Onuphidae	*Hyalinoecia* spp.			lp	ARC
				3, 15, 12	lp, ir, sm	SA
Phyllodocida	Acoetidae				lp	SA
	Alciopidae			10, 6, 7, 5	ca	PSC, ARC, SA
	Aphroditidae	*Aphrodita cf. acuminata*			lp	ARC
				3, 12	lp, sm	SA
	Chrysopetalidae			15, 12	ir, sm	SA
	Eulepethidae				sm	SA
	Glyceridae	*Glycera tesselata*	Grube, 1840	4, 2	ls	PSC
				15, 12	ir, sm	SA
	Goniadidae				sm	SA
	Hesionidae	*Hesione intertexta*	Grube, 1878		ls	PSC
		Hesione picta	Müller en Grube, 1858	4, 2	ls	PSC
				15, 12, 5	ir, sm, ca	SA
	Iospilidae			10, 6	ca	PS, ARC
	Lopadorrhynchidae			10, 6, 7	ca	PS, ARC
	Nephtyidae				ir	SA
	Nereididae	*Ceratonereis cf. Irritabilis*	(Webster, 1879)	2, 15	ls, mg	SA, PSC
		Ceratonereis irritabilis	(Webster, 1879)		mg	PSC
		Ceratonereis mirabilis	Kingberg, 1865	4, 2	ls	PSC
		Ceratonereis singularis	Treadwell, 1929	4, 2	ls	PSC

C Polychaeta

Sc Errantia — O Phyllodocida

Polychaeta incertae sedisntia

Sedentaria — Sabellida

F	S				
Nereididae	*Ceratonereis* sp.		8, 15	ls, mg	PSC
	Leptonereis sp.			ls	SA
	Neanthes acuminata	(Ehlers, 1868)		ls	PSC
	Neanthes caudata	(delle Chiaje, 1827)	4, 2	ls	PSC
	Neanthes sp.		1, 14	ls, mg	SA
	Neanthes succinea	(Frey & Leuckart, 1847)	8, 2, 1, 15	ls	PSC
	Nereis pelagica largoensis	Treadwell, 1931	4, 2	ls	PSC
	Nereis riisei	Grube, 1857	8, 2, 15	ls	PSC, SA
	Platynereis dumerilii	(Audouin & Milne-Edwards, 1834)	4, 2	ls	PSC
	Platynereis mucronata	de León-González, Solís-Weiss & Valadez-Rocha, 2001	1, 15	ls	PSC
	Stenoninereis sp.		8, 15	ls, mg	SA
Nereididae			13,3, 15, 12, 5	ls, ss, lr, sm, ca	SA
Pholoidae				lr	SA
Phyllodocidae			15, 12	lr, sm	SA
Pilargidae	*Pilargis* sp.		14	mg	SA
			15	lr	SA
Polynoidae	*Harmothoe lanceocirrata*	Treadwell, 1928		ls	PSC
	Lepidonotus sublevis	Verrill, 1873	4, 2	ls	PSC
			8, 3, 12, 6	lp, ls, sm, ca	SA, PSC
Sigalionidae			8, 15, 12, 12, 5	ir, sm, ca	SA
Syllidae	*Amblyosyllis* sp.				SA
	Branchiosyllis sp.		8, 14, 15	ls, mg,	PSC, SA
	Exogone sp.		14, 13	mg, ls	SA
	Haplosyllis spongicola	(Grube, 1855)	4, 2	ls	PSC
	Opistosyllis brunnea	Langerhans, 1879	8, 2	ls	PSC
	Syllides sp.			ls	SA
	Syllis corallicola	Verrill, 1900	4, 2	ls	PSC, SA
	Syllis cornuta	Rathke, 1843		ls	PSC
	Syllis gracilis	Grube, 1840	8, 13, 2, 15	ls, ss, mg	SA
	Syllis sp.			mg	SA
	Syllis variegata	Grube, 1860	8, 2, 15	ls, mg	PSC, SA
	Trypanosyllis sp.		13, 8, 14	ls, mg	SA, PSC
	Typosyllis aciculata	Treadwell, 1945	4, 2	ls, mg	PSC
	Typosyllis maculata	Imajima, 1966	4, 2	ls	PSC
	Typosyllis sp.		8, 14	ls, mg	PSC
			8, 3, 15, 12, 5	ls, ir, sm, ca	SA
Tomopteridae			3, 6, 7, 5	lp, ca	SA, ARC
Typhloscolecidae				ca	ARC
Saccocirridae				lr	SA
Protodrilidae				ls	PSC
Oweniidae				ls, ir	PSC
Sabellidae	*Bispira brunnea*	(Treadwell, 1917)	4, 2	mg	PSC, SA
	Bispira melanostigma	(Schmarda, 1861)	4, 2	ls, mg	SA, PSC
	Branchioma sp. 1			ls	PSC, SA
	Branchiomma nigromaculatum	(Baird, 1865)	4, 13, 8, 2, 15	ls	PSC
	Branchiomma sp.			ls	PSC
	Hypsicomus phaeotaenia	(Schmarda, 1861)	4, 2	ls, mg	PSC
	Hypsicomus torquatus	(Grube, 1877)	4, 2	ls	PSC
	Megaloma lobifera	(Ehlers, 1887)	4, 8, 2, 15	ls	PSC
	Parasabella microphtalma	(Verrill, 1873)		mg	SA
	Sabellastarte magnifica	(Shaw, 1800)	4, 2	ls, ss, sm, ca	SA
	Sabellastarte spp.		8, 13, 3, 15, 12, 5	ls	PSC
				ls	SA
Serpulidae	*Hydroides gairacensis*	Augener, 1934	4, 2	mg	SA
	Hydroides parvus	(Treadwell, 1902)	13, 2	ls	PSC
	Hydroides spp.			lr	SA
	Pomatostegus stellatus	(Abildgaard, 1789)	4, 2	ls	SA
				t	

Interactive table

Worms

Phylum Annelida

Class (C): Polychaeta — Subclass (Sc): Sedentaria

O	F	S				
Sabellida	Serpulidae	*Spirobranchus giganteus*	(Pallas, 1766)		mg	SA
		Spirobranchus sp.			ls	PSC
		Spirorbis sp.			mg, lp	SA
		Vermiliopsis infundibulum	(Philippi, 1844)		lp	RB
				4, 2	lp	RB
	Siboglinidae	*Siboglinoides caribbeanus*	Southward, 1971	14, 3	lp	RB
		Siboglinum angustum	Southward & Brattegard, 1968		lr	SA
		Siboglinum ekmani	Jägersten, 1956		ls	SA
Spionida	Magelonidae				ls	SA
	Spionidae	*Polydora* sp.			lr, sm, ca	SA, PSC
		Polydora websteri	Hartman in Loosanoff & Engle, 1943		lr	SA
				8, 2	ss, sm	SA
Terebellida	Acrocirridae			15, 12, 10, 5	ls	SA
	Ampharetidae				ss	SA
	Cirratulidae	*Cirratulus* sp.		3, 12	mg	SA
		Cirratulus spp.			ls	PSC
		Timarete filigera	(delle Chiaje, 1828)		ss, lr, sm	SA
						SA
					ls, sm	SA
	Fauveliopsidae	*Fauveliopsis* sp.		3, 15, 12	lr, ls, sm	SA
	Flabelligeridae				lr, ls	PSC
	Pectinariidae			4, 15, 12	lr	PSC
	Terebellidae	*Eupolymnia crassicornis*	(Schmarda, 1861)	4, 15, 12	lr	PSC
		Eupolymnia magnifica	(Webster, 1884)	4, 2	ls	PSC
		Eupolymnia rullieri	Londoño-Mesa, 2009		lr	PSC
		Loimia medusa	(Savigny, 1818)		ls	PSC
		Loimia salazari	Londoño-Mesa & Carrera-Parra, 2005		ls	PSC
		Pista cristata	(Müller, 1776)		lr	PSC
		Pista palmata	(Verrill, 1873)	4, 2	ls	SA
		Pista sp.			lr	PSC
		Streblosoma bairdi	(Malmgren, 1866)	9	mg	SA
		Streblosoma hartmanae	Kritzler, 1971	4, 8, 2	ls	PSC
		Streblosoma sp.			ls	SA
		Terebella rubra	(Verrill, 1873)		lr	PSC
		Terebella sp.		4, 2	ls, mg	PSC
		Terebella verrilli	Holthe, 1986		ls	PSC
		Thelepus setosus	(Quatrefages, 1866)		ls, ss, sm	SA
		Thelepus sp.		4, 8, 15	mg	SA
					ss	SA
	Trichobranchidae	*Terebellides* sp.		8, 15, 12	lr, sm	SA
		Terebellides stroemi	Sars, 1835		sm	SA
				4, 8, 2	ls	SA
	Arenicolidae			15, 12	ls	SA
	Capitellidae	*Anotomastus* spp.			ls	SA
		Capitella sp.			ls	SA
		Heteromastus spp.			ls, ir, sm	SA
		Mediomastus sp.			ss, ir	SA
					ls, ir, sm	SA
	Chaetopteridae			4, 15, 12	ls	SA
	Maldanidae			3, 15	ls	PSC
	Opheliidae	*Armandia* sp.		8, 14, 3, 15, 12	lr	SA
		Polyophtalmus pictus	(Dujardin, 1839)		ls	PSC
				4, 2	lr, sm	SA
	Orbiniidae	*Naineris laevigata*	(Grube, 1855)		lr, sm	SA
	Orbiniidae			4, 2	lr	SA
	Paraonidae			15, 12	lr	SA
				15, 12		

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The families Iospilidae, Lopadorrhynchidae and Typhloscolecidae are associated with the planktonic environment.

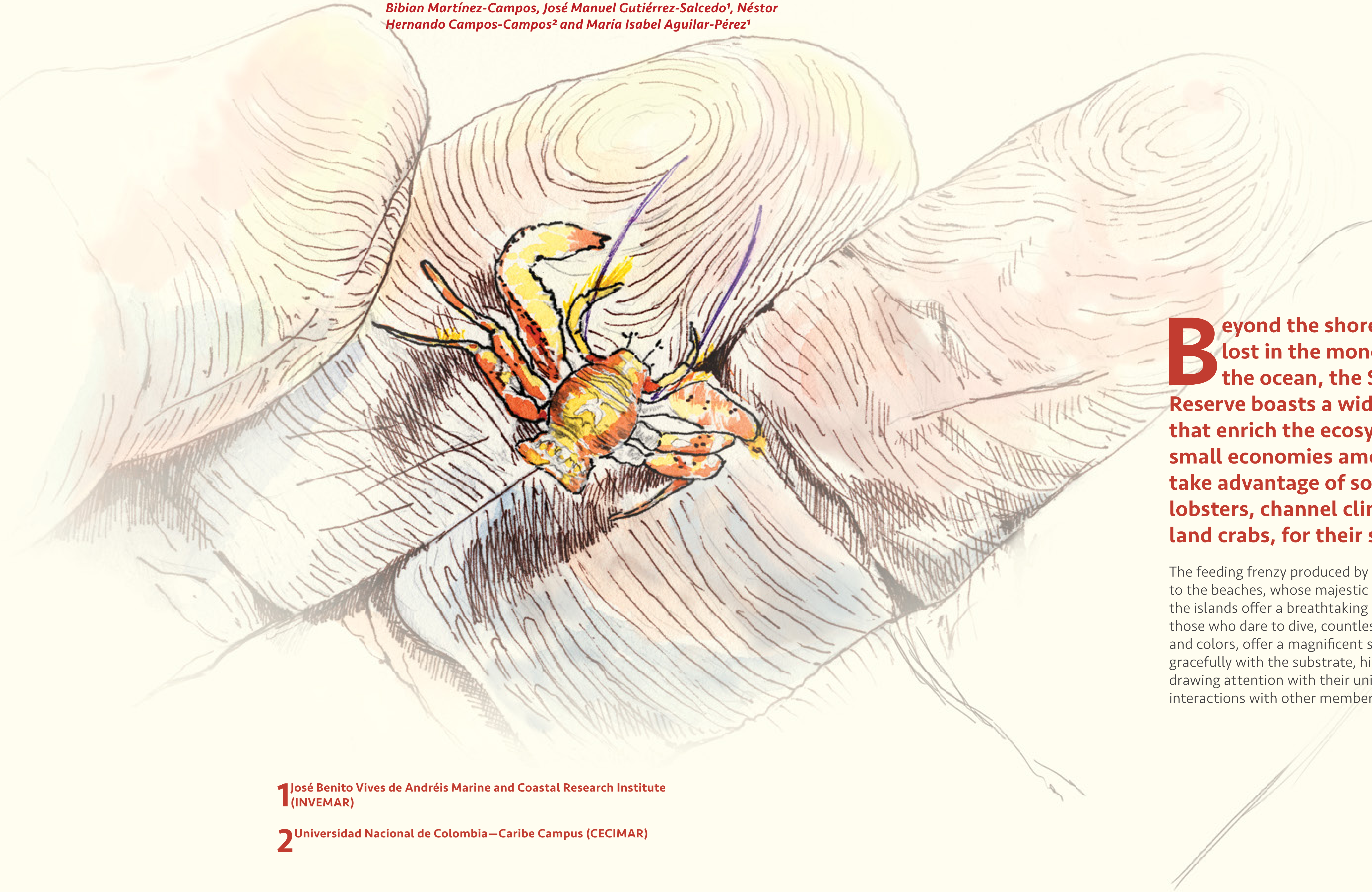
Interactive table

CRUSTACEANS

Of the Seaflower Biosphere Reserve

laboratory of evolution

Bibian Martínez-Campos, José Manuel Gutiérrez-Salcedo[1], Néstor Hernando Campos-Campos[2] and María Isabel Aguilar-Pérez[1]



Beyond the shores of the Americas and lost in the monotonous immensity of the ocean, the Seaflower Biosphere Reserve boasts a wide variety of crustaceans that enrich the ecosystem and maintain the small economies among Raizal people who take advantage of some species, such as lobsters, channel clinging crabs and black land crabs, for their survival.

The feeding frenzy produced by small sand crabs attracts birds to the beaches, whose majestic flights in the reddened sunsets of the islands offer a breathtaking sight for the foreign visitor. For those who dare to dive, countless crustaceans, of various sizes and colors, offer a magnificent spectacle of shapes that blend in gracefully with the substrate, hiding between sponges and corals or drawing attention with their unique behaviors and myriad curious interactions with other members of the ecosystem.

1 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

2 Universidad Nacional de Colombia—Caribe Campus (CECIMAR)

Crustaceans are part of the charm of the reserve and therefore it is not surprising that they have attracted the attention of researchers, whose first studies date back to 1901, completing up to date close to 50 publications (Rathbun, 1901; Shoemaker, 1942; Invemar—ANH, 2012)**. This knowledge comes from great explorations from foreign initiatives, as well as from small-scale studies conducted by Colombian researchers whose studies on crustaceans began to proliferate after 1980. Most publications obtained from this scientific effort are taxonomic, i.e., documents describing the morphology of species; many others are ecological; and others address the issue of valuation and management of fishery resources, or are photographic guides. However, and despite having a large documentation, many of these studies are far to complete a full assessment of the reserve; on the contrary, they include few locations and have regions that are better studied than others.**

More than half of the studies that have been conducted in the reserve support their records with specimens that have been deposited in biological collections, mainly in accredited institutions worldwide such as the marine natural history museums of INVEMAR in Colombia and the Smithsonian in the United States (**INVEMAR, 2015; Smithsonian, 2015**). However, there is also a lot of material from scientific explorations that has been preserved in museums and recorded in databases, but still remains unpublished, waiting to be used in future publications and are coming to the light for the first time in this book.

248 species of crustaceans are known in the reserve

This effort to recapitulate all this historical information and unpublished data reveals that so far 248 species of crustaceans are known in the reserve (General table of species), being decapods the best represented group with 218 records, which corresponds to 35% of the 631 species recorded for the Colombian Caribbean Sea, and it is known that at least 18 of these species are not found in other regions of Colombia. These are significant figures when considering the area represented by these islands and their distance from the mainland. What is the secret of their success? The reasons why they got there are diverse and will be explored in this chapter, in order to understand that the shapes of these organisms go beyond a whimsical arrangement and that, on the contrary, they have a strict functionality that has allowed them to colonize all ecosystems of the islands.

To understand colonization by crustaceans, we must go back to the moment when the reserve was geologically formed from the sudden explosions of several volcanoes emerging from the fractures of Nicaragua's elevation (**CORALINA—INVEMAR, 2012**). The masses of lava that rose to the surface generated a shallow substrate, resulting in a soil that happened to be touched by the sunlight, conglomerating photosynthetic organisms that drove a reverberation of life. These organisms emit countless chemical signals that are dispersed in water and were perceived by crustaceans that were strongly attracted by them, especially the young that became the intrepid pioneers of the islands.

These life-forms, known as larvae, differ sharply in morphology from adults that are dependent on soil (benthic life-forms), as they are designed to spread taking advantage of the ocean currents that allow them to reach the ocean regions. However, getting there is not enough to be successful, they must also have a design capable of adapting to the conditions of the ecosystem, and crustaceans are true masters of adaptation.

Imagine living your childhood as a shrimp. If we were like them, we would only perceive our surroundings with a huge nose in our first year of life; then, it would disappear and a huge eye would appear in our back, and we would use it to orient ourselves only by the incidence of light. This would then disappear to give rise to two small eyes and a long tongue, and we would continue to change until we become adults traveling the ocean guided by our senses. All these body structures, even puzzling to scientists, make them relentless trackers of three things: light, food and other crustaceans. Therefore, it is not surprising that, in a distant land emergence, crustaceans will colonize with ruthless efficiency.

Illustration: Bibían Martínez-Campos

Like butterflies, crustaceans also undergo an extremely complex metamorphosis. A shrimp, for instance, can have four main stages, with up to 13 intermediate shapes before becoming an adult. The most fascinating aspect of this process is that each of these intermediate shapes is provided with numerous sensory organs (eyes or sensitive hairs) that appear in a form only to disappear in the next, so each is virtually a different body with a very different sensory perception of the world (Baeza and Piantoni, 2010).

The three-dimensional scene of the marine environment provides a huge variety of small environments crustaceans have taken advantage of, standing out as one of the most impressive examples of evolutionary plasticity in nature. Their sophisticated and revolutionary shape, compared to that of the invertebrates that precede them, has allowed them to grow on multiple ecological niches for the sole purpose of avoiding competition, becoming true experts as the substrates of the islands become more complex and new enclaves are consolidated, including coral reefs, seagrass beds and regions where the land reaches the sea as mangrove swamps, beaches and littorals. To understand the diversity of shapes of crustaceans, it is necessary to go back to their ancestral body pattern that is similar, in many respects, to annelid worms whose body is divided into several segments that enable them to develop digging habits, and most are characterized by their small size. These forms dominate the mud or sand substrates on the seabed, which are perhaps the oldest niche of crustaceans.

Tanaids, amphipods, isopods and barnacles

In the universe of animals whose size ranges in the millimeter scale, the rules of physics are not the ones of our scale; and forces, such as viscosity, acquire even more relevance than the force of gravity that is so important to us (Gould, 1980). The size of a sand grain would, therefore, be equivalent to walking on a pool of balls, while the viscosity of seawater would feel like swimming in jelly. This universe of sand and mud is the kingdom of tanaids, amphipods and isopods that together are part of a group known as Peracarida. Like kangaroos, they are provided with a brood pouch in which they carry their offspring. Many tanaids still have the habit of living underground, as in the case of *Zeuxo kurilensis*, developing an interesting strategy that gives them greater adherence when building their home with sand grains and sediment they compact thanks to their ability to produce thread like spiders (Keiichi y Hiruta, 2014).

Amphipods, which for an untrained eye might resemble a flea, have been true pioneers and explorers in the conquest for the surfaces, which has allowed them to be one of the most diverse groups in the world. They are so successful that they can be found in such inhospitable places like the Mariana Trench, or such baffling places like a pot in the garden of a house. In the reserve, there are 13 species recorded, but this figure could be larger because they are very small, which makes them be, paradoxically, little studied in the region, as they are difficult to see and identify. Their enclaves on the beaches are so specific that dominant species can be identified in the area that remains constantly flooded and other very different species, in the area that is sometimes partially exposed to desiccation **(Figura 1).**

13
especies redorded

Figura 1. Specimen of the genus *Shoemakerella*, amphipod recorded for the archipelago.

Figura 2. . Illustration of a specimen of the amphipod *Parhyale hawaiensis* on a decaying mangrove leaf.

Most species are inhabitants of the sand, but some others are associated with sponges, like *Colomastix pusilla* **(Jones, 1948)**; the rocky littoral, like *Elasmopus brasiliensis* **(Vásquez Luis, 2011)**; or mangrove swamps, like *Parhyale hawaiensis* **(Figura 2)**. The latter feeds on the plant, red mangrove, and, like gazelles in Africa, serves as a primary consumer that transforms the energy of plants into food for predators, acquiring an important role in the food webs of these ecosystems. P. hawaiensis has also gained importance among geneticists, being used, like the fruit fly, as a model for the study of gene expression **(Poovachiranon *et al.*, 1986; Rehm *et al.*, 2009).**

Isopods are true masters of evolutionary plasticity, developing various body patterns: from long and delicate shapes, through some that might resemble termites, to the typical shape of the woodlouse (which is also an isopod), this being the most representative body pattern of the group **(Kensley y Shotte, 1989)**.The armored and large shape of isopods has allowed them to interact differently with the environment and not only dominate the sandy bottoms and marine sediments, but also venture into the terrestrial environment, as in the case of the woodlouse *Ligia baudiniana*, that breaths using tracheae and inhabits the mangrove swamps on San Andrés Island **(López Orozco *et al.*, 2014)**. Equally surprising is the fact that there are about 450 species of isopods that have adapted to living as parasites in fish and other crustaceans. For example, in Providence island, it is common to see the isopod *Anilocra laticauda* (Figura 3) firmly attached to the skin of the soldierfish *Miripristis jacobus*, through its mouth appendages modified as a suction cone that allows them to hold on to their host while feeding on its blood **(Williams y Williams, 1981).**

Figura 3. Ectoparasitic isopod of the genus Anilocra, attached to the soldierfish *Myripristis jacobus.* (Photograph by Juan David González Corredor)

450
isopod species parasites in the world

There are groups that, in their struggle to withstand the pounding waves of the marine environment, have developed body patterns that, to say the least, are an unusual adaptation, as in the case of barnacles that have the most baffling modifications among crustaceans: devoid of a visible head and tail. They are so different now that, two centuries ago, they were considered by scientists as molluscs because of their armored shape similar to a shell and only until their larva was studied, their identity could be clearly determined (Barazandeh et al., 2013). In the reserve, a representative of this group is Amphibalanus eburneus, frequent colonizer of littorals.

Barnacles hold the curious characteristic of having the largest penis, proportional to their body size, in nature **(Barazandeh *et al.*, 2013)**; However, the fact of living attached to the substrate sometimes makes it not very useful to them, so they eventually end up releasing their sperm into the water, hoping it will fertilize a female's eggs.

Stomatopods or mantis shrimp

The problem of fighting against the viscosity of the environment was gradually resolved for other species of crustaceans with larger body sizes. Although some of these species prefer living buried, they have the ability to explore the ecosystem more actively, increasing their interaction with other organisms, which requires a sophisticated sensory development. Excellent examples are stomatopods or mantis shrimp, such as *Neogonodactylus oerstedii* **(Figure 4)**, that wanders around Providencia Island to hunt other crustaceans and small fish, taking advantage of its powerful weapons of military strategist. Mantis shrimp have the best vision of nature, surpassing, by far, humans, eagles and even chameleons, since they can perceive 16 visual pigments including ultraviolet light and polarized light, invisible for humans, who can only see three pigments. Each one of their eyes has two pupils that provide it with binocular vision, and they can be moved independently, so if mantis shrimp lose one of their eyes, they could still have a vision like ours.

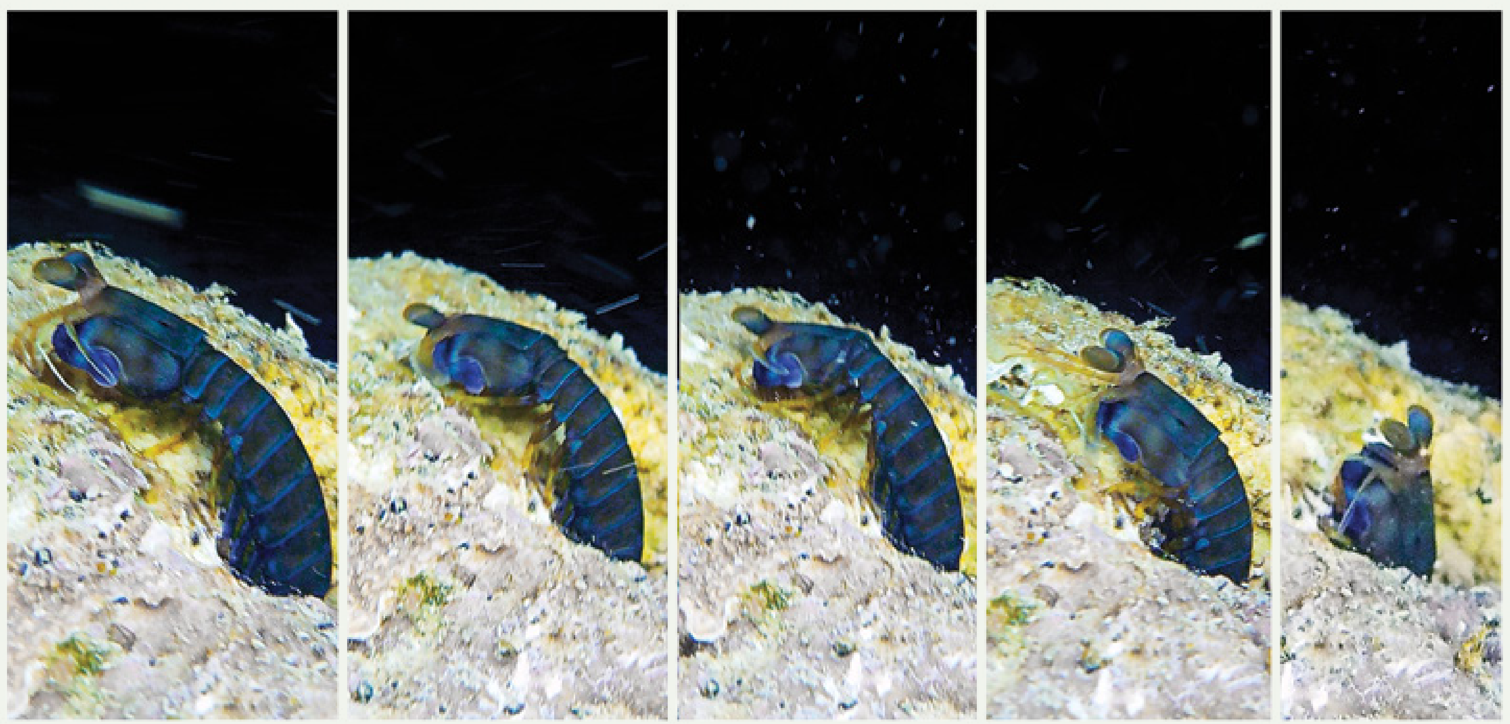


Figure 4. Mantis shrimp exploring the surroundings. (Photo: Juan David González Corredor).

Thanks to their stalked eyes, mantis shrimp have a stroboscopic vision that allows them to perceive 360° of their environment, like chameleons; and, as if that were not enough, their eyes have a line in the middle that works as the scope of a weapon and allows them to attack with deadly precision (Figure 5) (Cronin et al., 2000)**. They have the most well aimed strike of nature because their front legs are enormous and move with a speed of five milliseconds, attacking with a force as brutal as the impact of a bullet; in fact, they can break the glass of an aquarium. Lastly, our Morse code has nothing on its sophisticated system of communication using sparks. Mantis shrimp produce these flashing lights by moving the huge scale of their antenna, which has a polarized reflection that is perceived by their congeners, thanks to their accurate visual ability** (Patek et al., 2004).

Figure 5. Eyes of the mantis shrimp exploring the surroundings (Photo: Santiago Estrada).

Two significant innovations encouraged the largest crustaceans to start conquering the most diverse ecosystems. First, they developed longer and stronger legs that allowed them to displace more easily; and, second, the segmented body, ideal to dig sediments, gave way to increasingly more compact designs, product of the fusion of segments, which is known as tagmatization. This body pattern is a characteristic of decapods—that literally means ten-footed. Decapods have shells as a result of the complete fusion of their head and thorax segments. They show several life-forms: shrimp, lobsters, anomurans and crabs.

Shrimp

In the reserve are recorded
72
shrimp species

Shrimp exist on the planet since the Devonian period **(Porter *et al.*, 2005)** Seventy-two species have been recorded in the reserve. Their skills challenge the dependency on substrates of their ancestors because they have the ability to swim actively in the water column, taking advantage of their body design, compressed on the sides and equipped with a well-developed tail. Some families, such as the Penaeidae, are very active swimmers with migratory habits. That is the case of some shrimp of the genus *Farfantepenaeus* **(Figure 6a y 6b)** that, like salmon, start their life in the islands, migrate towards ocean waters when adults and come back only to reproduce.

To achieve their goal, they must bear extreme changes in terms of environmental conditions. During their youth, they inhabit coastal lagoons exposed to evaporation, as well as high levels of salinity and temperature; but they spend their adulthood under the scarce light incidence of deep waters, which are extraordinarily cold. To have an idea of their extreme adaptation ability, imagine growing up in a tropical island, then being taken to the Himalaya without any shelter and surviving successfully. They make it by completely modifying their metabolism and the osmotic pressure of their blood, in order to adapt themselves to the changes of pressure, salinity and temperature **(Scelzo y Zuñiga, 1987).**

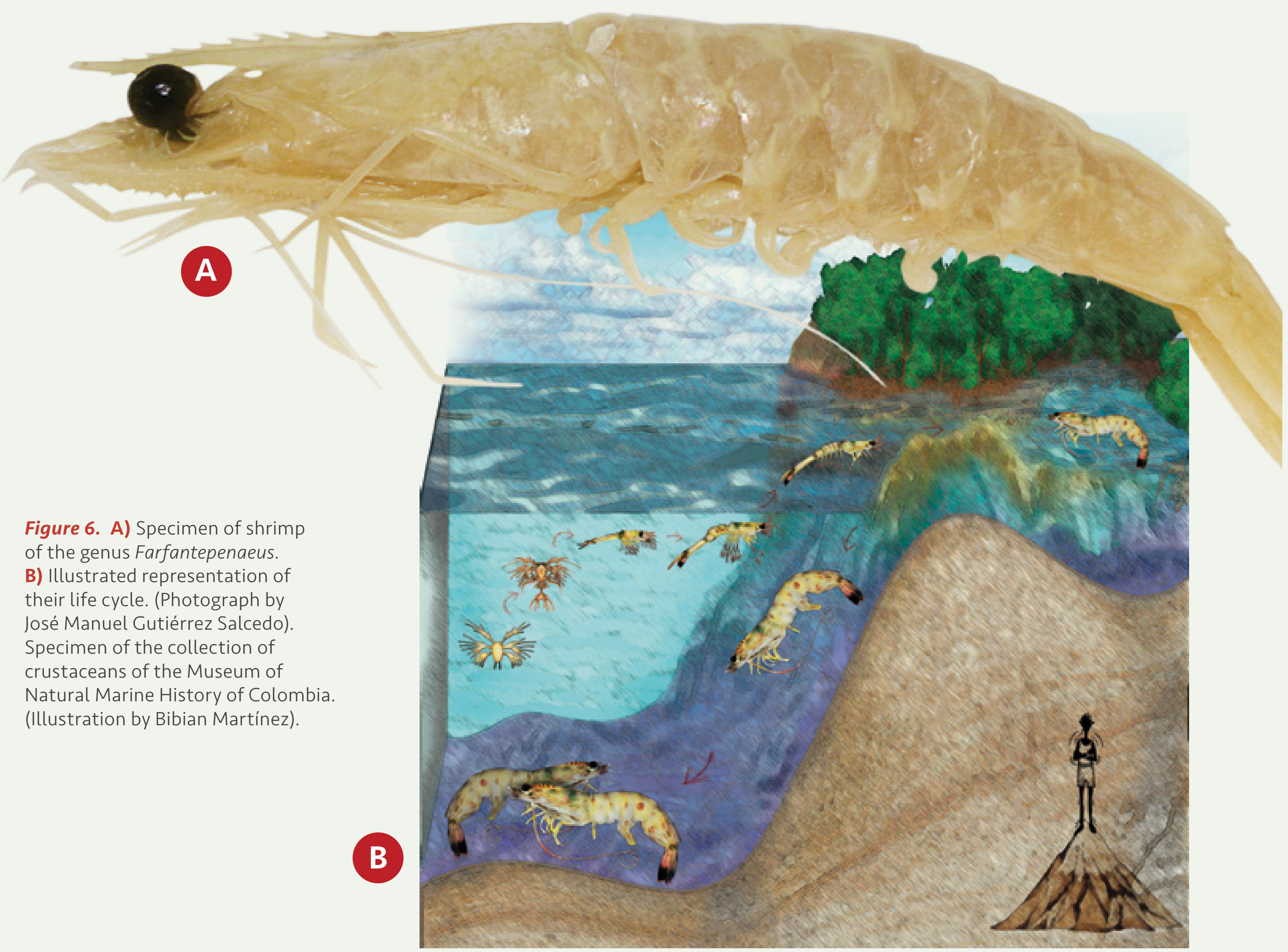
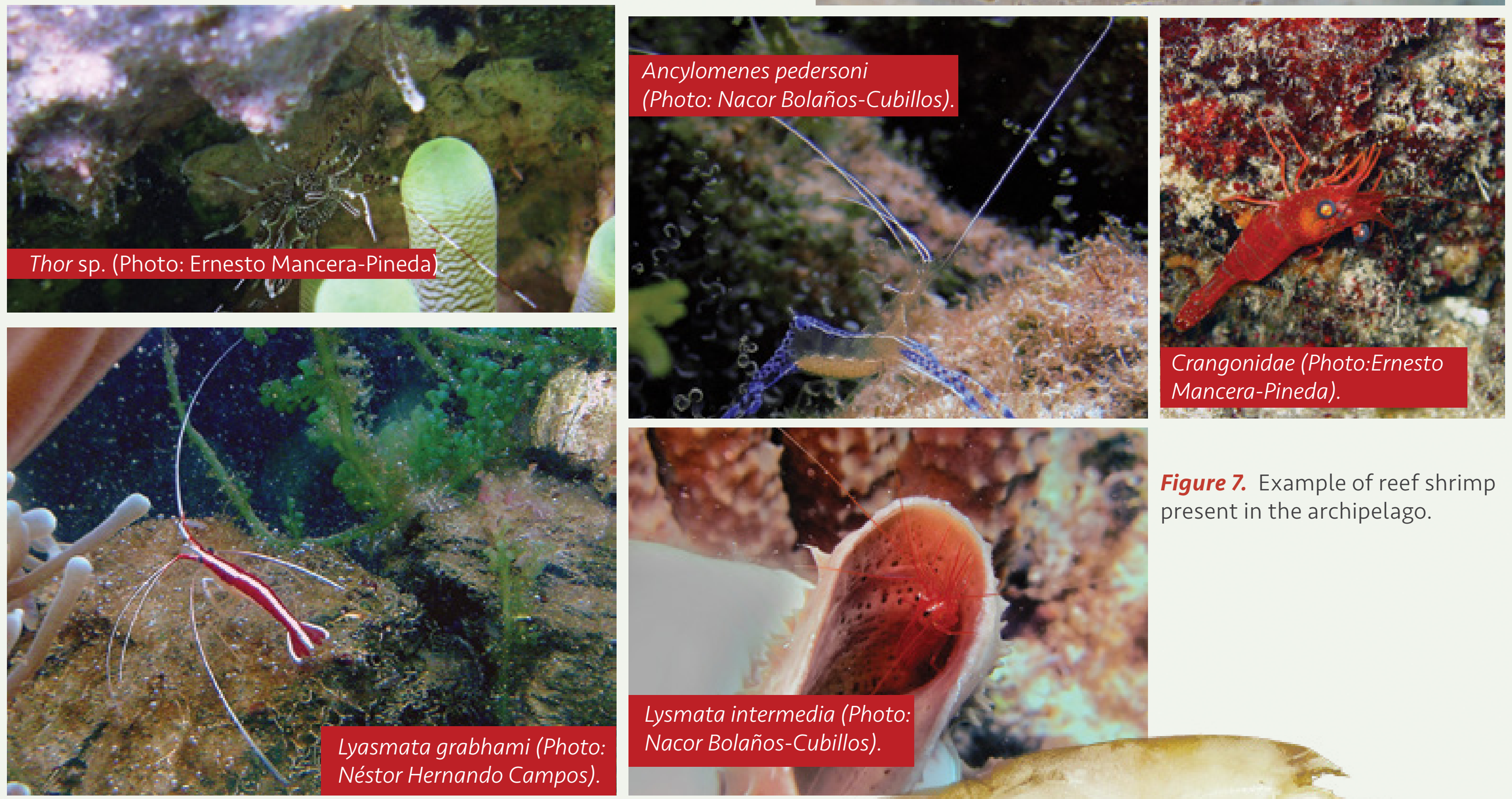


***Figure 6.* A)** Specimen of shrimp of the genus *Farfantepenaeus*. **B)** Illustrated representation of their life cycle. (Photograph by José Manuel Gutiérrez Salcedo). Specimen of the collection of crustaceans of the Museum of Natural Marine History of Colombia. (Illustration by Bibian Martínez).

Although shrimp are excellent swimmers, some of them feel very comfortable in coral reefs **(Figura 7)**; they even get a good job there cleaning fish's gills and releasing them from parasites; particularly shrimp *Stenopus hispidus* and *Ancylomenes pedersoni*. are really good at that. The latter stays exclusively in anemones *Bartholomea annulata* and *Condylactis gigantea*,which host several individuals that catch the attention of fish towards their cleaning station **(Mascaró *et al.*, 2012)**.

In many ways, coral reefs are like large cities, where individuals live together very closely with members of the same or different species; in that sense, social interactions are very particular. Some live with their siblings very cooperatively, as snapping shrimp *Synalpheus rathbunae* **(Figura 8)** do, which colonize sponges and build true apartment complexes in their interiors. Like bees and ants, these shrimp have been assigned a special role within their family: only one female reproduces, while the others work as babysitters; males are in charge of protecting, as soldiers, the sponge fortresses that provide them with shelter and food at the same time.

Leptochela sp. (Photo: Nacor Bolaños-Cubillos)



Thor sp. (Photo: Ernesto Mancera-Pineda)

Ancylomenes pedersoni (Photo: Nacor Bolaños-Cubillos).

Crangonidae (Photo:Ernesto Mancera-Pineda).

Lyasmata grabhami (Photo: Néstor Hernando Campos).

Lysmata intermedia (Photo: Nacor Bolaños-Cubillos).

Figure 7. Example of reef shrimp present in the archipelago.

Guards are duly armed with powerful pincers that give them the appearance of holding a pistol, which, like such gun, produces a sound so powerful when the shrimp attacks that it can stun any predator **(Duffy, 1996; 2002)**. Sex in the city is also very complex, and shrimp *Thor amboinensis* living in anemones and forming small groups, is an exceptional example. These small colorful shrimp, also called sexy shrimp because of the way they wiggle the tail when moving, have the ability to be born as males and, subsequently, change their gender to females, which is known as protandry. These behaviors are related to their social structure, so sex changes are usually more frequent when the group is numerous **(Baeza & Piantoni, 2010).**

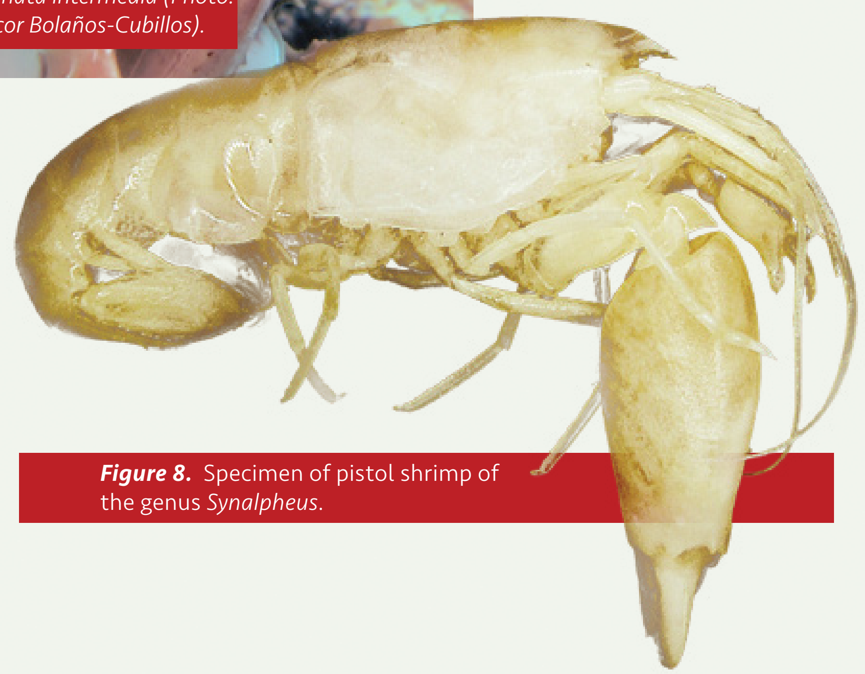
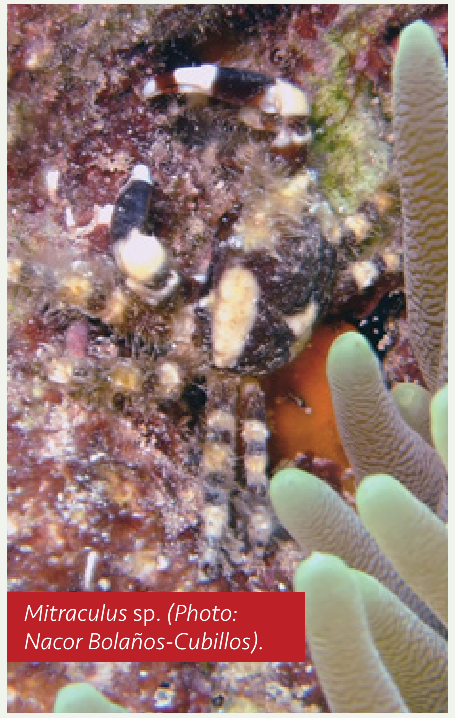


Figure 8. Specimen of pistol shrimp of the genus *Synalpheus*.

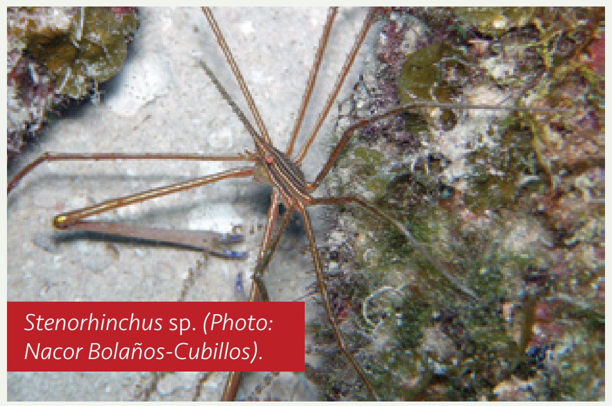
Lobsters, anomurans and crabs

Lobsters, anomurans and crabs are life-forms so ancient that genetic markers estimate that they exist since the Carboniferous period, about 2.5 million years ago (Porter *et al.*, 2005) **Fossil records in several Caribbean islands indicate that, to the rhythm of changes of sea level and current formation of the reserve, these groups were multiplying and diversifying in the emerging beaches and reefs between the Miocene and the Neogene** (Colins *et al.*, 2009). **Lobsters present heavy body patterns equipped with long tails dorsoventrally depressed; while anomura exhibit great variety of shapes; and, for their part, crabs have complete shells and varied shapes, such as triangular, oval, rectangular or square (Figure 9).**



Mitraculus sp. (Photo: Nacor Bolaños-Cubillos).

Portunus sp. (Photo: Alfredo Abril Howard).



Stenorhinchus sp. (Photo: Nacor Bolaños-Cubillos).

Mitraculus sp. (Photo: Ernesto Mancera Pineda).

Figure 9. Example of true crabs presenting a great variety of shapes and colors in the archipelago.

Surprisingly for those less observers, crabs still keep vestigial tails that they hide very well, folded on the ventral portion of their thorax, which have lost completely their functionality to swim. However, they have turned into the perfect stroller for crab mothers to carry the multiple egg sections where their offspring develop (Figure 10).

Figure 10. Blue crab female carrying a mass of eggs (orange eggs) in its abdomen, which is a vestige of its ancestors' tail.

With more than one million receptor neurons, the spiny lobster *Panulirus argus* **(Figure 11)** is more than a mouth-watering delicacy. This species is one of the most astonishing examples of hypersensitive senses of nature and has one of the most sensitive smells of the animal world **(Derby *et al.*, 2001)**. Unlike dogs and humans, lobsters smell their surroundings through a pair of small antennae called antennules **(Goldman y Patek, 2002)**, equipped with a dense row of bristles or aesthetascs that catch chemical substances from the environment and turn them into sensory impulses, through a nerve ending, sensitive to chemical compounds. Additionally, their more prominent antennae allow them to communicate through sound, using a movement that generates a strong friction called stridulation, similar to what crickets do when they rub their feet to generate their known nocturnal singing in the terrestrial environment **(Goldman y Koehl, 2001).**

Figure 11. Spiny lobster *Panulirus argus* (Photo: Nacor Bolaños Cubillos).

When it comes to lobsters, some of us immediately recall a steamy dish topped with an appealing glowing red crust, holding a lean portion of meat that goes perfectly with butter. Nevertheless, those who have seen a lobster alive know that they do not wear that exuberant coloring and that, in fact, they seem to be tinged by a blue hue, which can be more or less intense depending on the species. This gastronomic alchemy that attracts us so much happens when crustacyanin—pigment found in the chitin of lobsters' and shrimp's carapace—loses its three-dimensional shape by being exposed to heat, in the same way Chinese noodles stretch when boiled. During this process, known as protein denaturation, crustacyanin separates into two components: blue protein and astaxanthin; that separation changes the disposition of electrons within molecules, making that red color reflects on the surface instead of being absorbed (Cianci *et al.*, 2002).

Their congeners, slipper lobsters, *Scyllarides delfosi* and *Scyllarides nodifer* **(Figure 12)**, are characterized for having nocturnal habits and a cryptic behavior during the day, staying in cavities, preferably with multiple entrances **(Sumpton *et al.*, 2004)**. Their strong and compact bodies shield them perfectly; their antennae have been modified in the shape of laminar plates that provide them with greater protection; and, although they seem clumsy swimmers, when a predator flanks their shelter and their compacting body is not enough to face the attack, they escape very fast confusing the enemy **(Schram, 2007)**. Nevertheless, they only use this strategy in case of emergency since this fast flight implies a high-energy cost for them **(Spanier *et al.*, 1991)**.

Figure 12. Slipper lobster *Scyllarides* sp. Specimen walking on a clear sandy bottom.

Figure 13. Specimen of tuna crab Munida stimpsoni.

Several families of crustaceans are named **anomuros** formerly known as anomala, because they do not have a typical lobster tail or the traditional shape of crabs. Some clearly seem intermediate shapes of these two forms, such as tuna crabs that have prominent tails but folded against their thorax. Some examples are the genera *Eumunida*, *Munida* and *Munidopsis*,represented in the reserve by five species; or porcelain crabs, which look more like true crabs, represented by the genera *Megalobrachium*, *Pachycheles*, *Petrolishtes* and *Porcellana*, with 15 representatives.

Others, represented by the species *Albunea paretti* and *Hippa testudinaria*, show rare shapes, such as sand fleas, with less prominent tails folded against their torso and shovel-shaped legs designed to dig sandy substrates, and live buried in the soil **(Tam *et al.*, 1996)**. However, some are definitely disconcerting as if they were chimeras of the imagination of ancient Greeks, such as hermit crabs that, devoid of their shells, seem half-crab half-worm creatures since their tails, in most cases, lack the traditional hard covers on the body of crustaceans.

Figure 14. Specimen of water flea *Hippa testudinaria*. (Foto: José Manuel Gutierrez)

Figure 15. Hermit crab *Paguristes cadenati*, protecting its soft body in a gastropod's shell.

Figure 16. Hermit crab Dardanus fucosus sheltered in a snail shell, colonized by different types of algae.

Even though they seem an accident of nature, **hermit crabs** sare extremely successful and important in the marine environment. Only in our reserve, there are 21 species, which is a very significant figure. Hermit crabs have gained our affection thanks to documentaries that show them living in shells that once belonged to snails, and sticking anemones on them to defend themselves from predators. Their common interaction with anemones is so old that it dates back to the Jurassic period; the species *Dardanus fucosus* **(Figure 16)** benefits from them and other species such as barnacles and hydroids. However, what looks as an excellent strategy to repel predators, such as octopi, may not be so effective against predators equipped with strong chelas, such as some carnivorous crabs and lobsters. In fact, the presence of these symbionts may erode and weaken the shells, turning them into a threat. The symbiotic relationships of these crabs with other living beings are so impressive that they interact ecologically with more than 550 species of invertebrates that settle in or on their shelter. For that reason, they have been granted the only professional title among crustaceans, since—despite not having gone to college—they are considered the engineers of ecosystems, because they fill with life substrates those that were before inert and buried in the seafloor **(Williams y McDermott, 2004).**

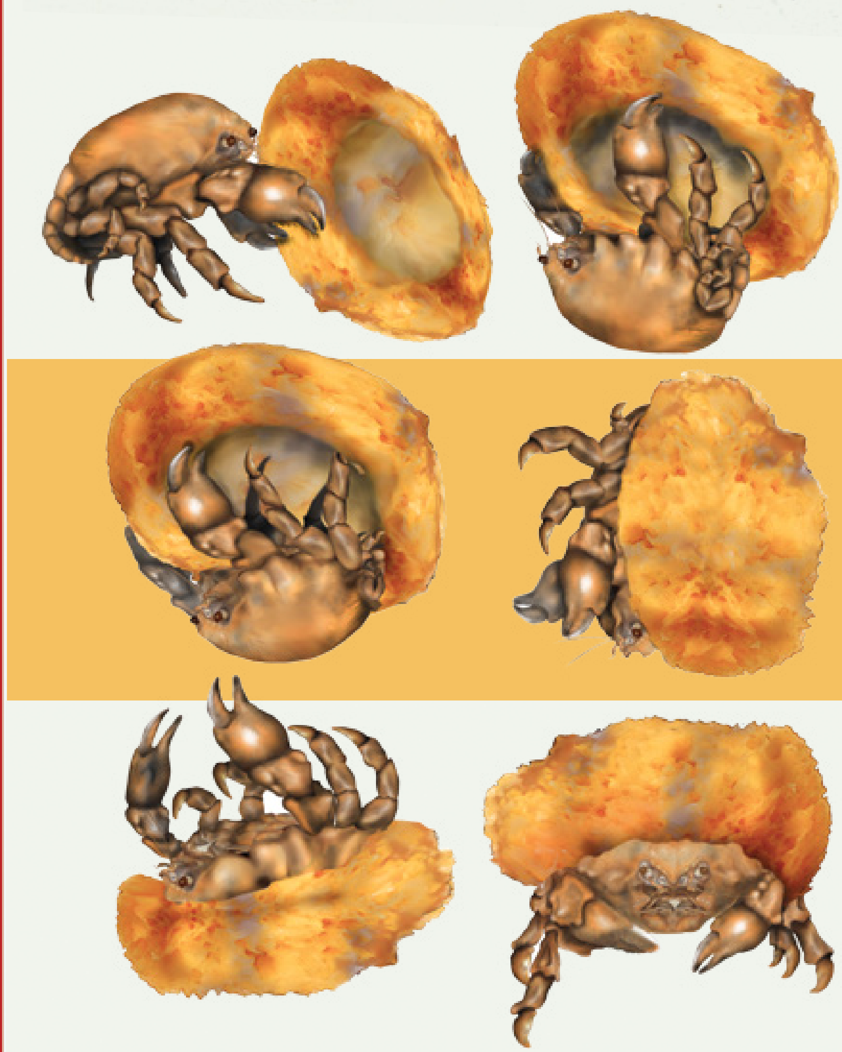
Another representative group of anomurans is porcelain crabs, whose name comes from the fact that their carapaces are very fragile. Records of porcelain crabs in the reserve cover 31% of all species present in the Tropical Western Atlantic, including Brazil, Florida, the Caribbean Sea and the Gulf of Mexico. Most of them are distributed in waters of less than 10 m deep, and at least four of these species show a limited distribution **(Hiller *et al.*, 2006)**. Some porcelain crabs, such as Petrolisthes galathinus, filter their food shaking their mouth appendages that are more prominent than those of the rest of crustaceans; for that reason, it seems as if they were dancing with fans **(Figure 17) (Krop, 1981; Baeza, 2007).**

Figure 17. Porcelain crab of the genus *Petrolisthes*, showing its prominent mouth appendages.

True crabs, or **brachyura,** are represented by 100 species in the reserve and are characterized by a great ability to walk thanks to the almost vestigial reduction of their tail; their mass is concentrated over their legs, which are, usually, very long and strong. These groups are dominant in three environments: the sublittoral, where coral reefs occur; the littoral, or intertidal zone; and the supralittoral, which has been colonized by some species during their adult life.
Coral reefs congregate both competitors and predators of every type, increasing the bets on the game of fighting for survival.

Consequently, the imperatives of eating and not being eaten, reproducing and leaving as many descendants as possible make crabs develop behavior strategies and countless body shapes and sizes. Being small gives crabs the ability to develop symbiotic or commensalistic associations; that is the case of the pea crab *Clypeasterophilus rugatus* **(Figure 18 a y b),** which lives at the expense of sea biscuits of the genus *Clypeaster*, emparentadas con las estrellas **(Campos & Griffith, 1990).**

Figure 18. **A)** Photograph of a representative of the genus *Clypeasterophilus*. **B)** Illustration of a representative of pea crab *Clypeasterophilus rugatus* on its home: the sea biscuit. (Illustration: Bibian Martinez-Campos)



For some crabs, falling through the cracks is the best survival strategy, and Dromia erythropus knows that very well; with its last legs upwards, it holds gracefully a piece of sponge that gives it the appearance of living under a hat (de Melo y Campos Jr., 1999). **(Figure 19)**

Figure 19. Illustration of how the crab *Dromia erythropus* puts the sponge over its body. (Illustration: Bibian Martinez-Campos).

Figure 20. Dorsal view of the batwing coral crab moro *Carpilius corallinus*, showing its bat-shaped spot.

For other crabs, the strategy of being big and threatening seems to give them a niche where they thrive successfully. Such is the case of the batwing coral crab *Carpilius corallinus* **(Figure 20)**, inhabitant of cavities of large sponges and corals. Its eye-catching orange or red colors, as well as the bat-shaped spot on its carapace have made it one of the favorite species of divers; therefore, it has become such an icon of underwater life in the Caribbean Sea **(Brown, 2015).**
However, no tropical water crab is as large as the channel clinging crab Damithrax spinosissimus **(Figure 21)**, which can have carapaces of 18 cm wide; males can reach a magnitude of 40-50 cm with its claws extended, according to recent observations of specimens captured in Providencia (pers. obs.). Even though it seems unbelievable, this gigantic gentle crab feeds practically on marine algae and is a shy nocturnal explorer that prefers hiding among the cracks of corals during the day **(Rathbun, 1925; Guzmán y Tewfik, 2004).**

Figure 21. Male specimen of the channel clinging crab *Damithrax spinosissimus.*

At least three important settlements dominated by different species of crabs occur in the intertidal zone. The rocky littorals are the territory of Grapsoidea, such as *Pachygrapsus transversus* (Figure 22), which climb rocky formations by means of their extended legs with an enviable expertise. However, they stay close to the splash zone to avoid dehydration, which can happen quickly because of their small size, or hide under rocks from the direct exposure to the sun (Fernandes Santos *et al.*, 1986).

Figure 22. Specimen of a Grapsoidea crab of the species *Pachygrapsus transversus on the rocky littoral.* (Photo: Daniela Gómez).

The substrate protected by mangrove swamps is the home to the special fiddler crab that avoids dehydration by staying in shady and fresh areas. However, when dealing with an estuarine environment, its main problem is keeping the levels of ions and mineral salts of its body; that is why they usually have mechanisms to recycle the urine several times in order to avoid losing valuable electrolytes during urination **(Thurman, 2003)**. The fiddler *Uca pugilator* **(Figure 23)** has the amazing ability to change the color of its carapace in response to temperature changes, making it noticeably clearer when temperature rises. It is even more surprising that such response is more evident in females, while males usually stay dark. Hence, such color changes may also be related to sexual strategies **(Silviger & Munguia, 2008)**.

Figure 23. Pair of fiddler crabs of the genus Uca. The male stands out because of its big pincer.

On the beaches, ghost crabs *Ocypode quadrata* **(Figure 24)** abound on the sandy surfaces that, in many senses, are an inhospitable environment with little shelter that can protect them from the climate harshness and the marine birds, among other terrestrial predators of which they are always alert. However, O. otros predadores terrestres; sin embargo, *O. quadrata* have learned to hide in deep vertical dens that they dig quickly and in which they introduce themselves sideways. Inside the den, the water that filters through the sand grains keeps them fresh until the night; then, they come out of their hypogeal shelters to collect detritus, mainly vegetal, that tides bring to the beaches **(Fernandes Santos *et al.*, 1986).**

Figure 24. Specimen of ghost crab *Ocypode quadrata* squadrata walking out of its den built on sandy beaches. (Photo: Daniela Gómez).

Crustaceans in the islands have been studied for more than 100 years

Although black land crabs *Gecarcinus ruricola* **(Figure 25)** have colonized the border of the supralittoral and live on land during their adulthood, when it is the time of bringing new descendants, they undertake a mass journey in which they invade the beaches of the islands, especially Providencia, as an army of red and black soldiers. Their journey takes them back to sea territory, providing, with their passage, one of the most astonishing shows occurring during the months of April and June, in which thousands of crab females come together in a reproductive frenzy that literally stops the traffic and gathers the whole community for their protection. Islanders respect and revere this species, whose consumption creates a traditional link among Raizals. They are so important for islanders that even songs have been written on their name and are a symbol of conservation of this lush Seaflower Biosphere Reserve **(Hartnoll *et al.*, 2007; CORALINA—INVEMAR, 2012).**

Figure 25. Specimen of the black land crab Gecarcinus ruricola, representative of the archipelago's culture. (Photo:Carlos Augusto Barreto-Valdés).

Crustaceans in the islands have been studied for more than 100 years, yet the effort of so many researchers seems incipient before so much diversity. This chapter, in which we got to meet briefly the life story of some inhabitants of the reserve, shows us how they have made their way in the great variety of ecosystems of the islands, through successful designs and strategies that have been tested by natural selection over hundreds of generations, and that are responsible for this biodiversity. The message for researchers is clear: there is still more to know and much to learn and apply on the design, the physics and the chemistry of crustaceans, from engineering to pharmacology. This motto should be one of the main driving forces inviting to preserve the Colombian archipelagos, which are small laboratories of evolution and invaluable sources of diversity that should become our main source of inspiration and development.

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Crustaceans

Phylum Arthropoda

Malacostraca — Thecostraca — Sessilia; Eumalacostraca — Amphipoda, Decapoda

O	F	S			
Sessilia	Balanidae	*Amphibalanus eburneus* (Gould, 1841)	16, 30, 34, 46	mg	SA
Amphipoda	Amphilochidae	*Apolochus neapolitanus* (Della Valle, 1893)	29	ab	PSC
		Hourstonius tortugae (Shoemaker, 1942)	29	ab	PSC
	Ampithoidae	*Ampithoe ramondi* Audouin, 1826	48	ab	PSC
	Atylidae	*Nototropis minikoi* (A.O. Walker, 1905)	15, 29	lp, pl	SA, PSC
	Colomastigidae	*Colomastix pusilla* Grube, 1861	48	ab	PSC
	Hyalidae	*Parhyale hawaiensis* (Dana, 1853)	16	mg	SA, PSC
	Lysianassidae	*Shoemakerella cubensis* (Stebbing, 1897)	29	ab	PSC
	Maeridae	*Ceradocus (Denticeradocus) sheardi* Shoemaker, 1948	29	ab	PSC
		Elasmopus brasiliensis (Dana, 1855)	48	ab	PSC
		Meximaera diffidentia J.L. Barnard, 1969	29	lp	PSC
	Oedicerotidae	*Synchelidium americanum* Bousfield, 1973	29	lp	PSC
	Photidae	*Gammaropsis togoensis* (Schellenberg, 1925)	29	lp	PSC
	Phoxocephalidae	*Metharpinia floridana* (Shoemaker, 1933)	29	ab	PSC
	Platyischnopidae	*Eudevenopus honduranus* Thomas & J.L. Barnard, 1983	29	ab, lp	PSC
	Synopiidae	*Synopia ultramarina* Dana, 1853	29	ab	PSC
Decapoda	Aethridae	*Hepatus pudibundus* (Herbst, 1785)	32	sm, ss	PSC
	Albuneidae	*Albunea paretii* Guérin-Méneville, 1853	6	pl	PSC
	Alpheidae	*Alpheus armatus* Rathbun, 1901	26, 32, 50	ab	PSC
		Alpheus bahamensis Rankin, 1898	32, 47	ir, ls	PSC
		Alpheus belli Coutière, 1898	32	sm	PSC
		Alpheus candei Guérin-Méneville, 1855 [in Guérin-Méneville, 1855-1856]	47	ir	PSC
		Alpheus cristulifrons Rathbun, 1900	47	ir	PSC
		Alpheus floridanus Kingsley, 1878	32	ls	PSC
		Alpheus formosus Gibbes, 1850	26, 32, 47	ab, ir	PSC
		Alpheus heterochaelis Say, 1818	26, 47	ab, ir	PSC
		Alpheus normanni Kingsley, 1878	32	ls	PSC
		Alpheus nuttingi (Schmitt, 1924)	9	ab	PSC
		Alpheus peasei (Armstrong, 1940)	47	ir	PSC
		Alpheus simus Guérin-Méneville, 1855 [in Guérin-Méneville, 1855-1856]	32	sm	PSC
		Alpheus websteri Kingsley, 1880	26	ab	PSC
		Synalpheus anasimus Chace, 1972	32	sm	PSC
		Synalpheus fritzmuelleri Coutière, 1909	32, 47	ab, ir, sm	PSC
		Synalpheus longicarpus (Herrick, 1891)	26	ab	PSC
		Synalpheus minus (Say, 1818)	26	ab	PSC
		Synalpheus rathbunae Coutière, 1909	47	ir	PSC
		Synalpheus townsendi Coutière, 1909	26	ab, mg	PSC
	Aristeidae	*Aristaeomorpha foliacea* (Risso, 1827)	49		C, N
		Aristeus antillensis A. Milne-Edwards & Bouvier, 1909	49		C
	Atyidae	*Atya innocous* (Herbst, 1792)	32	zt	PSC
	Calappidae	*Calappa gallus* (Herbst, 1803)	26	ab	SA
		Calappa ocellata Holthuis, 1958	49		BS
		Calappa tortugae Rathbun, 1933	27	lp	BN
		Cryptosoma bairdii (Stimpson, 1860)	32, 38, 42	ab, ir, ss	PSC
		Cyclozodion angustum (A. Milne-Edwards, 1880)	55	ab	PSC
	Carpiliidae	*Carpilius corallinus* (Herbst, 1783)	2, 7, 32, 38, 45	ab, ir, lr	SA, PSC
	Coenobitidae	*Coenobita clypeatus* (Fabricius, 1787)	32, 49	zt	PSC, S
	Cyclodorippidae	*Cyclodorippe bouvieri* Rathbun, 1934	27	lp	BN
	Diogenidae	*Bathynarius anomalus* (A. Milne-Edwards & Bouvier, 1893)	49		CS
		Calcinus tibicen (Herbst, 1791)	8, 32, 47, 49	ab, ir, pl, sm	PSC, S
	Diogenidae	*Cancellus spongicola* Benedict, 1901	49		CS
		Clibanarius antillensis Stimpson, 1859	32	lr	PSC
		Clibanarius sclopetarius (Herbst, 1796)	32, 49	ss	BS, PSC
		Clibanarius symmetricus (Randall, 1840)	49		BS
		Clibanarius tricolor (Gibbes, 1850)	16, 32, 47, 49	ir, lr, mg	PSC
		Dardanus fucosus Biffar y Provenzano, 1972	32, 47, 49	ir, sm	PSC
		Paguristes grayi Benedict, 1901	32	ss	PSC

Malacostraca — Eumalacostraca — Decapoda

F	S			
Domeciidae	*Domecia acanthophora* (Desbonne, in Desbonne & Schramm, 1867)	32	ab	PSC
Dromiidae	*Dromia erythropus* (Edwards, 1771)	47	ir	PSC
	Moreiradromia antillensis (Stimpson, 1858)	32	sm	PSC
Epialtidae	*Acanthonyx petiverii* H. Milne Edwards, 1834	26, 32	ab, sm	PSC
	Chorinus heros (Herbst, 1790)	32	sm	PSC
	Epialtus brasiliensis Dana, 1852	32	sm	PSC
	Esopus crassus A. Milne-Edwards, 1875	27	lp	BN
	Herbstia depressa Stimpson, 1860	26, 32	ab, sm	PSC
	Pitho aculeata (Gibbes, 1850)	32, 38, 44, 47	ab, ir, sm	PSC
	Pitho lherminieri (Desbonne, in Desbonne & Schramm, 1867)	38, 44	ab, ir	PSC
Eriphiidae	*Eriphia gonagra* (Fabricius, 1781)	7, 32, 40, 45, 47	ir, lr, sm	SA, PSC
Eumunididae	*Eumunida picta* Smith, 1883	17	lp	RB
Gecarcinidae	*Cardisoma guanhumi* Latreille, 1828	2, 11, 28, 32, 36, 40, 41, 51	mg, zt	SA, PSC
	Gecarcinus lateralis (Fréminville, 1835)	2, 32, 36, 40, 41, 51	mg, zt	SA, PSC
	Gecarcinus ruricola (Linnaeus, 1758)	2, 3, 11, 23, 28, 32, 36, 38, 40, 41, 50, 51	mg, pl, zt	SA, PSC
Gnathophyllidae	*Gnathophylloides mineri* Schmitt, 1933	32	sm	PSC
	Gnathophyllum americanum Guérin-Méneville, 1855 [in Guérin-Méneville, 1855-1856]	32, 47	ir, sm	PSC
Grapsidae	*Geograpsus lividus* (H. Milne Edwards, 1837)	11, 32, 38, 40, 43	ab, ir, lr	SA, PSC
	Goniopsis cruentata (Latreille, 1803)	11, 32, 38, 40	ab, ir, mg	SA, PSC
	Grapsus grapsus (Linnaeus, 1758)	2, 32, 38, 40	lr	SA, PSC
	Pachygrapsus gracilis (Saussure, 1858)	2, 32, 34, 40, 46	ir, lr, mg	SA, PSC
	Pachygrapsus transversus (Gibbes, 1850)	32, 40, 46	ir, lr, mg	SA, PSC
Hippidae	*Hippa testudinaria* (Herbst, 1791)	32, 49	pl	PSC, S
Hippolytidae	*Hippolyte obliquimanus* Dana, 1852	32	sm	PSC
	Hippolyte zostericola (Smith, 1873)	32	sm	PSC
	Latreutes fucorum (Fabricius, 1798)	32	sm	PSC
	Lysmata grabhami (Gordon, 1935)	26	ab	PSC
	Lysmata intermedia (Kingsley, 1878)	26, 32	ab, sm	PSC
	Lysmata moorei (Rathbun, 1901)	9, 47	ab, ir	PSC
	Thor amboinensis (de Man, 1888)	26, 32	ab, sm	PSC
	Thor manningi Chace, 1972	26, 32	ab, sm	PSC
	Thor paschalis (Heller, 1862)	47	ir	PSC
	Tozeuma carolinense Kingsley, 1878	26, 32, 42	ab, mg, sm	PSC
	Trachycaris restricta (A.Milne-Edwards, 1878)	32	sm	PSC
Inachidae	*Eucinetops blakianus* Rathbun, 1896	32	ls	PSC
	Podochela algicola (Stebbing, 1914)	26	ab	PSC
	Podochela curvirostris (A. Milne-Edwards, 1879)	27	lp	BN
	Podochela macrodera Stimpson, 1860	32	ss	PSC
	Stenorhynchus seticornis (Herbst, 1788)	18, 32, 50	ab	SA, PSC
Inachoididae	*Batrachonotus fragosus* Stimpson, 1871	35	sm	PSC
	Euprognatha rastellifera Stimpson, 1871	27	lp	ARC, BN
Latreilliidae	*Latreillia elegans* Roux, 1830	27	lp	ARC, BN
Leucosiidae	*Ebalia stimpsoni* A. Milne-Edwards, 1880	32	ss	PSC
Majidae	*Macrocoeloma diplacanthum* (Stimpson, 1860)	32, 38, 47	ab, ir, sm	PSC
	Macrocoeloma subparallelum (Stimpson, 1860)	32, 38, 44, 47	ab, ir, sm	PSC
	Microphrys bicornutus (Latreille, 1825)	2, 16, 26, 32, 38, 44, 47	ab, ir, lr, mg	SA, PSC
	Mithraculus coryphe (Herbst, 1801)	26, 32, 44, 47	ab, ir, sm	PSC
	Mithraculus forceps A. Milne-Edwards, 1875	26, 32, 38, 44	ab, ir	PSC
	Mithraculus ruber Stimpson, 1871	26, 47	ab, ir	PSC
	Mithraculus sculptus (Lamarck, 1818)	2, 26, 32, 33, 38, 44, 47	ab, ir, sm	SA, PSC
	Mithrax aculeatus (Herbst, 1790)	26, 32	ab, sm	PSC
	Mithrax hemphilli Rathbun, 1892	26, 32	ab, ir	PSC
	Mithrax spinosissimus (Lamarck, 1818)	32, 50	ab	PSC
	Nemausa cornuta (Saussure, 1857)	47	ir	PSC
	Temnonotus granulosus A. Milne-Edwards, 1875	49		CS
	Thoe puella Stimpson, 1860	26	ab	PSC
Munididae	*Munida miles* A. Milne Edwards, 1880	49		N
	Munida stimpsoni A. Milne Edwards, 1880	17	lp	RB
Munidopsidae	*Galacantha rostrata* A. Milne Edwards, 1880	17	lp	RB
	Munidopsis subspinoculata Pequegnat & Pequegnat, 1971	17	lp	RB
Nephropidae	*Nephropsis aculeata* Smith, 1881	49		C

Malacostraca — Eumalacostraca — Decapoda

F	S			
Ocypodidae	*Ocypode quadrata* (Fabricius, 1787)	2, 32, 38, 40	pl	SA, PSC
	Uca (Leptuca) leptodactyla Rathbun, 1898	12	mg	PSC
	Uca (Leptuca) pugilator (Bosc, 1802)	12, 38, 54	ir, mg, zt	PSC
	Uca (Minuca) burgersi Holthuis, 1967	40	zt	SA
	Uca (Minuca) rapax (Smith, 1870)	32	mg	PSC
	Uca (Minuca) vocator (Herbst, 1804)	40	zt	SA
	Uca (Uca) major Herbst, 1782	32	mg	PSC
Oziidae	*Ozius reticulatus* (Desbonne, in Desbonne & Schramm, 1867)	32	lr	PSC
Paguridae	*Agaricochirus erosus* (A. Milne-Edwards, 1880)	27	lp	BN
	Enallopaguropsis provenzanoi Lemaitre & McLaughlin, 2003	49		PSC
	Pagurus brevidactylus (Stimpson, 1859)	32, 49	ss	PSC
	Pagurus criniticornis (Dana, 1852)	49		BS
	Pagurus marshi Benedict, 1901	32, 47, 49	ir, ss	PSC
	Protoniopagurus bioperculatus Lemaitre & McLaughlin, 1996	49		CS
	Pylopagurus discoidalis (A. Milne-Edwards, 1880)	27	lp	BN
	Tomopagurus cubensis (Wass, 1963)	49		CS
Palaemonidae	*Ancylomenes pedersoni* (Chace, 1958)	26, 32, 50	ab, lr	PSC
	Brachycarpus biunguiculatus (Lucas, 1846)	26, 32, 47, 54	ab, ir, sm	PSC
	Leander tenuicornis (Say, 1818)	24, 26, 32, 43, 47	ab, ir, mg, sm, ss	PSC
	Macrobrachium acanthurus (Wiegmann, 1836)	32	zt	PSC
	Macrobrachium carcinus (Linnaeus, 1758)	32	zt	PSC
	Macrobrachium faustinum (de Saussure, 1857)	2, 32	ir, zt	PSC
	Macrobrachium hancocki Holthuis, 1950	49		PSC
	Palaemon northropi (Rankin, 1898)	26	ab	PSC
	Periclimenes americanus (Kingsley, 1878)	26, 32, 42, 43	ab, sm	PSC
	Periclimenes iridescens Lebour, 1949	26	ab	PSC
	Periclimenes rathbunae Schmitt, 1924	26, 32	ab	PSC
	Periclimenes yucatanicus (Ives, 1891)	26, 32	ab, sm	PSC
	Urocaris longicaudata Stimpson, 1860	32	sm	PSC
Palicidae	*Palicus faxoni* Rathbun, 1897	54	ab	PSC
Palinuridae	*Panulirus argus* (Latreille, 1804)	1, 2, 4, 13, 14, 18, 19, 32, 37, 39, 49, 50	ab, sm, ss	BS, CA, CB, SA, PSC, N
Panopeidae	*Acantholobulus bermudensis* (Benedict & Rathbun, 1891)	7, 38, 40, 45	ab, ir	SA, PSC
	Eurypanopeus abbreviatus (Stimpson, 1860)	7, 32, 40, 45	ab, ir, lr	SA, PSC
	Eurypanopeus depressus (Smith, 1869)	16	mg	SA, PSC
Panopeidae	*Eurytium limosum* (Say, 1818)	7, 32, 40	ir, mg	SA, PSC
	Panopeus boekei Rathbun, 1915	7, 45, 49	ab, ir, sm	SA, PSC, S
	Panopeus herbstii H. Milne Edwards, 1834	7, 32, 40, 45	ab, ir, mg, sm	SA, PSC
	Panopeus occidentalis Saussure, 1857	32, 38	ab, ir, sm	PSC
Parapaguridae	*Oncopagurus gracilis* (Henderson, 1888)	27	lp	BN
Parthenopidae	*Platylambrus granulatus* (Kingsley, 1879)	32	ss	PSC
	Solenolambrus tenellus Stimpson, 1871	27	lp	BN
Pasiphaeidae	*Leptochela (Leptochela) bermudensis* Gurney, 1939	29	lp	PSC
Penaeidae	*Farfantepenaeus brasiliensis* (Latreille, 1817)	49		BS, S
	Farfantepenaeus duorarum (Burkenroad, 1939)	26	ab, mg	PSC
	Farfantepenaeus notialis (Pérez Farfante, 1967)	32, 49	sm	BS,PSC
	Farfantepenaeus subtilis (Pérez Farfante, 1967)	26, 49	mg	PSC,S
	Metapenaeopsis gerardoi Pérez Farfante, 1971	32	sm	PSC
	Parapenaeus longirostris (Lucas, 1846)	49		C
	Rimapenaeus similis (Smith, 1885)	25, 47, 49	ir, ss	PSC, S
Percnidae	*Percnon gibbesi* (H. Milne Edwards, 1853)	32	lr	PSC
Pilumnidae	*Pilumnus holosericus* Rathbun, 1898	7, 47	ir	SA, PSC
	Pilumnus lacteus Stimpson, 1871	32	sm	PSC
	Pilumnus pannosus Rathbun, 1896	32	sm	PSC
Pinnotheridae	*Clypeasterophilus rugatus* (Bouvier, 1917)	53	ir	PSC
Plagusiidae	*Plagusia depressa* (Fabricius, 1775)	32, 40	ir, lr	SA, PSC
Polychelidae	*Polycheles typhlops* Heller, 1862	27	lp	BN
Porcellanidae	*Megalobrachium poeyi* (Guérin-Méneville, 1855)	52	ir, sm	PSC
	Pachycheles chacei Haig, 1956	52	ir	PSC
	Pachycheles pilosus (H. Milne Edwards, 1837)	52	ir	PSC
	Pachycheles riisei (Stimpson, 1859)	52	ir	PSC
	Petrolisthes amoenus (Guérin-Méneville, 1855)	52	ab	PSC
	Petrolisthes caribensis Werding, 1983	52	ab	PSC
	Petrolisthes cessacii (A. Milne-Edwards, 1878)	20	ir	PSC
	Petrolisthes dissimulatus Gore, 1983	52	lr	PSC
	Petrolisthes galathinus (Bosc, 1802)	52	ab, ir, lr, sm	PSC
	Petrolisthes jugosus Streets, 1872	2, 52	ir	PSC

Interactive table

Crustaceans

Phylum Arthropoda

Class / Order	F	S			
Malacostraca / Eumalacostraca / Decapoda	Porcellanidae	*Petrolisthes marginatus* Stimpson, 1859	52	ir	PSC
		Petrolisthes politus (Gray, 1831)	20, 52	ir	PSC
		Petrolisthes quadratus Benedict, 1901	47	ir	PSC
		Petrolisthes tridentatus Stimpson, 1859	32, 47, 52	ir, ls	PSC
		Porcellana sayana (Leach, 1820)	52	ir	PSC
	Portunidae	*Achelous depressifrons* (Stimpson, 1859)	32, 35, 38, 45	ab, ir, sm, ss	PSC
		Achelous ordwayi Stimpson, 1860	32, 33, 35, 38, 47	ab, ir, sm	SA, PSC
		Achelous sebae (H. Milne Edwards, 1834)	32	ss	PSC
		Callinectes bocourti A. Milne-Edwards, 1879	26, 32	ab, ss	PSC
		Callinectes danae Smith, 1869	11, 45	ir, ss	PSC
		Callinectes exasperatus (Gerstaecker, 1856)	11, 32, 45	ir, ss	PSC
		Callinectes marginatus (A. Milne-Edwards, 1861)	11, 32, 45	ir, ss	PSC
		Callinectes similis Williams, 1966	2, 54	mg, sm	PSC
		Cronius ruber (Lamarck, 1818)	32	mg	PSC
		Cronius tumidulus (Stimpson, 1871)	32, 33, 38, 45	ab, ir, sm	SA, PSC
		Lupella forceps (Fabricius, 1793)	32	ss	PSC
	Processidae	*Processa canaliculata* Leach, 1815 [in Leach, 1815-1875]	31, 42	ab	PSC
		Processa fimbriata Manning & Chace, 1971	32	sm	PSC
	Psalidopodidae	*Psalidopus barbouri* Chace, 1939	10, 49	lp	N
	Pylochelidae	*Pylocheles agassizi* A. Milne-Edwards, 1880	49		N
	Rhynchocinetidae	*Cinetorhynchus rigens* (Gordon, 1936)	32, 50	ab, ir	PSC
	Scyllaridae	*Scyllarides nodifer* (Stimpson, 1866)	32	ss	PSC
	Sesarmidae	*Aratus pisonii* (H. Milne Edwards, 1837)	40, 46	ir, mg	SA
		Armases ricordi (H. Milne Edwards, 1853)	32, 38	ab, ir, lr	PSC
	Sicyoniidae	*Sicyonia parri* (Burkenroad, 1934)	32	sm	PSC
	Solenoceridae	*Hadropenaeus affinis* (Bouvier, 1906)	49		C
		Mesopenaeus tropicalis (Bouvier, 1905)	49		C
		Pleoticus robustus (Smith, 1885)	49		C, N
		Solenocera acuminata Pérez Farfante & Bullis, 1973	49		N
		Solenocera necopina Burkenroad, 1939	49		C, N
	Spongicolidae	*Microprosthema manningi* Goy & Felder, 1988	21	ir	PSC
		Microprosthema semilaeve (von Martens, 1872)	22, 32, 44, 47, 49	ab, ir, sm	PSC
	Stenopodidae	*Stenopus hispidus* (Olivier, 1811)	18, 26, 32	ab	SA, PSC
		Stenopus scutellatus Rankin, 1898	26	ab	PSC
	Ucididae	*Ucides cordatus* (Linnaeus, 1763)	2, 28, 32, 40, 41, 51	mg, zt	SA, PSC
	Upogebiidae	*Upogebia affinis* (Say, 1818)	32	ss	PSC
	Varunidae	*Cyclograpsus integer* H. Milne Edwards, 1837	32, 40	ir, lr	SA, PSC
	Xanthidae	*Actaea bifrons* Rathbun, 1898	32	sm	PSC
		Banareia palmeri (Rathbun, 1894)	32	sm	PSC
		Cataleptodius floridanus (Gibbes, 1850)	32	sm	PSC
		Chlorodiella longimana (H. Milne Edwards, 1834)	7, 32, 47	ir, sm	SA, PSC
		Carthiope spinipes (A. Milne-Edwards, 1880)	32	sm	PSC
		Carthiope barbadensis (Rathbun, 1921)	7, 47	ab, ir	SA, PSC
		Micropanope nuttingi (Rathbun, 1898)	7, 32, 38, 45	ab, ir, sm	SA, PSC
		Paractaea nodosa (Stimpson, 1860)	32	sm	PSC
		Paraliomera dispar (Stimpson, 1871)	7, 45, 47	ab, ir	SA,PSC
		Platyactaea setigera (H. Milne Edwards, 1834)	35, 45, 47	ab, ir	PSC
		Williamstimpsonia denticulatus (White, 1848)	7, 32	ab, ir, sm, ss	SA,PSC
		Xanthodius parvulus (Fabricius, 1793)	32	sm	PSC
	Xiphocarididae	*Xiphocaris elongata* (Guérin-Méneville, 1855 [in Guérin-Méneville, 1855-1856])	32	zt	PSC
Isopoda	Anthuridae	*Indanthura caribbica* (Paul & Menzies, 1971)	29	ab, lp	PSC
	Cirolanidae	*Cirolana parva* Hansen, 1890	5, 15, 49	ab, ir, pl	SA, PSC
	Corallanidae	*Alcirona krebsii* Hansen, 1890	29	lp	PSC
	Cymothoidae	*Anilocra laticauda* H. Milne Edwards, 1840	49		PSC
	Janiridae	*Carpias minutus* (Richardson, 1902)	49		PSC
	Ligiidae	*Ligia baudiniana* H. Milne Edwards, 1840	34	mg	SA
	Sphaeromatidae	*Exosphaeroma diminutum* Menzies & Frankenberg, 1966	15	pl	SA
Lophogastrida	Eucopiidae	*Eucopia unguiculata* (Willemoes-Suhm, 1875)	49		S
Tanaidacea	Kalliapseudidae	*Mesokalliapseudes macsweenyi* (Drumm, 2003)	29	ab	PSC
	Leptochelidae	*Mesotanais vadicola* Sieg & Heard, 1989	29	lp	PSC
	Tanaidae	*Zeuxo kurilensis* (Kussakin & Tzareva, 1974)	29	lp	PSC
Hoplocarida / Stomatopoda	Gonodactylidae	*Gonodactylellus spinosus* (Bigelow, 1893)	49		PSC
		Neogonodactylus oerstedii (Hansen, 1895)	2, 49	ir	PSC
	Pseudosquillidae	*Pseudosquilla ciliata* (Fabricius, 1787)	49		PSC

Conservation status

LC

Atya innocous
Nephropsis aculeata
Macrobrachium acanthurus
Macrobrachium carcinus
Macrobrachium faustinum
Macrobrachium hancocki
Polycheles typhlops
Scyllarides nodifer
Xiphocaris elongata

VU

Carpilius corallinus
Cardisoma guanhumi
Mithrax spinosissimus
Panulirus argus

All crustacean species are associated with the benthic environment.

SPAW *Panulirus argus* is included in Annex III of the SPAW Protocol

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Interactive table

MOLLUSCS

Underwater Gems of the Archipielago

Adriana Osorno-Arango[1] and Juan Manuel Díaz Merlano[2,3]

1 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

2 Department of Geography, Universidad Nacional de Colombia

3 Fundación MarViva.

At the global level, molluscs are the second zoological group or animal phylum of greatest diversity (only arthropods, which include insects, are more numerous in species), with around 120 thousand living species, and no less than 35 thousand fossil species described.

Their origin dates back to the Cambrian period, 550 million years ago. That early origin in the geological history has resulted in the development of a prodigious morphological plasticity, making possible the existence of representatives of the group practically in all the terrestrial and aquatic environments known in the biosphere, with the exception of the most arid zones and those permanently covered by ice. The vast majority of molluscs are marine species, and they are usually notable and abundant elements in the littoral, along the shores worldwide.

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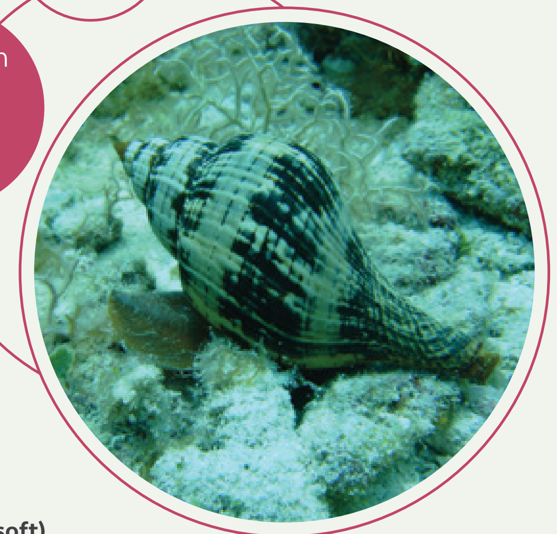
Class
Bivalvia

Almost
13
Thousand
species

Class Bivalvia, *Lima lima* (Foto:Nacor Bolaños)

Class
Gastrópoda

More than
75
Thousand
species



Class Gastrópoda, *Fasciolaria tulipa* (Photo: Nacor Bolaños)

Classification

The phylum Mollusca (from Greek molluscum: soft) comprises coelomate unsegmented invertebrate animals with bilateral symmetry and soft body; the latter naked or protected by plates, spicules or a calcareous shell. It is divided into eight well-differentiated classes, but those most representative and having the highest number of species are the classes Polyplacophora (chitons, which are about 600 species with their body covered, generally, by eight transverse plates surrounded by a belt of scales or spicules), Bivalvia (mussels, clams and oysters; which are almost 13 thousand species), Gastropoda (snails, limpets and slugs, totaling more than 75 thousand species) and Cephalopoda (octopi, squid and cuttlefish, with about 800 species (Figure 1). Additionally, it is worth mentioning the class Scaphopoda (elephant's tusk shells, 900 species), whose body is covered by a curved cone-shaped shell.

Class
Polyplacophora

cerca de
600
species

Class Polyplacophora, *Chiton marmoratus* (Photo: Adriana Osorno)

With about
800
species

Class
Cephalópoda

Class Cephalópoda, *Octopus* sp. (Photo: Ernesto Mancera).

Figure 1. The most representative classes having the highest number of species of the phylum Mollusca

The presence of more than three thousand species of living molluscs has been recorded in waters and coasts of the Caribbean Sea, of which 1,200 certainly live in the Colombian Caribbean **(Miloslavich *et al.*, 2010)**; Nonetheless, some estimations, not entirely well supported, rise such figure to more than 1,500 **(Yidi Daccarett y Sarmiento Bossio, 2011)**. Such diversity of species is possible thanks to the wide range of marine and coastal environments of the Colombian Caribbean, including estuaries, mangrove swamps, beaches, rocky littorals, coral reefs, seagrass beds and sandy and muddy bottoms, as well as depth gradients going from the coastline to the abyssal plain at more than 3,000 m.

Although most species of molluscs are small—even many do not exceed a few millimeters—some snails, octopi and squid reach considerable dimensions. Many molluscs, mainly clams, oysters, mussels, squid, octopi and some snails, are considered food; and the shells or parts of shells of various snails and bivalves are used to manufacture handicrafts and jewelry (Figure 2).

This chapter brings to light the great diversity of species of molluscs found around islands, cays and shallow bottoms (0-40 m) of banks and atolls of the Archipelago of San Andrés, Providencia and Santa Catalina. Many species are unusual and small, therefore, unknown to most people; but some are common and conspicuous, allowing them to be part of the emblematic marine fauna and the traditional cuisine in the archipelago.

Figure 2. Species of the most common molluscs recorded in the Archipelago of San Andrés, Providencia and Santa Catalina. (Photographs: courtesy of Víctor Sarmiento Bossio and Enrique Yidi Daccarett).

This chapter contains information extracted from papers published in indexed journals and books, information derived from observations or collections made in field by the authors, and data taken from the Information System on Marine Biodiversity (SIBM), which has the records of material kept in the collection of molluscs of the Museum of Natural Marine History of Colombia (MHNMC). All the information collected was useful to build a synthetic table containing all the species recorded of the five main classes of the phylum Mollusca (Polyplacophora, Gastropoda, Bivalvia, Scaphopoda and Cephalopoda), differentiating them according to the locations and habitats of collection or observation in the Archipelago of San Andrés, Providencia and Santa Catalina. Moreover, unpublished documents and gray literature (dissertations and reports) were also taken into account; however, the information from such documents, given the high level of uncertainty of taxonomic determinations in most of them, was not considered for the preparation of the inventory of species. Only taxons determined to the level of species or genus were included.

In addition, given the multiple changes that systematics and taxonomic nomenclature of Mollusca have experienced in recent years, the name and classification of each species were verified in the database of the World Register of Marine Species **(WoRMS Editorial Board, 2015)** and the Integrated Taxonomic Information System **(ITIS, 2015)**. Lastly, this chapter includes information and photographs of the species most frequently found in the area, which have certain importance of use at the local level or that are in some level of threat.

Cyprea (Photo: Juan Carlos Marquez)

Distribution

So far, for the Archipelago of San Andrés, Providencia and Santa Catalina, 293 taxons of molluscs have been recorded in total (94.54% identified to the species level and 5.46%, to the genus level), belonging to 92 families and 197 genera. Of that total, 188 correspond to species of gastropods (64.16%), 93 to bivalves (31.74%), six to cephalopods (2.05%), five to polyplacophores (1.71%) and one to scaphopods (0.34%) **(Figure 3).**

292
mollusc taxon

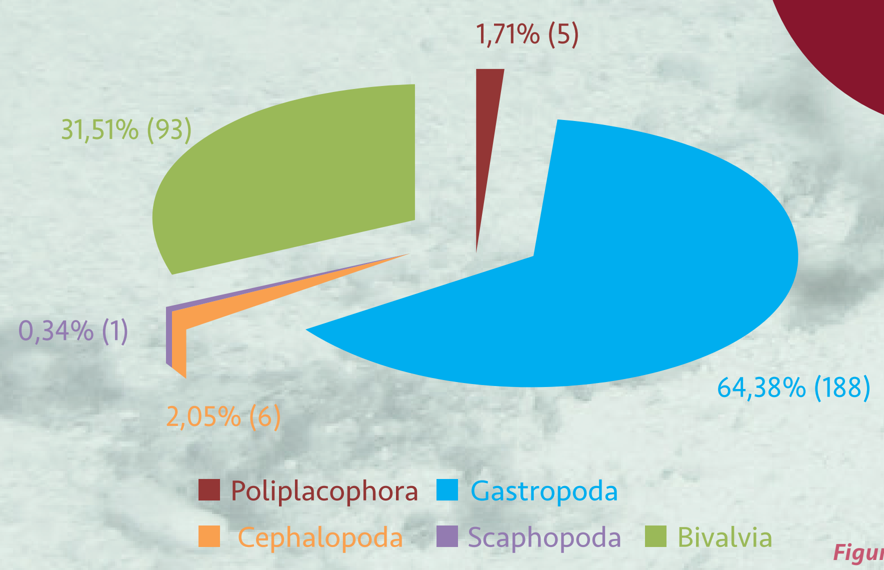


Figure 3. Proportional number of species of molluscs registered in the Archipelago of San Andrés, Providencia and Santa Catalina of the classes Polyplacophora, Gastropoda, Caphalopoda, Scaphopoda and Bivalvia. (Percentage and absolute number in parentheses)

In accordance with the information displayed in the list of species of molluscs (Table MOLLUSCS), most of the species are benthic organisms, i.e. they spend most of their life cycle associated to a substrate of the seafloor ; while only a few are pelagic species (Figure 4, planktonic), i.e., their life cycle develops in the water column, as is the case of octopi, squid and some planktonic gastropods. (Figure 4).

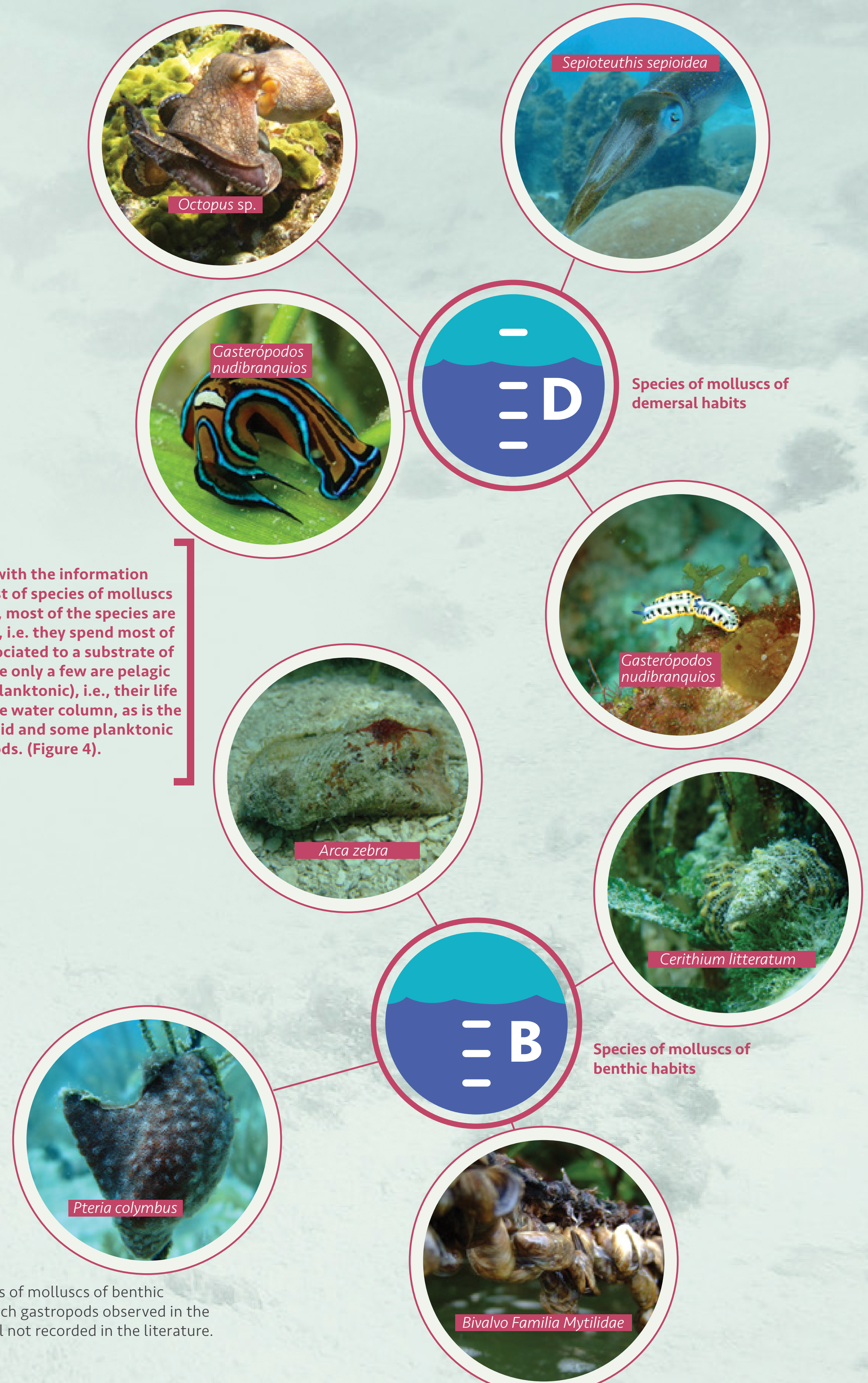


Figure 4. Species of molluscs of benthic habits Nudibranch gastropods observed in the archipelago, still not recorded in the literature.

Most of the benthic species (156) have been observed or collected in the sedimentary littoral; however, an important amount (65) is also associated to the rocky substrate. Fewer species are in the mangrove swamp (31), in sublittoral biogenic reefs (29), in the sedimentary sublittoral dominated by macrophytes (24) and in the water column (6) **(Figure 5).**

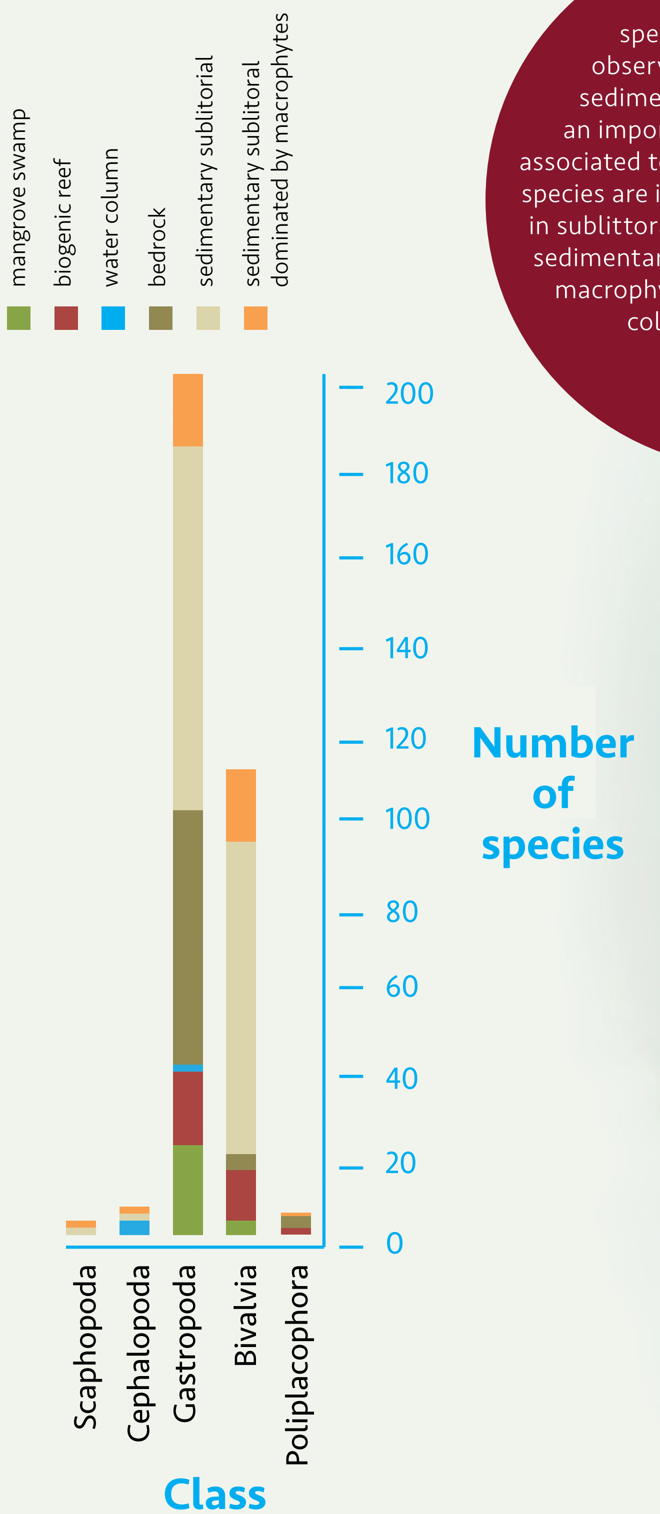


Figure 5. Number of species of each class of the phylum Mollusca recorded in the different marine habitats of the Archipelago of San Andrés, Providencia and Santa Catalina.

(Photo:Nacor Bolaños).

According to the information collected, most of the records of species correspond to San Andrés Island and its surroundings. It means that the greatest wealth or diversity of species is consolidated, seemingly, in marine habitats that surround such island. The second place, with a huge difference regarding San Andrés Island in terms of wealth of species, corresponds to the surrounding areas of Providencia and Santa Catalina Islands. With differences even greater regarding those two areas, the third place is for coral banks and atolls of Quitasueño, Serrana, Roncador, Albuquerque and Bolívar or Courtown Cays; while the lowest numbers correspond to the most remote coral banks: Serrana, Bajo Nuevo Bank and Alicia Shoal, in the northwestern part of the archipelago.

Although it is reasonable to think that, in fact, areas with greater wealth of species should be those located around the major islands of the archipelago due to the great amount of habitats existing there (mangroves, rocky littorals, and seagrass beds are not found or are poorly represented in other areas of the archipelago) **(Díaz et al., 2000)**, differences in the number of records and, thus, the number of species recorded in different areas of the archipelago are, ultimately, a reflection of the sampling effort made. San Andrés Island and, to a lesser extent, Providencia and Santa Catalina Islands, are permanently populated areas, whose adjacent habitats are relatively accessible to researchers and have some logistical and infrastructure resources for conducting wildlife surveys and other research.

In summary, it can be said that fauna of marine molluscs found in the Archipelago of San Andrés and Providencia—where the Seaflower Biosphere Reserve is located—, is characteristic of the insular ocean waters of the central Caribbean, where Jamaica and Grand Cayman Islands, extensive surrounding coral banks and part of the continental shelf of Honduras and Belize are also included **(Miloslavich *et al.*, 2011)**. The diversity of species of molluscs in the archipelago (293 species) represents about 10% of the diversity in the Caribbean Sea, with 3,000 species; and between 20% and 25% of the diversity recorded in the Colombian Caribbean, with 1,492 species, according to Yidi Daccarett and Sarmiento Bossio (2011), and 1,168, according to **Miloslavich *et al.* (2011)**.

Sepiotheuthis sepioidea
(Photo:Nacor Bolaños).

Threatened and commercially important species

Lobatus gigas (Photo: Sarmiento&Yidi)

Cittarium pica (Photo: Adriana Osorno)

Charonia variegata (Photo: Gabriel Restrepo).

Figure 6 Examples of threatened species of molluscs in the Archipelago of San Andrés, Providencia and Santa Catalina

The compilation of the species of molluscs listed under some threat category for Colombia **(Gracia & Díaz, 2002)** is found in the Red Book of Marine Invertebrates of Colombia **(Ardila *et al.*, 2002)**. Some of these species are present in the Archipelago of San Andrés, Providencia and Santa Catalina and in the Seaflower Biosphere Reserve, including the bivalve *Tellina magna* (in the category of Data Deficient, or DD, which is not exactly a threat category, but is a warning of the insufficiency of the available information to make a proper assessment of its risk of extinction) and the gastropods *Lobatus gigas, Cittarium pica, Charonia variegata* **(Figure 6)**, *Cassis flammea, Cassis tuberosa, Cassis madagascariensis* and *Propustularia surinamensis* (all in the category of Vulnerable, or VU, according to which the best evidence available indicates that the species faces a moderate risk of extinction or population decline in the medium term). All these species are also listed in the Resolution 192 of 2014, by which the Ministry of Environment and Sustainable Development of Colombia establishes the list of endangered wild species of the Colombian biodiversity found in national territory and in which other provisions are enacted.

The queen conch that can regulate and control the proliferation of algae in coral formations.

Other evidence suggests that, of the above species, the gastropods *Lobatus gigas* and *Cittarium pica* may have a higher level of threat than the others, not only in the archipelago but throughout the Colombian Caribbean, mainly because their meat is seen as food and their shells as raw material for handicrafts, so they are subject to excessive levels of exploitation **(Gracia & Díaz, 2002; Osorno-Arango & Díaz-Merlano, 2006; Osorno-Arango *et al.*, 2009; Osorno *et al.*, 2012).** *Lobatus gigas*, commonly called conch in the archipelago and "caracol pala" in the Colombian coast, is considered threatened by international trade, thus appearing in the CITES Appendix II.

According to Reyes and Santodomingo (2002), the Archipelago of San Andrés, Providencia and Santa Catalina is the largest producer and exporter of queen conch in Colombia, which is based on an important artisanal and industrial fishery. This species is of great importance in the local economy and is deep-rooted in the island culture, as it is part of the traditional cuisine and its shell is a common decorative item in the homes of San Andrés and Providencia **(Castro *et al.*, 2008)**; additionally, its pearls are highly appreciated on international markets **(Reyes & Santodomingo, 2002)**. From an ecological point of view, the queen conch plays an important role since it is one of the few herbivores that can regulate and control the proliferation of algae in coral formations **(Lagos Bayona *et al.*, 1996).**

Queen conch fishery in the archipelago is ruled in general by the Law 611 of 2000, and there is also a legislation for the management of this species, which includes the granting of exploitation permits, catching quotas and closed seasons. This regulation has undergone changes over the past three decades based on the results of fish stock assessments **(cf. Appeldoorn *et al.*, 2003; Rueda *et al.*, 2005)** and precautionary principles. Since 2008, the Ministry of Environment and Sustainable Development, with the support of local and national institutions, is working in the design of a National Action Plan for the queen conch. This plan is expected to establish policies and management guidelines for the species in the short, medium and long term. Marine Protected Areas (MPA), such as the Seaflower Biosphere Reserve and the McBean Lagoon National Natural Park, safeguard a portion of the distribution area of *L. gigas* in the archipelago. However, the greatest challenge for its conservation in these MPAs lies in the effective implementation of control and surveillance measures in remote areas of the archipelago, which provide breeding habitats for adult animals and recruitment habitats of juveniles **(Castro *et al.*, 2009).**

As for the gastropod *Cittarium pica*, known in the archipelago as wilks (and in the rest of Colombia as "cigua" or "burgao"), INVEMAR, CORALINA and the Old Providence McBean Lagoon National Natural Park have conducted some researches in order to determine the status of its populations in the area and establish management measures. **Osorno *et al.* (2012)**, by means of surveys to local residents, found that this species is mainly caught in the archipelago for local consumption and is used in the preparation of various typical dishes such as stew wilks and rondon, the latter also prepared using other types of snails.

Most survey respondents stated that *C. pica* has been caught for many years, even before the queen conch fishery were established in the area in 1990. Respondents also indicated that, although *C. pica* is found throughout the year, there is a season during the time of Easter (March to April) in which fishery is more frequent. This is due to a tradition according to which the *C. pica* meat is consumed instead of other meats. 88% of respondents consider that this species population has declined dramatically in the archipelago **(Osorno *et al.*, 2012)**. Such decrease coincides with the general trend throughout the Caribbean **(cf. Robertson, 2003; Osorno-Arango & Díaz-Merlano, 2006).**

Osorno *et al.* (2012) also found, by means of population sampling, that the average density of Cittarium pica was 2.90 (± 0.72) Ind./m2, being higher in San Andrés than in Providencia and Santa Catalina. On the other hand, the sector displaying a higher median size was Providencia and Santa Catalina (32.05 mm), compared to San Andrés (18.39 mm), which is the opposite result to that of density. Both the predominance of small individuals and the shortage or absence of large individuals of *C. pica*, added to the low densities estimated for the Archipelago of San Andrés and Providencia, indicate that the resource is overexploited. In the face of this situation, CORALINA and the administrative unit of the Old Providence McBean Lagoon National Natural Park are currently working to establish measures to protect and ensure the sustainability of this and other valuable resources; a task in which we must all work together.

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Molluscs

Phylum Mollusca

Class	Family	Species				
Bivalvia	Arcidae	*Arca zebra* Swainson, 1833	3,18	B	ss	C, RB
		Acar domingensis Lamarck, 1819	3	B	ss	RB
		Anadara chemnitzii Philippi, 1851	3	B	ss	RB
		Anadara notabilis Röding, 1798	3	B	sm	RB
		Arca imbricata Bruguière, 1789	3	B	ss	RB
		Barbatia candida Heilblind, 1779	3	B	ss	RB
	Cardiidae	*Americardia media* Linnaeus, 1758	3,9	B	ss	SA, S, RB
		Fulvia laevigata Linnaeus, 1758	3,9	B	ss	SA, S, RB
	Chamidae	*Chama* sp. Linnaeus, 1758	9	B	ab	SA, S, RB
		Chama congregata Conrad, 1833	3	B	ss	RB
		Chama florida Lamarck, 1819	3	B	ss	RB
		Chama macerophylla Gmelin, 1791	3	B	ss	RB
		Pseudochama cristella Lamarck, 1819	3	B	ss	RB
		Arcinella arcinella Linnaeus, 1767	3	B	ss	RB
	Dreissenidae	*Mytilopsis sallei* Dillwyn, 1817	17	B	mg	SA, S, RB
	Glycymerididae	*Spengleria rostrata* Spengler, 1793	3	B	ss	SA, S, RB
		Glycymeris decussata Linnaeus, 1758	3	B	ss	SA, S, RB
		Glycymeris undata Linnaeus, 1758	3	B	ss	RB
		Tucetona pectinata Gmelin, 1791	3,9,18			IN, N, BQ
	Limidae	*Ctenoides scaber* Born, 1778	3,9,18,20	B	ss,ab	IN, N, BQ
		Lima lima Linnaeus, 1758	3	B	ss	RB
	Lucinidae	*Anodontia alba* Link, 1807	9	B	ss	SA, S, RB
		Codakia sp. Scopoli, 1777	18			IN, N, BQ
		Lucina pensylvanica Linnaeus, 1758	3,18			IN, N, BQ
		Codakia orbicularis Linnaeus, 1758	3	B	sm	RB
		Ctena orbiculata Montagu, 1808	3	B	sm	RB
		Divalinga quadrisulcata d'Orbigny, 1846	3	B	ss	RB
		Phacoides pectinatus Gmelin, 1791	3	B	sm, ss	RB
	Malleidae	*Malleus candeanus* D'orbigny, 1853	3,18	B	ab	IN, N, BQ
	Mytilidae	*Lithophaga* sp. Röding, 1798	9	B	lr	SA, S, RB
		Lithophaga teres Philippi, 1846	9	B	ab	SA, S, RB
		Lithophaga aristata Dillwyn, 1817	3	B	ab,	RB
		Lithophaga corrugata Philippi, 1846	3	B	ab, ss	RB
		Modiolus americanus Leach, 1815	9	B	ss	SA, S, RB
		Amygdalum sagittatum Rehder, 1934	3	B	ss	SA, S, RB
		Botula fusca Gmelin, 1791	3	B	sm	RB
		Brachiodontes exustus Linnaeus, 1758	3	B	lr	RB
		Leiosolenus appendiculatus Philippi, 1846	3	B	ab,	RB
	Ostreidae	*Dendostrea frons* Linnaeus, 1758	18			IN, N, BQ
		Ostrea c.f. equestris Say, 1834	9	B	lr	SA, S, RB
	Pectinidae	*Nodipecten nodosus* Linnaeus, 1758	18, 3	B	ss	IN, N, BQ
		Lindapecten muscosus W. Wood, 1828	9	B	ss	SA, S, RB
	Pinnidae	*Pinna carnea* Gmelin, 1791	18			SA, S, RB
		Pinna sp. Linnaeus, 1758	20	B		IR, CS
	Pteriidae	*Pinctada imbricata radiata* Leach, 1814	9	B	ss	SA, S, RB
		Isognomon radiatus Anton, 1838	18			IN, N, BQ
	Spondylidae	*Spondylus americanus* Hermann, 1781	9	B	lr	SA, S, RB
	Tellinidae	*Arcopagia fausta* Pulteney, 1799	18	B	ss	IN, N, BQ
		Strigilla carnaria Linnaeus, 1758	18	B	ss	IN, N, BR
		Tellina radiata Linnaeus, 1758	18	B	ss	IN, N, BQ
		Tellina sp. Linnaeus, 1758	9	B	ss	SA, S, RB
	Teredinidae	*Bankia* sp. Gray, 1842	17	B	mg	SA, S, RB
	Ungulinidae	*Diplodonta punctata* Say, 1822	9	B	ss	SA, S, RB
	Veneridae	*Chione cancellata* Linnaeus, 1767	9	B	ss	SA, S, RB
	Cardiidae	*Dallocardia muricata* Linnaeus, 1758	3	B	ss	RB
		Laevicardium pictum Ravenel, 1861	3	B	ss	RB
		Papyridea soleniformis Bruguière, 1789	3	B	ss	RB
		Trachycardium isocardia Linnaeus, 1758	3	B	ss	RB
	Gastrochaenidae	*Lamychaena hians* Gmelin, 1791	3	B	ab	RB
	Mactridae	*Mactrotoma fragilis* Gmelin, 1791.	3	B	ss	RB

Interactive table

Phylum Mollusca

Class	Family	Species				
Bivalvia	Noetiidae	*Arcopsis adamsi* Dall, 1886	3	B	ss	RB
	Nuculidae	*Condylonucula cynthiae* Moore, 1977	12	B	ss	SA, S, RB
		Nucula calcicola Moore, 1977	12	B	ss	SA, S, RB
	Ostreidae	*Crassostrea virginica* Gmelin, 1791	3	B	mg	RB
		Ostrea equestris Say, 1834	3,9	B	ab	RB
		Dendostrea frons Linnaeus, 1758	3,18	B	ab	RB
	Pectinidae	*Antillipecten antillarum* Récluz, 1853	10	B	ss	RB
		Caribachlamys ornata Lamarck, 1819	3	B	ss	RB
		Caribachlamys pellucens Linnaeus, 1758	3	B	ss	RB
		Euvola ziczac Linnaeus, 1758	3	B	ss	RB
		Lindapecten exasperatus Sowerby II, 1842	3	B	ss	RB
	Psammobiidae	*Psammotella cruenta* Lightfoot, 1786	3	B	ss	SA, S, RB
	Pteriidae	*Isognomon alatus* Gmelin, 1791	3	B	mg	RB
		Isognomon bicolor C. B. Adams, 1845	3	B	lr	RB
		Pinctada imbricata Röding, 1798	3	B	ab	RB
		Pteria colymbus Röding, 1798	3	B	ab	RB
		Lindapecten muscosus W. Wood, 1828	3,9	B	ss	SA, SS, SF
		Nodipecten nodosus Linnaeus, 1758	3,18	B	ss	RB
	Semelidae	*Abra aequalis* Say, 1822	3	B	ss	SA, S, RB
		Semele bellastriata Conrad, 1837	3	B	ss	RB
		Semele proficua Pulteney, 1799	3	B	ss	SA, S, RB
		Semele purpurascens Gmelin, 1791	10	B	ss	SA, S, RB
	Solecurtidae	*Tagelus divisus* Spengler, 1794	3	B	ss	SA, S, RB
		Tagelus plebeius Lightfoot, 1786	3	B	ss	RB
	Solemyidae	*Solemya occidentalis* Deshayes, 1857	3	B	sm	RB
	Spondylidae	*Spondylus* sp. Linnaeus, 1758	20	B		IR, CS
		Spondylus tenuis Schreibers, 1793	3	B	ss	C, RB
	Tellinidae	*Psammotreta intastriata* Say, 1827	3	B	ss	C, RB
		Tellina laevigata Linnaeus, 1758	3	B	ss	RB
		Tellina listeri Röding, 1798	3	B	ss	RB
		Tellina magna Spengler, 1798	3	B	ss	RB
	Veneridae	*Globivenus rigida* Dillwyn, 1817	10	B	ss	RB
		Lamelliconcha circinata Born, 1778	3	B	ss	RB
		Lirophora paphia Linnaeus, 1767	3	B	ss	RB
		Periglypta listeri J.E. Gray, 1838	3	B	ss	RB
		Pitar fulminatus Menke, 1828	3	B	ss	RB
Cephalopoda	Argonautidae	*Argonauta argo* Linnaeus, 1758	3	P	ca	RB
	Loliginidae	*Sepioteuthis sepioidea* Blainville, 1823	3,20	P	ca	RB
	Octopodidae	*Callistoctopus macropus* Risso, 1826	3	D	ss	SA, S, RB
		Octopus hummelincki Adam, 1936	3	D	ss	C, RB
		Octopus sp. Cuvier, 1798	13,18	D	ca	C, RB
	Spirulidae	*Spirula spirula* Linnaeus, 1758	3	P	ca	SA, S, RB
Gastropoda	Aplustridae	*Micromelo undatus* Bruguière, 1792	10	D	ss	IN, N, RB, BS
	Architectonicidae	*Architectonica nobilis* Röding, 1798	3	B	ss	C, RB
		Psilaxis krebsii Mörch, 1875	3	B	ss	SA, S, RB
	Assimineidae	*Assimenea succinea* Pfeiffer, 1840	17	B	mg	SA, S, RB
	Batillariidae	*Batillaria minima* Gmelin, 1791	3	B	mg, ss	SA, S, RB
	Buccinidae	*Engina turbinella* Kiener, 1836	3	B	ss	RB
		Engoniophos unicinctus Say, 1826	3	B	ss, sm	SA, S, RB
		Pisania pusio Linnaeus, 1758	3	B	ss	SA, S, RB
		Pollia auritula Link, 1807	18			IN, N, RB, BQ
	Bullidae	*Bulla striata* Bruguière, 1792	9,17	D	ss	SA, S, RB
	Bursidae	*Bursa granularis* Röding, 1798	3	B	ss	RB
		Bursa rhodostoma thomae d'Orbigny, 1847	3	B	ss	RB
	Caecidae	*Meioceras cornucopiae* Carpenter, 1859	17	B	mg	SA, S, RB
	Calliostomatidae	*Calliostoma barbouri* Clench & Aguayo, 1946	3	B	lr, ss	SA, S, RB
		Calliostoma fucosum Quinn, 1992	10	B	lr, ss	SA, S, RB
		Calliostoma javanicum Lamarck, 1822	3	B	lr, ss	SA, S, RB
		Calliostoma jujubinum Gmelin, 1791	3	B	lr, ss	SA, S, RB
		Calliostoma orion Dall, 1889	3	B	lr, ss	SA, S, RB
		Calliostoma pulchrum C.B. Adams, 1850	16	B	lr, ss	SA, S, RB

Phylum Mollusca

Class	Family	Species				
Gastropoda	Cassidae	*Cypraecassis testiculus* Linnaeus, 1758	9	B	ab	SA, S, RB
		Cassis flammea Linnaeus, 1758	3	B	sm	C, RB
		Cassis madagascariensis Lamarck, 1822	3	B	sm	C, RB
		Cassis sp. Scopoli, 1771	20	B		BA
		Cassis tuberosa Linnaeus, 1758	3	B	sm, ss	RB
		Echinophoria coronadoi Crosse, 1867	10	B	ss	IN, N, RB, BQ
	Cerithiidae	*Cerithium atratum* Born, 1778	3	B	lr, ss, sm	RB
		Cerithium eburneum Bruguière, 1792	3,18,20	B	r, ss	C, RB
		Cerithium litteratum Born, 1778	3,18,20	B	r, ss	C, RB
		Cerithium sp. Bruguière, 1789	9	B	ss	SA, S, RB
		Cerithium lutosum Menke, 1828	17	B	mg	SA, S, RB
	Colubrariidae	*Colubraria testacea* Mörch, 1854	21			SA, S, RB
	Columbellidae	*Columbella mercatoria* Linnaeus, 1758	3,18	B	ss	C, RB
		Conella ovulata Lamarck, 1811	10	B	ss	IS, S, RB, CA
		Nitidella nitida Lamarck, 1822	3	B	lr	RB
		Zafrona pulchella Blainville, 1829	3	B	ss	RB
		Costoanachis sertulariarum d'Orbigny, 1839	17	B	mg	SA, S, RB
		Costoanachis sparsa Reeve, 1859	17	B	mg	SA, S, RB
	Conidae	*Conasprella jaspidea* Gmelin, 1791	3,18	B	ss	IN, N, RB, BQ
		Conasprella puncticulata Hwass in Bruguière, 1792	18			IS, RB
		Conus cerutii Cargile, 1997	21			SA, S, RB
		Conus flammeacolor Petuch, 1992	21			SA, S, RB
		Conus mus Hwass in Bruguière, 1792	9	B	ab	SA, S, RB
		Conasprella mindana Hwass in Bruguière, 1792	3	B	ss	C, RB
		Conus daucus Hwass in Bruguière, 1792	3	B	ss	RB
		Conus regius Gmelin, 1791	3	B	ss	RB
		Conus rosalindensis Petuch, 1998	21			IR, BN, CS
		Conus spurius Gmelin, 1791	3	B	ss	SA, S, RB
	Cypraeidae	*Luria cinerea* Gmelin, 1791	9	B	ab	SA, S, RB
		Macrocypraea zebra Linnaeus, 1758	9	B	ab	SA, S, RB
		Propustularia surinamensis G. Perry, 1811	3	B	ss	IN, N, RB, BQ
	Cystiscidae	*Persicula pulcherrima* Gaskoin, 1849	3	B	ss	SA, S, RB
		Cystiscus sp. Stimpson, 1865	17	B	mg	SA, S, RB
	Drilliidae	*Clathrodrillia albicoma* Dall, 1889	21			SA, S, RB
		Fenimorea kathyae Tippett, 1995	21			SA, S, RB
		Globidrillia smirna Dall, 1881	10	B	ss	SA, S, RB
	Ellobiidae	*Melampus coffea* Linnaeus, 1758	17	B	mg	SA, S, RB
	Epitoniidae	*Cycloscala echinaticosta* d'Orbigny, 1842	3	B	ab, ss	SA, S, RB
		Gyroscala lamellosa Lamarck, 1822	3	B	ab, ss	SA, S, RB
	Fasciolariidae	*Fasciolaria tephrina* de Souza, 2002	2	B	ss	SA, S, RB
		Fasciolaria tulipa Linnaeus, 1758	3	B	ss	RB
		Hemipolygona carinifera Lamarck, 1816	3	B	ss	RB
		Hemipolygona mcgintyi Pilsbry, 1939	18			IN, BR
		Leucozonia leucozonalis Lamarck, 1822	3	B	lr, ss	PSC, SA, S, RB
		Leucozonia nassa Gmelin, 1791	3	B	lr, ss	RB
		Polygona abbotti Snyder, 2003	21			SA, S, RB
		Triplofusus giganteus Kiener, 1840	20	B		CS
	Fissurellidae	*Altrix trifolium* Dall, 1881	11	B	ss	SA
		Diodora cayenensis Lamarck, 1822	9	B	lr	SA, S, RB
		Diodora dysoni Reeve, 1850	3	B	lr	RB
		Diodora listeri d'Orbigny, 1847	3	B	lr	RB
		Diodora minuta Lamarck, 1822	3	B	lr	RB
		Diodora sayi Dall, 1889	3	B	lr	RB
		Diodora viridula Lamarck, 1822	3	B	lr	RB
		Fissurella angusta Gmelin, 1791	3	B	lr	RB
		Fissurella barbadensis Gmelin, 1791	3,9,21	B	lr	SA
		Hemitoma octoradiata Gmelin, 1791	18			IN, N, RB, BQ
		Lucapina sowerbii Sowerby I, 1835	3	B	lr	SA, S, RB
		Lucapina suffusa Reeve, 1850	3	B	lr	SA, S, RB
		Montfortia emarginata Blainville, 1825	3	B	lr	RB
	Haliotidae	*Haliotis pourtalesii* Dall, 1881	21			SA, S, RB

Molluscs

Phylum Mollusca

C	F	S					
Gastropoda	Haminoeidae	*Haminoea cf. antillarum*	d'Orbigny, 1841	17	B	mg	SA, S, RB
		Haminoea spp	Turton & Kingston [in Carrington], 1830	17	D	mg	SA, S, RB
	Harpidae	*Morum oniscus*	Linnaeus, 1767	3	B	ss	C, RB
	Hipponicidae	*Cheilea equestris*	Linnaeus, 1758	18			IN, N, RB, BQ
		Hipponix antiquatus	Linnaeus, 1767	3	B	ss	RB
	Janthinidae	*Janthina globosa*	Swainson, 1822	3	P	ca	SA, S, RB
		Janthina janthina	Linnaeus, 1758	3	P	ca	SA, S, RB
	Litiopidae	*Litiopa melanostroma*	Rang, 1829	21			SA, S, RB
	Littorinidae	*Echinolittorina ziczac*	Gmelin, 1791	9	B	lr	SA, S, RB
		Cenchritis muricatus	Linnaeus, 1758	3	B	lr	RB
		Echinolittorina angustior	Mörch, 1876	3	B	lr	RB
		Echinolittorina dilatata	d'Orbigny, 1842	3	B	lr	RB
		Echinolittorina meleagris	Potiez & Michaud, 1838	3	B	lr	RB
		Echinolittorina tuberculata	Menke, 1828	3	B	lr	RB
		Littoraria angulifera	Lamarck, 1822	3,9,18	B	mg	RB
		Tectarius antonii	Philippi, 1846	3	B	lr	RB
	Lottiidae	*Lottia antillarum*	G. B. Sowerby I, 1834	3	B	lr	RB
	Marginellidae	*Prunum amabile*	Redfield, 1852	1	B	ss	SA, S, RB
		Prunum apicinum	Menke, 1828	3	B	ss	SA, S, RB
		Prunum guttatum	Dillwyn, 1817	18			C, RB
		Prunum labrosum	Redfield, 1870	3	B	ss	SA, S, RB
		Prunum sp.	Herrmannsen, 1852	18			C, RB
		Pugnus serrei	Bavay, 1911	3	B	ss	SA, S, RB
		Volvarina avena	Kiener, 1834	3	B	ss	RB
	Melongenidae	*Melongena melongena*	Linnaeus, 1758	3	B	mg	C, RB
	Mitridae	*Mitra* sp.	Lamarck, 1798	18			IN, N, RB, BQ
		Dibaphimitra florida	Gould, 1856	10	B	ss	IN, N, RB, BQ
		Mitra nodulosa	Gmelin, 1791	3	B	ss	C, RB
	Modulidae	*Modulus modulus*	Linnaeus, 1758	9	B	ss	SA, S, RB
		Modulus sp.	Gray, 1842	18			C, RB
		Trochomodulus carchedonius	Lamarck, 1822	3	B	sm, ss	SA, S, RB
	Muricidae	*Coralliophila erosa*	Röding, 1798	9	B	ab	SA, S, RB
		Murex sp.	Linnaeus, 1758	18			C, RB
		Siratus bessei	Houart, 2000	21			SA, S, RB
		Plicopurpura patula	Linnaeus, 1759	9	B	lr	SA, S, RB
		Stramonita rustica	Lamarck, 1822	9	B	lr	SA, S, RB
		Vasula deltoidea	Lamarck, 1822	9	B	lr	SA, S, RB
	Nassariidae	*Nassarius consensus*	Ravenel, 1861	3	B	ss	SA, S, RB
	Naticidae	*Naticarius canrena*	Linnaeus, 1758	3	B	ss	C, RB
		Polinices hepaticus	Röding, 1798	3	B	ss	SA, S, RB
		Polinices lacteus	Guilding, 1834	3	B	ss	RB
		Sigatica semisulcata	Gray, 1839	3	B	ss	C, S, RB
		Sinum perspectivum	Say, 1831	3	B	ss	C, S, RB
		Tectonatica pusilla	Say, 1822	3	B	ss	IN, N, RB, BQ
	Neritidae	*Nerita fulgurans*	Gmelin, 1791	3	B	lr	RB
		Nerita peloronta	Linnaeus, 1758	3	B	lr	RB
		Nerita tessellata	Gmelin, 1791	3	B	lr	RB
		Nerita versicolor	Gmelin, 1791	3	B	lr	RB
		Neritina virginea	Linnaeus, 1758	3	B	lr	C, RB
		Puperita pupa	Linnaeus, 1767	3	B	lr	SA, S, RB
		Smaragdia viridis	Linnaeus, 1758	3,18	B	sm	C, RB
	Olividae	*Americoliva reticularis*	Lamarck, 1811	9	B	ss	SA, S, RB
		Oliva fulgurator	Röding, 1798	21			SA, S, RB
		Olivella nivea	Gmelin, 1791	3	B	ss	RB
		Olivella petiolita	Duclos, 1844	3	B	ss	SA, S, RB
	Ovulidae	*Cymbovula acicularis*	Lamarck, 1811	3	B	ab	RB
		Cyphoma gibbosum	Linnaeus, 1758	18			C, RB
		Cyphoma mcgintyi	Pilsbry, 1939	3	B	ab	C, RB
		Cyphoma signatum	Pilsbry & McGinty, 1939	3	B	ab	RB
		Simnialena uniplicata	G. B. Sowerby II, 1849	3	B	ab	RB

Interactive table

C	F	S					
Gastropoda	Phasianellidae	*Eulithidium affine*	C. B. Adams, 1850	3	B	sm	RB
		Eulithidium adamsi	Philippi, 1853	17	B	mg	SA, S, RB
		Eulithidium bellum	M. Smith, 1937	3,17	B	sm,mg	SA, S, RB
	Plakobranchidae	*Elysia* sp.	Risso, 1818	18			C, RB
	Planaxidae	*Supplanaxis nucleus*	Bruguière, 1789	3	B	lr	C, RB
	Pleurobranchidae	*Pleurobranchus* sp.	Cuvier, 1804	18			C, RB
	Potamididae	*Cerithideopsis pliculosa*	Menke, 1829	3,17	B	sm,mg	SA, S, RB
	Pseudomelatomidae	*Crassispira dysoni*	Reeve, 1846	18			C, RB
		Crassispira fuscescens	Reeve, 1843	3	B	sm, ss	SA, S, RB
		Hindsiclava tippetti	Petuch, 1987	10	B	ss	IN, N, RB, BQ
		Pilsbryspira albocincta	C. B. Adams, 1845	3	B	ss	SA, S, RB
	Ranellidae	*Charonia variegata*	Lamarck, 1816	9	B	ss	SA, S, RB
	Scissurellidae	*Scissurella garciai*	Geiger,2006	21			SA, S, RB
		Sinezona garciai	Geiger, 2006	7	B	ss	SA, S, RB
	Siliquariidae	*Tenagodus squamatus*	Blainville, 1827	3	B	ab, ss	C, RB
	Skeneidae	*Lodderena ornata*	Olsson & McGinty, 1958	21			SA, S, RB
		Lodderena pulchella	Olsson & McGinty, 1959	21			SA, S, RB
	Solariellidae	*Lamellitrochus inceratus*	Quinn, 1991	21			SA, S, RB
	Strictispiridae	*Strictispira paxillus*	Reeve, 1845	18			C, RB
	Strombidae	*Lobatus raninus*	Gmelin, 1791	3,18,20	B		IR, CS
		Lobatus costatus	Gmelin, 1791	3	B	ss	RB
		Lobatus gallus	Linnaeus, 1758	3	B	ss	RB
		Lobatus gigas	Linnaeus, 1758	9,18,20	B	ss	RB
		Strombus pugilis	Linnaeus, 1758	3	B	ss, mg	SA, S, RB
	Tegulidae	*Tegula fasciata*	Born, 1778	18, 3	B	lr, ss	C, RB
		Cittarium pica	Linnaeus, 1758	9	B	lr	SA, S, RB
		Tegula lividomaculata	C. B. Adams, 1845	3	B	lr	RB
	Tonnidae	*Tonna pennata*	Mörch, 1853	3	B	ss	IN, N, RB, BQ
		Cyclostremiscus sp.	Pilsbry & Olsson, 1945	17	B	mg	SA, S, RB
		Solariorbis sp.	Conrad, 1865	17	B	mg	SA, S, RB
	Triviidae	*Niveria quadripunctata*	J.E. Gray, 1827	3	B	ss	RB
		Pusula pediculus	Linnaeus, 1758	3	B	ss	SA, S, RB
	Turbinellidae	*Fulgurofusus xenismatis*	Harasewych, 1983	21			SA, S, RB
		Turbinella angulata	Lightfoot, 1786	10	B	ss	IN, N, RB, BQ
		Vasum muricatum	Born, 1778	18			SA, S, RB
	Turbinidae	*Astraea* sp.	Röding, 1798	20	B		IR, BA
		Lithopoma caelatum	Gmelin, 1791	3,9,18	B	ab	C, RB
		Lithopoma phoebium	Röding, 1798	3,18,20	B	ss	C, RB
		Lithopoma tectum	Lightfoot, 1786	3,18	B	ss	IN, N, RB, BQ
		Turbo cailletii	P. Fischer & Bernardi, 1856	3,18	B	r,ss	IN, N, RB, BQ
		Lithopoma brevispina	Lamarck, 1822	3	B	ss	RB
	Vermetidae	*Dendropoma corrodens*	d'Orbigny, 1841	3	B	ss	RB
		Petaloconchus sp.	Lea, 1843	9	B	ab	SA, S, RB
		Petaloconchus varians	d'Orbigny, 1839	3	B	lr, ss	RB
	Volutidae	*Voluta polypleura*	Crosse, 1876	15	B	ss	CS
Polyplacophora	Acanthochitonidae	*Choneplax lata*	Guilding, 1829	18			IN, N, RB, BQ
	Chitonidae	*Acanthopleura granulata*	Gmelin, 1791	3	B	lr	RB
		Chiton viridis	Spengler, 1797	6	B		SA, S, RB
		Chiton marmoratus	Gmelin, 1791	3	B	lr	RB
		Chiton tuberculatus	Linnaeus, 1758	3	B	lr	RB
Scaphopoda	Dentaliidae	*Dentalium* sp.	Linnaeus, 1758	9	B	ss	SA, S, RB

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Conservation status

LC

Argonauta argo
Spirula spirula
Conus ceruttii
Conus daucus
Conus flammeacolor
Conus mus
Conus regius
Conus rosalindensis
Conus spurius

VU

Cassis flammea
Cassis madagascariensis
Cassis tuberosa
Propustularia surinamensis
Charonia variegata
Lobatus gigas
Cittarium pica

DD

Tellina magna

SPAW *Lobatus gigas* is included in Annex III of the SPAW Protocol and in Appendix II of the CITES Convention.

BRYOZOANS

Models of extravagant designs

Erika Montoya-Cadavid[1] y Paola Flórez[2]

This fascinating group of invertebrates inhabit the earth since the Cambrian period, over 500 million years ago. Since then, they have adapted and survived to extreme and changing conditions in the history of our planet, including several mass extinctions, sea-level fluctuations, and glacial periods, among others. Bryozoans are found in nearly all aquatic environments; however, they remain little-known to most people. One of the main reasons for this is their diminutive sizes: it is almost certain that non-specialist observers overlook them, and, if they actually notice them, these organisms are likely to be confused with other animals or algae, due to their similar forms. That is why, throughout history, they have been called in many ways, and, although they are just bryozoans for us, they have been given other names in other countries, the most popular being the names used in English, such as moss animals, sea mats or lace corals **(Cadavid & Montoya Florez, 2010; Taylor & Waeschenbach, 2015).**

1 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

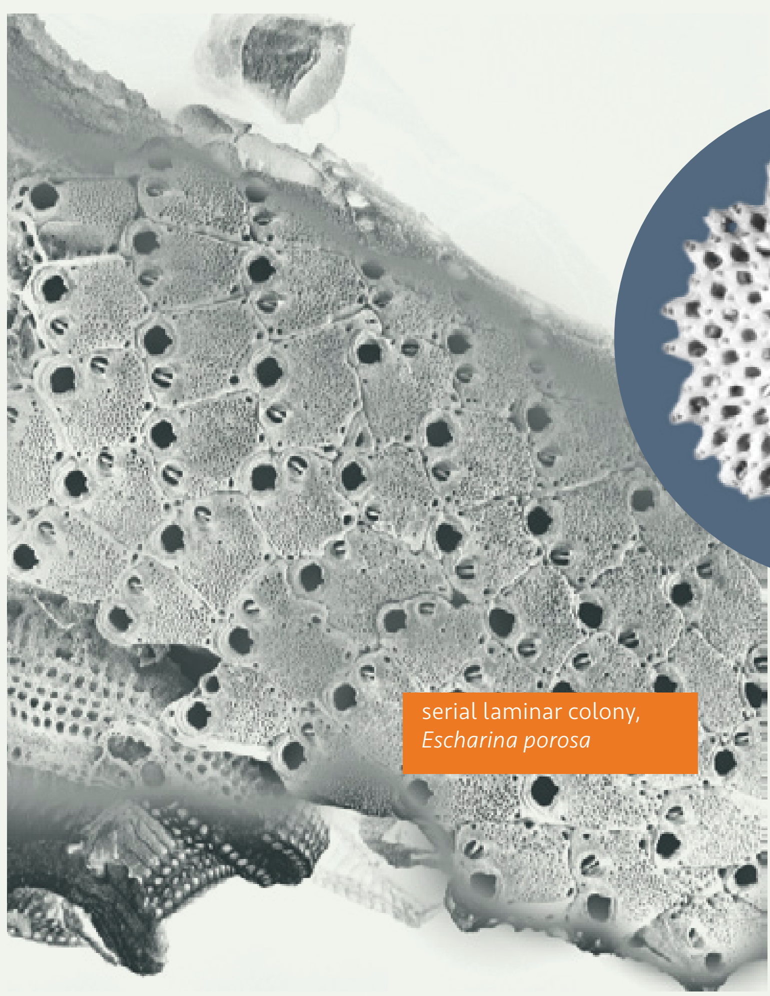
2 Department of Stratigraphy and Paleontology, Universidad de Granada - Spain

Today, there are probably more than 8,000 species

(Bock & Gordon, 2013; Fortunato, 2015), most of them marine, since only a hundred live exclusively in lakes and rivers. They are widely found around the world, from the polar to the tropical regions, and from the tidal zone to abyssal depths of 8,300 meters **(Hayward, 1981)**. Moreover, they will take advantage of any available area for settling and developing their larvae; this is why they are successful colonizers of artificial and natural substrates, even if it comes to other animals: they are known as an important component of epifaunal communities, i.e., communities that live on other organisms.

Phylum Bryozoa individuals do not usually exceed one millimeter in length; however, the ensemble of tens or thousands of them forms colonies that can reach large sizes and, in some cases, build complex three-dimensional structures **(Coccito *et al.*, 2000; Wood *et al.*, 2012)**. By observing a colony in detail, it is possible to distinguish each of the individuals or zooids that are part of it, as a set of calcareous little boxes or tubes that house the animal's soft body, also called polypide. The arrangement of these zooids within colonies is varied, from series of rows to disorganized and arbitrary groups. Most colonies live attached to substrates (sessile), in single or multiple sheets. They may also stand as trees, some of them rigid and others, flexible, with or without joints. In some other groups, there are free-living species, which are able to slowly move through the seabed or float in the water column **(Figure 1)**.

multilaminar
Stephanollona asper



serial laminar colony,
Escharina porosa

free-living colony
Cupuladria sp.

articulated and erect,
Pasythea tulipifera

Figura 1. Different bryozoan growth forms

Anatomically, the group has a feeding structure called lophophore, which consists of a striking crown of ciliated tentacles that generate water currents in order to draw food particles into the mouth, which is located at the base of the crown. They have a characteristic U-shaped digestive tube with the anus outside the crown, which caused the phylum to be called Ectoprocta (ecto: external, outside; procto: anus) for a long time. This differentiates it from the phylum Entoprocta or Kamptozoa, which has the anus within the tentacular crown **(Figure 2)**. The lophophore is apparently similar to the one found in the lamp shells (brachiopods) and horseshoe worms (phoronids), but the bryozoan's lophophore has a different ancestral origin; therefore, these groups are not truly related **(Gordon *et al.*, 2009)**.

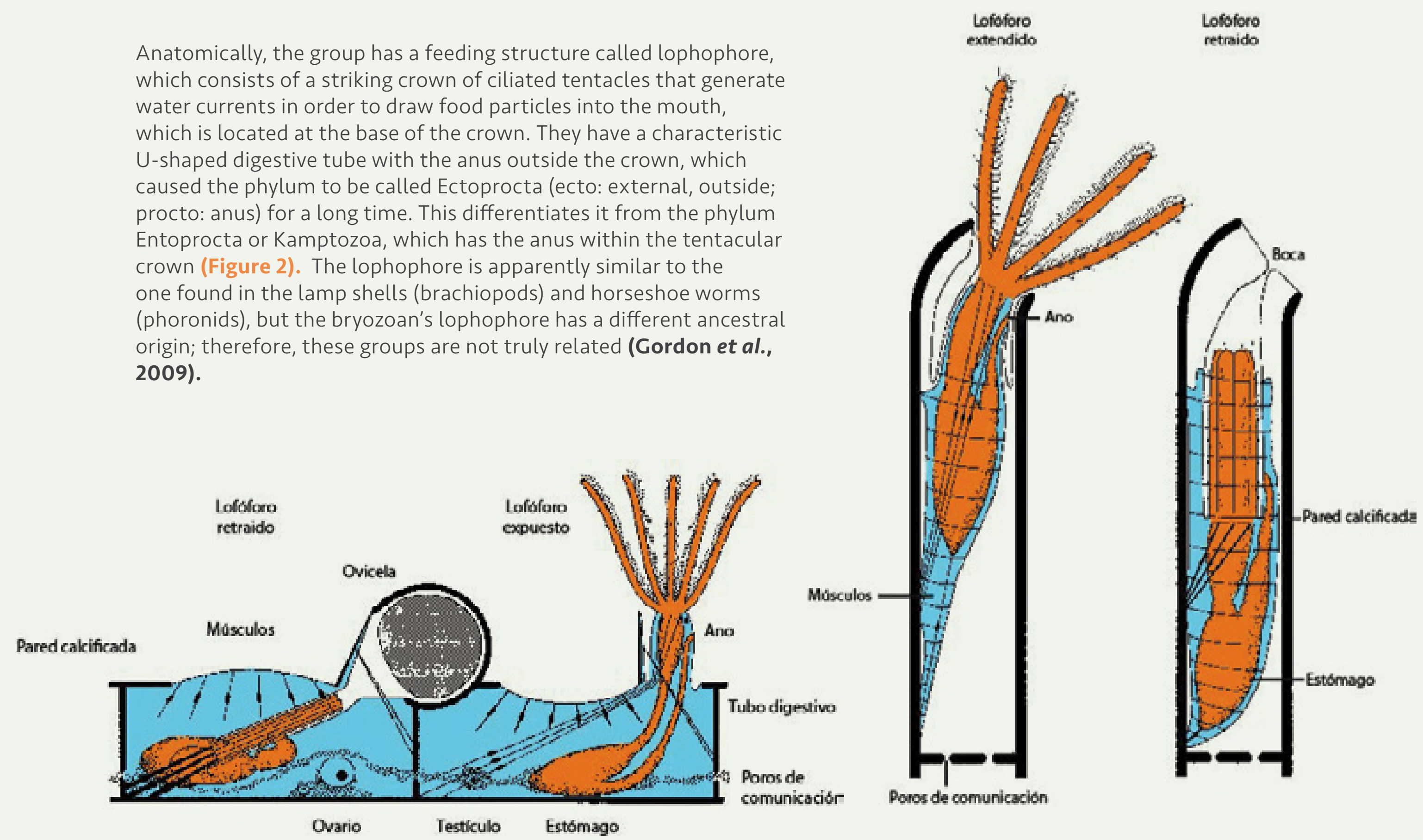


Figure 2. Morphology of a cheilostome bryozoan (left) and a cyclostome bryozoan (right) (Taken and modified from © C. Nielsen).

[Bryozoan organisms are essentially filters since they benefit from small particles and microorganisms, such as bacteria and plankton, taken from the water around them. This way, they contribute to purify the environments they inhabit. They also play another important role in ecological processes since they are part of the first communities settled in a free space, thus, preparing surfaces for other fauna and flora to settle. For this reason, they are known as pioneers in ecological succession.]

A distinctive aspect of these animals is the functional specialization of some individuals within the colony, which, in order to fulfill their task, develop different structures. This is known as polymorphism, and, although it occurs in other groups of colonial animals such as hydroids, this condition is highly developed in bryozoans. Because of this, in a polymorphic colony, it is possible to distinguish feeding zooids from other zooids responsible for reproduction, defense, and transportation, as well as for construction of cavitities for nutrient storage and structures for substrate anchoring. All of them have a variety of extravagant shapes, ornaments, and sizes, which give a unique diversity to species, especially calcareous **(Figure 3)**.

Bryozoans have nervous, digestive and muscular systems, as well as reproductive organs. Besides, they have a combination of characteristics that makes them unique, and, despite advances in research, they remain as one of the most enigmatic groups for those who study evolutionary relationships with other organisms **(Ryland, 1970; McKinney & Jackson, 1989; Nielsen, 2002; Gordon *et al.*, 2009)**.

Figure 3. Diversity of specialized structures in bryozoans (polymorphism).

Moreover, given the calcareous nature of most of their species and their small size, they contribute to the cementation and accretion (growth in mass or volume by aggregation of individuals) in microhabitats and reef ecosystems, by filling and compacting the spaces, as well as consolidating three-dimensional structures that serve as shelter or food to other species; that is, they contribute to biodiversity **(Winston, 1986; Cocito, 2004)**. In addition, due to their fossil record, they serve as stratigraphic and paleoenvironmental (past environment condition) indicators, by recording changes in earth's history. They are also useful in determining the current status of habitats regarding the effects of ocean acidification due to the increase of CO_2 emissions on the planet **(Fortunato, 2015).**

[**Thanks to the progress in research in recent decades, the group has been recognized as an important source of chemicals that can be used as raw material in the manufacture of cosmetics, industrial products (especially paint for boats) and, particularly, antitumor drugs for cancer treatment** (Philip et al., 1993; Kraft, 1993; Kuziriam *et al.*, 2006).]

Classification

The phylum is taxonomically classified into three classes

class Phylactolaemata

which covers freshwater bryozoans and is characterized by not having a calcareous skeleton

class Gymnolaemata

class Stenolaemata

mainly with calcified forms, which, in the case of the gymnolaemata, show complex forms and ornaments that are used for identifying families, genera and species.

[**In Colombia, there are 133 species identified for the Colombian Caribbean** (Flórez *et al.*, 2007; Montoya Cadavid *et al.*, 2007; Montoya Cadavid y Flórez, 2010; Yepes Narváez, 2013; Delgadillo Garzón y Flórez, 2015)]

which represent about 40% of those estimated for the Tropical Western Atlantic. For the Seaflower Biosphere Reserve, no survey of the group has been made, and known records so far are the result of two specific works: a characterization of the deep seafloor, held in the Joint Regime Area (ARC) between Colombia and Jamaica **(INVEMAR-ANH, 2012)**, and a quick ecological assessment conducted at the Old Point Regional Natural Park in San Andrés Island **(Mejía Ladino *et al.*, 2008).**

Based on these studies, a total of 38 records, classified into 12 species of cheilostome and cyclestome bryozoans, were collected. Although most of them are not fully identified, data indicate that, at least, five of these species could be the first reports for the country, and need to be studied in greater detail to determine their identity. Among the species that are the first reports for the country are: *Gemellipora* sp., *Cellaria* sp., *Lepralielloidea* sp., *Cheilostomata* sp. 1, *Cheilostomata* sp. 4 y *Cheilostomata* sp. 5. Otras especies, como *Parellisina curvirostris*, *Jellyella tuberculata* y *Trematooecia* cf. *turrita* **(Figura 4)**, had been already found in the Colombian Caribbean **(Flórez *et al.*, 2007; Montoya Cadavid *et al.*, 2007)**, but their record in this area represents a larger geographic and bathymetric distribution.

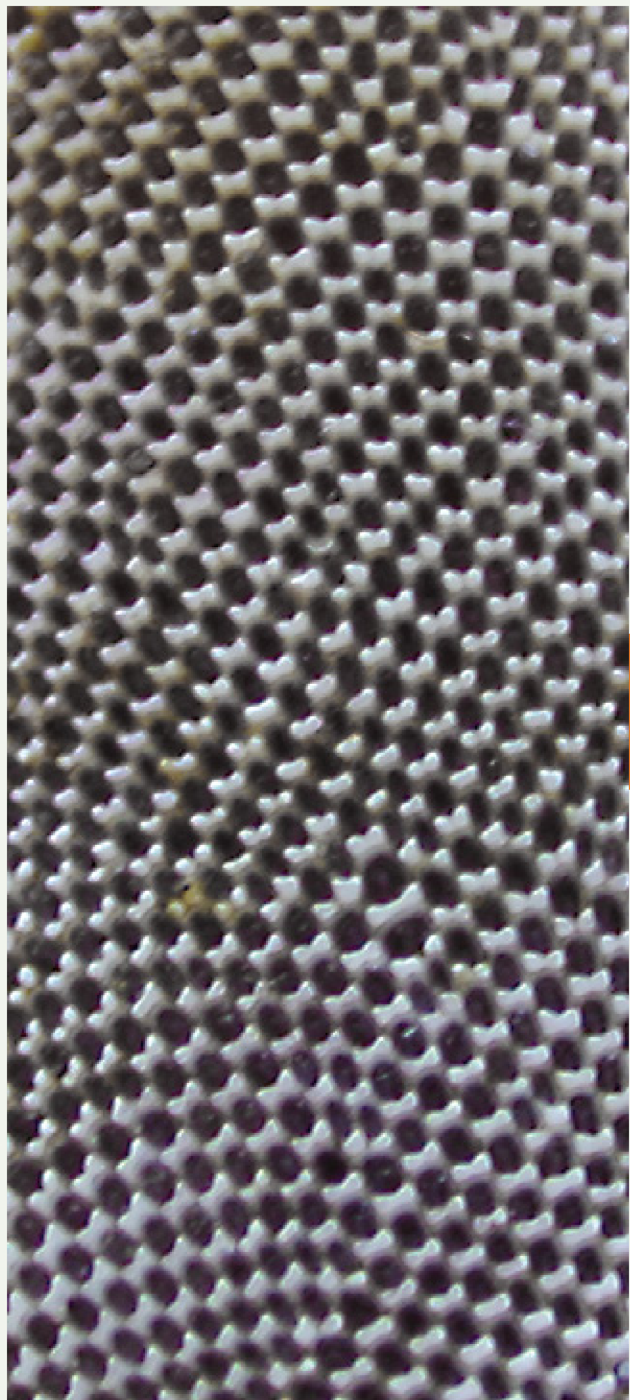


Figure 4. *Jellyella tuberculata* colony colonizing a leaf of Sargassum sp., found in Old Point Regional Park in San Andrés Island (left). *Trematooecia turrita*, colony colonizing an agglomerate of algae and rubble in Serranilla bank (ARC between Colombia and Jamaica) (right).

Although, exploration of bryozoans in the reserve has been limited so far, it is a target region with great potential for studies aimed at assessing biodiversity of bryozoans, not only of current fauna related to rich marine ecosystems found in the islands, such as coral reefs, seagrass beds, rocky littorals, and mangrove roots underwater, but also during exploration and characterization of fossil reef outcrops. This would help to know and understand evolutionary processes of this interesting group of organisms in the Caribbean.

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Bryozoans

Phylum Bryozoa

C	O	Sf	F	S			
Gymnolaemata	Cheilostomatida	Calloporoidea	Calloporidae	*Parellisina curvirostris*	(Hincks, 1862)	1	ARC
		Cellaroidea	Cellariidae	*Cellaria sp.*		1	ARC
		Cribrilinoidea	Cribrilinidae	*Puellina sp.*		1	ARC
		Hippothoidea	Pasytheidae	*Gemellipora sp.*		1	ARC
		Membraniporoidea	Membraniporidae	*Jellyella tuberculata*	(Bosc, 1802)	1,2	SA, ARC
		Lepralielloidea				1	ARC
		Celleporoidea	Colatooeciidae	*Trematooecia cf. turrita*		1	ARC
Stenolaemata	Cyclostomatida		Tubuliporidae	*Tubulipora sp.*		1	ARC

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Interactive table

Biodiversity OF THE SEVEN colors sea

ECHINODERMS

Innovative invertebrates

Giomar H. Borrero-Pérez[1], Christian M. Díaz-Sánchez[2] y Milena Benavides-Serrato[3]

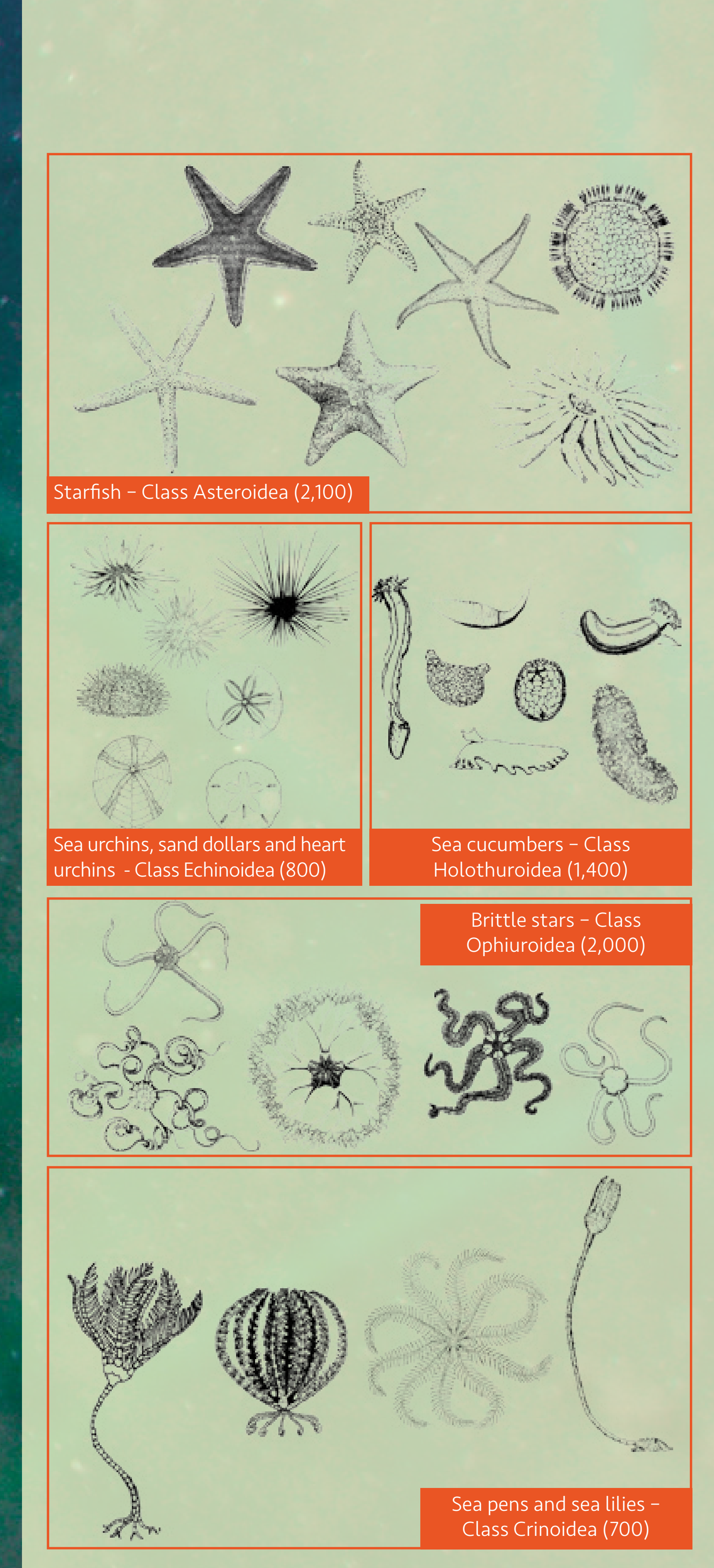


Figure 1. We currently live with at least 6,950 species belonging to five groups or classes: sea lilies and sea pens (class Crinoidea, 700 species); starfish (class Asteroidea, 2,100 species); brittle stars and basket stars (class Ophiuroidea, 2,000 species); sea urchins, heart urchins and sand dollar or sea cookies (class Echinoidea, 800 species); and sea cucumbers (class Holothuroidea, 1,400 species) **(Pawson, 2007)**. * As for sea daisies, discovered in 1986 and considered a sixth class of echinoderms (class Concentricycloidea), it is now known that they belong to the group of starfish **(Janies *et al.*, 2011).**

1 **José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)**

2 **Colombian Ocean Commission (CCO)**

3 **Universidad Nacional de Colombia**

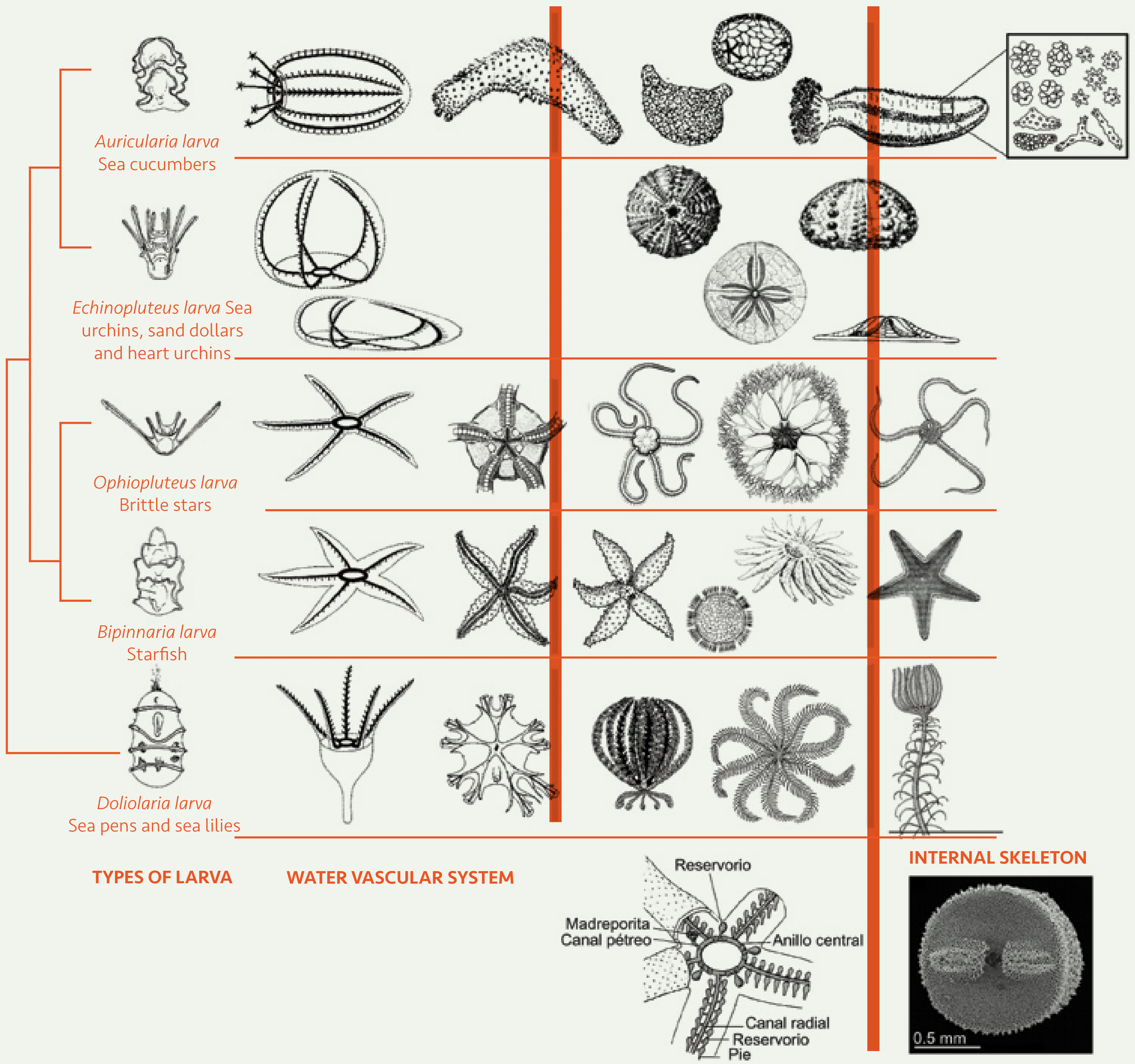


Figure 2. Class variation of morphological characteristics that distinguish an echinoderm, organized within the context of their evolutionary relationships. From left to right:

A the most accepted theory regarding echinoderms relationships, which places sea pens and lilies as relatives of the rest, starfish being closer to brittle stars, and sea urchins, to sea cucumbers **(Telford *et al.*, 2015)**

B Typical larvae of each class in which bilateral symmetry is observed before becoming adults with pentaradial symmetry

C in these schemes, the aquifer vascular system and its modifications in each class is also detailed, with its general morphology in the bottom diagram. In this part of the figure, variations that can occur in symmetry and changes in body shape following the position of mouth and anus are also shown

D Finally, ossicle shape and organization in each of the classes are shown; the lower photograph shows the internal structure of an ossicle, which is similar to a mesh with pores filled with fibers and dermal cells in living organisms.

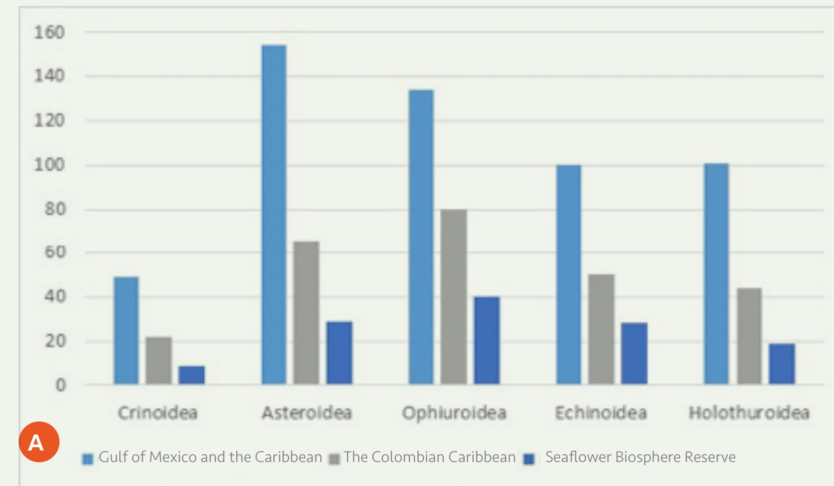
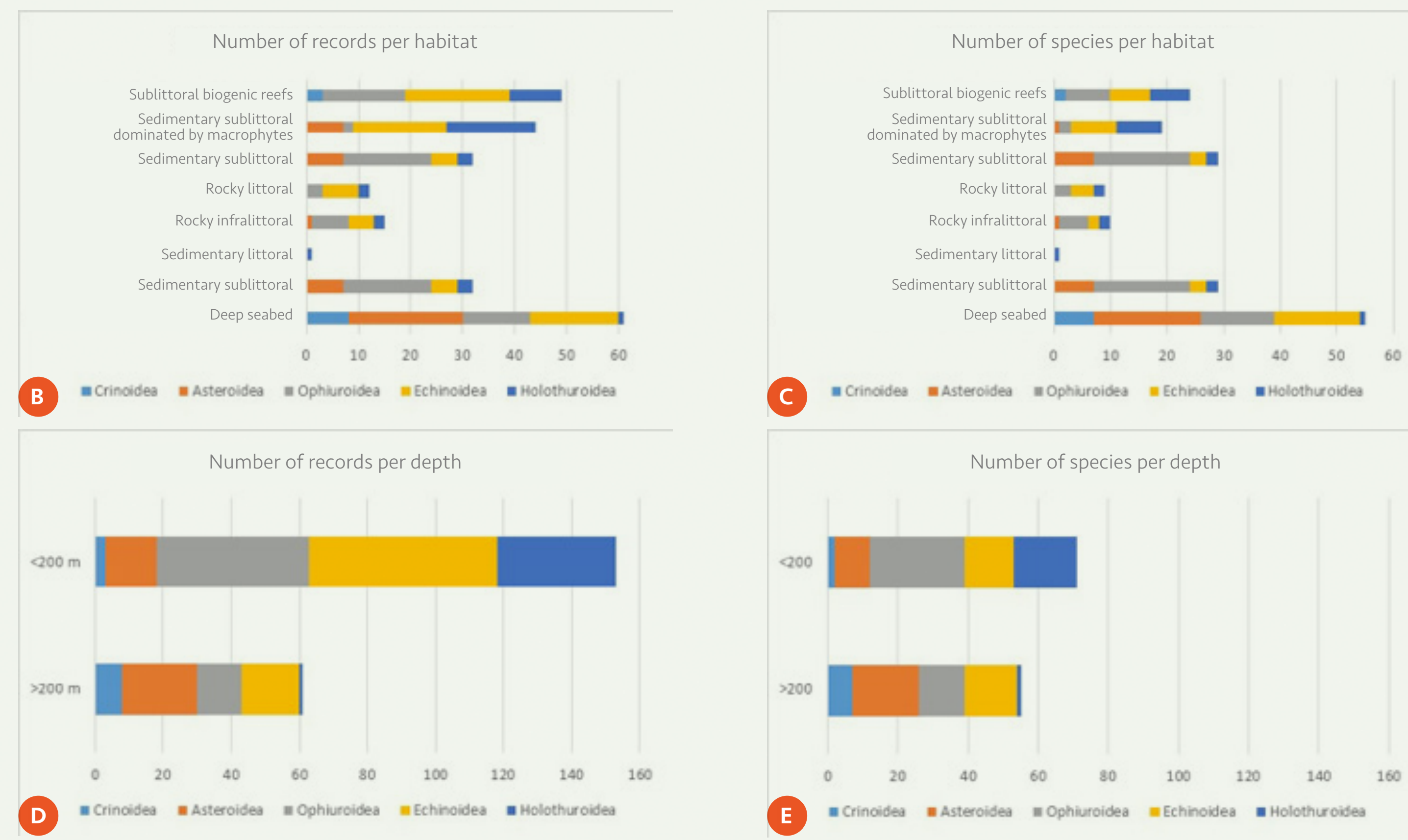


Figure 3. Number of species of echinoderms in the Seaflower Biosphere Reserve: **A)** the Colombian Caribbean and the Caribbean Sea - Gulf of Mexico **B)** number of records and **C)** of species per habitat. **D)** number of records and **E)** of species in depth intervals ranging from 0 to 200 m and >200 m



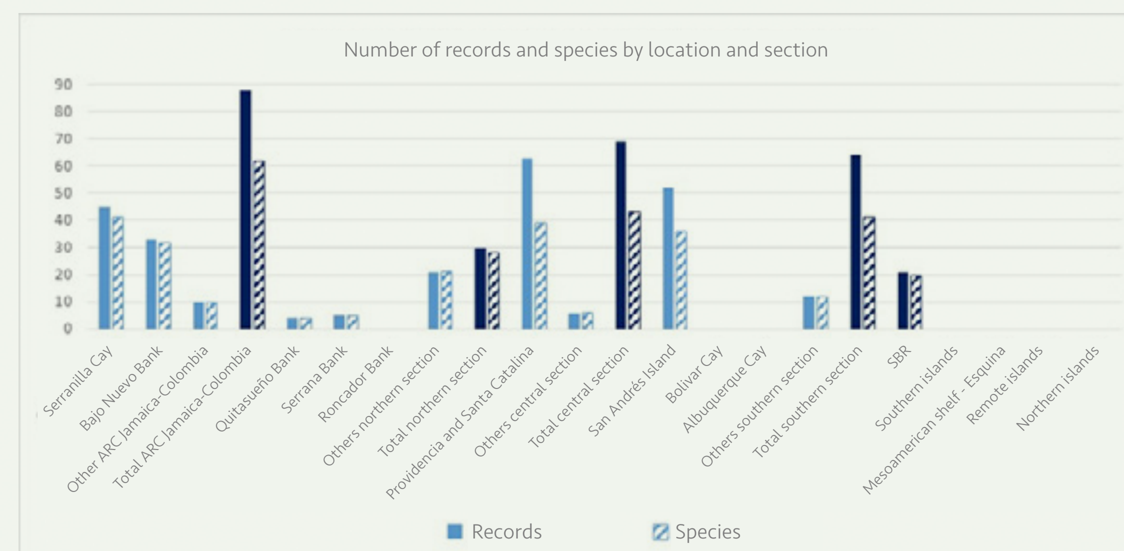
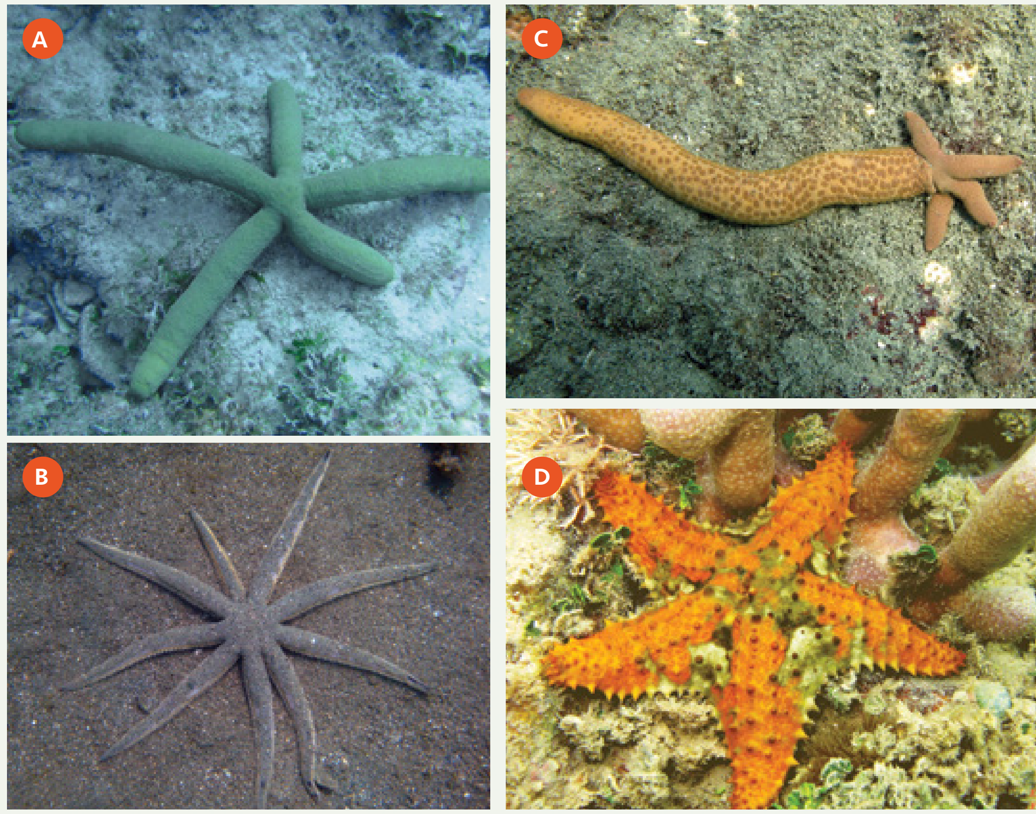


Figure 4. Number of records and species by location and by defined section in the Seaflower Biosphere Reserve.



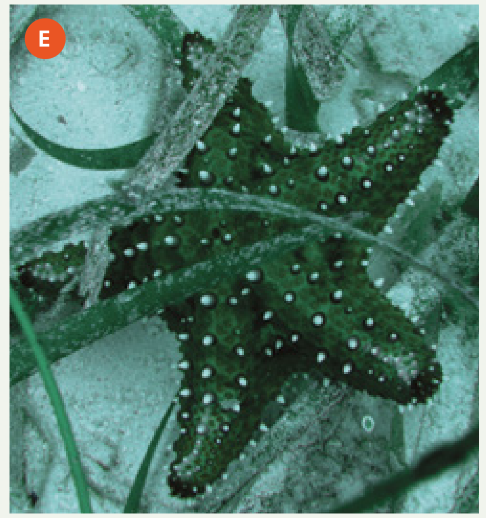


Figure 5. Starfish commonly found in the Seaflower Biosphere Reserve:: **A)** Linckia guildingi. **B)** Linckia guildingi,regenerating its body from an arm. **C)** Luidia senegalensis. **D)** Oreaster reticulatus. **E)** Juvenile Oreaster reticulatus (Photographs: A. y E. Archivo CORALINA; B. Sven Zea; C. María Eugenia Oviedo; D. Ernesto Mancera).

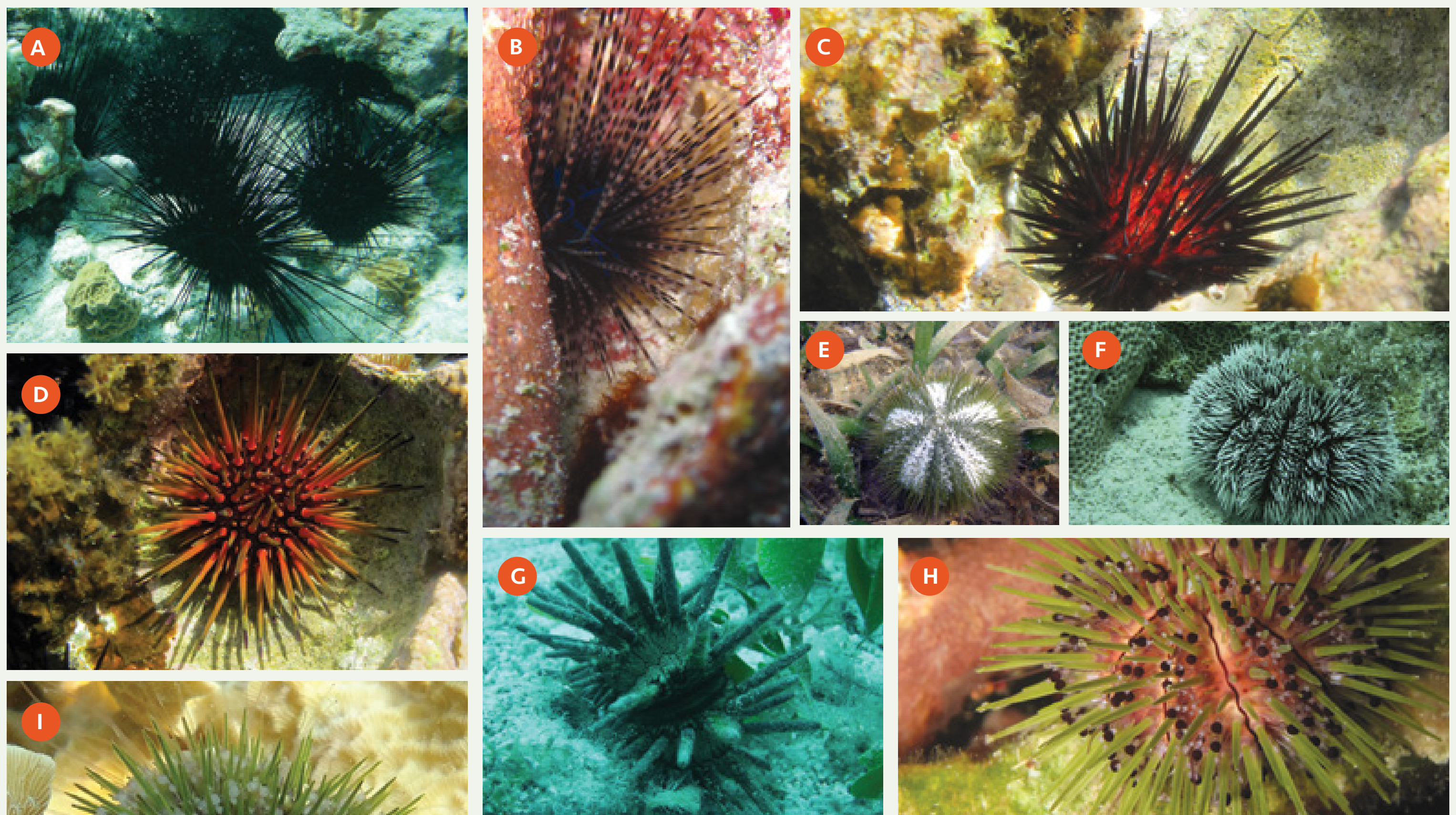


Figure 6. Regular urchins commonly found in the Seaflower Biosphere Reserve: **A)** *Diadema antillarum*; **B)** Juvenile *Diadema antillarum*; **C)** *Echinometra lucunter*; **D)** *Echinometra viridis*; **E)** *Lytechinus variegatus variegatus*; **F)** *Tripneustes ventricosus*; **G)** *Eucidaris tribuloides*; **H)** and **I)** *Lytechinus williamsi* in its two colors; **J)** Juvenile *Tripneustes ventricosus*.

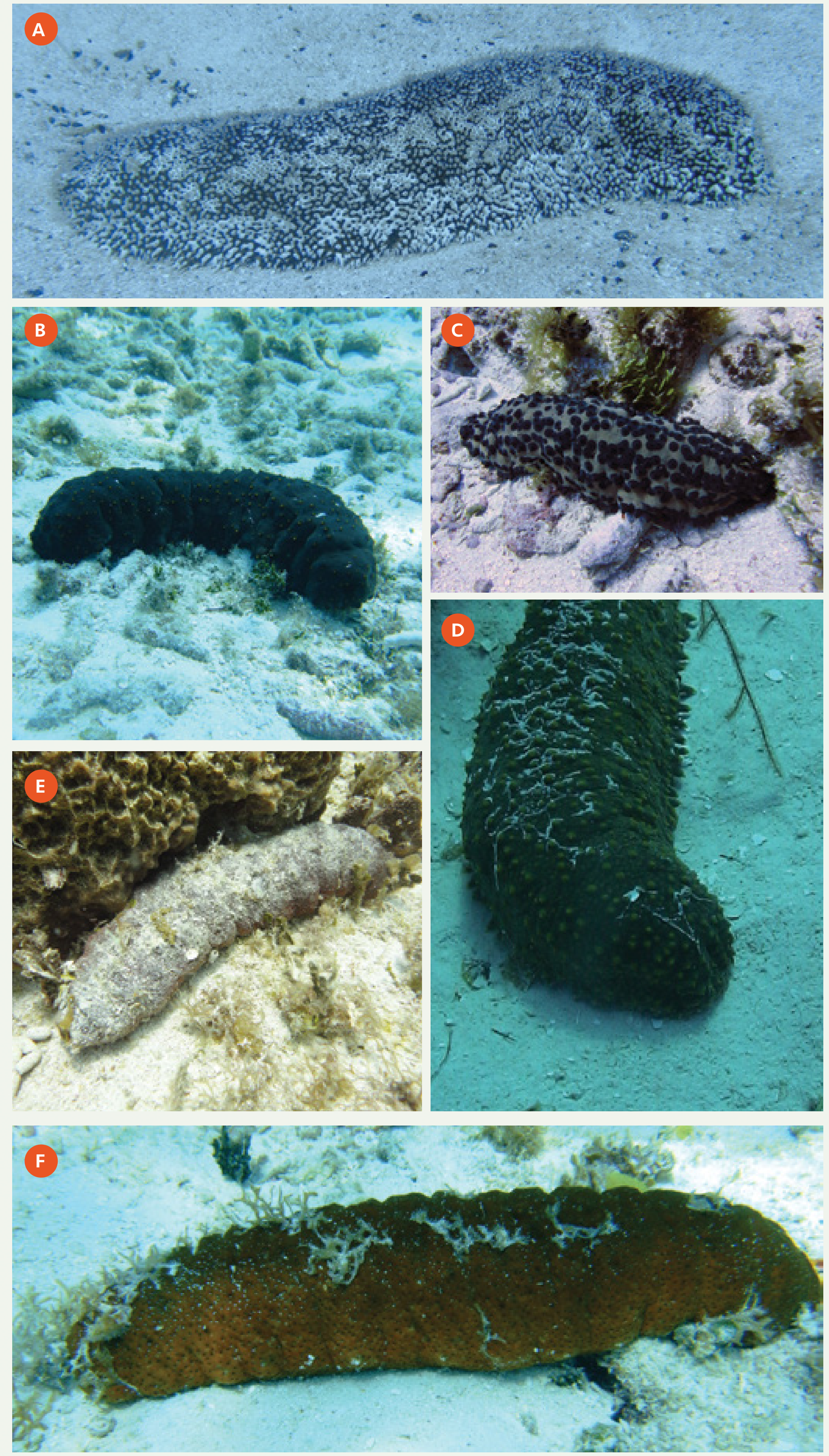


Figure 7. Sea cucumbers commonly found in the Seaflower Biosphere Reserve: **A.** *Astichopus multifidus*. **B., C., D.**, *Isostichopus badionotus* in its three most common colors. **E.** and **F.**, *Holothuria (Halodeima) mexicana*, uncovered and completely covered with sand, respectively.

Echinoderms are a group of invertebrates that stand out, not only for its diversity, beauty, and colors, but also for their morphological and biological characteristics, which represent innovation and particularities in animal evolution. Among the most representative and well-known echinoderms are starfish (class Asteroidea) and sea urchins (class Echinoidea), which are outstanding, primarily, because of their shape and because they are very noticeable organisms in shallow waters **(Figure 1)**. However, there are other groups or classes of echinoderms imperceptible to the human eye due to their small sizes and shapes and to the fact that they live hidden under living organisms or inert objects in the sea and, even, inhabit deep waters where there is no sunlight. Among these, besides starfish and sea urchins, there are sea lilies or pens (class Crinoidea), ophiuroids or brittle stars (class Ophiuroidea) and sea cucumbers (class Holothuroidea).

Currently, our oceans worldwide have, at least, 6,950 species of echinoderms *(Figure 1)* and at least 125 species live in the shallow and deep marine environments of the Seaflower Biosphere Reserve.

Innovative and specialized invertebrates

fossils from 600 million years ago

Although the shape of some echinoderms is very different if we compare, for example, a starfish with a sea cucumber, they also have unique characteristics that identify them as echinoderms and that alone distinguish them from other animal groups. These characteristics include the presence of an internal skeleton consisting of calcium carbonate, the shape of the body divided into five equal parts when they reach adulthood, a system of interconnected canals or tubes known as water vascular system, and a kind of tissue with special features called mutable collagenous tissue **(Ax, 2003; Wilkie, com. pers. 2011).**). Each echinoderm is a variation of these characteristics and such variation is what defines the five existing classes, through which the evolutionary history of this group of invertebrates can be observed **(Figure 2).**

All current echinoderms, and even fossil echinoderms **(Zamora y Rahman, 2014),** have an internal skeleton formed within the skin and typically covered by a delicate epidermis containing thousands of neurosensory cells. This endoskeleton of calcium carbonate is organized into individual mobile or fixed parts known as ossicles, and other structures such as pedicellariae and spines. These structures gave birth to the name Echinodermata, which means skin with spines ***(from Greek echinos: spines, and derma: skin)***. Thanks to this kind of skeleton, echinoderms have a very complete fossil record and scientists could discover that it is a very ancient group, with fossils from 600 million years ago (Early Cambrian) and more than 13,000 extinct species **(Pawson, 2007).**

Ossicles can be very small (microscopic) and be immersed in the skin, as in sea cucumbers; or they can be very large and have the shape of vertebrae or plates articulated or fused together, as in sea pens, starfish, brittle stars and sea urchins **(Figure 2)**. Connection among ossicles is possible thanks to muscles and/or ligaments that regulate the rigidity of the body wall and control the movement of the body and its accessory structures (spines and pedicellariae). The mutable collagenous tissue is involved in these processes and it is responsible for the extreme rigidity or the fluidity and relaxation that any echinoderm can adopt in seconds, either by its entire body or over specific structures **(Wilkie, 2001, 2005; Wilkie *et al.*, 2004).**

Another characteristic that differentiates the current echinoderms, although it is not present in some fossil echinoderms **(Zamora y Rahman, 2014)**,), is the secondary pentaradial symmetry, which is evident in most starfish and brittle stars, since they have five arms **(Figure 2)**. However, although this pattern is not as clear in sea pens, sea lilies, sea urchins and sea cucumbers, a detailed observation of the body, either external or internal, can confirm such symmetry. Sea cucumbers and some urchins, called heart urchins and sand dollars, have also developed a bilateral symmetry superimposed on the radial symmetry. Despite their adult form, echinoderms are actually bilateral organisms because, during the larva stage, their body is divided into two equal parts on each side of an anteroposterior axis **(Figure 2).**

The great ability to regenerate parts of their body allows echinoderms to avoid predation, among other conditions.

The pentaradial symmetry defines the organization of muscles and internal systems, including the water vascular system, which is a hydraulic system consisting of a central disc from which five canals are derived and go to the arms **(Figure 2)**. Water enters through the madreporite, a plate on the surface of the animal that can be considered as a sieve; then it flows through the calcareous canal toward the central disc and reaches the five radial canals, where external ambulacral feet are generated. In some cases, the madreporite is internal, so the system is full of coelomic fluid. The system works by contraction and relaxation of internal reservoirs located around the central disc and at the base of each of the thousands ambulacral feet. Thus, feet extend or contract in a concerted manner and under the control of the nervous system, to develop sensory, locomotive, adhesive, breathing and feeding functions or a combination of them, depending on each group or species and their habits **(Figure 2)**.

Most of the aforementioned characteristics place echinoderms as the closest invertebrates to chordates, which are higher animals in the evolutionary tree of life and include mammals and, therefore, humans. In addition, echinoderms, unlike other invertebrates such as molluscs, annelids and arthropods, belong to a group called Deuterostomia, a name that expresses the method of embryonic development typical of higher animals, especially vertebrates. This feature, as well as the presence of an internal skeleton, constitute two key evolutionary advances in animals that make their first appearance in echinoderms.

The singularity of echinoderms increases when considering other special or peculiar characteristics that, unlike the previous ones, seem to group them with organisms in the lowest part of the animal evolution, such as sponges, corals and hydrozoans. Some of these characteristics are: a) the pentaradial symmetry of adults; b) the absence of head, brain, heart, eyes and other organs of the external senses; c) the ability to regenerate tissues and organs; d) sexual reproduction with external fertilization, usually with separate sexes, although difficult to distinguish based on the external morphology; and e) the absence of specialized organs that allow the interaction of their body fluids with seawater, a feature that restricts them to the marine environment.

The great ability to regenerate parts of their body allows echinoderms to avoid predation, among other conditions. Sea pens, starfish, brittle stars and sea urchins regenerate within a few weeks or months any part of their bodies, including spines and part of the test of sand dollars **(Figura 5 - B)**. Additionally, some echinoderms have the ability to voluntarily release any part of their body to escape from an attack, either an arm in the case of brittle stars, or the intestine and its associated organs in the case of sea cucumbers. For some species of starfish, brittle stars and sea cucumbers, this regenerative capacity is also used as a way of asexual reproduction. In this process, an individual is divided into two or more parts and each part becomes a perfect adult. That is the case of several species of brittle stars belonging to the genus Ophiactis, including *Ophiactis savignyi* **(Hendler *et al.*, 1995)** which lives in shallow environments of the Seaflower Biosphere Reserve.

However, echinoderms reproduce mainly by sexual means, that is, the female egg is fertilized by the sperm. In most cases, gametes are released into the sea, where fertilization takes place. After fertilization, a free-living larva appears and can stay in the plankton during several days or weeks, until it settles on the seabed. Each class of echinoderms presents a different type of larva and, in many cases, the characteristics of larvae make possible the identification of families, genera and species **(Figure 2).**

Although it is not common, some species of echinoderms may be hermaphrodites (they can reproduce by self-fertilization) or viviparous (after fertilization, embryos develop within the womb of the individual). In marine environments such as sedimentary bottoms and seagrass beds of the Seaflower Biosphere Reserve, two species present this type of reproduction: *Amphipholis squamata* and *Synaptula hydriformis*, **(Figure 8-G)** **(Hendler *et al.*, 1995).**

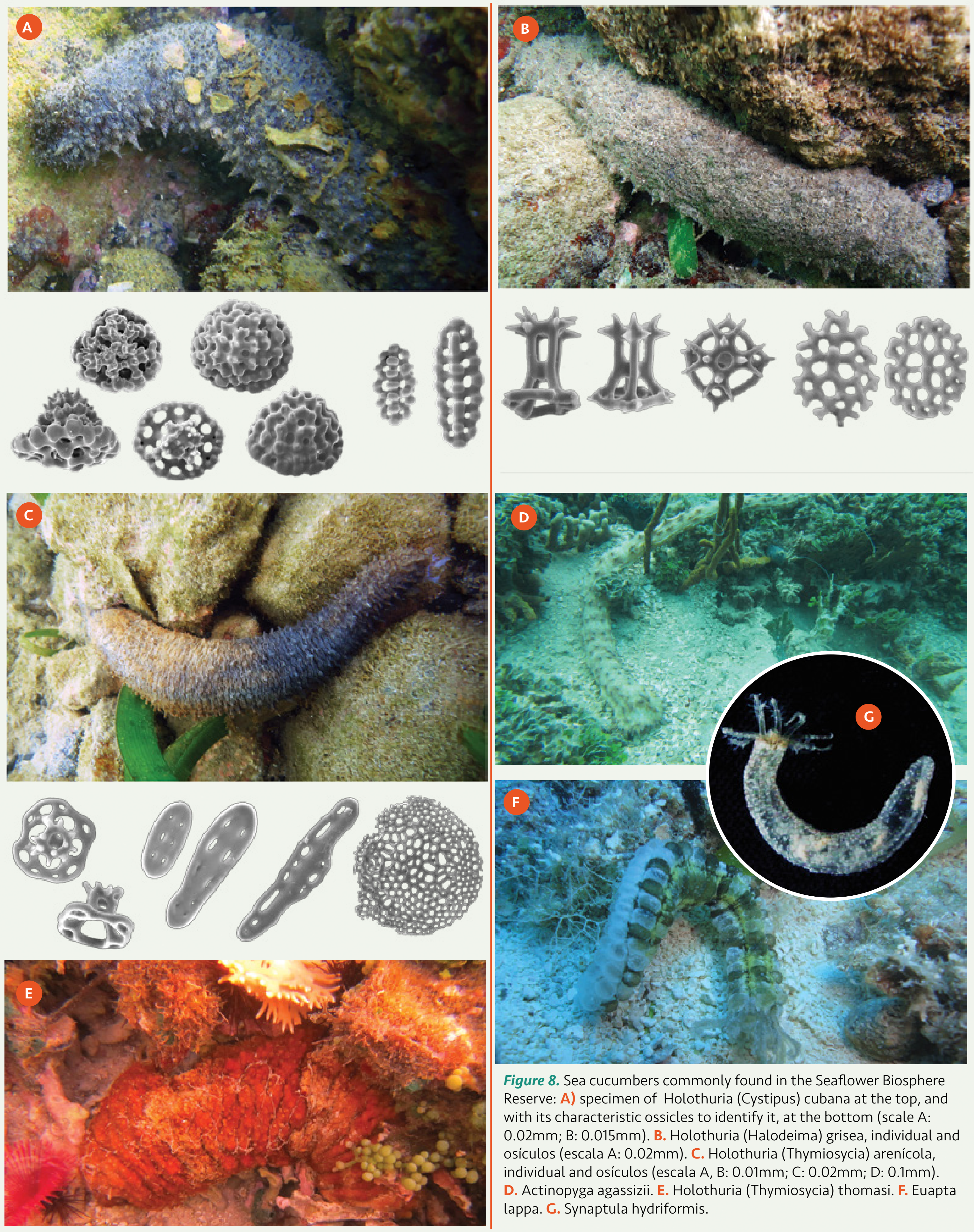
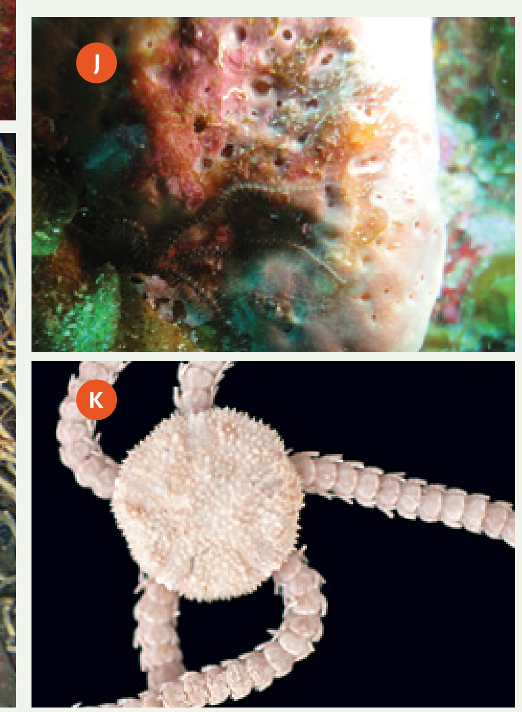


Figure 8. Sea cucumbers commonly found in the Seaflower Biosphere Reserve: **A)** specimen of Holothuria (Cystipus) cubana at the top, and with its characteristic ossicles to identify it, at the bottom (scale A: 0.02mm; B: 0.015mm). **B.** Holothuria (Halodeima) grisea, individual and osículos (escala A: 0.02mm). **C.** Holothuria (Thymiosycia) arenícola, individual and osículos (escala A, B: 0.01mm; C: 0.02mm; D: 0.1mm). **D.** Actinopyga agassizii. **E.** Holothuria (Thymiosycia) thomasi. **F.** Euapta lappa. **G.** Synaptula hydriformis.

Figure 9. Brittle stars commonly found in the Seaflower Biosphere Reserve. **A.** *Ophioderma brevicauda*; **B.** *Ophiothrix (Acanthophiothrix) suensoni*; **C.** *Ophiocoma echinata*; **D.** *Astrophyton muricatum* with arms folded; **E.** *Ophioderma rubicunda*; **F.** *Ophiocoma pumila*; **G.** *Ophiothrix (Ophiothrix) oerstedii*; **H.** *Ophiocoma wendtii*; **I.** *Astrophyton muricatum* with arms extended overnight; **J.** *Ophiothrix (Ophiothrix) oerstedii*; **K.** *Ophiostigma isocanthum* (Photo: Erika Ortiz; Archivo CORALINA; Ernesto Mancera; Archivo ARCJamaicaSomero; Luis Amaro, Erika Ortiz, Jair Mendoza; l. Natalia Arbeláez).



Making a difference in ecosystems

Diadema antillarum

Echinoderms could be considered true micro-ecosystems, since they host a great variety of symbionts that can be found in different parts of their body, such as fish, crustaceans, polychaetes, molluscs, among others. Similarly, populations of some echinoderms have demonstrated that they can make significant differences in the health and conservation of important ecosystems such as coral reefs.

One of the best known cases of imbalance in ecosystems due to the presence or absence of an echinoderm is what happened in the Caribbean Sea with the herbivorous urchin *Diadema antillarum* (Figure 6). Because of a mass mortality of this species in 1983, an increase of algal biomass occurred and caused the dead of the corals. In Colombia, the absence or decrease of its populations was detected in coral areas and, although for 2000 a substantial recovery was appreciated in many places **(Díaz *et al.*, 2000)**, lthe lack of information on the populations of the species and its importance led to its inclusion in the red book of marine invertebrates of Colombia, in the category of Data Deficient **(Benavides Serrato *et al.*, 2002)**. Recent reviews show that the density of the populations of *D. antillarum*, ein the Caribbean Sea is about 12% of what it was before the mortality (Lessios, 2015). It is currently included in the monitoring processes carried out by the Monitoring System for the Coral Reefs of Colombia (SIMAC) in the Colombian Caribbean and, specifically, in the Seaflower Biosphere Reserve **(Abril Howard *et al.*, 2012)**.

An opposite but equally critical situation occurred in the eastern Atlantic with Diadema africanum, classified in 2013 as a different species from *D. antillarum* **(Rodríguez *et al.*, 2013)**. In this case, the populations of *D. africanum* increased significantly, probably due to the overexploitation of their predator fish; therefore, it devastated the vegetation of the littorals of the Canary Islands, contributing to the growth of areas compared to deserts, known as barren grounds. **(Tuya *et al.*, 2004; Wangesteen, 2010).** In addition, regular sea urchins that inhabit the reefs and graze on the substrate looking for food or shelter can have a high impact, since they erode the rocks and produce sediment, modifying the structure of the reefs **(Bak, 1994; Hendler *et al.*, 1995; Brown Saracino *et al.*, 2007)**.

The importance of echinoderms on the ecosystem is often underestimated, as in the case of sea cucumbers, mainly of the group Aspidochirotida (Figures 7 and 8). These cucumbers feed on the organic matter deposited in the sediment and, as a result, they clean and oxygenate the marine sediment. The negative effect of the absence of these organisms in the ecosystem has been recently demonstrated through experiments, in this specific case, in seagrasses

Of interest to humans

Besides the interest in echinoderms as key species in the ecosystem dynamics and, therefore, in its conservation, human beings have other interests in these invertebrates. Currently, some characteristics of echinoderms, such as the composition and functioning of their skeleton and spines, are motivating some researches to apply this information to engineering designs **(Tsafnat *et al.*, 2012).**). Similarly, as an interest for the cosmetic industry, the genes that control the quick hardening or softening of the mutable collagenous tissue have been studied in the body wall of sea urchins and cucumbers, as this information could lead to new ways to keep a young skin **(Elphick, 2012; Rowe y Elphick, 2012).**

As an interesting fact, gonads of regular sea urchins are consumed in several countries. Currently, an intense fishing activity is being carried out on some species, as in the case of *Paracentrotus lividus* on the coasts of Europe. This species is even starting to be cultivated **(Segovia Viadero *et al.*, 2016)**. In the Caribbean Sea, this interest has focused—so far on a small scale—on the species *Lytechinus variegatus variegatus*, known as green sea urchin (Figure 6) **(Domínguez *et al.*, 2007).**

Furthermore, there is a growing interest in sea cucumbers for human consumption, mainly those belonging to the order Aspidochirotida (Figures 7 and 8).These cucumbers have been used traditionally in Asian countries; however, due to the high demand and problems of conservation of the species in the region, the cucumber fishery is currently developed worldwide in an illegal and uncontrolled way, overexploiting natural populations **(Toral Granda *et al.*, 2008).** Several species of this order are commercially relevant **(Purcell *et al.*, 2012)**, and most are included in the list of threatened species of the International Union for Conservation of Nature (IUCN) in the category of Least Concern ***(www.iucnrelist.org)***.

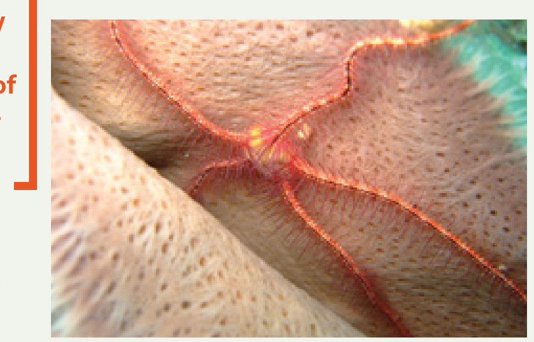
Echinoderms of the Seaflower Biosphere Reserve | Figures and implications

Although marine organisms, and in this case echinoderms, do not understand about borders or boundaries between regions and countries, one of the basic activities to get to know a group and its state of knowledge is to develop inventories or lists of species. Through these instruments, the presence of a species in a particular locality is recorded, thus contributing to the study of the species, to the assessment of the biodiversity at global, national and regional levels, and to the generation of critical information for other disciplines such as ecology, biogeography, evolutionary biology, among others **(Sites y Marshall, 2003; Dayrat, 2005).**

An inventory is more reliable when it has physical evidence of each species. This means that when a researcher wants to know or confirm a species in a given area, they can do it through the material deposited in biological collections. This evidence is fundamental in taxonomy because it makes possible to standardize criteria for identification, especially of species or groups with variable characteristics, and where there are doubts about the identity of the species. In this regard,

77% of the species included in this inventory have specimens deposited in the Museum of Natural Marine History of Colombia-INVEMAR (MHNMC-INVEMAR) or in the National Museum of Natural History-Smithsonian (NMNH-Smithsonian).

Among the species without physical evidence, there are some common species that are usually easy to identify, such as *Astrophyton muricatum* (Figure 9), *Ophiothrix (Acanthophiothrix) suensoni* (Figure 9) and *Diadema antillarum* (Figure 6), among others. However, for all species of the family Amphiuridae (one of the most complicated groups of echinoderms in terms of taxonomy), recorded mostly by Vélez (2003), the pictures included in that work are the only evidence, since no specimens from the reserve were deposited in any collection.



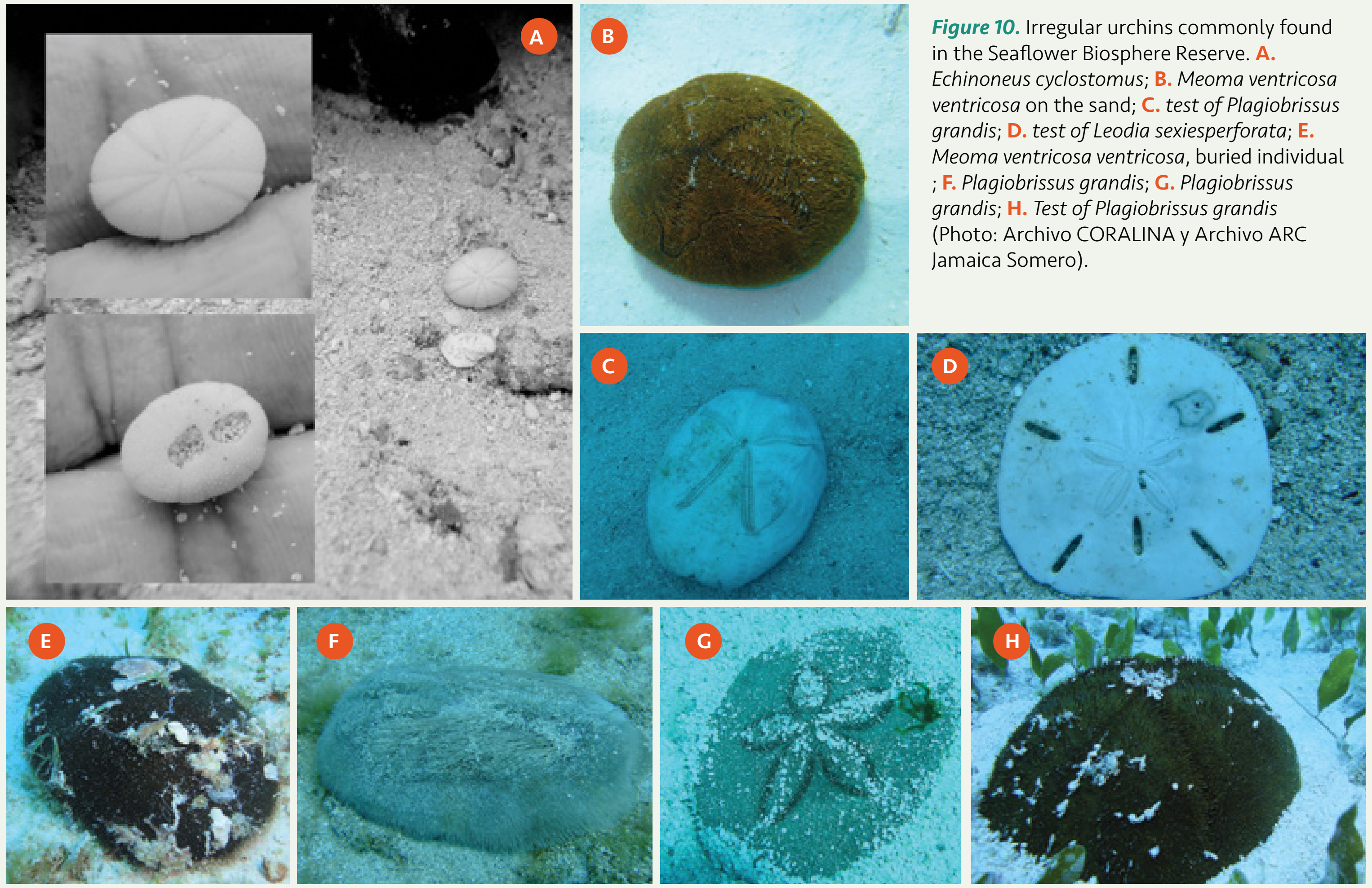


Figure 10. Irregular urchins commonly found in the Seaflower Biosphere Reserve. **A.** *Echinoneus cyclostomus*; **B.** *Meoma ventricosa ventricosa* on the sand; **C.** *test of Plagiobrissus grandis*; **D.** *test of Leodia sexiesperforata*; **E.** *Meoma ventricosa ventricosa*, buried individual ; **F.** *Plagiobrissus grandis*; **G.** *Plagiobrissus grandis*; **H.** *Test of Plagiobrissus grandis* (Photo: Archivo CORALINA y Archivo ARC Jamaica Somero).

Figura 11. Shallow-water crinoids found in the Seaflower Biosphere Reserve: **A.** *Davidaster rubiginosus*. **B.** *Davidaster* sp.

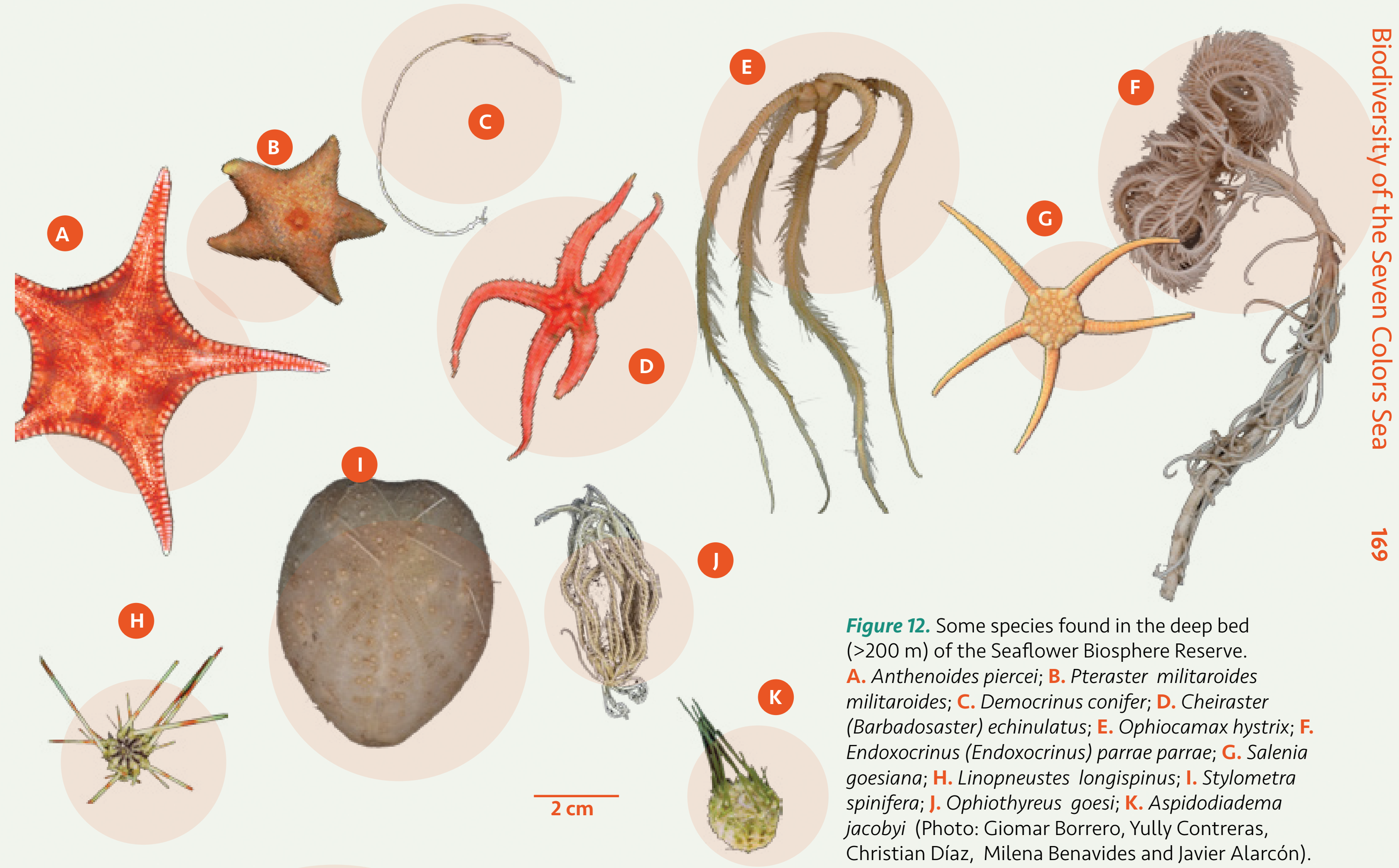


Figure 12. Some species found in the deep bed (>200 m) of the Seaflower Biosphere Reserve. **A.** *Anthenoides piercei*; **B.** *Pteraster militaroides militaroides*; **C.** *Democrinus conifer*; **D.** *Cheiraster (Barbadosaster) echinulatus*; **E.** *Ophiocamax hystrix*; **F.** *Endoxocrinus (Endoxocrinus) parrae parrae*; **G.** *Salenia goesiana*; **H.** *Linopneustes longispinus*; **I.** *Stylometra spinifera*; **J.** *Ophiothyreus goesi*; **K.** *Aspidodiadema jacobyi* (Photo: Giomar Borrero, Yully Contreras, Christian Díaz, Milena Benavides and Javier Alarcón).

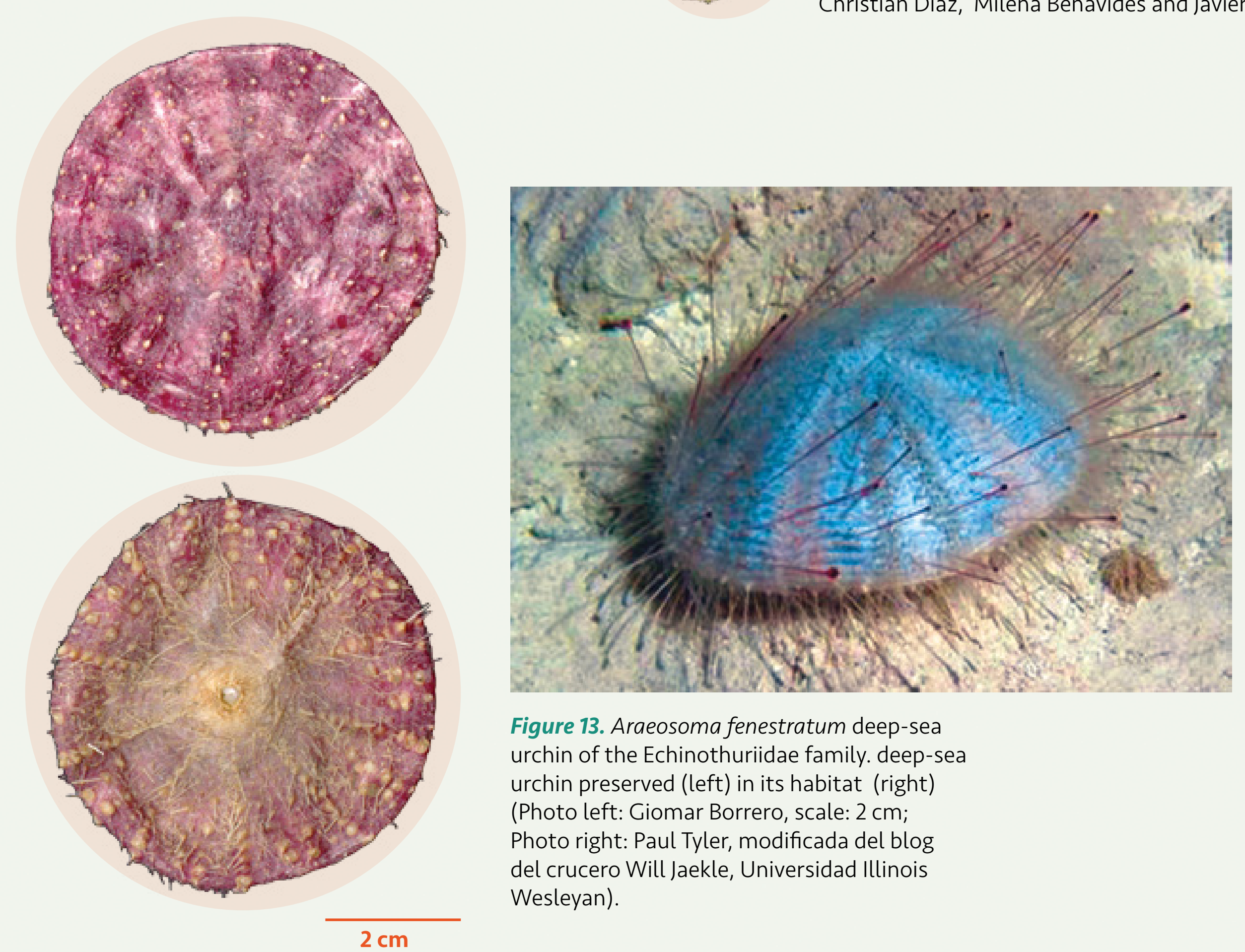


Figure 13. *Araeosoma fenestratum* deep-sea urchin of the Echinothuriidae family. deep-sea urchin preserved (left) in its habitat (right) (Photo left: Giomar Borrero, scale: 2 cm; Photo right: Paul Tyler, modificada del blog del crucero Will Jaekle, Universidad Illinois Wesleyan).

To prepare this inventory, only the information identified to the species level was included; however, most of the forms that were not considered have specimens deposited in the collection of echinoderms of MHNMC-INVEMAR. This physical evidence makes it possible to continue the identification process, which will surely increase the number of species for this area.

The species that are part of the inventory presented herein come from 16 references or research papers. Of these, only two are specific to echinoderms of the islands of San Andrés and Providencia, of which several records of shallow-water species are generated **(Quiñones, 1981; Vélez, 2003).** A considerable amount of records is derived from the ANH-Jamaica expedition, held in the Joint Regime Area between Jamaica and Colombia **(INVEMAR-ANH, 2012; Vega-Sequeda *et al.*, 2015)**,), which evaluated shallow and deep environments. An important contribution to this inventory comes from research cruises, such as the R/V Albatross (1884), Presidential Cruise (1938), R/V Oregon (1957, 1964) and R/V Pillsbury (1971), which mainly include species from deep environments, although with several shallow-environment records.

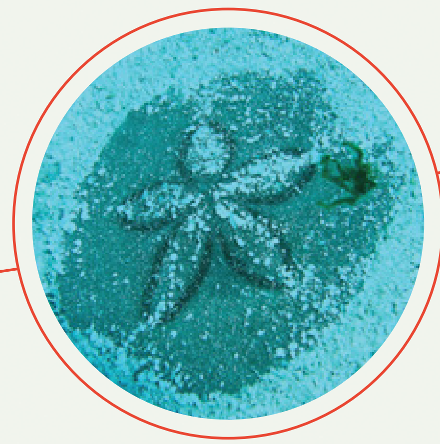
The specimens of these inventories are deposited in the NMNH-Smithsonian and, most of them, were included in the catalogs of echinoderms of Colombia **(Clark H, 1939; Clark y Downey, 1992; Benavides Serrato *et al.*, 2011; Borrero Pérez *et al.*, 2012).** Finally, there are records arising from reports and studies that have examined some ecosystem and that record some species of echinoderms **(CORALINA, 2001; García *et al.*, 2003; Díaz *et al.*, 2003; García Hanse y Álvarez León, 2007; Lasso, 2007 a, b; Mejía Ladino *et al.*, 2008; Abril Howard *et al.*, 2012).**

Based on that information, this study updates the inventory of 47 species for the San Andrés and Providencia (SAN) ecoregion **(Benavides Serrato *et al.*, 2012)**, to a total of 118 species. Seven species are recorded for the first time for the reserve; three of them were identified based on the photographic archive of CORALINA, corresponding to the sea urchins of shallow-water environments *Echinoneus cyclostomus* **(Figure 10)**, *Clypeaster subdepressus* y *Plagiobrissus grandis*. The other four records, which had not been published, come from the NMNH-Smithsonian, including the sea lily *Democrinus rawsonii* the starfishes *Luidia alternata alternata* and *Linckia bouvieri*, and the sea cucumber *Lissothuria braziliensis*.

[Altogether, an inventory of 125 species of echinoderms is showed, including representatives of the five groups, being brittle stars (40 species), starfishes (29 species) and sea urchins (28 species) the most diverse ones (Figure 3).]

Despite this richness of species and the variety of forms that we can find, the comparison of these figures with the ones currently known for the Colombian Caribbean and the Caribbean Sea shows us that there is still a lot of more species that could be found in the area. We only know 48% of the species recorded in the Colombian Caribbean **(Benavides Serrato *et al.*, 2013)**, and 23% of the species of the Caribbean Sea and the Gulf of Mexico **(Alvarado Barrientos y Solís Marín, 2013)** **(Figure 3)**. These comparisons do not imply that all of the species known in the Caribbean Sea should be there. However, these percentages are added to the lack of specific research works on the group of echinoderms, mainly in shallow-water environments of cays and banks of the Seaflower Biosphere Reserve **(Figure 4).**

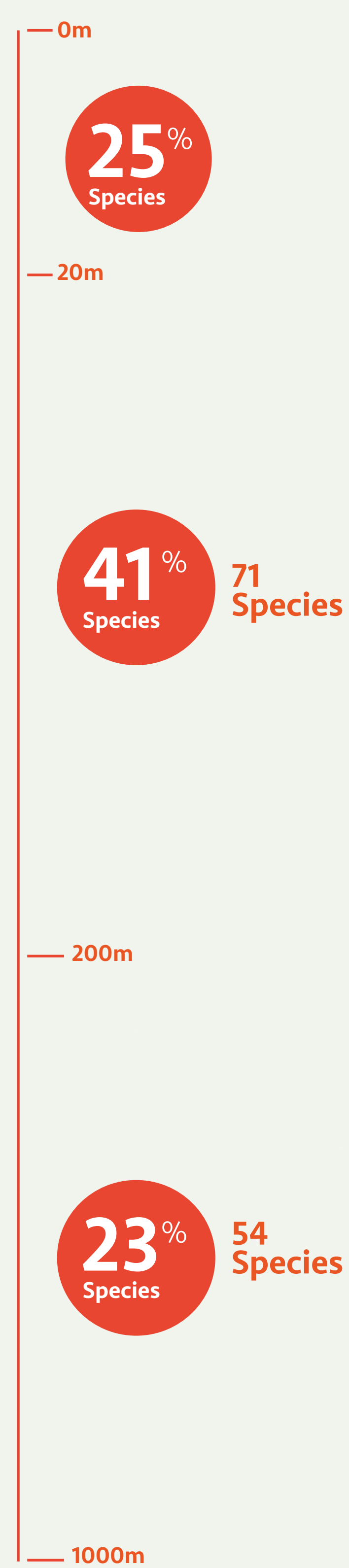
125 species



Distribution of echinoderms

The immense ocean is the only option for echinoderms as they are exclusively marine and only some species can survive in brackish waters. Apart from such restriction, these invertebrates occupy almost all the marine habitats, from the intertidal area to abyssal depths. They have colonized almost all the benthic environments and present a wide variety of nutritional habits (carnivorous, filter feeders, detritivores, among others). Some species of deep-water sea cucumbers have the ability to swim remaining in the water column for a long time, and in some sea pens and brittle stars, short swimming movements have been recorded.

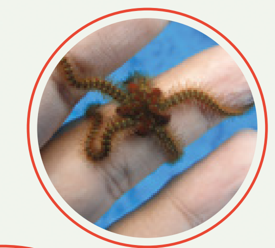
Echinoderms present a zonation by depth that has been recorded in several areas, including the Colombian Continental Caribbean **(Benavides Serrato y Borrero Pérez, 2010)**. This zonation includes some families that belong mainly to shallow waters, other families that may include some species of both shallow and deep waters and other families that belong to deep water environments only. A first change in the composition of these groups was observed, more or less, 200 m deep **(Benavides Serrato y Borrero Pérez, 2010)**. The distribution of echinoderms that is currently known in the Seaflower Biosphere Reserve shows a pattern associated with depth. In this pattern, species that have been recorded in the deep seabed (>200 m) are different to those that have been found in other habitats, which are found at less than 200 m deep; reefs, seagrasses, rocky and sedimentary littorals and infralittorals are included among those habitats. As for the classes, while starfishes and sea urchins are those presenting more species in the deep seabed, the better-known classes in shallow-water environments are brittle stars and sea cucumbers **(Figure 3).**



As for the number of species, it is known that, in the Caribbean and in the Atlantic, the greatest number of species is found between 0 and 200 m deep (25% between 0 and 20 m; 41% between 20 and 200 m); while 23% of species are found between 200 and 1,000 m **(Pérez Ruzafa *et al.*, 2013)**.Although in the reserve this tendency is observed where there are more species recorded between 0 and 200 m (71 species), the species are not as many as in the deep seabed (54 species), which, besides, is the most diverse habitat, with figures exceeding the sedimentary sublittoral, the reefs and the seagrasses **(Figure 3).** Although studies intended to examine echinoderms should increase for all the environments and depths in the Seaflower Biosphere Reserve, it could be said that, based on the data collected in this book, the lack of information is greater for shallow ecosystems, mainly in the rocky habitat and others, such as mangrove swamps.

As for the presence and distribution of echinoderms in the Seaflower Biosphere Reserve, as expected, the greatest number of present records and species is in San Andrés, Providencia and Santa Catalina. Serranilla and Bajo Nuevo cays are next, which is the result of the different components of the ANH-Jamaica project **(INVEMAR—ANH, 2012; Vega Sequeda *et al.*, 2015)**,and also of the records generated by the previously mentioned research cruises. The information analyzed shows how echinoderms of shallow environments of the reserve, specifically cays and banks (Quitasueño, Serrana, Roncador, Bolívar and Alburquerque), are practically unknown. Most of the records in areas near to those correspond to species of deep-water environments.

Ten species of echinoderms have been recorded in almost the entire Seaflower Biosphere Reserve, which are: the starfishes *Oreaster reticulatus* **(Figure 5)** y *Ophiothrix (Ophiothrix) oerstedii* **(Figure 9)**; the sea urchins *Diadema antillarum* **(Figure 6)**, *Eucidaris tribuloides* **(Figure 6)**, *Lytechinus variegatus* variegatus **(Figure 6)**, *Tripneustes ventricosus* **(Figure 6)**, *Echinometra lucunter lucunter* **(Figure 6)**, *Echinometra viridis* **(Figure 6)**, y *Clypeaster rosaceus* **(Figure 10)**; and the sea cucumber *Holothuria (Halodeima)* mexicana **(Figure 7).**



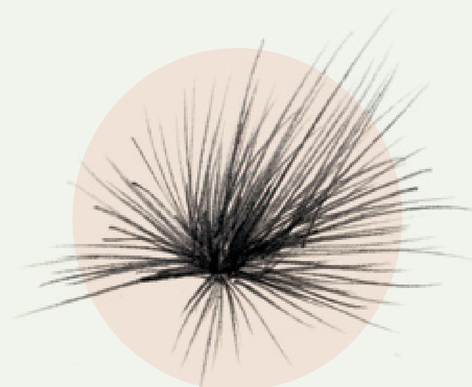
[Diez especies de equinodermos se han registrado en prácticamente toda la reserva de biosfera Seaflower]

Species

In shallow environments, both rocky and sedimentary, as well as in coral reefs and seagrass beds, some starfishes, sea urchins and sea cucumbers are the most notable and representative organisms. In the reserve, it is common to find the cushion sea star Oreaster reticulatus, which is easy to recognize because of its size and color (Figure 5), In many places of Colombia and the Caribbean, this starfish is removed to be used as a souvenir. This situation motivated its inclusion in the Red Book of Marine Invertebrates of Colombia, in the category of Least Concern (LC) (Borrero Pérez et al., 2002). **It is also common to see the *Linckia guildingi*,a striking starfish because of its coloration and shape, as well as the regeneration process that can be frequently observed in its arms (Figura 5). Other starfishes commonly present in the sedimentary bottoms of the archipelago belong to the genera *Luidia* (Figure 5) and *Astropecten*, although these can be found partially buried.**

Linckia guildingi

The most notable sea urchins in the shallow environments of the reserve include *Eucidaris tribuloides, Diadema antillarum, Lytechinus variegatus variegatus, L. williamsi, Tripneustes ventricosus, Echinometra lucunter lucunter* and *E. viridis* **(Figure 6)**. EThese are the echinoderms with the greatest number of records in the reserve and, except for *L. williamsi* and *Tripneustes ventricosus*, they have been found in the entire area. *L. williamsi* inhabits only in reefs, and *T. ventricosus* is usually found in seagrass beds, although it can also be observed in rocky and coral environments **(Figure 6)**. *D. antillarum* and *E. viridis*,had already been recorded among the most common species of vagile invertebrates in the insular shelf of San Andrés, Providencia and Santa Catalina by Abril Howard ***et al.*** (2012).



Sea urchins also have some representatives that, because of their big sizes and habits to remain exposed during the day, are very visible to any unaware diver o swimmer; the principal ones among them are *Astichopus multifidus, Isostichopus badionotus* and *Holothuria* (Halodeima) mexicana **(Figure 7)**. *H. mexicana* is one of the species distributed in the entire reserve, and it is common in the reefs and seagrasses of the insular shelf of San Andrés, Providencia and Santa Catalina **(Abril Howard et al., 2012)**. *I. badionotus*, also common in the seagrasses of these islands, is a sea cucumber with a great variability in its coloration and external morphology **(Figure 7)**. These sea cucumbers belong to the most diverse group (Aspidochirotida), with a total of 13 species. However, most of them have minor sizes and/or remain less exposed, being found between rocks or covered by algae or sand. In most of these cases, it is necessary to examine the microscopic ossicles of their skin to confirm their taxonomic identification **(Figure 8)**.Sea cucumber populations in this distant area may be relevant to understand their dynamic, within the context of the increasing interest in the fishery of these echinoderms and the need to preserve them.

ABesides echinoderms that are commonly observed in shallow environments, there are also many other species that usually go unnoticed, because they remain partially or completely hidden between crevices, under rocks, buried within sediments, among the roots of seagrasses or among sponges and corals. These species include mainly brittle stars, which is one of the classes with more species among echinoderms and the most diverse one so far in the Seaflower Biosphere Reserve. Representatives of the genera Ophiocoma, Ophioderma, Ophionereis and Ophiothrix **(Figure 9)**. are commonly found in these environments. To discover the diversity and abundance of these groups, it is necessary to lift rocks, as well as to observe in detail the surface of other invertebrates, such as sponges and corals. They can occasionally come out and remain completely exposed, or stretch out their arms to catch food from the water column.

Other echinoderms that remain hidden during the day show themselves during the night, when they come out from their crevices or choose a place to get food, surprising with their forms and sizes. This is the case of the great basket star *Astrophyton muricatum* **(Figure 9)** that stretches out its five ramified arms; some individuals can reach up to one meter in diameter **(Tommasi, 1970)**. Likewise, the sea

cucumber *Holothuria (Thymiosycia) thomasi* **(Figura 8)**, described for the first time in 1980 by David Pawson and the Colombian researcher, Ivan Caycedo **(Pawson y Caycedo, 1980)**. can reach up to 2 m long and goes unnoticed until dusk, when it turns into one of the most notable echinoderms in the reefs of many locations of the Caribbean Sea.

In shallow seafloors dominated by sediments, brittle stars of the family Amphiuridae are one of the most diverse and abundant groups **(Figure 9)**.These organisms live buried, and often the only visible part of them is their arms outstretched to feed. Along with the work presented by Quiñones (1981), the study of brittle stars, associated with shallow soft bottoms of San Andrés and Providencia Islands, is one of the few specific studies about echinoderms in this region of the Colombian Caribbean **(Vélez, 2003)**. In sedimentary environments, very dense populations of irregular sea urchins (heart urchins and sand dollars) can also be found; these populations are adapted to live within sediments, leaving only the upper part of their heads visible. These animals can breathe through tube feet coming out from a petal-shaped structure that can be observed in them. In the sedimentary environments of the Seaflower Biosphere Reserve, six species of this class of sea urchins of the genera Clypeaster, Encope, Leodia, Meoma and Plagiobrissus are known; two of them were not recorded for this area **(Figura 10)**.

Due to their small size and the fact that they live within sediments, among algae or seagrasses, or attached to or inside small holes of rocks, sea cucumbers belonging to the orders Dendrochirotida and Apodida are not usually easily observed. These groups exhibit a degree of diversity comparable to, and even greater than, that of the groups of large sea cucumbers mentioned above (Aspidochirotida). However, only six of these species have been recorded in the reserve; among them are *Euapta lappa* and *Synaptula hidriformis* **(Figure 8)**.

Among the groups that go unnoticed are also sea pens that, besides having cryptic habits, are not as diverse and abundant as the other classes of echinoderms. Only two species have been recorded in the shallow rocky environments of the Seaflower Biosphere Reserve (Figura 11) **and four species are known in deep environments** (Figura 12). **Within this class, besides sea pens that are found at all depths and include 600 species, there are also sea lilies that were very abundant millions of years ago. The 100 existing species are currently restricted to depths greater than 200 m** (Pawson, 2007). **TThree sea lilies have been recorded in the deep seabed of the reserve and are as follows: *Endoxocrinus (Endoxocrinus) parrae parrae, Democrinus conifer* and *D. rawsonii*, The latter had not been recorded in the region (Figure 12).**

As mentioned above, like crinoids, every class of echinoderms is represented in deep environments. The records of the Seaflower Biosphere Reserve include some deep-water families, such as starfish belonging to the families Goniasteridae, Benthopectinidae, Echinasteridae and Pterasteridae; brittle stars belonging to the families Ophiacanthidae and Ophiolepididae; and sea urchins belonging to the families Echinothuriidae, Aspidodiadematidae, Saleniidae and Paleopneustidae, among others **(Figure 12)**. Although some families of sea cucumbers are common and abundant in deep sedimentary environments, there are currently no records of these groups in the reserve. Usually, species living in the depths undergo some modifications in their morphology to cope with the extreme characteristics of these environments such as darkness or pressure. A modification of this type occurs with the family Echinothuriidae (sea urchins) whose test is flexible, allowing them to adapt to the high pressure **(Figure 13)**.

From different points of view, echinoderms are a group of fascinating marine animals, relevant for the conservation of marine ecosystems and of interest to humans. The sustainable use of some species of sea urchins and cucumbers, which are common and abundant in the reserve and are key to the welfare of some of the most important ecosystems, depends, to a large extent, on our knowledge of the dynamics of their populations. The gap in this type of information, as well as in the basic knowledge

of which species mainly inhabit shallow environments in this area, is evident after a literature review conducted before writing this book.

Therefore, it is essential to continue with the efforts that have been made to collect and increase knowledge of the Seaflower Biosphere Reserve. A list of the species currently known in these remote areas of the Colombian Caribbean which become more strategic for our country every day is presented below.

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Echinoderms

Phylum Echinodermata

C	Sc	O	F	S				
Asteroidea		Notomyotida	Benthopectinidae	*Cheiraster (Barbadosaster) echinulatus*	(Perrier, 1875)	2	ls	N
				Cheiraster (Christopheraster) mirabilis	(Perrier, 1881)	2	ls	C
		Paxillosida	Astropectinidae	*Astropecten americanus*	Verrill, 1880	2	ls	N
				Astropecten antillensis	Lütken, 1859	2	ss	CS
				Astropecten articulatus	(Say, 1825)	2	ss	CS
				Astropecten cingulatus	Sladen, 1833	2	ls	N
				Astropecten nitidus	Verrill, 1915	2	ss	N
				Persephonaster echinulatus	Clark, 1941	2	ls	C
			Luidiidae	*Luidia clathrata*	(Say, 1825)	2	ss	CS
				Luidia alternata alternata	(Say, 1825)	16	ss	CS
				Luidia barbadensis	Perrier, 1881	2	ls	N
				Luidia senegalensis	(Lamark, 1816)	2	ss	CS
		Spinulosida	Echinasteridae	*Echinaster (Othilia) brasiliensis*	Müller & Troschel, 1842	2	ss	BS
				Henricia antillarum	Perrier, 1881	12, 16	ls	ARC
		Valvatida	Asterinidae	*Asterinides folium*	(Lutken, 1860)	2	ls	S
				Stegnaster wesseli	(Perrier, 1875)	2	ls	S
			Goniasteridae	*Anthenoides piercei*	Perrier, 1881	2, 12	ls	N
				Apollonaster yucatanensis	Halpern, 1970	4	ls	S
				Circeaster americanus	(Clark, 1916)	2	ls	N, C
				Nymphaster arenatus	(Perrier, 1881)	2	ls	N, C
				Pseudarchaster gracilis gracilis	(Sladen, 1889)	2	ls	C
				Rosaster alexandri	(Perrier, 1881)	2	ls	N
			Ophidiasteridae	*Linckia guildingi*	Gray, 1840	17, 7	lr, ir	PSC
				Linckia bouvieri	Perrier, 1875	16	ls	BS
				Ophidiaster guildingi	Gray, 1840	17	lr	PSC
				Tamaria halperni	Downey, 1971	2, 12	ls	CS
			Oreasteridae	*Oreaster reticulatus*	(Lütken, 1859)	2, 18, 17, 17, 7, 6, 13, 14, 1	sm, lr	CS, PSC, SA
			Poraniidae	*Marginaster pectinatus*	Perrier, 1881	12	ls	BN
		Velatida	Pterasteridae	*Pteraster militaroides militaroides*	H.L. Clark, 1941	2	ls	C
Crinoidea	Articulata	Bourgueticrinida	Bourgueticrinidae	*Democrinus conifer*	(A.H. Clark, 1909)	2	ls	N
				Democrinus rawsonii	(Pourtalès, 1874)	16	ls	N
		Comatulida	Antedonidae	*Caryometra atlantidis*	A.H. Clark, 1940	12	ls	BN
				Trichometra cubensis	(Pourtalès, 1869)	12, 2	ls	N
			Charitometridae	*Crinometra brevipinna*	(Pourtalès, 1867)	12	ls	BN
			Comasteridae	*Davidaster discoideus*	(Carpenter, 1888)	2	ab	SA
				Davidaster rubiginosus	(Pourtalès, 1869)	2, 17	ab	PSC
			Thalassometridae	*Stylometra spinifera*	(Carpenter, 1881)	12	ls	BN
		Isocrinida	Isocrinidae	*Endoxocrinus (Endoxocrinus) parrae parrae*	(Gervais in Guérin, 1835)	12	ls	BN
Echinoidea	Cidaroidea	Cidaroida	Cidaridae	*Eucidaris tribuloides*	(Lamarck, 1816)	3, 18, 12, 11, 17, 13, 14	ab, ls, lr	SA
				Stylocidaris affinis	(Philippi, 1845)	3	ls	N
				Stylocidaris lineata	Mortensen, 1910	12	ls	BN, CS
	Euechinoidea	Echinothurioida	Echinothuriidae	*Araeosoma belli*	Mortensen, 1903	3	ls	N
		Arbacioida	Arbaciidae	*Coelopleurus floridanus*	A. Agassiz, 1872	3	ls	BS
		Clypeasteroida	Clypeasteridae	*Clypeaster lamprus*	H. L. Clark, 1914	3	ls	N, BQ
				Clypeaster rosaceus	(Linnaeus, 1758)	18, 8, 17, 7	sm	RB
				Clypeaster subdepressus	(Gray, 1825)	7	sm	SA, RB
			Fibulariidae	*Echinocyamus grandiporus*	Mortensen, 1907	3, 12, 11	ls	PSC
			Mellitidae	*Encope emarginata*	(Leske, 1778)	3	ss	CS
				Leodia sexiesperforata	(Leske, 1778)	3, 17, 7	ss	S
		Diadematoida	Aspidodiadematidae	*Aspidodiadema jacobyi*	A. Agassiz, 1880	3	ls	N
			Diadematidae	*Diadema antillarum*	Philippi, 1845	3, 18, 11, 10, 17, 17, 17, 7, 13, 14, 1	ab, lr	N, S
				Echinometra lucunter	(Linnaeus, 1758)	3	lr	S, CS
		Echinoida	Echinometridae	*Echinometra lucunter lucunter*	(Linnaeus, 1758)	18, 11, 10, 17, 5	ab, lr	BN, CS
				Echinometra viridis	A. Agassiz, 1863	18, 11, 17, 9, 1	ab, lr	PSC, SA
		Echinolampadoida	Echinolampadidae	*Conolampas sigsbei*	(A. Agassiz, 1878)	12	ls	N, BN
		Echinoneoida	Echinoneidae	*Echinoneus cyclostomus*	Leske, 1778	7	sm	SA, RB
		Salenioida	Saleniidae	*Salenia goesiana*	Lovén, 1874	12	ls	BN, CS
		Spatangoida	Brissidae	*Meoma ventricosa ventricosa*	(Lamarck, 1816)	18, 17, 7	sm, ss	RB
				Plagiobrissus grandis	(Gmelin, 1788)	7	sm	RB
			Palaeotropidae	*Palaeobrissus hilgardi*	A. Agassiz, 1880	12	ls	BN, CS
			Paleopneustidae	*Linopneustes longispinus*	(A. Agassiz, 1878)	3	ls	N
			Paleopneustina	*Heterobrissus hystrix*	(A. Agassiz, 1880)	3	ls	N
			Prenasteridae	*Agassizia excentrica*	A. Agassiz, 1869	12	ls	BN
		Temnopleuroida	Toxopneustidae	*Lytechinus variegatus variegatus*	(Lamarck, 1816)	3, 11, 8, 17, 7	sm, ab	RB
				Lytechinus williamsi	Chesher, 1968	11, 7	ab	SA
				Tripneustes ventricosus	(Lamarck, 1816)	3, 11, 8, 10, 17, 7, 6, 1	sm, ab, ir	S, CS
			Trigonocidaridae	*Trigonocidaris albida*	A. Agassiz, 1869	12	ls	ARC, BN

Conservation status

LC

Actinopyga agassizii
Holothuria (Halodeima) floridana
Holothuria (Thymiosycia) thomasi
Holothuria (Vaneyothuria) lentiginosa
Holothuria (Cystipus) cubana
Holothuria (Halodeima) grisea
Holothuria (Halodeima) mexicana
Holothuria (Platyperona) parvula
Holothuria (Selenkothuria) glaberrima
Astichopus multifidus
Isostichopus badionotus
Oreaster reticulatus

DD

Holothuria (Thymiosycia) arenicola
Holothuria (Thymiosycia) impatiens
Diadema antillarum

Interactive table

Echinoderms
Phylum Echinodermata

C	O	F	S			
Holothuroidea	Apodida	Synaptidae	*Euapta lappa* (J. Müller, 1850)	18	ir	CS
			Synaptula hydriformis (Lesueur, 1824)	17, 15	sm	PSC
	Aspidochirotida	Holothuriidae	*Actinopyga agassizii* (Selenka, 1867)	17	ab	PSC
			Holothuria (Halodeima) floridana Pourtalés, 1851	17, 15	ab, sm	PSC, SA
			Holothuria (Thymiosycia) thomasi Pawson y Caycedo, 1980	17, 7	sm, ab	RB
			Holothuria (Vaneyothuria) lentiginosa Marenzeller von, 1892	16	ls	BS
			Holothuria (Cystipus) cubana Ludwig, 1875	17	ab	PSC
			Holothuria (Halodeima) grisea Selenka, 1867	3	sm	CS
			Holothuria (Halodeima) mexicana Ludwig, 1875	18, 8, 17, 7, 6, 13, 14, 1, 1	sm, ab	PSC, SA
			Holothuria (Platyperona) parvula (Selenka, 1867)	3	ab	S
			Holothuria (Selenkothuria) glaberrima Selenka, 1867	3	lr	S, CS
			Holothuria (Thymiosycia) arenicola Semper, 1868	3	sm	CS
			Holothuria (Thymiosycia) impatiens (Forskål, 1775)	3	sm	PSC
		Stichopodidae	*Astichopus multifidus* (Sluiter, 1910)	3, 18, 7	ss, sm	CS
			Isostichopus badionotus (Selenka, 1867)	18, 8, 17, 17, 7, 1	ab, sm	PSC, SA
	Dendrochirotida	Cucumariidae	*Ocnus suspectus* (Ludwig, 1875)	3	ir	CS
			Thyonella sabanillaensis (Deichmann, 1930)	3	ss	CS
		Phyllophoridae	*Pentamera pulcherrima* Ayres, 1852	3	ls	CS
		Psolidae	*Lissothuria braziliensis* (Théel, 1886)	16	lr	CS
Ophiuroidea	Euryalida	Gorgonocephalidae	*Astrophyton muricatum* (Lamarck, 1816)	17, 18, 7	ab	RB
	Ophiurida	Amphiuridae	*Amphiodia pulchella* (Lyman, 1869)	19	ss	PSC, SA
			Amphiodia trychna H.L. Clark, 1918	19	ss	SA
			Amphipholis squamata (Delle Chiaje, 1828)	19	ss	PSC, SA
			Amphipholis gracillima (Stimpson, 1852)	19	ss	SA
			Amphipholis januarii Ljungman, 1867	19	ss	PSC, SA
			Amphiura stimpsonii Lütken, 1859	19	ss	SA
			Microphiopholis atra (Stimpson, 1854)	2	ss	CS
			Ophionephthys limicola Lütken, 1869	19	ss	SA
			"Ophiophragmus pulcher" H. L. Clark, 1918	19	ss	PSC, SA
			Ophiostigma siva Hendler, 1995	19	ss	PSC, SA
			Ophiostigma isocanthum (Say, 1825)	19	ss	PSC, SA
		Ophiacanthidae	*Ophiacantha bidentata* (Bruzelius, 1805)	12	ls	ARC
			Ophiocamax hystrix Lyman, 1878	12	ls	BN
			Ophiomitra valida Lyman, 1869	12	ls	ARC, BN
			Ophiomyces frutectosus Lyman, 1869	12	ls	BN
			Ophiopristis hirsuta (Lyman, 1875)	12	ls	ARC, BN, CS
			Ophiotreta cf. sertata (Lyman, 1869)	12	ls	ARC, BN
		Ophiactidae	*Ophiactis savignyi* (Müller y Troschel, 1842)	15	sm	SA
		Ophiocomidae	*Ophiocoma echinata* (Lamarck, 1816)	2, 17, 9	ir	S
			Ophiocoma pumila Lutken, 1859	18	ir	CS
			Ophiocoma wendtii Müller & Troschel, 1842	17, 7	ir, ab	PSC
		Ophiodermatidae	*Bathypectinura heros* (Lyman, 1879)	12	ls	BN
			Ophioderma appressa (Say, 1825)	5, 19	ab, ss	PSC, S
			Ophioderma brevicauda Lütken, 1856	19	ss	SA
			Ophioderma brevispina (Say, 1825)	2, 7	ir, sm	RB
			Ophioderma rubicunda Lütken, 1856	2	ss	SA
			Ophiopaepale goesiana Ljungman, 1872	12	ls	BN
		Ophiolepididae	*Ophiolepis elegans* Lütken, 1859	19	ss	SA
			Ophiomusium validum Ljungman, 1872	12	ls	BN
			Ophiomusium acuferum Lyman, 1875	12	ls	ARC, BN
			Ophiomusium eburneum Lyman, 1869	12	ls	BN
			Ophiomusium testudo Lyman, 1875	12	ls	BN, CS
			Ophiothyreus goesi Ljungman, 1872	2	ls	BQ
		Ophiomyxidae	*Ophiomyxa flaccida* (Say, 1825)	5	ab	PSC
		Ophionereididae	*Ophionereis reticulata* (Say, 1825)	18, 19	ir, ss	BN
		Ophionereididae	*Ophiothrix (Acanthophiothrix) suensoni* Lütken, 1856	7, 18, 17	ab	PSC
			Ophiothrix (Ophiothrix) angulata Say, 1825	2	ab	PSC, SA
			Ophiothrix (Ophiothrix) oerstedii Lütken, 1856	2, 18, 19, 17, 5, 7	ab, ss	RB
			Ophiothrix lineata Lyman, 1860	18	ab	CS

Interactive table

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FISH

of the seaflower biosphere reserve

Andrea Polanco F.[1], Arturo Acero P.[2], Nacor Bolaños Cubillos y Juan David González[1]

The Seaflower Biosphere Reserve is a Colombian marine territory comprising a great variety of ecosystems ranging from the largest coral reef (Quitasueño Bank) located in open sea in the Caribbean (Burke y Maidens, 2004),), going through seagrass beds, mangrove swamps, rocky reefs, beaches, sandy bottoms, atolls, rock pinnacles and lagoons (Díaz *et al.*, 2000), until reaching a deeper bottom of 200 m having a heterogeneous structure originated at steep inclination of the outer sea cliff in almost all reef complexes of the Archipelago of San Andrés, Providencia and Santa Catalina (Díaz *et al.*, 1996).

EThis great diversity of environments makes the archipelago a place that holds a wide variety of fish species compared to other locations in the Colombian Caribbean. In total, 731 fish species, included in 143 families, are known for this area. Of these, 653 species were documented in a previous study that aimed at inventorying fish known in the archipelago and that includes a higher percentage (80%) of records of coastal species **(Bolaños *et al.*, 2015)**,), together with 78 species present in deep waters in the area, taken from a study of fish from these existing environments in the Colombian Caribbean below 200 m (Polanco, 2015), for a total of 135 deep-water species. Given the 1,045 coastal species known in the Caribbean **(Robertson *et al.*, 2015)**,the coastal fish fauna of the archipelago represents a non-negligible amount, more than 50%, without including the species richness of our deep waters.

In this text, a review of some fish families in the archipelago is carried out, going through all environments (demersal and pelagic, shallow and deep) and habitats (seagrass beds, reefs, water column and deep bottoms) that can be found in the area, to give an idea of the magnitude of this fish biodiversity.

1 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

2 Universidad Nacional de Colombia - Caribe Campus (CECIMAR)

3 Autonomous Corporation for the Sustainable Development of the Archipelago of San Andrés, Providencia and Santa Catalina (CORALINA)

Hagfish

There is a great variety of groups of fish in the Archipelago of San Andrés, Providencia and Santa Catalina. This review starts with hagfish (myxines), a group of worm-like organisms whose jaws consist of a circular mouth with some horny teeth and whose body is coated with mucus to protect themselves. They are scavengers and diggers, inhabitants of the seabed, that are distributed from a few meters to 2,400 m deep (**Wisner y McMillan, 1995**), They are represented by a single species found in the area (*Eptatretus caribbeaus*).

Sharks, rays and chimaeras

The list continues with cartilaginous fish, such as sharks, rays and chimaeras. They are in the spotlight for global conservation due to their special biological conditions that make them susceptible to overfishing because they are slow-growing organisms. They reach sexual maturity in late stages, have low levels of fertility and reproductive potential and live long lives (Walker, 1998).). In the archipelago, sharks have been heavily exploited throughout history through targeted fishing and by-catch (Castro González y Ballesteros Galvis, 2009). Thanks to the efforts of gathering information on the exploitation of this resource in the archipelago, the first rules to regulate it were established in 2008, prohibiting targeted fishing of this species, which is later complemented by two popular actions, which reaffirms the prohibition of targeted fishing in the first instance and, subsequently, of by-catch.

29
Species of sharks

In the area, there are 29 species of sharks exhibiting a great variety of sizes and different habits. From small deep-water lantern sharks or etmopterids with small slightly-compressed cylindrical bodies, dark-adapted green eyes and small luminescent organs in the belly, reaching maximum lengths of around 31 cm and living close to the bottom between 200 and 2,200 m deep **(Compagno, 2002)**;to the giant of the sea, the whale shark (*Rhincodon typus*), that reaches 16 m in total length and travels around the world.

From sharks frequently found in hard bottoms, such as the famous nurse shark (*Ginglymostoma cirratum*)and the Caribbean reef shark (*Carcharhinus perezii*), to great swimmers like most hammerhead sharks or sphyrnids, such as the scalloped hammerhead (*Sphyrna lewini*), that can be seen forming schools.

Among rays, there are a variety of these marine winged animals having different shapes and sizes (17 species). Small species, such as the lesser electric ray (Narcine bancroftii), reaching about 58 cm in length, with deep-water habits, associated with coral formations and that can be found up to 43 m deep **(McEachran, 2002).** are reported. In the archipelago, there are also rays having a guitar-like shape, whiptail stingrays and eagle rays, until the very manta rays, the giant manta (*Manta birostris*), being their representative in the area. It swims actively in the water column in coastal and ocean areas and reaches impressive body sizes with a span of up to 7 m. Whiptail stingrays (*Dasyatidae*) are a group that has also been included in the fishery resource of cartilaginous organisms being somehow affected by by-catch **(Caldas, 2002)**, and, in the area, it is represented by the southern stingray (*Dasyatis americana*).

Moreover, there are also the chimaeras, those bizarre fish that, as their name suggests, seem to be formed by different parts of animals: a rabbit's head, a body with large pectoral wing-like fins and a mouse's tail. In the area, they swim at great depths and are represented by two species: *Hydrolagus alberti and Chimaera cubana.*

200 m

2.200 m

Ginglymostoma cirratum

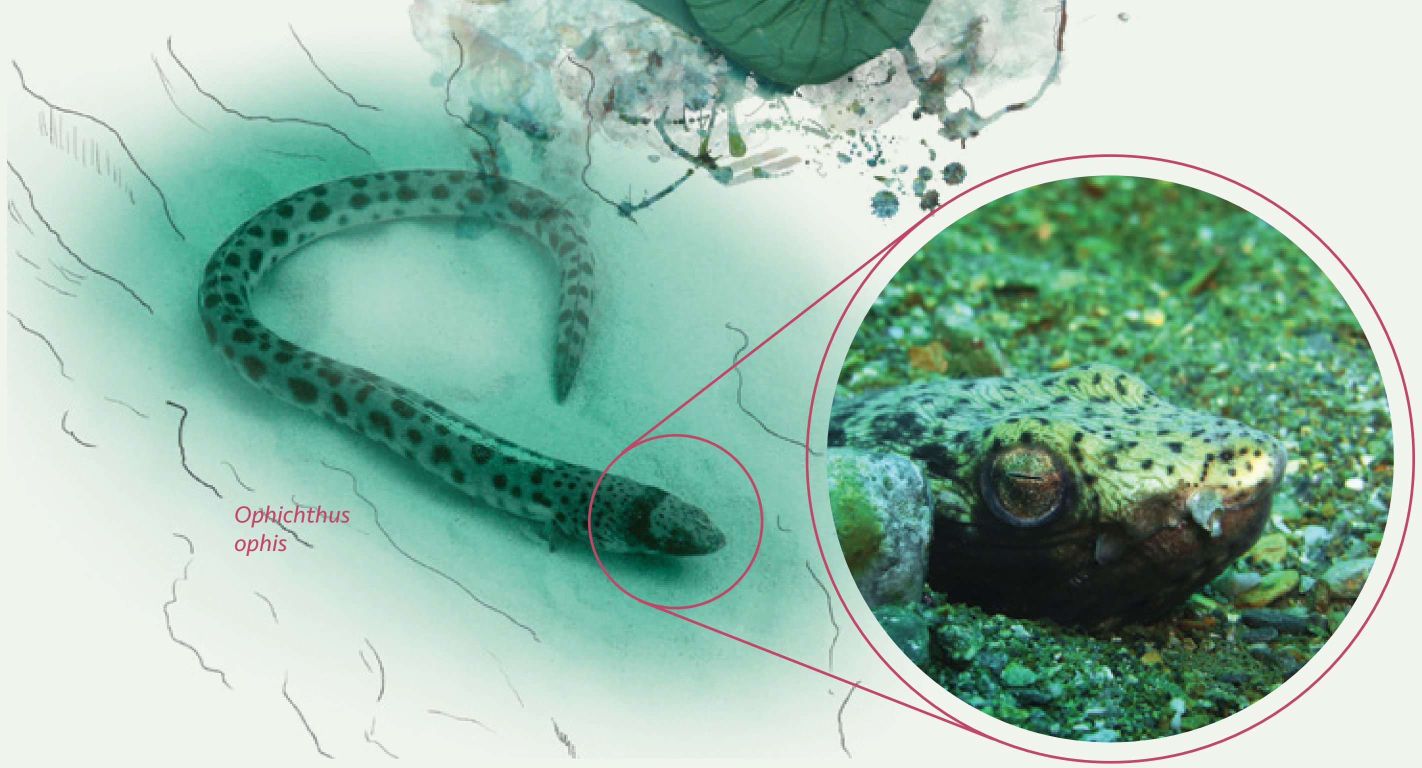
Dasyatis americana

Bony fish

Among fish having a bony skeleton, much more diversified than those mentioned above, there is a variety of families occupying all possible environments and habitats in the Archipelago of San Andrés, Providencia and Santa Catalina. This review can start by mentioning some of these families found in waters near the coast in environments associated with the seafloor. Some groups, such as the well-known mullets (mugilids), are found there. They are coastal inhabitants tolerant of brackish waters in estuaries and, in some cases, of freshwaters. They are usually found at depths no greater than 20 m **(Harrison, 2002)**.). In the area, they are represented by four species, and it is worth mentioning that among them are three species of the genus *Mugil* (*M. curema, M.liza and M.trichodon*), that have a high commercial and alimentary importance in the country.

Morena moteada

Gymnothorax funebris



Ophichthus ophis

In these same brackish environments, small mollies or poeciliids are found. They also occupy the coastal lagoons of the islands (*Gambusia aestiputeus and Poecilia orri*). When submerging in water, we find eels, with ten families in the area, very diversified in the use of habitats and some of them associated with freshwater environments (freshwater eels such as Anguilla rostrata), soft sandy or mud bottoms and hard bottoms in rocky or reef areas, in a depth range that goes from the shoreline to beyond 2,000 m deep.

Moray eels, that, within the group of eels, prefer to live in rocky or reef bottoms, include twelve species present in the area, ranging in size from the pygmy moray (*Anarchias similis*) **to the imposing green moray (*Gymnothorax funebris*), that reaches two meters in length** **(Smith, 2002).**

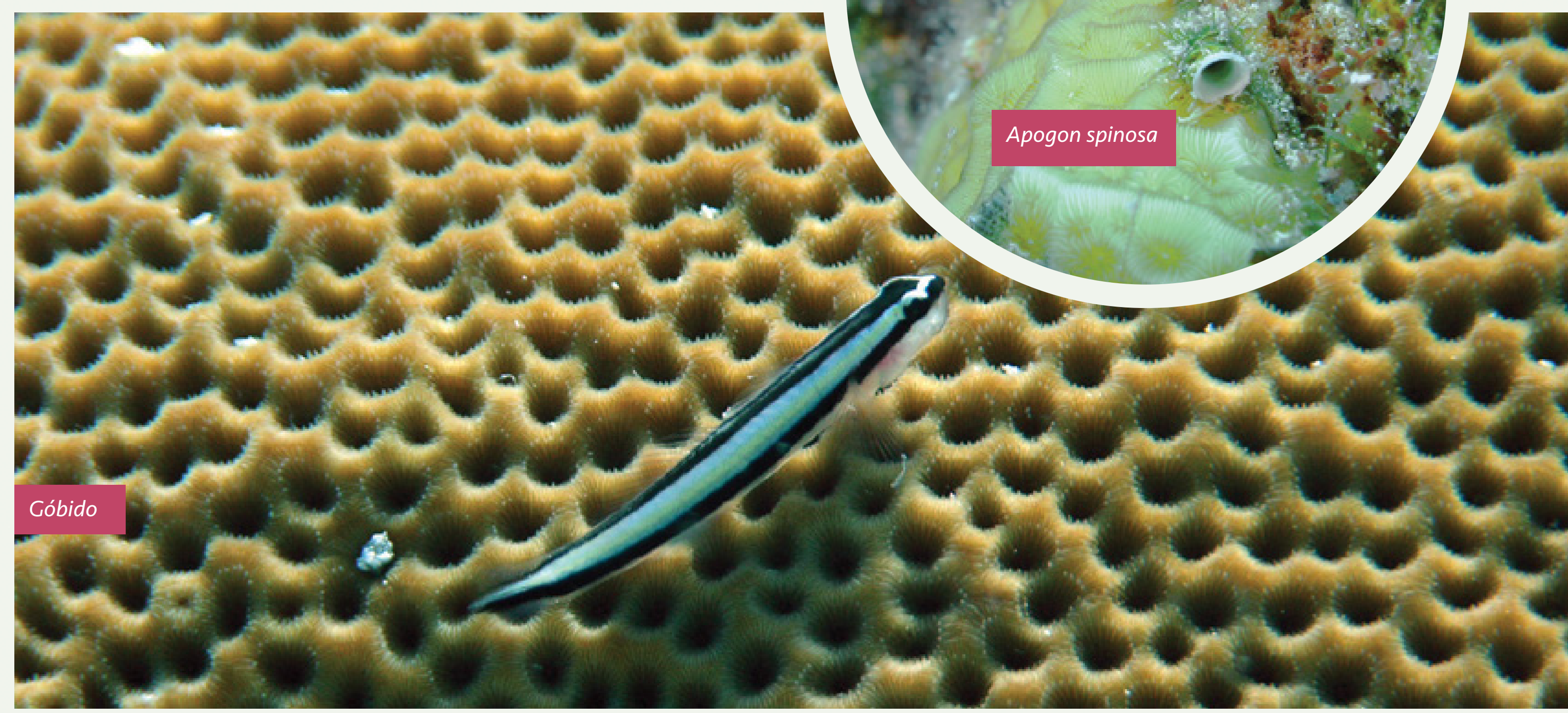
DAmong families living in soft bottoms, we find snake eels or ophichthids that are the most diverse group in real eels, crawling on sand (*Callechelys bilinearis*) or mud in estuaries and near reefs (*Ophichthus ophis*). Conger eels are found from coastal ecosystems, such as the brown garden eel (*Heteroconger longissimus*)to the depths (*Xenomystax congroides*), every of them usually buried during the day and foraging for food at night.

Other coastal fish found swimming over seagrass beds, sandy and estuarine bottoms, or in areas bordered by mangrove swamps, and that are also transients of reefs are mojarras. This group of silvery fish, which is heavily exploited in the national continental areas, has nine representative species in the archipelago, including the well-known striped mojarra (*Eugerres plumieri*) and the yellowfin mojarra (*Gerres cinereus*).

As bottom-dwelling fish traveling between the great sandy areas and the areas adjacent to reefs, we find lizardfish or synodontids that, as their name implies, are elongated with a lizard-like head. They stalk their prey from the bottom where they rest on their pectoral fins. The largest species of this group are like the shortjaw lizardfish (*Saurida normani*),inhabitant of relatively-deep waters, or the sand diver (*Synodus intermedius*), inhabitant of shallow bottoms available for tourists to see. They have close relatives at great depths with peculiar adaptations to rest on the seabed, such as the well-known tripod fish (ipnopids) represented by the species *Bathypterois bigelowi* in the archipelago.

Entering the reef world, there is a range of families distributed in the habitat according to their needs for food and shelter. Some families include cryptic fish that use the coral structure as a shelter or permanent niche in some cases. Among these families, cardinalfish or apogonids stand out, with 20 species known in the area. The group's species are nocturnal, feed on small invertebrates and exhibit a striking biological adaptation: males being those who brood the eggs in a bag in the oral cavity **(Gon, 2002)**. As for the species known in the archipelago, *Apogon maculatus, Astrapogon stellatus y Phaeoptyx conklini.*

Apogon spinosa



Góbido

Another family found in the area, having cryptic habits and blending into the seafloor, are gobies, with 50 species.

These tiny fish can be found in reefs and adjacent substrates. On a global level, they are particularly abundant organisms showing, in many cases, symbiotic associations with other organisms to carry out cleaning tasks **(Murdy, 2002)**, as in the case of the species *Elacatinus illecebrosus*.

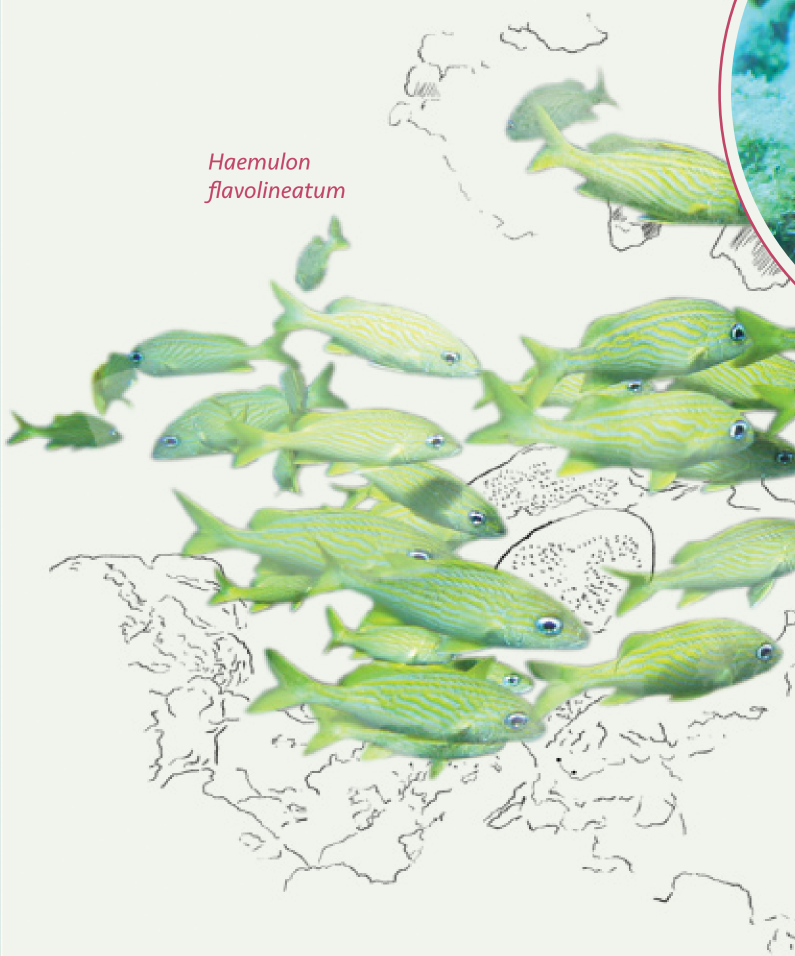
t is also worth including tube blennies or chaenopsids, with 18 species, comprising a group of small fish usually limited to living in holes in environments associated with corals or rocks **(Williams, 2002)**. They have a variety of colors and ornaments that make them very bright to the human eye, but that, at the same time, enable them to blend into their habitats, such as the case of *Acanthemblemaria spinosa*.

Taking a closer look to swimmers among reefs, we find active predators that are also an important part of the food resource and security of the islands. Snappers or lutjanids, with 15 species in the islands, are a group of great economic importance because, over time, they have become one of the main resources in tropical marine fisheries. For instance, the queen snapper (*Etelis oculatus*) is one of the most consumed species in the islands of the archipelago, and the silk snapper (*Lutjanus vivanus*) is one of the most affected by overfishing.

Groupers and sea basses or serranids, with 47 species, are another heavily exploited family to the point of causing, in many cases, a large decline in their populations in the area. The goliath grouper (*Epinephelus itajara*), one of the bony fish that reaches very large sizes, growing over two meters in length, is one of the examples of overfishing in the insular and continental Caribbean **(Acero *et al.*, 2002)**. Also, among this group are the species *Mycteroperca bonaci* and *Cephalopholis fulva*, which are also highly prized in the islands for the quality of their meat.

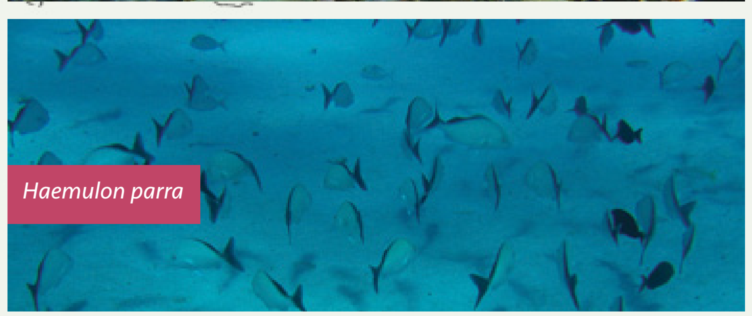
Epinephelus itajara

Cephalopholis fulva



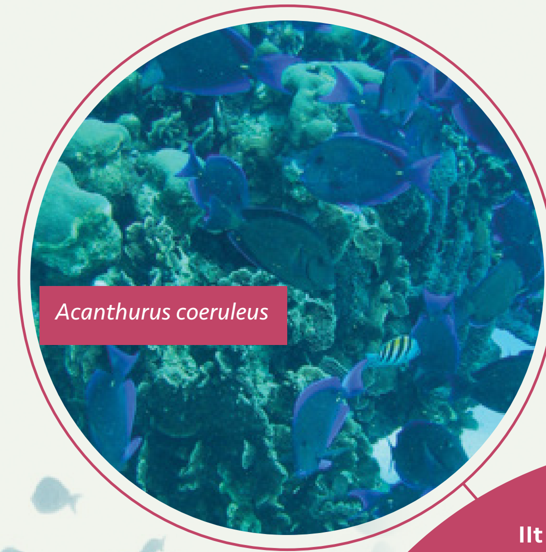
Haemulon flavolineatum

Haemulon plumieri



Haemulon parra

Among other families of active carnivores, grunts or haemulids also occupy an important place, with 16 species in the area. These fish are commonly known that way because they produce a guttural sound by rubbing together their pharyngeal teeth **(Lindeman, 2002)**. Among them, it is worth highlighting the presence of the margate, *Haemulon album*, a species that is important for its large sizes and abundances.

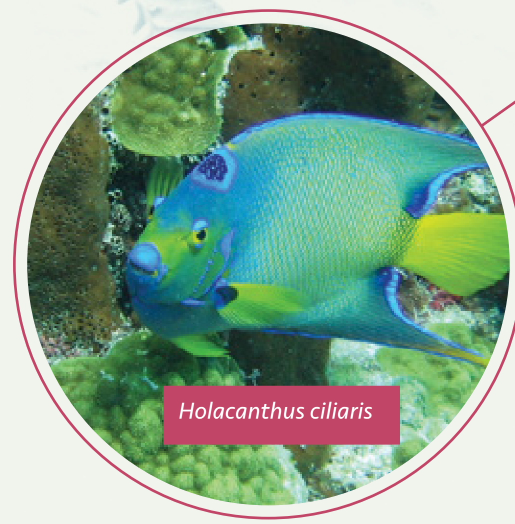


Acanthurus coeruleus

Chaetodon capistratus

It is also possible to consider other families that are permanent residents of reefs and vital to the health of the ecosystem, as in the case of grazers because they keep reefs free of algae. Among these herbivores, we find parrotfish that were recently included in the family Labridae. Besides playing this fundamental ecological role, they are also important as a food resource. They have been heavily overfished in the area of the northern cays. These include the species *Scarus guacamaia*, uone of the most prized species by fishers. Surgeonfish or acanthurids, with three species in the area, are another group of herbivores that are frequent swimmers found in the reef, as well as angelfish or pomacanthids that feed on sponges, with six species; and globefish or tetraodontids that feed on molluscs, with four species. In this review, only some families, among many others that make up the communities in these demersal ecosystems, are mentioned, as the expected length of this text restricts us from naming them all.

Chaetodon striatus



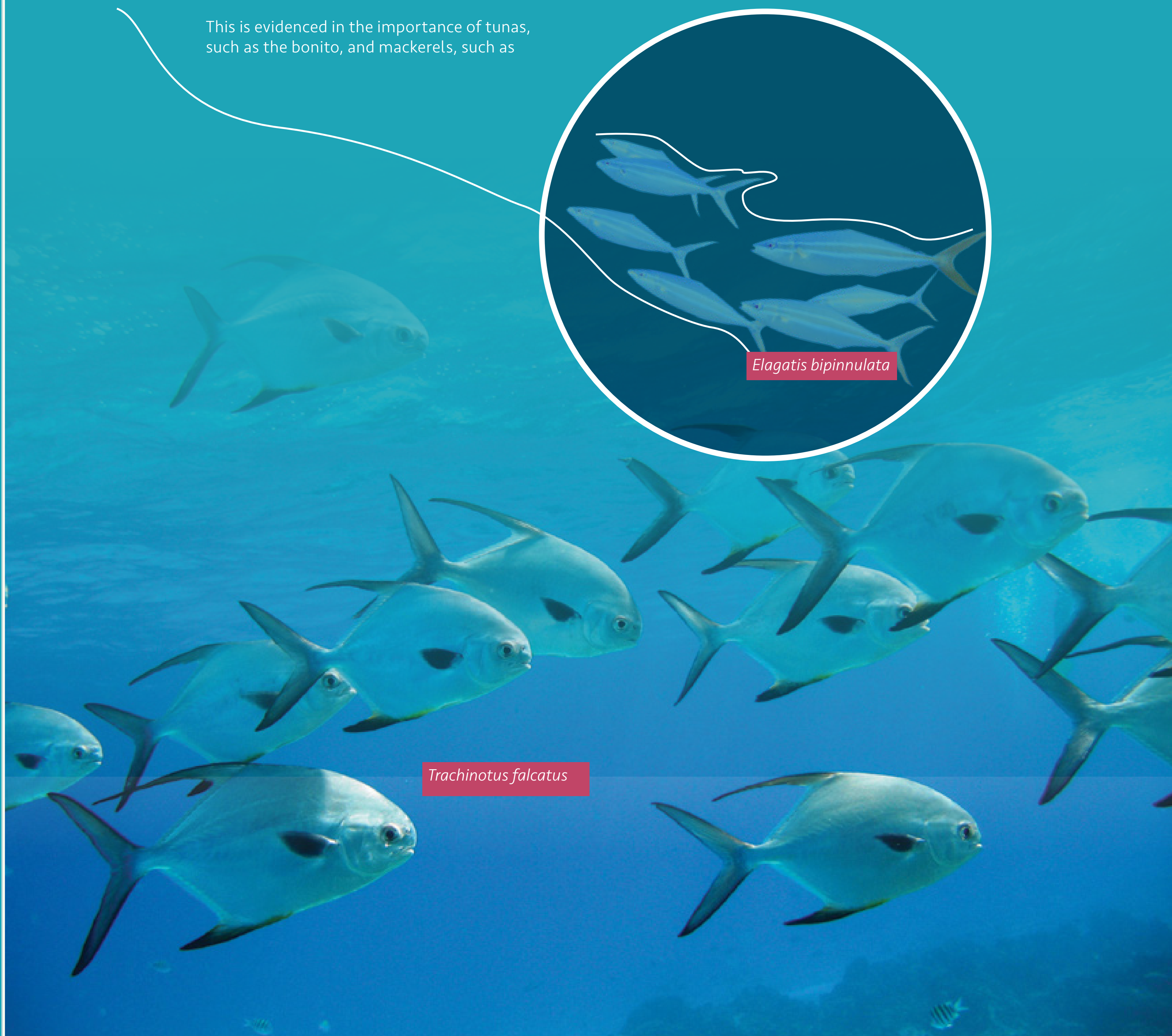
Holacanthus ciliaris

Holacanthus tricolor

Pomacanthus arcuatus

Moving on to the water column, we find active swimmers, shallow-water groups such as needlefish or belonids, with six species. They have the elongated shape of a needle with both jaws extended and full of teeth. They are often found swimming in the waters, curious around divers and attracted to light and, in some cases, causing accidents **(Collette, 2002)**. Among the species recorded in the area, it is worth mentioning the agujon (*Tylosurus acus acus*) and the houndfish (*Tylosurus crocodilus crocodilus*), both species being somehow exploited through artisanal fishing. Among the great migratory swimmers are families like mackerels and tunas or scombrids, with ten species in the islands; all of which are of considerable importance to artisanal and industrial fisheries.

This is evidenced in the importance of tunas, such as the bonito, and mackerels, such as the king mackerel and the wahoo (*Thunnus atlanticus, Scomberomorus cavalla and Acanthocybium solandri*). OThe well-known jacks or carangids are another of these large families considered a food tradition in tropical waters, with twenty species found in the area of the archipelago. They are also one of the most important groups for fishing. Among the best-known species for being offered in restaurants are the blue runner (*Caranx crysos*),), the rainbow runner (*Elagatis bipinnulata*), the Pacific amberjack (*Seriola rivoliana*) and pompanos (*Trachinotus falcatus y T. goodei*), among others.



Elagatis bipinnulata

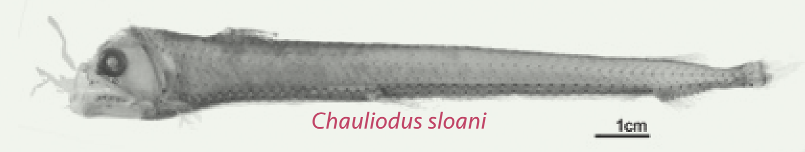
Trachinotus falcatus

Finally, within this group of families, it is important to mention the dolphinfish, a beautiful rainbow-colored fish, prized for its soft and delicate meat and included in some menus with its Hawaiian name, mahi-mahi (*Coryphaena hippurus*).

In deep waters, the environmental conditions of light, pressure, temperature, space, availability of food and energy conservation change with respect to the surface, playing an important role in the selectivity of fish found in this environment. These fish adapted over time thanks to typical structures such as light-emitting organs known as photophores, large mouths filled with dagger-like teeth, mental barbels or rays modified as hooks, thin and elongated bones and large and tubular eyes or small eyes **(Helfman *et al.*, 2009).**

Like in shallow environments, at depths exceeding 200 m, fish associated with open waters in the water column and with the seabed can be found. So far, all records known for the area were found at depths less than 800 m, the maximum sampling depth that has been reached in the archipelago.

Among the groups of fish living in open waters, deep-water eels have been recorded, such as slender snipe eels or nemichthyids (*Nemichthys scolopaceus*) and cutthroat eels or synaphobranchids (*Dysommina rugosa*). as well as deep-sea hatchetfish or sternoptychids (*Polypnus asteroides* y *P. laternatus*) and barbeled dragonfish or stomiids (*Chauliodus sloani y Eustomias* spp.), both groups having large arrangements of photophores on their bodies.



Chauliodus sloani

Dysommina rugosa

There are also barracudinas or paralepidids, with species such as Lestrolepis intermedia and Stemonosudis rothschildi; telescopefish with modified tubular eyes (*Gigantura chuni*).lanternfish or myctophids, with nine species recorded for the area, that could be named "nocturnal sardines" after their bioluminescence; and blackchins or neoscopelids (*Neoscopelus macrolepidotus and N. microchir*). Finally, in this environment, we also find some representatives of snake mackerels or gempylids such as *Prometichthys prometheus* y *Ruvettus pretiosus*, among others.

Within the group of fish associated with the seafloor, interesting families have been recorded for the archipelago such as halosaurs, with one species, *Halosaurus ovenii*, with powerful olfactory organs used to locate females at maturity through pheromones **(Smith, 2002)**. lizardfish or synodontids, *Saurida caribbaea*, being its deepest-dwelling representative; greeneyes or chlorophthalmids; and tripod fish mentioned above are other related groups found at these depths. We also found widely diversified groups in deep waters such as grenadiers or macrourids, with nine species in the area, also known as rattails and characterized by the absence of a caudal fin and the confluence of their dorsal and anal fins; and cusk-eels or ophidiids, with twelve species in the area, among which are several species belonging to the genus *Lepophidium*, among others.

All these groups and species have been recorded through some scientific collections conducted at specific sites. Nonetheless, it is clear that, given the extension of the archipelago and the heterogeneity of its bottoms, what is known today is only a small part of the biodiversity inhabiting these deep environments, this book being the beginning of an inventory that poses new challenges to continue exploring and getting to know the richness of the Colombian ocean waters in the Caribbean Sea.

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Fish

Phylum Chordata

C: Actinopteri

F	G	S					
Acanthuridae	Acanthurus	*Acanthurus chirurgus* (Bloch, 1787)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Acanthurus coeruleus Bloch y Schneider, 1801	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Acanthurus tractus Poey, 1860	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
Achiridae	Trinectes	*Trinectes paulistanus* (Miranda Ribeiro, 1915)	1	D	ls, sm	LC	IS
Acropomatidae	Synagrops	*Synagrops bellus* (Goode y Bean, 1896)	1	D	lr, ab, lp	LC	IN, S, N, C
		Synagrops pseudomicrolepis Schultz 1940	2	D	lp	NE	N
		Synagrops spinosus Schultz, 1940	1	D	lr, lp, ca	LC	IN, PSC, SA, N
		Synagrops trispinosus Mochizuki y Sano, 1984	1	D	lp, ca	LC	IN, N
	Verilus	*Verilus sordidus* Poey, 1860	1	D	lr, ls	LC	PSC
Albulidae	Albula	*Albula vulpes* (Linnaeus, 1758)	1	P	ab	NT	IR, IN, PSC, SA
Anguillidae	Anguilla	*Anguilla rostrata* (Lesueuer, 1817)	1	D	lp	EN	PSC
Antennariidae	Antennarius	*Antennarius multiocellatus* (Valenciennes, 1837)	1	D	lr, ab	LC	PSC, SA
		Antennarius pauciradiatus Schultz, 1957	1	D	ls, sm	LC	PSC
		Antennarius scaber (Cuvier, 1817)	1	D	lr, ls, sm	NE	SA
	Histrio	*Histrio histrio* (Linnaeus, 1758)	1	D	ls, sm	LC	IR, PSC, SA
Apogonidae	Apogon	*Paroncheilus affinis* (Poey, 1875)	1	D	ca	LC	IN, SA, IS
		Apogon aurolineatus (Mowbray, 1927)	1	D	ca	LC	PSC, IS
		Apogon binotatus (Poey, 1867)	1	D	ab, lr	LC	IR, IN, PSC, IS
		Apogon lachneri Böhlke, 1959	1	D	ab, lr	LC	IN, PSC, IS
		Apogon leptocaulus Gilbert, 1972	1	D	ab, lr	LC	PSC
		Apogon maculatus (Poey, 1860)	1	D	ls	LC	IR, IN, PSC, S, CS, BS
		Apogon phenax Böhlke y Randall, 1968	1	D	ls	LC	PSC, SA
		Apogon pillionatus Böhlke y Randall, 1969	1	D	ls	LC	PSC
		Apogon planifrons Longley y Hildebrand, 1940	1	D	ab, lr	LC	PSC, SA
		Apogon pseudomaculatus Longley, 1932	1	D	ab, lr	LC	IR, PSC, SA
		Apogon quadrisquamatus Longley, 1934	1	D	sm, lr	LC	IN, PSC, IS
		Apogon robbyi Gilbert y Tyler, 1997	1	D	sm, lr	LC	PSC
		Apogon robinsi Böhlke y Randall, 1968	1	D	ab, lr	LC	PSC
		Apogon townsendi (Breder, 1927)	1	D	ab, lr	LC	IN, PSC, S, BS
	Astrapogon	*Astrapogon puncticulatus* (Poey, 1867)	1	D	sm	LC	IN, PSC, SA
		Astrapogon stellatus (Cope, 1867)	1	D	sm	DD	IR, IN, PSC, S, BS, CA
	Phaeoptyx	*Phaeoptyx conklini* (Silvester, 1915)	1	D	sm	LC	IN, PSC, SA, IS, CB, CA
		Phaeoptyx pigmentaria (Poey, 1860)	1	D	ab, lr	LC	PSC, S
		Phaeoptyx xenus (Böhlke y Randall, 1968)	1	D	ab, lr	LC	PSC, SA
	Zapogon	*Zapogon evermanni* (Jordan y Snyder, 1904)	1	D	ab, lr	LC	PSC
Argentinidae	Argentina	*Argentina brucei* Cohen & Atsaides 1969	2	D	lp	NE	C
		Argentina stewarti Cohen & Atsaides 1969	2	D	lp	NE	N
		Argentina striata Goode & Bean 1896	2	D	lp	LC	N
	Glossanodon	*Glossanodon pygmaeus* Cohen, 1958	1	P	lp	LC	IN, IS, N
Ateleopodidae	Ijimaia	*Ijimaia antillarum* Howell Rivero 1935	2	D	lp	NE	N
Atherinidae	Atherina	*Atherina harringtonensis* Goode, 1877	1	P	sm, ca	LC	IR, IN, PSC, S
	Atherinomorus	*Atherinomorus stipes* (Müller y Troschel, 1848)	1	P	ab, ca	LC	IR, IN, PSC, S, BS, BR
Aulostomidae	Aulostomus	*Aulostomus maculatus* Valenciennes, 1841	1	D	ab, ca	LC	IR, IN, PSC, S, BS, BR
Balistidae	Balistes	*Balistes capriscus* Gmelin, 1789	1	D	ss, sm, ab	VU	IN, PSC, S
		Balistes vetula Linnaeus, 1758	1	D	lr, sm, ab	EN*	IR, IN, PSC,S, BA, BS, BR
	Canthidermis	*Canthidermis maculata* (Bloch, 1786)	1	P	lr, ab, ca	LC	IR, IN
		Canthidermis sufflamen (Mitchill, 1815)	1	D	lr, ab, ca	LC	IR, IN, PSC, S, BS, BR
	Melichthys	*Melichthys niger* (Bloch, 1786)	1	D	lr, ab, ca	LC	IR, IN, PSC, S, BA, BS, BR
	Xanthichthys	*Xanthichthys ringens* (Linnaeus, 1758)	1	D	ab, ca, lm	LC	IR, IN, PSC, SA, BN, BA, BS
Bathyclupeidae	Bathyclupea	*Bathyclupea argentea* (Goode & Bean 1896)	2	D	lp	NE	N
		Bathyclupea schroederi Dick 1962	2	D	lp	NE	N, C
Batrachoididae	Porichthys	*Porichthys bathoiketes* Gilbert 1968	2	D	lp	NE	N
Belonidae	Ablennes	*Ablennes hians* (Valenciennes, 1846)	1	P	ca	LC	IR, IN, PSC, S
	Platybelone	*Platybelone argalus argalus* (Lesueur, 1821)	1	P	ca	LC	IR, IN, PSC, S, BS
	Strongylura	*Strongylura notata* (Poey, 1860)	1	P	sm, ca	LC	IN, SA
		Strongylura timucu (Walbaum, 1792)	1	P	sm, ca	LC	PSC, SA
	Tylosurus	*Tylosurus acus acus* (Lacepède, 1803)	1	P	ca	LC	IR, IN, PSC, SA, IS, BR
		Tylosurus crocodilus crocodilus (Péron y Lesueur, 1821)	1	P	ca	LC	IR, IN, PSC, SA, IS, CB
Berycidae	Beryx	*Beryx splendens* Lowe, 1834	1	D	lp	LC	IN, N
Blenniidae	Entomacrodus	*Entomacrodus nigricans* Gill, 1859	1	D	lr, ab	LC	IN, PSC, S
	Hypleurochilus	*Hypleurochilus springeri* Randall, 1966	1	D	lr, ab	LC	PSC, S, CA
	Ophioblennius	*Ophioblennius macclurei* (Silvester, 1915)	1	D	lr, ab	LC	IR, IN, PSC, S, CS, BS, BR
	Parablennius	*Parablennius marmoreus* (Poey, 1876)	1	D	lr, ab	LC	PSC
	Scartella	*Scartella cristata* (Linnaeus, 1758)	1	D	lr, ab	LC	SA
Bothidae	Bothus	*Bothus lunatus* (Linnaeus, 1758)	1	D	ls, sm	LC	IN, PSC, SA, IS, BR, CB
		Bothus maculiferus (Poey, 1860)	1	D	ls, sm	LC	PSC, SA
Bothidae	Bothus	*Bothus ocellatus* (Agassiz, 1831)	1	1	ls, sm	LC	PSC, S
	Chascanopsetta	*Chascanopsetta lugubris* Alcock. 1894	1	1	ls, sm	LC	SA
	Trichopsetta	*Trichopsetta orbisulcus* Anderson y Gutherz, 1967	1	1	ls, sm	LC	S
Bythitidae	Calamopteryx	*Calamopteryx goslinei* Böhlke y Cohen, 1966	1	1	ab	LC	PSC
	Ogilbia	*Ogilbia boehlkei* Møller, Schwarzhans y Nielsen, 2005	1	1	ab	LC	PSC, IS
	Ogilbichthys	*Ogilbichthys puertoricoensis* Møller, Schwarzhans y Nielsen, 2004	1	1	ab	DD	PSC
Callionymidae	Callionymus	*Callionymus bairdi* Jordan, 1888	1	1	ss, sm	LC	IR, IN, PSC, SA
	Diplogrammus	*Diplogrammus pauciradiatus* (Gill, 1865)	1	1	ls, sm	LC	PSC, SA
	Foetorepus	*Foetorepus agassizi* (Goode y Bean, 1888)	1	1	lp	NE	IN, PSC, S, N
Caproidae	Antigonia	*Antigonia capros* Lowe, 1843	1	1	lr, ab, lp	LC	IN, S
		Antigonia combatia Berry y Rathjen, 1959	1	1	lp	LC	IN, S, N
Carangidae	Alectis	*Alectis ciliaris* (Bloch, 1787)	1	1	ls, ab, ca	LC	IN, PSC, IS, BS, CA
	Caranx	*Caranx bartholomaei* Cuvier, 1833	1	1	ls, ab, ca	LC	IR, IN, PSC, S, BS, BR
		Caranx crysos (Mitchill, 1815)	1	1	ls, ab, ca	LC	IR, IN, PSC, S, BA, BS
		Caranx hippos (Linnaeus, 1766)	1	1	ls, ab, ca	LC	IN, S, BR
		Caranx latus Agassiz, 1831	1	1	ls, ab, ca	LC	IR, IN, PSC, S, BN, BS, BR
		Caranx lugubris Poey, 1860	1	1	ab, ca	LC	IR, IN, PSC, IS, BR
		Caranx ruber (Bloch, 1793)	1	1	ls, ab, ca	LC	IR, IN, PSC, S, BA, BS, BR
	Decapterus	*Decapterus macarellus* (Cuvier, 1833)	1	1	ca	LC	IR, IN, IS
		Decapterus punctatus (Cuvier, 1829)	1	1	ca	LC	IN, SA, IS, CB
	Elagatis	*Elagatis bipinnulata* (Quoy y Gaimard, 1825)	1	1	ca	LC	IR, IN, PSC, S, BN, BS, CB
	Naucrates	*Naucrates ductor* (Linnaeus, 1758)	1	1	ca	LC	SA
	Oligoplites	*Oligoplites palometa* (Cuvier, 1832)	1	1	ls, sm, ab	LC	SA
		Oligoplites saurus (Bloch y Schneider, 1801)	1	1	ls, sm, ab	LC	PSC
	Selar	*Selar crumenophthalmus* (Bloch, 1793)	1	1	ca	LC	PSC, IS, CB
	Selene	*Selene vomer* (Linnaeus, 1758)	1	1	ca	LC	SA
	Seriola	*Seriola dumerili* (Risso, 1810)	1	1	ca	LC	IN, IS, CB
		Seriola fasciata (Bloch, 1793)	1	1	ca	LC	IN, IS
		Seriola rivoliana Valenciennes, 1833	1	1	ca	LC	IR, IN, PSC,S
	Trachinotus	*Trachinotus falcatus* (Linnaeus, 1758)	1	1	ab, ca	LC	IN, PSC, S, CA
		Trachinotus goodei Jordan y Evermann, 1896	1	1	ab, ca	LC	IN, PSC, S, BR
Carapidae	Carapus	*Carapus bermudensis* (Jones, 1874)	1	1	ab	LC	PSC
Centropomidae	Centropomus	*Centropomus pectinatus* Poey, 1860	1	1	ls, sm	LC	PSC
		Centropomus undecimalis (Bloch, 1792)	1	1	ls, sm	VU*	PSC, SA
Chaenopsidae	Acanthemblemaria	*Acanthemblemaria aspera* (Longley, 1927)	1	1	lr, ab	LC	PSC, SA
		Acanthemblemaria greenfieldi Smith-Vaniz y Palacio, 1974	1	1	lr, ab	LC	PSC
		Acanthemblemaria maria Böhlke, 1961	1	1	lr, ab	LC	PSC, SA
		Acanthemblemaria rivasi Stephens, 1970	1	1	lr, ab	LC	SA
		Acanthemblemaria spinosa Metzelaar, 1919	1	1	lr, ab	LC	PSC, S
	Chaenopsis	*Chaenopsis limbaughi* Robins y Randall, 1965	1	1	sm, ab	LC	PSC, SA
		Chaenopsis ocellata Poey, 1865	1	1	ls, sm	LC	SA
	Coralliozetus	*Coralliozetus cardonae* Evermann y Marsh, 1899	1	1	lr, ab	LC	PSC
	Emblemaria	*Emblemaria caldwelli* Stephens, 1970	1	1	sm, ab	LC	PSC
		Emblemaria caycedoi Acero, 1984	1	1	sm, ab	LC	IN, PSC, S
		Emblemaria diphyodontis Stephens y Cervigón, 1970	1	1	sm, ab	LC	PSC
	Emblemariopsis	*Emblemariopsis bahamensis* Stephens, 1961	1	1	lr, ab	LC	PSC,S, CA
		Emblemariopsis bottomei Stephens, 1961	1	1	lr, ab	LC	PSC
		Emblemariopsis leptocirris Stephens, 1970	1	1	lr, ab	LC	PSC
		Emblemariopsis occidentalis Stephens, 1970	1	1	lr, ab	LC	PSC
		Emblemariopsis signifer (Ginsburg, 1942)	1	1	lr, ab	LC	PSC
	Hemiemblemaria	*Hemiemblemaria simula* Longley y Hildebrand, 1940	1	1	lr, ab	LC	PSC
	Lucayablennius	*Lucayablennius zingaro* (Böhlke, 1957)	1	1	lr, ab, ca	LC	IN, PSC, S, BR, CA
Chaetodontidae	Chaetodon	*Chaetodon capistratus* Linnaeus, 1758	1	1	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Chaetodon ocellatus Bloch, 1787	1	1	lr, sm, ab	LC	IR, IN, PSC,S, BS, BR
		Chaetodon sedentarius Poey, 1860	1	1	lr, sm, ab	LC	IR, PSC, SA, CS
		Chaetodon striatus Linnaeus, 1758	1	1	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
	Prognathodes	*Prognathodes aculeatus* (Poey, 1860)	1	1	lr, ab	LC	IR, IN, PSC, S, BN, BS, BR
Chaunacidae	Chaunax	*Chaunax pictus* Lowe 1846	2	2	lp	LC	N
		Chaunax suttkusi Caruso 1989	2	2	lp	LC	N
Chlopsidae	Chilorhinus	*Chilorhinus suensonii* Lütken, 1852	1	1	ab	LC	PSC, S
	Kaupichthys	*Kaupichthys hyoproroides* (Strömman, 1896)	1	1	ab	LC	IN, PSC, S
		Kaupichthys nuchalis Böhlke, 1967	1	1	ab	LC	PSC
Chlorophthalmidae	Chlorophthalmus	*Chlorophthalmus agassizi* Bonaparte, 1840	1	1	lp	LC	IN, PSC, S, N
	Parasudis	*Parasudis truculenta* (Goode & Bean 1896)	2	2	lp	LC	N
Cirrhitidae	Amblycirrhitus	*Amblycirrhitus pinos* (Mowbray, 1927)	1	1	lr, ab	LC	IR, IN, PSC, S, BR, CA
Clupeidae	Harengula	*Harengula clupeola* (Cuvier, 1829)	1	1	ca	LC	PSC, SA
		Harengula humeralis (Cuvier, 1829)	1	1	ca	LC	IR, IN, PSC, S, BS
Clupeidae	Harengula	*Harengula jaguana* Poey, 1865	1	P	ca	LC	PSC, SA
	Jenkinsia	*Jenkinsia lamprotaenia* (Gosse, 1851)	1	P	ab, ca	LC	IN, PSC, S
		Jenkinsia majua Whitehead, 1963	1	P	ab, ca	LC	IN, PSC
		Jenkinsia stolifera (Jordan y Gilbert, 1884)	1	P	ab, ca	LC	PSC, SA
	Opisthonema	*Opisthonema oglinum* (Lesueur, 1818)	1	P	ab, ca	LC	PSC, SA
	Sardinella	*Sardinella aurita* Valenciennes, 1847	1	P	ca	LC	PSC, IS
Colocongridae	Coloconger	*Coloconger meadi* Kanazawa 1957	2	D	lp	NE	N, C
Congridae	Acromycter	*Acromycter atlanticus* Smith 1989	2	D	lp	NE	C
	Ariosoma	*Ariosoma balearicum* (Delaroche, 1809)	1	B	lp	LC	PSC, IS
	Bathycongrus	*Bathycongrus thysanochilus* (Reid 1934)	2	D	lp	NE	N
		Bathycongrus vicinalis (Garman 1899)	2	D	lp	LC	N, C
	Conger	*Conger esculentus* (Poey, 1861)	1	B	ab	LC	IN, SA
		Conger triporiceps Kanazawa, 1958	1	B	ab	LC	PSC
	Heteroconger	*Heteroconger longissimus* Günther, 1870	1	B	ab, lr	LC	IR, IN, PSC,S, BS, BR
	Pseudophichthys	*Pseudophichthys splendens* (Lea, 1913)	1	D	lp	LC	IN, IS, N
	Rhynchoconger	*Rhynchoconger flavus* (Goode y Bean, 1896)	1	D	lp	LC	PSC, N
		Rhynchoconger gracilior (Ginsburg, 1951)	1	D	lp	LC	IN, N
	Uroconger	*Uroconger syringinus* Ginsburg, 1954	1	D	lp	LC	IS
	Xenomystax	*Xenomystax congroides* Smith & Kanazawa 1989	2	D	lp	LC	N, C
Coryphaenidae	Coryphaena	*Coryphaena equiselis* Linnaeus, 1758	1	P	ca	LC	PSC
		Coryphaena hippurus Linnaeus, 1758	1	P	ca	LC	IR, IN, PSC, S, CB
Cynoglossidae	Symphurus	*Symphurus arawak* Robins y Randall, 1965	1	D	ls, sm	LC	PSC, SA
		Symphurus caribbeanus Munroe, 1991	1	D	ls, sm	LC	PSC
		Symphurus piger (Goode & Bean 1886)	2	D	lp	LC	N
		Symphurus stigmosus Munroe 1998	2	D	lp	NE	N
Dactylopteridae	Dactylopterus	*Dactylopterus volitans* (Linnaeus, 1758)	1	D	ss, ab	LC	IR, IN, PSC, S, BS
Dactyloscopidae	Dactyloscopus	*Dactyloscopus poeyi* Gill, 1861	1	D	ls, sm	LC	PSC
		Dactyloscopus tridigitatus Gill, 1859	1	D	ls, sm	LC	PSC, SA
	Gillellus	*Gillellus greyae* Kanazawa, 1952	1	D	ls, sm	LC	PSC
		Gillellus uranidea Böhlke, 1968	1	D	ls, sm	LC	PSC, SA
	Leurochilus	*Leurochilus acon* Bohlke, 1968	1	D	ls, sm	LC	SA
	Platygillellus	*Platygillellus rubrocinctus* (Longley, 1934)	1	D	ls, sm	LC	PSC, S
Diodontidae	Chilomycterus	*Chilomycterus antennatus* (Cuvier, 1816)	1	D	lr, ls, sm	LC	PSC, SA
	Diodon	*Diodon holocanthus* Linnaeus, 1758	1	D	lr, sm, ab	LC	IR, IN, PSC, S
		Diodon hystrix Linnaeus, 1758	1	D	lr, sm, ab	LC	IR, IN, PSC, S, CS
Diretmidae	Diretmoides	*Diretmoides pauciradiatus* (Woods 1973)	2	D	lp	LC	N
Echeneidae	Echeneis	*Echeneis naucrates* Linnaeus, 1758	1	P	ca	LC	IN, PSC, S, BR, CA
		Echeneis neucratoides Zuiew, 1786	1	P	ca	DD	IN, SA
	Phtheirichthys	*Phtheirichthys lineatus* (Menzies, 1791)	1	P	ca	LC	IR, PSC, IS
	Remora	*Remora brachyptera* (Lowe, 1839)	1	P	ca	LC	IN
		Remora remora (Linnaeus, 1758)	1	P	ca	LC	SA
Eleotridae	Dormitator	*Dormitator maculatus* (Bloch, 1792)	1	D	sm, ab	LC	PSC, SA
	Eleotris	*Eleotris amblyopsis* (Cope, 1871)	1	D	sm, ab	LC	PSC, SA
	Gobiomorus	*Gobiomorus dormitor* Lacepède, 1800	1	D	sm, ab	LC	PSC
Elopidae	Elops	*Elops smithi* McBride, Rocha, Ruiz-Carus y Bowen, 2010	1	P	ca	DD	PSC, SA
Engraulidae	Anchoa	*Anchoa cayorum* (Fowler, 1906)	1	P	ca	LC	PSC
		Anchoa cubana (Poey, 1868)	1	P	ca	LC	PSC
		Anchoa hepsetus (Linnaeus, 1758)	1	P	ca	LC	PSC
		Anchoa lamprotaenia Hildebrand, 1943	1	P	ca	LC	IN, PSC
Ephippidae	Chaetodipterus	*Chaetodipterus faber* (Broussonet, 1782)	1	D	lr, ab, ca	LC	IN, PSC, SA
Epigonidae	Epigonus	*Epigonus macrops* (Brauer 1906)	2	D	lp	NE	N
		Epigonus occidentalis Goode & Bean 1896	2	D	lp	NE	N, C
		Epigonus pandionis (Goode & Bean 1881)	2	D	lp	LC	N
Exocoetidae	Cheilopogon	*Cheilopogon cyanopterus* (Valenciennes, 1847)	1	P	ca	LC	IN
		Cheilopogon exsiliens (Linnaeus, 1771)	1	P	ca	LC	IN
		Cheilopogon melanurus (Valenciennes, 1847)	1	P	ca	LC	IN, PSC
	Cypselurus	*Cypselurus comatus* (Mitchill, 1815)	1	P	ca	LC	IR
	Exocoetus	*Exocoetus obtusirostris* Günther, 1866	1	P	ca	LC	IR, IN, PSC, S
		Exocoetus volitans Linnaeus, 1758	1	P	ca	LC	IN, IS
	Hirundichthys	*Hirundichthys affinis* (Günther, 1866)	1	P	ca	LC	IR, IN, PSC, S, CB
	Parexocoetus	*Parexocoetus hillianus* (Gosse, 1851)	1	P	ca	LC	IR, IN, S, CB
	Prognichthys	*Prognichthys occidentalis* Parin, 1999	1	P	ca	LC	IN
Fistulariidae	Fistularia	*Fistularia tabacaria* Linnaeus, 1758	1	D	ab, ca	LC	PSC, SA
Gempylidae	Gempylus	*Gempylus serpens* Cuvier, 1829	1	P	lp, ca	LC	IR, IN, SA, BS
	Nealotus	*Nealotus tripes* Johnson, 1865	1	P	lp, ca	LC	IN

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Actinopteri	Serranidae	Hyporthodus	*Hyporthodus flavolimbatus* (Poey, 1865)	1	D	sm, ab	VU	IN, SA, BS
			Hyporthodus mystacinus (Poey, 1852)	1	D	lr, ab	LC	IN, IS
			Hyporthodus niveatus (Valenciennes, 1828)	1	D	lr, ab	VU	IN, SA
		Liopropoma	*Liopropoma carmabi* (Randall, 1963)	1	D	ab	LC	PSC
			Liopropoma mowbrayi (Woods y Kanazawa, 1951)	1	D	ab	LC	PSC, SA
			Liopropoma rubre Poey, 1861	1	D	ab	LC	IR, IN, PSC, S, BR, CB
		Mycteroperca	*Mycteroperca acutirostris* (Valenciennes, 1828)	1	D	lr, sm, ab	LC	PSC
			Mycteroperca bonaci (Poey, 1860)	1	D	lr, sm, ab	NT	IR, IN, PSC, S, BN, BR
			Mycteroperca interstitialis (Poey, 1860)	1	D	lr, sm, ab	VU	IR, IN, PSC, S, BN, BA, BR, CA
			Mycteroperca phenax Jordan y Swain, 1884	1	D	lr, sm, ab	LC	PSC
			Mycteroperca tigris (Valenciennes, 1833)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
			Mycteroperca venenosa (Linnaeus, 1758)	1	D	lr, sm, ab	NT	IR, IN, PSC, S, BS, BR
		Paranthias	*Paranthias furcifer* (Valenciennes, 1828)	1	D	lr, ab	LC	IR, IN, PSC, SA
		Plectranthias	*Plectranthias garrupellus* (Robins y Starck, 1961)	1	D	lr, ab, lp	LC	IN
		Pronotogrammus	*Pronotogrammus martinicensis* (Guichenot, 1868)	1	D	lr, ab, lp	LC	IN, IS, N
		Pseudogramma	*Pseudogramma gregoryi* (Breder, 1927)	1	D	lr, ab	LC	IN, PSC, S, CB, CA
		Rypticus	*Rypticus carpenteri* Baldwin y Weigt, 2012	1	D	lr, ab	LC	PSC
			Rypticus saponaceus (Bloch y Schneider, 1801)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, CS, BR, CB
			Rypticus subbifrenatus Gill, 1861	1	D	lr, ab	LC	PSC, SA
		Schultzea	*Schultzea beta* (Hildebrand, 1940)	1	D	lr, ab	LC	PSC, IS
		Serranus	*Serranus baldwini* (Evermann y Marsh, 1899)	1	D	lr, sm, ab	LC	IR, IN, PSC, SA
			Serranus chionaraia Robins y Starck, 1961	1	D	lr, ls, sm	LC	SA
			Serranus flaviventris (Cuvier, 1829)	1	D	lr, sm, ab	LC	IN
			Serranus phoebe Poey, 1851	1	D	lr, ab, lp	LC	IS, N, CA
			Serranus tabacarius (Cuvier, 1829)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BS, BR, CA
			Serranus tigrinus (Bloch, 1790)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BS, BR
			Serranus tortugarum Longley, 1935	1	D	lr, sm, ab	LC	SA
	Sparidae	Archosargus	*Archosargus rhomboidalis* (Linnaeus, 1758)	1	D	ls, sm	LC	PSC
		Calamus	*Calamus bajonado* (Bloch y Schneider, 1801)	1	D	ls, sm, ab	LC	IN, PSC, S, CB
			Calamus calamus (Valenciennes, 1830)	1	D	lr, ls, sm	LC	IR, IN, PSC, S, CS, BR
			Calamus penna (Valenciennes, 1830)	1	D	ls, sm, ab	LC	PSC, SA
			Calamus pennatula Guichenot, 1868	1	D	ls, sm, ab	LC	SA, CB
	Sphyraenidae	Sphyraena	*Sphyraena barracuda* (Edwards, 1771)	1	P	ls, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
			Sphyraena picudilla Poey, 1860	1	P	ca	NE	SA
	Steindachneriidae	Steindachneria	*Steindachneria argentea* Goode & Bean, 1896	1	D	ca	LC	SA
	Sternoptychidae	Polyipnus	*Polyipnus asteroides* Schultz 1938	2	D	lp	NE	N, C
			Polyipnus laternatus Garman 1899	2	D	lp	NE	N
		Sonoda	*Sonoda megalophthalma* Grey 1959	2	D	lp	NE	N
	Stomiidae	Chauliodus	*Chauliodus sloani* Bloch & Schneider 1801	2	D	lp	LC	N
		Eustomias	*Eustomias acinosus* Regan & Trewavas 1930	2	D	lp	DD	N
			Eustomias schmidti Regan & Trewavas 1930	2	D	lp	NE	N
	Synaphobranchidae	Dysommina	*Dysommina rugosa* Ginsburg 1951	2	D	lp	NE	N
	Syngnathidae	Acentronura	*Acentronura dendritica* (Barbour, 1905)	1	D	lr, ls, sm	LC	SA
		Bryx	*Bryx dunckeri* (Metzelaar, 1919)	1	D	lr, ls, ab	LC	IN, PSC, BS
			Bryx randalli (Herald, 1965)	1	D	lr, ls, ab	LC	PSC
		Cosmocampus	*Cosmocampus albirostris* (Kaup, 1856)	1	D	ls, sm	LC	PSC
			Cosmocampus brachycephalus (Poey, 1868)	1	D	ls, sm	LC	PSC
			Cosmocampus elucens (Poey, 1868)	1	D	lr, ls, sm	LC	PSC, SA
		Halicampus	*Halicampus crinitus* (Jenyns, 1842)	1	D	lr, ls, sm	LC*	PSC, SA
		Hippocampus	*Hippocampus reidi* (Ginsburg, 1933)	1	D	sm, ab	VU*	PSC, SA
		Microphis	*Microphis lineatus* (Kaup, 1856)	1	D	ls, sm	NE	IN, PSC
		Penetopteryx	*Penetopteryx nanus* (Rosén, 1911)	1	D	lr, ab	LC	PSC
		Syngnathus	*Syngnathus caribbaeus* Dawson, 1979	1	D	ls, sm	LC	PSC, SA
			Syngnathus pelagicus Linnaeus, 1758	1	P	ca	LC	PSC, SA
	Synodontidae	Saurida	*Saurida brasiliensis* Norman, 1935	1	D	ca	LC	IN, PSC
			Saurida caribbaea Breder, 1927	1	D	lp	LC	IN, N
			Saurida normani Longley, 1935	1	D	lp	LC	IN, N
		Synodus	*Synodus intermedius* (Spix y Agassiz, 1829)	1	B	lr, ab	LC	IR, IN, PSC, S, BA, BS
			Trachinocephalus myops (Forster, 1801)	1	B	ls, ab	LC	PSC
			Synodus saurus (Linnaeus, 1758)	1	B	lr, ab	LC	PSC, SA
			Synodus synodus (Linnaeus, 1758)	1	B	lr, ab	LC	IN, PSC, S
	Tetraodontidae	Canthigaster	*Canthigaster rostrata* (Bloch, 1786)	1	D	lr, ab	LC	IN, PSC, S, BN, CS
		Sphoeroides	*Sphoeroides dorsalis* Longley, 1934	1	D	ls, sm	LC	IN
			Sphoeroides pachygaster (Müller y Troschel, 1848)	1	D	lr, sm, ab	LC	SA
			Sphoeroides spengleri (Bloch, 1785)	1	D	ls, sm	LC	IR, IN, PSC, S, CS
	Trachichthyidae	Hoplostethus	*Hoplostethus occidentalis* Woods, 1973	1	P	lp	NE	IN, N, C
	Triacanthodidae	Hollardia	*Hollardia hollardi* Poey, 1861	1	D	ls, sm, lp	NE	IN, PSC, IS, N
		Parahollardia	*Parahollardia schmidti* Woods, 1959	1	D	ls, sm, lp	NE	IN, IS, N
	Steindachneriidae	Steindachneria	*Steindachneria argentea* Goode y Bean, 1896	1	D	lp	NE	IN, S, N

C	F	G	S					
Actinopteri	Trichiuridae	Benthodesmus	*Benthodesmus tenuis* (Günther 1877)	2	D	lp	LC	N
		Trichiurus	*Trichiurus lepturus* Linnaeus, 1758	1	B	lp, ca	LC	IS
	Triglidae	Bellator	*Bellator brachychir* (Regan, 1914)	1	D	ss, sm, lp	LC	IN, IS, N
			Bellator egretta (Goode y Bean, 1896)	1	D	ss, sm, lp	LC	S
			Bellator militaris (Goode y Bean, 1896)	1	D	ss, sm	LC	IN
		Prionotus	*Prionotus stearnsi* Jordan & Swain 1885	2	D	ss, sm, lp	LC	N
	Tripterygiidae	Enneanectes	*Enneanectes altivelis* Rosenblatt, 1960	1	D	lr, ab	LC	PSC, S
			Enneanectes atrorus Rosenblatt, 1960	1	D	lr, ab	LC	PSC, SA
			Enneanectes boehlkei Rosenblatt, 1960	1	D	lr, ab	LC	PSC, S
			Enneanectes jordani (Evermann y Marsh, 1899)	1	D	lr, ab	LC	PSC, SA
			Enneanectes pectoralis (Fowler, 1941)	1	D	lr, ab	LC	IN, PSC, S, CB
	Uranoscopidae	Kathetostoma	*Kathetostoma cubana* Barbour, 1941	1	D	ls, sm, lp	NE	IN, PSC, IS, N
	Xiphiidae	Xiphias	*Xiphias gladius* Linnaeus, 1758	1	P	lp, ca	DD*	SA
	Zenionidae	Zenion	*Zenion hololepis* (Goode y Bean, 1896)	1	D	lp	LC	IN, PSC, S, N, C
Elasmobranchii	Carcharhinidae	Carcharhinus	*Carcharhinus acronotus* (Poey, 1860)	1	P	ab	NT	IN
			Carcharhinus altimus (Springer, 1950)	1	P	ca	DD	IN
			Carcharhinus falciformis (Müller y Henle, 1839)	1	P	ca	NT	IR, IN, PSC
			Carcharhinus leucas (Müller y Henle, 1839)	1	P	ca	NT	IN
			Carcharhinus limbatus (Müller y Henle, 1839)	1	P	ca	VU*	IR, IN, PSC
			Carcharhinus longimanus (Poey, 1861)	1	P	ca	VU	PSC
			Carcharhinus obscurus Lesueur, 1818	1	P	ca	VU	IR, IN
			Carcharhinus perezii (Poey, 1876)	1	P	ab	NT	IR, IN, PSC, S, BS
			Carcharhinus plumbeus Nardo, 1827	1	P	ca	LC*	IR, IN, PSC
		Galeocerdo	*Galeocerdo cuvier* (Péron y Lesueur, 1822)	1	P	ca	NT	IR, IN, PSC, S
		Negaprion	*Negaprion brevirostris* (Poey, 1868)	1	P	ls	NT	IR, IN, SA
		Prionace	*Prionace glauca* (Linnaeus, 1758)	1	P	ca	NT	IN
		Rhizoprionodon	*Rhizoprionodon porosus* (Poey, 1861)	1	P	ca	LC	IR, IN, PSC, SA
	Dasyatidae	Dasyatis	*Dasyatis americana* Hildebrand y Schroeder, 1928	1	B	ab	DD	IR, IN, PSC, S, BN, BS, BR
	Ginglymostomatidae	Ginglymostoma	*Ginglymostoma cirratum* (Bonnaterre, 1788)	1	B	ab	VU*	IR, IN, S, N, C, BA, BS, BR
	Hexanchidae	Heptranchias	*Heptranchias perlo* (Bonnaterre, 1788)	1	D	lp	NT	IN
		Hexanchus	*Hexanchus nakamurai* Teng, 1962	1	D	lp	DD	IN
	Lamnidae	Isurus	*Isurus oxyrinchus* Rafinesque, 1810	1	P	ca	VU	IR, PSC, IS
	Myliobatidae	Aetobatus	*Aetobatus narinari* (Euphrasen, 1790)	1	P	ab, ca	NT	IR, IN, PSC, S, BS
		Manta	*Manta birostris* (Walbaum, 1792)	1	P	ab, ca	VU	PSC, S
	Narcinidae	Narcine	*Narcine bancroftii* (Griffith y Smith, 1834)	1	B	ls	CR	IR, PSC, SA
	Rajidae	Breviraja	*Breviraja mouldi* McEachran & Matheson 1995	2	D	lp	NE	N, C
		Cruriraja	*Cruriraja rugosa* Bigelow & Schroeder 1958	2	D	lp	DD	N, C
		Dactylobatus	*Dactylobatus clarkii* (Bigelow & Schroeder 1958)	2	D	lp	DD	N
		Dipturus	*Dipturus teevani* (Bigelow & Schroeder 1951)	2	D	lp	DD	N, C
		Fenestraja	*Fenestraja ishiyamai* (Bigelow & Schroeder 1962)	2	D	lp	DD	N
			Fenestraja sinusmexicanus (Bigelow y Schroeder, 1950)	1		lp	DD	IN, C
		Gurgesiella	*Gurgesiella atlantica* (Bigelow & Schroeder 1962)	2	D	lp	DD	N, C
		Leucoraja	*Leucoraja caribbaea* (McEachran 1977)	2	D	lp	NE	N
			Leucoraja garmani (Whitley, 1939)	1	B	lp	LC	IN, N
	Rhincodontidae	Rhincodon	*Rhincodon typus* Smith, 1828	1	P	ca	DD*	PSC, S
	Rhinobatidae	Rhinobatos	*Rhinobatos percellens* (Walbaum, 1792)	1	B	ls	NT	IR, IN
	Scyliorhinidae	Galeus	*Galeus arae* (Nichols 1927)	2	D	lp	LC	RB
		Schroederichthys	*Schroederichthys maculatus* Springer 1966	2	D	lp	LC	N
		Scyliorhinus	*Scyliorhinus boa* Goode & Bean 1896	2	D	lp	LC	N
			Scyliorhinus retifer (Garman, 1881)	1	D	lp	LC	IN
	Sphyrnidae	Sphyrna	*Sphyrna lewini* (Griffith y Smith, 1834)	1	P	ca	EN	IR, IN
			Sphyrna mokarran (Rüppell, 1837)	1	P	ca	EN	IR, SA
	Squalidae	Squalus	*Squalus cubensis* Howell Rivero, 1936	1	D	lp	DD	IN, IS
			Squalus mitsukurii Jordan & Snyder 1903	2	D	lp	DD	C
	Torpedinidae	Torpedo	*Torpedo andersoni* Bullis, 1962	1	D	lp	DD	SA
			Torpedo nobiliana Bonaparte, 1835	1	B	lp	DD*	IS
	Triakidae	Mustelus	*Mustelus canis insularis* Heemstra, 1997	1	D	lp	NT	IN, IS
	Urotrygonidae	Urobatis	*Urobatis jamaicensis* (Cuvier, 1816)	1	B	ab	LC	IR, IN, PSC, BN, CS
	Etmopteridae	Etmopterus	*Etmopterus robinsi* Schofield & Burgess 1997	2	D	lp	LC	N
			Etmopterus virens Bigelow, Schroeder & Springer 1953	2	D	lp	LC	C
Holocephali	Chimaeridae	Chimaera	*Chimaera cubana* Howell Rivero, 1936	1	B	lp	DD	IN, PSC
		Hydrolagus	*Hydrolagus alberti* Bigelow & Schroeder 1951	2	D	lp	DD	N, C
Myxini	Myxinidae	Eptatretus	*Eptatretus caribbeaus* Fernholm 1982	2	D	lp	LC	N

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References

[1]Bolaños-Cubillos N., A. Abril-Howard, H. Bent-Hooker, J.P. Caldas y A. Acero. 2015. Lista de peces conocidos del archipiélago de San Andrés, Providencia y Santa Catalina, Reserva de Biosfera Seaflower, Caribe occidental colombiano. Boletín de Investigaciones marinas y Costeras, 44(1): 127-162.

[2]Polanco F., A. 2015. Dynamics of the continental slope demersal fish community in the Colombian Caribbean. Tesis doctoral. Universidad Nacional de Colombia and Justus Liebig University Giessen, Germany, 189 p.

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Actinopteri	Macrouridae	Kuronezumia	*Kuronezumia bubonis* (Iwamoto 1974)	2	D	lp	LC	N
		Malacocephalus	*Malacocephalus laevis* (Lowe 1843)	2	D	lp	LC	N
			Malacocephalus occidentalis Goode & Bean 1885	2	D	lp	LC	N
		Nezumia	*Nezumia aequalis* (Günther 1878)	2	D	lp	LC	N
		Ventrifossa	*Ventrifossa macropogon* Marshall 1973	2	D	lp	NE	N
			Ventrifossa mucocephalus Marshall 1973	2	D	lp	NE	N
	Malacanthidae	Caulolatilus	*Caulolatilus cyanops* Poey, 1866	1	D	ls, sm, lp	LC	IN
			Caulolatilus guppyi Beebe y Tee-Van, 1937	1	D	ls, sm, lm	LC	IS, CB
			Caulolatilus williamsi Dooley y Berry, 1977	1	D	ls, sm, lm	DD	SA
		Malacanthus	*Malacanthus plumieri* (Bloch, 1786)	1	B	ls, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
	Megalopidae	Megalops	*Megalops atlanticus* Valenciennes, 1847	1	P	ab, ca	EN*	IN, SA
	Merlucciidae	Merluccius	*Merluccius albidus* (Mitchill, 1818)	1	D	lp	LC	IN, PSC, SA, IS, N, C
	Monacanthidae	Aluterus	*Aluterus monoceros* (Linnaeus, 1758)	1	D	sm, ab, ca	LC	PSC, SA
			Aluterus schoepfii (Walbaum, 1792)	1	D	lr, sm, ab	LC	PSC
			Aluterus scriptus (Osbeck, 1765)	1	D	lr, ab, ca	LC	IR, IN, PSC, S, BN, BS, BR, CB
		Cantherines	*Cantherines macrocerus* (Hollard, 1853)	1	D	lr, ab	LC	IR, IN, PSC, S, CS, BS, BR
			Cantherines pullus (Ranzani, 1842)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
		Monacanthus	*Monacanthus ciliatus* (Mitchill, 1818)	1	D	ss, sm	LC	PSC, SA
		Monacantus	*Monacanthus tuckeri* Bean, 1906	1	D	ss, sm	LC	IR, IN, PSC, S, CS
		Stephanolepis	*Stephanolepis hispidus* (Linnaeus, 1766)	1	D	ls, sm, ab	LC	PSC, SA
			Stephanolepis setifer (Bennett, 1831)	1	D	ls, sm	LC	PSC, SA
	Moridae	Laemonema	*Laemonema goodebeanorum* Meléndez C. & Markle 1997	2	D	lp	NE	N
	Moringuidae	Moringua	*Moringua edwardsi* (Jordan y Bollman, 1889)	1	B	ab	LC	IN, PSC, IS
	Mugilidae	Agonostomus	*Agonostomus monticola* (Bancroft, 1834)	1	D	ls, sm	LC	PSC
		Mugil	*Mugil curema* Valenciennes, 1836	1	P	ls, sm	LC	IR, IN, PSC, SA, BS
			Mugil liza Valenciennes, 1836	1	P	ls, sm	EN*	PSC, SA, BS
			Mugil trichodon Poey, 1875	1	P	ls, sm	LC	IR, IN, PSC, IS, BS, CB
	Mullidae	Mulloidichthys	*Mulloidichthys martinicus* (Cuvier, 1829)	1	D	ls, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Pseudupeneus	*Pseudupeneus maculatus* (Bloch, 1793)	1	D	ls, ab	LC	IR, IN, PSC, S, BS, BR
		Upeneus	*Upeneus parvus* Poey, 1852	1	D	ls, sm	LC	PSC
	Muraenidae	Anarchias	*Anarchias similis* (Lea, 1913)	1	B	ab	LC	IN, PSC
		Echidna	*Echidna catenata* (Bloch, 1795)	1	B	ab	LC	IN, PSC, SA
		Enchelycore	*Enchelycore carychroa* Böhlke y Böhlke, 1976	1	B	ab	LC	PSC, IS, CB, CA
			Enchelycore nigricans (Bonnaterre, 1788)	1	B	ab	LC	IN, PSC, S
		Gymnothorax	*Gymnothorax conspersus* Poey, 1867	1	B	lp	NE	IN
			Gymnothorax funebris Ranzani, 1839	1	B	ab	LC	IR, IN, PSC, S, BR
			Gymnothorax maderensis (Johnson, 1862)	1	D	ls	LC	IN
			Gymnothorax miliaris (Kaup, 1856)	1	B	ab	LC	IR, IN, PSC, S, CS, CA
			Gymnothorax moringa (Cuvier, 1829)	1	B	ab	LC	IR, IN, PSC, S, BS, BR
			Gymnothorax ocellatus Agassiz, 1831	1	B	ab	LC	PSC
			Gymnothorax vicinus (Castelnau, 1855)	1	B	ab	LC	IN, PSC, S
		Uropterygius	*Uropterygius macularius* (Lesueur, 1825)	1	B	ab	LC	IN, PSC
	Myctophidae	Centrobranchus	*Centrobranchus nigroocellatus* (Günther, 1873)	1	P	ca	LC	RB
		Diaphus	*Diaphus dumerilii* (Bleeker, 1856)	1	P	lp	LC	IS, N, CB, CA
			Diaphus lucidus (Goode y Bean, 1896)	1	P	lp	LC	IS, CB, CA
			Diaphus perspicillatus (Ogilby, 1898)	1	P	lp	LC	IS, CB, CA
			Diaphus taaningi	2	D	lp	DD	N
		Myctophum	*Myctophum affine* (Lütken, 1892)	1	P	lp	LC	IS, CB
			Myctophum asperum Richardson, 1845	1	P	lp	LC	RB
			Myctophum nitidulum Garman, 1899	1	P	lp	LC	RB
			Myctophum obtusirostre (Tåning, 1928)	1	P	lp	LC	RB
	Nemichthyidae	Nemichthys	*Nemichthys scolopaceus* Richardson 1848	2	D	lp	LC	N
	Neoscopelidae	Neoscopelus	*Neoscopelus microchir* Matsubara 1943	2	D	lp	NE	C
			Neoscopelus macrolepidotus Johnson 1863	2	D	lp	LC	N
	Nettastomatidae	Faciollela	*Faciollela sp.*	2	D	lp	NE	N, C
		Hoplunnis	*Hoplunnis macrura* Ginsburg 1951	1	B	lp	LC	IN
			Hoplunnis similis Ginsburg, 1951	2	D	lp	NE	N
			Hoplunnis tenuis Ginsburg, 1951	1	B	lp	LC	IN, SA, N
	Nomeidae	Nomeus	*Nomeus gronovii* (Gmelin, 1789)	1	P	lp, ca	LC	IR, IN
		Psenes	*Psenes cyanophrys* Valenciennes, 1833	1	P	lp, ca	LC	PSC, IS
	Ogcocephalidae	Dibranchus	*Dibranchus atlanticus* Peters, 1876	1	D	ls, sm, lp	LC	IN, PSC, S, N
		Halieutichthys	*Halieutichthys caribbaeus* Garman, 1896	1	D	ls, sm, lm	NE	SA, IS
		Malthopsis	*Malthopsis gnoma* Bradbury, 1998	1	D	ls, sm, lp	NE	IN, N
		Ogcocephalus	*Ogcocephalus pumilus* Bradbury, 1980	1	D	ls, sm, lp	LC	IN
		Zalieutes	*Zalieutes mcgintyi* (Fowler, 1952)	1	D	ls, sm, lm	LC	IN, IS, N
	Ophichthidae	Ahlia	*Ahlia egmontis* (Jordan, 1884)	1	B	sm, ab	LC	IN, PSC, S
		Callechelys	*Callechelys bilinearis* Kanazawa, 1952	1	B	ab	LC	IR, PSC
Actinopteri	Ophichthidae	Callechelys	*Callechelys guineensis* (Osório, 1894)	1	B	ab	LC	SA
		Myrichthys	*Myrichthys breviceps* (Richardson, 1848)	1	B	ab	LC	IR, IN, PSC, S, BN, BS
			Myrichthys ocellatus (Lesueur, 1825)	1	B	ab	LC	IN, PSC
		Myrophis	*Myrophis platyrhynchus* Breder, 1927	1	D	ls	LC	IN, PSC
			Myrophis punctatus Lütken, 1852	1	D	ls	LC	PSC
		Ophichthus	*Ophichthus ophis* (Linnaeus, 1758)	1	B	ls	LC	IN, SA, BR
			Ophichthus spinicauda (Norman, 1922)	1	B	ls	LC	IN
	Ophidiidae	Lepophidium	*Lepophidium entomelan* Robins, Robins y Brown, 2012	1	D	lp	LC	IN, PSC, N, C
			Lepophidium kallion Robins, 1959	1	D	lp	NE	IN, N
			Lepophidium marmoratum (Goode y Bean, 1885)	1	D	lp	LC	IN, N
			Lepophidium staurophor Robins, 1959	1	D	lp	LC	IN, IS, N
			Lepophidium zophochir Robins, Robins & Brown 2012	2	D	lp	LC	N
		Monomitopus	*Monomitopus agassizii* (Goode y Bean, 1896)	1	B	lp	LC	S
		Neobythites	*Neobythites marginatus* Goode y Bean, 1886	1	B	lp	LC	IR, IN, PSC, N, C
			Neobythites multiocellatus Nielsen, Uiblein y Mincarone, 2009	1	B	lp	LC	IN, IS, N
			Neobythites ocellatus Günther 1887	2	D	lp	NE	N
		Parophidion	*Parophidion schmidti* (Woods y Kanazawa, 1951)	1	B	sm	LC	PSC
		Petrotyx	*Petrotyx sanguineus* (Meek y Hildebrand, 1928)	1	B	ab	LC	PSC
		Pycnocraspedum	*Pycnocraspedum sp*	2	D	lp		N
	Opistognathidae	Opistognathus	*Opistognathus aurifrons* (Jordan y Thompson, 1905)	1	B	ls, ab	LC	IR, IN, PSC, S, CS, BA, BS, BR
			Opistognathus macrognathus Poey, 1860	1	B	ls, ab	LC	PSC, SA
			Opistognathus maxillosus Poey, 1860	1	B	ls, ab	LC	IN, PSC, S, CA
			Opistognathus whitehursti (Longley, 1927)	1	B	ls, ab	LC	IN, PSC, SA
	Ostraciidae	Acanthostracion	*Acanthostracion polygonius* Poey, 1876	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR, CB
			Acanthostracion quadricornis (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S
		Lactophrys	*Lactophrys bicaudalis* (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S, BN, BR
			Lactophrys trigonus (Linnaeus, 1758)	1	D	lr, ab	LC	IN, PSC, S
			Lactophrys triqueter (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
	Paralepididae	Lestrolepis	*Lestrolepis intermedia* (Poey 1868)	2	D	lp	LC	N
		Stemonosudis	*Stemonosudis rothschildi* Richards 1967	2	D	lp	NE	N
	Paralichthyidae	Ancylopsetta	*Ancylopsetta cycloidea* Tyler 1959	2	D	lp	LC	N
			Ancylopsetta microctenus Gutherz, 1966	1	B	lp	NE	IN, IS, N
		Citharichthys	*Citharichthys amblybregmatus* Gutherz y Blackmann, 1970	1	B	lp	DD	S
			Citharichthys cornutus (Günther, 1880)	1	B	lp	LC	IS, N, C
			Citharichthys dinoceros Goode y Bean, 1886	1	B	lp	LC	IN, S
			Citharichthys gymnorhinus Gutherz y Blackmann, 1970	1	B	lp	LC	S
		Syacium	*Syacium micrurum* Ranzani, 1842	1	B	sm, lp	LC	PSC
	Parazenidae	Cyttopsis	*Cyttopsis rosea* (Lowe, 1843)	1	P	lp	LC	IN, PSC, S, N
		Parazen	*Parazen pacificus* Kamohara, 1935	1	D	lp	NE	IN, S
	Pempheridae	Pempheris	*Pempheris poeyi* Bean, 1885	1	D	lr, ab, ca	LC	SA
			Pempheris schomburgkii Müller y Troschel, 1848	1	D	lr, ab, ca	LC	IR, IN, PSC, S, CS, CA
	Percophidae	Bembrops	*Bembrops anatirostris* Ginsburg, 1955	1	D	sm, lp	LC	IN, S, N
			Bembrops macromma Ginsburg, 1955	1	D	sm, lp	LC	IN, N
			Bembrops magnisquamis Ginsburg, 1955	1	D	sm, lp	NE	IN, S, N
			Bembrops ocellatus Thompson y Suttkus, 1998	1	D	sm, lp	NE	IN, S, N, C
			Bembrops quadrisella Thompson & Suttkus, 1996	1	D	sm, lp	NE	IN, S, N, C
		Chrionema	*Chrionema squamentum* (Ginsburg, 1955)	1	D	ss	NE	IS
	Peristediidae	Peristedion	*Peristedion brevirostre* (Günther, 1860)	1	D	ss, sm, ab	NE	IN
			Peristedion ecuadorense Teague, 1961	1	D	ss, lp	NE	PSC, S
			Peristedion greyae Miller, 1967	1	D	ss, lp	NE	IN, PSC, S, N, C
			Peristedion longispatha Goode y Bean, 1896	1	D	ss, lp	NE	IN, SA, N
			Peristedion sp1	1	D	lp		N
			Peristedion sp2	1	D	lp		N
			Peristedion truncatum (Günther, 1880)	1	D	ss, sm, lp	NE	IN, PSC, S, N, C
	Phosichthyidae	Polymetme	*Polymetme thaeocoryla* Parin & Borodulina 1990	2	D	lp	LC	N, C
		Yarrella	*Yarrella blackfordi* Goode & Bean 1896	2	D	lp	LC	N
	Pleuronectidae	Poecilopsetta	*Poecilopsetta inermis* (Breder 1927)	2	D	lp	NE	N
	Poeciliidae	Gambusia	*Gambusia aestiputeus* Fowler, 1950	1		mg	VU*	SA
		Poecilia	*Poecilia orri* Fowler, 1943	1		mg	NE	PSC
	Polymixiidae	Polymixia	*Polymixia lowei* Günther, 1859	1		lp	NE	IR, IN, PSC, S, N
			Polymixia nobilis Lowe 1836	2	D	lp	LC	N
	Polynemidae	Polydactylus	*Polydactylus virginicus* (Linnaeus, 1758)	1	D	ls, sm	LC	IN, PSC, IS, CB
	Pomacanthidae	Centropyge	*Centropyge argi* Woods y Kanazawa, 1951	1	D	lr, ls, sm	LC	IR, IN, CS, BR
			Centropyge aurantonotus Burgess, 1974	1	D	lr, ls, sm	LC	PSC
		Holacanthus	*Holacanthus ciliaris* (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
			Holacanthus tricolor (Bloch, 1795)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
		Pomacanthus	*Pomacanthus arcuatus* (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S, CS, BS
Actinopteri	Pomacanthidae	Pomacanthus	*Pomacanthus paru* (Bloch, 1787)	1	D	lr, ab	LC	IR, IN, PSC, S, BA, BS
		Abudefduf	*Abudefduf saxatilis* (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
			Abudefduf taurus (Müller y Troschel, 1848)	1	D	lr, ab	LC	IR, IN, PSC, S, BN, BR
		Chromis	*Chromis cyanea* (Poey, 1860)	1	D	ab, ca	LC	IR, IN, PSC, S, BA, BS, BR
			Chromis insolata (Cuvier, 1830)	1	D	lr, ab	LC	IR, IN, PSC, S, CS, BR, CB
			Chromis multilineata (Guichenot, 1853)	1	D	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Microspathodon	*Microspathodon chrysurus* (Cuvier, 1830)	1	D	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Stegastes	*Stegastes adustus* (Troschel, 1865)	1	D	lr, ab	LC	IR, IN, PSC, S
			Stegastes diencaeus (Jordan y Rutter, 1897)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
			Stegastes leucostictus (Müller y Troschel, 1848)	1	D	lr, ab	LC	IR, IN, PSC, S, BR
			Stegastes partitus (Poey, 1868)	1	D	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
			Stegastes planifrons (Cuvier, 1830)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
			Stegastes xanthurus (Poey, 1860)	1	D	lr, ab	LC	IR, IN, PSC, S
	Priacanthidae	Cookeolus	*Cookeolus japonicus* (Cuvier, 1829)	1	D	lr, ab, lp	NE	IN
		Heteropriacanthus	*Heteropriacanthus cruentatus* (Lacepède, 1801)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
		Priacanthus	*Priacanthus arenatus* Cuvier, 1829	1	D	lr, ab, ca	LC	PSC, S, CB
		Pristigenys	*Pristigenys alta* (Gill, 1862)	1	D	lr, ab, lm	LC	S
	Rachycentridae	Rachycentron	*Rachycentron canadum* (Linnaeus, 1766)	1	P	ca	LC	IN, PSC, SA
	Rivulidae	Kryptolebias	*Kryptolebias marmoratus* (Poey, 1880)	1		mg	LC	SA
	Sciaenidae	Corvula	*Corvula batabana* (Poey, 1860)	1	D	ls, sm, ab	LC	PSC
		Equetus	*Equetus lanceolatus* (Linnaeus, 1758)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, CS
			Equetus punctatus (Bloch & Schneider, 1801)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BS
		Odontoscion	*Odontoscion dentex* (Cuvier, 1830)	1	D	lr, ab	LC	PSC, SA,IR
		Pareques	*Pareques acuminatus* (Bloch y Schneider, 1801)	1	D	lr, sm, ab	LC	IN, PSC, SA, IS, CS
		Umbrina	*Umbrina coroides* Cuvier, 1830	1	D	ls, sm	LC	PSC
	Scombridae	Acanthocybium	*Acanthocybium solandri* (Cuvier, 1832)	1	P	ca	LC	IN, PSC, S, CB
		Auxis	*Auxis thazard thazard* (Lacepède, 1800)	1	P	ca	LC	PSC, S, CB
		Euthynnus	*Euthynnus alletteratus* (Rafinesque, 1810)	1	P	ca	LC	IR, IN, PSC, S, CB
		Katsuwonus	*Katsuwonus pelamis* (Linnaeus, 1758)	1	P	ca	LC	IN, PSC, S
		Scomberomorus	*Scomberomorus cavalla* (Cuvier, 1829)	1	P	ca	LC	IR, IN, PSC, S
			Scomberomorus regalis (Bloch, 1793)	1	P	ca	LC	IN, PSC, S, CB
		Thunnus	*Thunnus alalunga* (Bonnaterre, 1788)	1	P	ca	DD*	SA
			Thunnus albacares (Bonnaterre, 1788)	1	P	ca	NT	IN, SA
			Thunnus atlanticus (Lesson, 1831)	1	P	ca	LC	IR, IN, PSC, S, CB
			Thunnus obesus (Lowe 1839)	1	P	ca	DD*	IR, IN, PSC, S, CB
	Scombropidae	Scombrops	*Scombrops oculatus* (Poey, 1860)	1	D	lp	NE	SA
	Scorpaenidae	Ectreposebastes	*Ectreposebastes imus* Garman, 1899	1	D	sm, lp, ca	LC	IN
		Pontinus	*Pontinus castor* Poey, 1860	1	D	lr, sm, ab	LC	IN
		Pterois	*Pterois volitans* (Linnaeus, 1758)	1	D	lr, ls, sm, lp		IR, IN, PSC, S
		Scorpaena	*Scorpaena agassizi* Goode y Bean, 1896	1	D	lr, ab, lp	LC	IS
			Scorpaena albifimbria Evermann y Marsh, 1900	1	D	ls, sm	LC	S, CA
			Scorpaena brachyptera Eschmeyer, 1965	1	D	ls, sm, ab	LC	IS
			Scorpaena inermis Cuvier, 1829	1	D	lr, sm, ab	LC	PSC
			Scorpaena plumieri Bloch, 1789	1	D	lr, sm, ab	LC	IR, IN, PSC, S, CS, BA, BR
		Scorpaenodes	*Scorpaenodes caribbaeus* Meek y Hildebrand, 1928	1	D	lr, ab	LC	PSC, S
			Scorpaenodes tredecimspinosus (Metzelaar, 1919)	1	D	lr, ab	LC	PSC, SA
		Setarches	*Setarches guentheri* Johnson, 1862	1	B	ss, sm, lp	LC	IN, PSC, IS, N
	Serranidae	Alphestes	*Alphestes afer* (Bloch, 1793)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BR
		Bullisichthys	*Bullisichthys caribbaeus* Rivas, 1971	1	D	lr, ab, lp	LC	IN, SA, N
		Cephalopholis	*Cephalopholis cruentata* (Lacepède, 1802)	1	D	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Cephalopolis	*Cephalopolis fulva* (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Epinephelus	*Epinephelus adscensionis* (Osbeck, 1765)	1	D	lr, ab	LC	IN, PSC, S, BS
			Epinephelus guttatus (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
			Epinephelus itajara (Lichtenstein, 1822)	1	D	lr, sm, ab	CR*	IR, IN, PSC, S, BR, CB
			Epinephelus morio (Valenciennes, 1828)	1	D	lr, sm, ab	NT	IN, S
			Epinephelus striatus (Bloch, 1792)	1	D	lr, ab	EN*	IR, IN, PSC, S, BS
		Hypoplectrus	*Hypoplectrus aberrans* Poey, 1868	1	D	ab	LC	IR, IN, PSC, S
			Hypoplectrus castroaguirrei Del Moral Flores, Tello-Musi y Martínez-Pérez	1	D	lr, ab	EN	PSC
			Hypoplectrus chlorurus (Cuvier, 1828)	1	D	lr, ab	LC	IN, PSC, IS
			Hypoplectrus gummigutta (Poey, 1851)	1	D	ab	LC	IN, PSC, SA
			Hypoplectrus guttavarius (Poey, 1852)	1	D	ab	LC	IR, IN, PSC, S, CS, BS, BR
			Hypoplectrus indigo (Poey, 1851)	1	D	ab	LC	IR, IN, PSC, S, BR
			Hypoplectrus nigricans (Poey, 1852)	1	D	ab	LC	IR, IN, PSC, S, BN, BS, BR
			Hypoplectrus providencianus Acero y Garzón-Ferreira, 1994	1	D	ab	VU*	IR, IN, PSC, S, BS, BR
			Hypoplectrus puella (Cuvier, 1828)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
			Hypoplectrus randallorum Lobel, 2011	1	D	ab	LC	IN, PSC, SA
			Hypoplectrus unicolor (Walbaum, 1792)	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR

Interactive table

Fish

Phylum Chordata

Actinopteri

F	G	S					
Gempylidae	Neoepinnula	*Neoepinnula americana* (Grey 1953)	2	D	lp	LC	N
	Promethichthys	*Promethichthys prometheus* (Cuvier, 1832)	1	P	lp	LC	IN, SA, N
	Ruvettus	*Ruvettus pretiosus* Cocco, 1833	1	B	lp, ca	LC	IS
Gerreidae	Diapterus	*Diapterus auratus* Ranzani, 1842	1	D	ls, sm	LC	PSC, SA
	Eucinostomus	*Eucinostomus argenteus* Baird y Girard, 1855	1	D	ls, sm	LC	IR, PSC, SA
		Eucinostomus gula (Quoy y Gaimard, 1824)	1	D	ls, sm	LC	PSC, SA
		Eucinostomus havana (Nichols, 1912)	1	D	ls, sm	LC	PSC, SA
		Eucinostomus jonesii (Günther, 1879)	1	D	ls, sm	LC	PSC, SA
		Eucinostomus lefroyi (Goode, 1874)	1	D	ls, sm	LC	SA
		Eucinostomus melanopterus (Bleeker, 1863)	1	D	ls, sm	LC	PSC, SA
	Eugerres	*Eugerres plumieri* (Cuvier, 1830)	1	D	ls, sm	VU*	SA
	Gerres	*Gerres cinereus* (Walbaum, 1792)	1	D	ls, sm	LC	IN, PSC, S
Giganturidae	Gigantura	*Gigantura chuni* Brauer 1901	2	D	lp	LC	N
Gobiesocidae	Acyrtus	*Acyrtus artius* Briggs, 1955	1	D	lr, ab	LC	PSC
		Acyrtus rubiginosus (Poey, 1868)	1	D	lr, ab	LC	PSC, SA
	Arcos	*Arcos nudus* (Linnaeus, 1758)	1	D	lr, ab	LC	PSC, SA
	Gobiesox	*Gobiesox punctulatus* (Poey, 1876)	1	D	lr, ab	LC	IN, PSC
	Tomicodon	*Tomicodon cryptus* Williams y Tyler, 2003	1	D	lr	LC	PSC
		Tomicodon fasciatus (Peters, 1859)	1	D	lr, ab	LC	PSC, SA
		Tomicodon reitzae Briggs, 2001	1	D	lr, ab	LC	PSC
		Tomicodon rupestris (Poey, 1860)	1	D	lr, ab	LC	SA
Gobiidae	Awaous	*Awaous banana* (Valenciennes, 1837)	1	D	mg	NE	PSC
	Barbulifer	*Barbulifer ceuthoecus* (Jordan y Gilbert, 1884)	1	D	sm	LC	PSC
	Bathygobius	*Bathygobius curacao* (Metzelaar, 1919)	1	D	sm, ab	LC	PSC
		Bathygobius mystacium Ginsburg, 1947	1	D	sm, ab	LC	S
		Bathygobius soporator (Valenciennes, 1837)	1	D	sm, ab	LC	IN, PSC, SA, BR
	Cerdale	*Cerdale floridana* Longley, 1934	1	D	ab, lr	LC	SA
	Coryphopterus	*Coryphopterus alloides* Böhlke y Robins, 1960	1	D	ab, lr	VU	PSC
		Coryphopterus dicrus Böhlke y Robins, 1960	1	D	lr, sm, ab	LC	IR, IN, PSC, S, CS
		Coryphopterus eidolon Böhlke y Robins, 1960	1	D	ab, sm	VU	IR, IN, PSC, S, CB
		Coryphopterus glaucofraenum Gill, 1863	1	D	sm, ab	LC	IR, IN, PSC, S, BS, BR
		Coryphopterus hyalinus Böhlke y Robins, 1962	1	D	ab	VU	PSC
		Coryphopterus kuna Victor, 2007	1	D	sm, ls	DD	SA
		Coryphopterus lipernes Böhlke y Robins, 1962	1	D	ab	VU	IN, PSC, SA, BS
		Coryphopterus personatus (Jordan y Thompson, 1905)	1	D	lr, ab	VU	IR, IN, PSC, S, BS, BR
		Coryphopterus thrix Böhlke y Robins, 1960	1	D	sm, ab	VU	PSC, SA
		Coryphopterus tortugae (Jordan, 1904)	1	D	sm, ab	VU	IN, PSC, BR
	Ctenogobius	*Ctenogobius boleosoma* (Jordan y Gilbert, 1882)	1	D	sm	LC	PSC
		Ctenogobius saepepallens (Gilbert y Randall, 1968)	1	D	sm	LC	PSC, CB, CA
	Elacatinus	*Elacatinus evelynae* (Böhlke y Robins, 1968)	1	D	ab	LC	IR, IN, PSC, S, CS, BS, BR
		Elacatinus horsti (Metzelaar, 1922)	1	D	ab, lr	LC	IR, IN, PSC, S, BS, BR
		Elacatinus illecebrosus (Böhlke y Robins, 1968)	1	D	lr, ab	LC	PSC, SA, IR
		Elacatinus lori Colin, 2002	1	D	ab	LC	IN, PSC
		Elacatinus louisae (Böhlke y Robins, 1968)	1	D	ab, lr	LC	IN, PSC, SA, BR
		Elacatinus prochilos (Böhlke y Robins, 1968)	1	D	ab	VU	IN, PSC, SA
		Elacatinus serranilla Randall y Lobel, 2009	1	D	ab, lr	LC	IR, PSC
		Elacatinus sp. P	1	D	ab		PSC
	Evermannichthys	*Evermannichthys metzelaari* Hubbs, 1923	1	D	ab, lr	LC	PSC
	Ginsburgellus	*Ginsburgellus novemlineatus* (Fowler, 1950)	1	D	ab, lr	LC	PSC, SA
	Gnatholepis	*Gnatholepis thompsoni* Jordan, 1904	1	D	lr, ab	LC	IR, IN, PSC, S, CS, BS, BR
	Lythrypnus	*Lythrypnus crocodilus* (Beebe y Tee-Van, 1928)	1	D	lr, ab	LC	PSC
		Lythrypnus elasson Böhlke y Robins, 1960	1	D	lr, ab	LC	PSC, IS, CB, CA
		Lythrypnus heterochroma Ginsburg, 1939	1	D	lr, ab	LC	PSC, S
		Lythrypnus minimus Garzón-Ferreira y Acero P., 1988	1	D	lr, ab	LC	PSC
		Lythrypnus nesiotes Böhlke y Robins, 1960	1	D	lr, ab	LC	PSC
		Lythrypnus okapia Robins y Böhlke, 1964	1	D	lr, ab	LC	PSC
		Lythrypnus spilus Böhlke y Robins, 1960	1	D	lr, ab	LC	PSC
	Nes	*Nes longus* (Nichols, 1914)	1	D	ls	LC	IN, PSC, S, BS, BR, CA
	Oxyurichthys	*Oxyurichthys stigmalophius* (Mead y Böhlke, 1958)	1	D	ls	LC	SA
	Priolepis	*Priolepis hipoliti* (Metzelaar, 1922)	1	D	lr, ab	LC	PSC, S, CA
	Psilotris	*Psilotris batrachodes* Böhlke, 1963	1	D	ls	LC	PSC
		Psilotris celsus Böhlke, 1963	1	D	lr, ab	LC	PSC
	Ptereleotris	*Ptereleotris helenae* (Randall, 1968)	1	D	lr, ls, ab	LC	PSC, SA
	Pycnomma	*Pycnomma roosevelti* Ginsburg, 1939	1	D	lr, ls, ab	LC	PSC, SA
	Risor	*Risor ruber* (Rosén, 1911)	1	D	lr, ab	LC	IR, IN, PSC, SA, BR
	Tigrigobius	*Tigrigobius dilepis* (Robins y Böhlke, 1964)	1	D	lr, ab	LC	IN, PSC, S, BS
		Tigrigobius gemmatus (Ginsburg, 1939)	1	D	lr, ab	LC	PSC

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F	G	S					
Gobiidae	Tigrigobius	*Tigrigobius pallens* (Ginsburg, 1939)	1	D	lr, ab	LC	PSC, SA, IS
		Tigrigobius panamensis Victor 2010	1	D	lr, ab		SA
		Tigrigobius saucrus (Robins, 1960)	1	D	lr, ab	LC	PSC
	Varicus	*Varicus bucca* Robins y Böhlke, 1961	1	D	ls	NE	IN
Grammatidae	Gramma	*Gramma loreto* Poey, 1868	1	D	ab	LC	IR, IN, PSC, S, CS, BR
		Gramma melacara Böhlke y Randall, 1963	1	D	ab	LC	IR, IN, PSC, S, BR, CB
	Lipogramma	*Lipogramma evides* Robins y Colin, 1979	1	D	ab	LC	SA
		Lipogramma roseum Gilbert, 1979	1	D	ab	LC	PSC
		Lipogramma trilineatum Randall, 1963	1	D	ab	LC	PSC
Grammicolepididae	Grammicolepis	*Grammicolepis brachiusculus* (Poey, 1873)	1	P	lp	LC	SA, IS
	Xenolepidichthys	*Xenolepidichthys dalgleishi* Gilchrist, 1922	1	P	lp	LC	IN, PSC, S, N
Haemulidae	Anisotremus	*Anisotremus surinamensis* (Bloch, 1791)	1	D	lr, ab	NE	IN, PSC, S
		Anisotremus virginicus (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S, CB
	Emmelichthyops	*Emmelichthyops atlanticus* Schultz, 1945	1	P	ab, ca	LC	PSC, IS
	Haemulon	*Haemulon album* Cuvier, 1830	1	D	lr, sm, ab	NE	IR, IN, PSC, S, BN, BS, BR
		Haemulon aurolineatum Cuvier, 1830	1	D	lr, sm, ab	LC	IR, IN, PSC, S, CS, BR, CB
		Haemulon bonariense Cuvier, 1830	1	D	ls, sm, ab	NE	PSC, SA
		Haemulon carbonarium Poey, 1860	1	D	lr, ab	LC	IR, IN, PSC, S
		Haemulon chrysargyreum Günther, 1859	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BS, BR
		Haemulon flavolineatum (Desmarest, 1823)	1	D	lr, sm, ab	NE	IR, IN, PSC, S, BA, BS, BR
		Haemulon macrostomum Günther, 1859	1	D	lr, ab	LC	IR, IN, PSC, SA
		Haemulon melanurum (Linnaeus, 1758)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR, CB
		Haemulon parra (Desmarest, 1823)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, CS, BA, BS, BR
		Haemulon plumierii (Lacepède, 1801)	1	D	lr, sm, ab	NE	IR, IN, PSC, S, CS, BS, BR
		Haemulon sciurus (Shaw, 1803)	1	D	lr, sm, ab	NE	IR, IN, PSC, S, CS
		Haemulon striatum (Linnaeus, 1758)	1	D	lr, ab, ca	LC	IR, PSC, S, CS
		Haemulon vittatum (Poey, 1860)	1	D	ab, ca	LC	IR, IN, PSC, S, CB
Halosauridae	Halosaurus	*Halosaurus ovenii* Johnson 1864	2	D	lp	LC	N
Hemiramphidae	Euleptorhamphus	*Euleptorhamphus velox* Poey, 1868	1	P	ca	LC	SA, IS, CB
	Hemiramphus	*Hemiramphus balao* Lesueur, 1821	1	P	ca	LC	IR, IN, IS, CB
		Hemiramphus brasiliensis (Linnaeus, 1758)	1	P	ca	LC	IR, PSC, SA, BS, BR
	Oxyporhamphus	*Oxyporhamphus similis* Bruun, 1935	1	P	ca	LC	IS, CB
Holocentridae	Flammeo	*Flammeo marianus* (Cuvier, 1829)	1	B	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
	Holocentrus	*Holocentrus adscensionis* (Osbeck, 1765)	1	B	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Holocentrus rufus (Walbaum, 1792)	1	B	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
	Myripristis	*Myripristis jacobus* Cuvier, 1829	1	B	lr, ab	LC	IR, IN, PSC, S, CS, BA, BS, BR
	Ostichthys	*Ostichthys trachypoma* (Günther, 1859)	1	D	lp	LC	IN
	Plectrypops	*Plectrypops retrospinis* (Guichenot, 1853)	1	B	ab	LC	PSC, S, CB, CA
	Sargocentron	*Sargocentron coruscum* (Poey, 1860)	1	B	ab	LC	IN, PSC, S
		Sargocentron poco (Woods, 1965)	1	B	lr, ab	LC	PSC
		Sargocentron vexillarium (Poey, 1860)	1	B	lr, ab	LC	IR, IN, PSC, S, BN, BA, BS, BR
Ipnopidae	Bathypterois	*Bathypterois bigelowi* Mead 1958	2	D	lp	NE	N
Istiophoridae	Istiophorus	*Istiophorus platypterus* (Shaw, 1792)	1	P	ca	LC	PSC, SA, IS
	Makaira	*Makaira nigricans* Lacepède, 1802	1	P	ca	VU	IR, IS, CB
Kyphosidae	Kyphosus	*Kyphosus cinerascens* (Forsskal, 1775)	1	D	lr, ab, ca	LC	SA
		Kyphosus sectatrix (Linnaeus, 1758)	1	D	lr, ab, ca	LC	IR, IN, PSC, S
		Kyphosus vaigiensis (Quoy y Gaimard, 1825)	1	D	lr, ab, ca	LC	IR, IN, PSC, S
Labridae	Bodianus	*Bodianus pulchellus* (Poey, 1860)	1	D	lr, ab	LC	PSC, S
		Bodianus rufus (Linnaeus, 1758)	1	D	lr, ab	LC	IR, IN, PSC, S, BA, BS, BR
	Clepticus	*Clepticus parrae* (Bloch y Schneider, 1801)	1	D	lr, ab, ca	LC	IR, IN, PSC, S, BS, BR, CB
	Cryptotomus	*Cryptotomus roseus* Cope, 1871	1	D	ls, sm	LC	IN, PSC, SA, BR
	Decodon	*Decodon puellaris* (Poey, 1860)	1	D	lr, sm, ab	LC	SA
	Doratonotus	*Doratonotus megalepis* Günther, 1862	1	D	ls, sm, ab	LC	PSC, SA
	Halichoeres	*Halichoeres bivittatus* (Bloch, 1791)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Halichoeres cyanocephalus (Bloch, 1791)	1	D	lr, sm, ab	LC	IR, IN, PSC, SA
		Halichoeres garnoti (Valenciennes, 1839)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Halichoeres maculipinna (Müller y Troschel, 1848)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BN, CS, BS, BR
		Halichoeres pictus (Poey, 1860)	1	D	lr, sm, ab	LC	IR, IN, PSC, SA, CS
		Halichoeres poeyi (Steindachner, 1867)	1	D	lr, sm, ab	LC	IR, IN, PSC, SA, CS
		Halichoeres radiatus (Linnaeus, 1758)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
	Lachnolaimus	*Lachnolaimus maximus* (Walbaum, 1792)	1	D	lr, sm, ab	EN*	IR, IN, PSC, S, CS, BR
	Nicholsina	*Nicholsina usta* (Valenciennes, 1840)	1	D	lr, ls, sm	LC	IN
	Scarus	*Scarus coelestinus* Valenciennes, 1840	1	D	lr, ab	DD	IR, IN, PSC, S, BS, BR
		Scarus coeruleus (Bloch, 1786)	1	D	lr, ab	LC	IN, PSC, S, BS, BR, CB
		Scarus guacamaia Cuvier, 1829	1	D	lr, sm, ab	VU*	IN, PSC, S, CA
		Scarus iseri (Bloch, 1789)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BN, BS, BR
		Scarus taeniopterus Desmarest, 1831	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR

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F	G	S					
Labridae	Scarus	*Scarus vetula* Bloch y Schneider, 1801	1	D	lr, ab	LC	IR, IN, PSC, S, BS, BR
	Sparisoma	*Sparisoma atomarium* (Poey, 1861)	1	D	sm, ab	LC	IR, IN, PSC, S, BS, BR
		Sparisoma aurofrenatum (Valenciennes, 1840)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BS, BR
		Sparisoma chrysopterum (Bloch y Schneider, 1801)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BS, BR
		Sparisoma radians (Valenciennes, 1840)	1	D	lr, sm, ab	LC	IN, PSC, S, BR
		Sparisoma rubripinne (Valenciennes, 1840)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
		Sparisoma viride (Bonnaterre, 1788)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BN, BS, BR
	Thalassoma	*Thalassoma bifasciatum* (Bloch, 1791)	1	D	lr, sm, ab	LC	IR, IN, PSC, S, BA, BS, BR
	Xyrichthys	*Xyrichthys martinicensis* Valenciennes, 1840	1	D	ls, sm, ab	LC	IN, PSC, SA, BS
		Xyrichthys novacula (Linnaeus, 1758)	1	D	ls, sm, ab	LC	IN, PSC, SA
		Xyrichthys splendens Castelnau, 1855	1	D	ls, sm, ab	LC	IR, IN, PSC, S
Labrisomidae	Labrisomus	*Labrisomus albigenys* Beebe y Tee-Van, 1928	1	D	lr, ab	LC	IN
		Labrisomus bucciferus Poey, 1868	1	D	lr, ls, sm	LC	IN, PSC, S, CB
		Labrisomus filamentosus Springer, 1960	1	D	lr, ab	LC	PSC, IS
		Labrisomus gobio (Valenciennes, 1836)	1	D	lr, sm, ab	LC	IN, PSC, SA
		Labrisomus guppyi (Norman, 1922)	1	D	lr, ab	LC	IN, PSC, SA
		Labrisomus haitiensis Beebe y Tee-Van, 1928	1	D	lr, ab	LC	PSC, SA
		Labrisomus kalisherae (Jordan, 1904)	1	D	lr, ls, sm	LC	PSC, SA
		Labrisomus nigricinctus Howell Rivero, 1936	1	D	lr, ab	LC	IN, PSC, S, CB
		Labrisomus nuchipinnis (Quoy y Gaimard, 1824)	1	D	lr, ls, sm	LC	IN, PSC, S, CA
	Malacoctenus	*Malacoctenus aurolineatus* Smith, 1957	1	D	lr, ab	LC	IN, PSC, SA
		Malacoctenus boehlkei Springer, 1959	1	D	lr, ab	LC	IR, IN, PSC, S, BR, CA
		Malacoctenus erdmani Smith, 1957	1	D	lr, ls, sm	LC	PSC, S, CA
		Malacoctenus gilli (Steindachner, 1867)	1	D	lr, ls, sm	LC	IN, PSC, S, CB, CA
		Malacoctenus macropus (Poey, 1868)	1	D	lr, ls, sm	LC	IN, PSC, S, CB, CA
		Malacoctenus triangulatus Springer, 1959	1	D	lr, ls, sm	LC	IR, IN, PSC, S, BN, CS
		Malacoctenus versicolor (Poey, 1876)	1	D	lr, sm, ab	LC	S
	Nemaclinus	*Nemaclinus atelestos* Bohlke y Springer, 1975	1	D	ls, sm	LC	IS
	Paraclinus	*Paraclinus fasciatus* (Steindachner, 1876)	1	D	lr, sm, ab	LC	PSC, SA
		Paraclinus marmoratus (Steindachner, 1876)	1	D	lr, sm, ab	LC	PSC
		Paraclinus naeorhegmis Böhlke, 1960	1	D	lr, ab	LC	PSC
		Paraclinus nigripinnis (Steindachner, 1867)	1	D	lr, sm, ab	LC	PSC, S
	Starksia	*Starksia atlantica* Longley, 1934	1	D	lr, ab	LC	PSC, CB
		Starksia elongata Gilbert, 1971	1	D	lr, ab	LC	PSC
		Starksia fasciata (Longley, 1934)	1	D	lr, ab	LC	PSC, IS
		Starksia hassi Klausewitz, 1958	1	D	lr, ab	LC	PSC, SA
		Starksia langi Baldwin y Castillo, 2011	1	D	lr, ab	LC	PSC, SA
		Starksia lepicoelia Böhlke y Springer, 1961	1	D	lr, ab	LC	PSC, CA
		Starksia nanodes Böhlke y Springer, 1961	1	D	lr, ab	LC	PSC, S, CA
		Starksia occidentalis Greenfield, 1979	1	D	lr, sm, ab	LC	PSC
		Starksia robertsoni Baldwin, Victor y Castillo, 2011	1	D	lr, ab	LC	PSC, S
		Starksia sluiteri (Metzelaar, 1919)	1	D	lr, ab	LC	PSC, IS, CB, CA
		Starksia sp B	1	D	lr, ab		PSC, S
		Starksia y-lineata Gilbert, 1965	1	D	lr, ab	DD	PSC, S, CB
	Stathmonotus	*Stathmonotus hemphillii* Bean, 1885	1	D	lr, ab	LC	PSC, IS, CB, CA
		Stathmonotus tekla Nichols, 1910	1	D	lr, ab	LC	PSC, IS
Lobotidae	Lobotes	*Lobotes surinamensis* (Bloch, 1790)	1	D	ls, sm, ca	LC	IN, IS, CB
Lophiidae	Lophiodes	*Lophiodes monodi* (Le Danois 1971)	2	D	lp	NE	N
		Lophiodes reticulatus Caruso y Suttkus, 1979	1	D	ls, sm, lp	LC	SA
Lutjanidae	Apsilus	*Apsilus dentatus* Guichenot, 1853	1	D	lr, ab, lp	LC	IN, PSC, S, CB
	Etelis	*Etelis oculatus* (Valenciennes, 1828)	1	D	lr, ab, lp	NE	IR, IN, PSC, S, CA
	Lutjanus	*Lutjanus analis* (Cuvier, 1828)	1	D	lr, sm, ab	NT*	IR, IN, PSC, S
		Lutjanus apodus (Walbaum, 1792)	1	D	lr, sm, ab	NE	IR, IN, PSC, S, CS, BS, BR
		Lutjanus buccanella (Cuvier, 1828)	1	D	ls, sm, ab	NE	IN, PSC, SA
		Lutjanus cyanopterus (Cuvier, 1828)	1	D	ls, sm, ab	VU*	IN, PSC, SA
		Lutjanus griseus (Linnaeus, 1758)	1	D	lr, sm, ab	NE	IR, IN, PSC, S, CS, CB
		Lutjanus jocu (Bloch y Schneider, 1801)	1	D	lr, sm, ab	NE	IR, IN, PSC, S, BS, BR
		Lutjanus mahogoni (Cuvier, 1828)	1	D	lr, sm, ab	NE	IR, IN, PSC, S, BS, BR
		Lutjanus purpureus (Poey, 1866)	1	D	lp	NE	IR, IN, PSC, S
		Lutjanus synagris (Linnaeus, 1758)	1	D	lr, ls, sm	NE	IR, IN, PSC, SA, CS
		Lutjanus vivanus (Cuvier, 1828)	1	D	lr, ls, sm, lp	NE	IR, IN, PSC, S, CA
	Ocyurus	*Ocyurus chrysurus* (Bloch, 1791)	1	D	lr, sm, ab	NE	IR, IN, PSC, S, BN, CS, BS, BR
	Pristipomoides	*Pristipomoides macrophthalmus* (Müller y Troschel, 1848)	1	D	lr, ls, sm, lp	LC	IR, IN, PSC, S
	Rhomboplites	*Rhomboplites aurorubens* (Cuvier, 1829)	1	D	lp	NE	IR, IN, PSC, S, N, CA
Macrouridae	Coelorinchus	*Coelorinchus caelorhincus* (Risso 1810)	2	D	lp	LC	N
	Hymenocephalus	*Hymenocephalus billsam* Marshall & Iwamoto 1973	2	D	lp	NE	N
		Hymenocephalus italicus Giglioli 1884	2	D	lp	LC	N

Interactive table

MARINE TETRAPODS

Maria Camila Rosso Londoño[1], Erika Paola Ortiz Gómez[1], Lilie Duque Caicedo[1], Dalila Caicedo Herrera[1], Fernando Trujillo[1], Andrea Pacheco Garzón[2], Martha García Escobar[2], Jairo Lasso Zapata y Manuel Garrido-Linares[3]

1 Omacha Foundation

2 Autonomous Corporation for the Sustainable Development of the Archipelago of San Andrés, Providencia and Santa Catalina (CORALINA)

3 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

Tetrapods are vertebrate animals having two pairs of limbs (Kardong, 2007). In the oceans, groups meeting these characteristics are aquatic turtles, birds and mammals, each having different and important roles in the ecosystem.

Sea turtles act as links between environments of low and high productivity as they facilitate energy transport and promote stabilization of vegetated bottoms in their feeding areas **(Bjorndal y Jackson, 2003).** Birds have control over some fish stocks **(Beron, 2003; Bugoni y Voorem, 2004; Silva Rodríguez *et al.*, 2000)** and transport energy between terrestrial and marine ecosystems, playing an important role in the phosphorus cycle **(Cushman, G. 2013; Lukkari *et al.*, 2008).**

Regarding marine mammals, that are at different levels of the food chain, besides regulating other populations **(Cury *et al.*, 2001; Savenkoff *et al.*, 2008; Tollit *et al.*, 2010)**, they are indicators of the health of ecosystems because of their rapid behavioral changes due to disturbances in the environment. They are also considered sentinel species as their ability to bioaccumulate allow them to detect a large number of persistent contaminants in the places they inhabit **(Bossard, 2006; Dorneles *et al.*, 2013; Reddy *et al.*, 2001; Van Bressem *et al.*, 2009)**. Recently, whales (mysticetes) have been listed as biotic buffers, i.e., species capable of stabilizing systems that are constantly exposed to external natural and anthropogenic stressors **(Schwarzmüller *et al.*, 2015).**

Despite their importance, knowledge about these groups is limited at a national level, and biological and management information for the Seaflower Biosphere Reserve is poor **(CORALINA—INVEMAR, 2012)**. The information known regarding the species of these groups recorded for the reserve and its vicinities is presented below.

SEA TURTLES

Seven species of sea turtles are known in the world, representing the families Cheloniidae and Dermochelyidae, and are as follows: the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*), the hawksbill sea turtle (*Eretmochelys imbricata*), the Kemp's ridley sea turtle (*Lepidochelys kempii*), the olive ridley sea turtle (*Lepidochelys olivacea*), the flatback sea turtle (*Natator depressus*) and the leatherback sea turtle (*Dermochelys coriacea*) **(Meylan y Meylan, 2000)**. The existence of an eighth species, the Pacific green turtle (*Chelonia agassizii*) that inhabits the eastern Pacific is under discussion, as some authors say it is the very green sea turtle and others consider it a different species due to its genetic features (haplotypes) and morphological characteristics **(Urbiola y Chassin, 2011)**.

Sea turtles exhibit a highly-specialized morphology due to their adaptations for living in the sea: their limbs are paddle-shaped, their lacrimal glands are elongated and have been modified to remove the excess of salts accumulated in body fluids from drinking seawater, the bone material of their shells is reduced and they have an elongated coracoid in the shoulder that anchors the pectoral muscles used during swimming **(Meylan y Meylan, 2000)**.

In general, all species of sea turtles are born on beaches. After hatching, they leave the nest and head out to the open sea where they begin their pelagic phase whose duration varies depending on the species and populations. When they reach adulthood, they travel to feeding sites. Copulation occurs along migration corridors, in courtship and mating sites and in nearby nesting beaches. In the breeding season, they move to the nesting beaches where, in most cases, females arrive more than once per season **(Carr *et al.*, 1978)**.

In Colombia, six of the seven existing sea turtle species classified have been reported. They nest on 127 beaches and feed on seagrass beds (phanerogams) and coral formations in the Caribbean littoral **(Ceballos Fonseca, 2004)**.

In the Seaflower Biosphere Reserve, four species have been reported: *Caretta caretta, Eretmochelys imbricata, Chelonia mydas* and *Demochelys coriacea*, They arrive each year to lay eggs on some beaches of the reserve from August to November **(CORALINA—INVEMAR, 2012)**.

The most frequently reported species on the beaches within the Seaflower Biosphere Reserve is *Caretta caretta*, commonly known as loggerhead sea turtle. It has a large head and powerful jaws resulting from adaptation processes for the consumption of molluscs and hard-shell crabs, although their diet also includes tunicates, fish and plants **(Dodd, 1988)**.Adults reach a straight carapace length of 120 cm and weigh up to 200 kg **(Pritchard *et al.* 1983; REF: Figura 1)**.

It has been determined that the breeding season of this species in the archipelago occurs from May to November, with a peak in June (Herrón, 2004).

Figura 1. Tortuga *caretta caretta*—Loggerhead (*Caguama*). Photo: Omacha Foundation.

For its part, *Eretmochelys imbricata* has a high frequency of nesting records on the beaches of the archipelago, especially in San Andrés Island and Albuquerque and Bolívar Cays in the south **(McCormick 1997, 1998, 1999)**. **Guerra (2013)** reports nine positive nesting records in Albuquerque Cay; six, in San Andrés Island; and five, in Bolívar Cay, identifying the breeding season of this species in the reserve between May and November, with a peak in August **(Herrón, 2004)**.

This turtle is commonly known as carey or hawksbill. It is distinguished by a strong, narrow and pointed horny beak it uses to feed on sponges and other organisms with a soft body found in coral reefs. Its carapace is oval, often serrated, has four pairs of lateral scutes that are overlapped like tiles, and black, brown, orange and gold streaks. This turtle has two pairs of pre-frontal scutes between the eyes. Adults rarely exceed 80 kg in weight and reach a straight carapace length of up to 90 cm **(Pritchard *et al.* 1983)**.

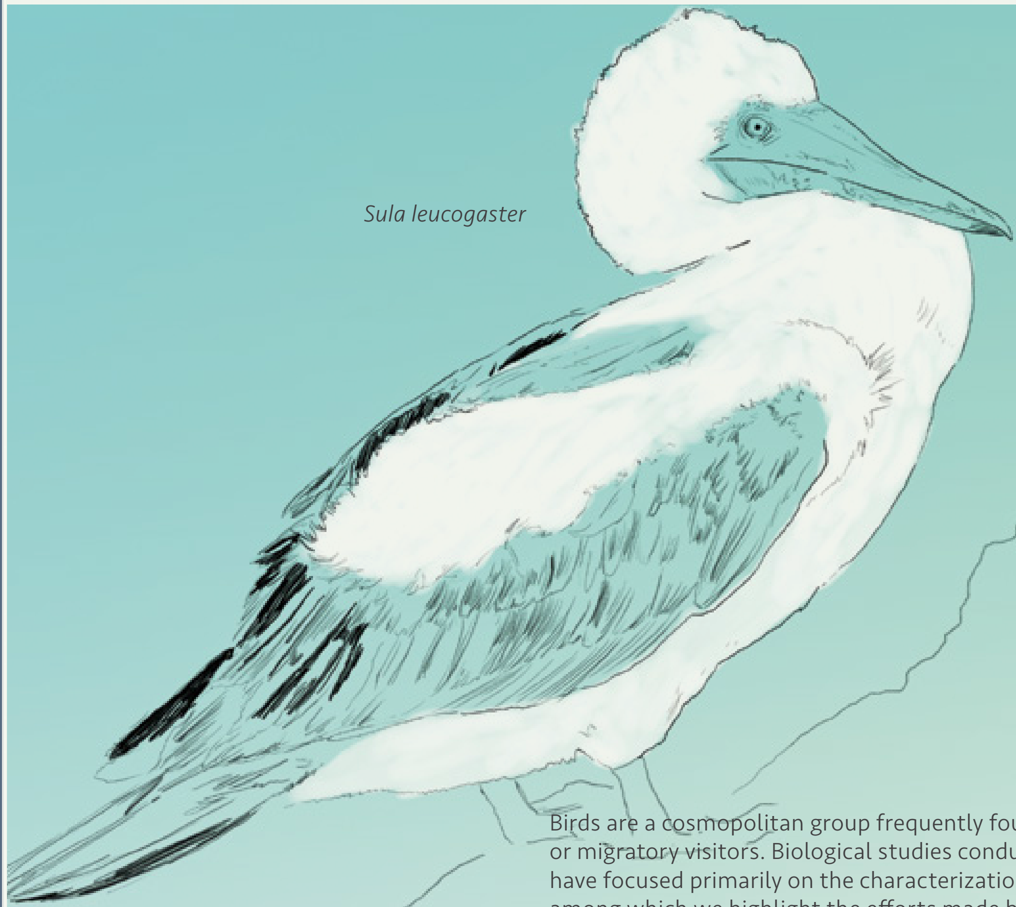
The species *Chelonia mydas* or green sea turtle uses the beaches of the archipelago between April and November, with a peak in July **(Herrón, 2004)**. Moreover, sightings of juveniles (with a carapace length between 20 and 50 cm) have been reported in seagrass beds in the waters adjacent to Albuquerque Cay. There has also been evidence of foraging behavior in the seagrass beds near the islet in patches of approximately 8 m² **(McCormick, 1997, 1998)**.

Lastly, there is the species *Dermochelys coriácea*, known as the leatherback sea turtle, lute turtle, trunk turtle or leathery turtle, which is considered rare or occasional on the beaches of the archipelago **(Herrón, 2004)**. This species is the largest sea turtle reaching carapace lengths of up to 2.5 m and weighing between 300 and 500 kg in its adult stage **(Pritchard y Mortimer, 2000)**.

It is easily distinguished from other sea turtles because its carapace has no scutes; instead, it has a smooth and slightly flexible surface covered with a layer of soft and black skin with small white spots. In addition, the carapace is elongated and has seven vertical ridges. Ventrally, the coloration is similar although some areas are predominantly light. Its pectoral fins are almost as long as its body **(Pritchard y Mortimer, 2000)**.

The leatherback sea turtle has a more extensive distribution area compared to that of any other reptile. Thanks to its ability to produce metabolic heat and to its large body fat content, it lives in tropical waters where it nests and in cold waters in Canada and Europe **(Eckert y Eckert, 1988)**.

Dermochelys coriácea **reaching carapace lengths of up to 2,5m and weighing between 300- 500 kg in its adult stage**



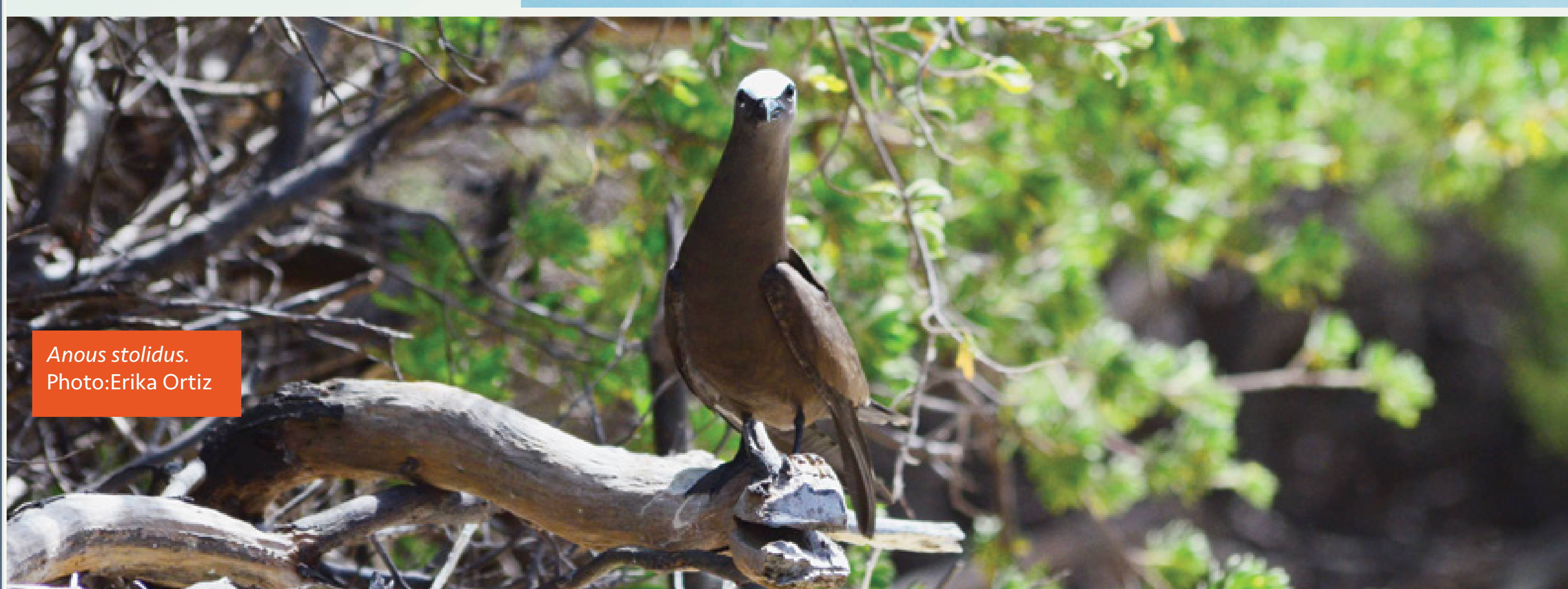
Sula leucogaster

AVIFAUNA

Birds are a cosmopolitan group frequently found in almost every environment, as residents or migratory visitors. Biological studies conducted so far in the Seaflower Biosphere Reserve have focused primarily on the characterization and monitoring of marine and coastal birds, among which we highlight the efforts made by the government and private entities, as well as universities and research groups. In 2011 (August and October), 2013 (August) and 2014 (April), researchers from the Omacha Foundation made observations in the northern cays and surrounding areas, as part of three research projects, obtaining records of 26 species of birds, which has enabled to add ten new species to the inventory of avifauna available in the Management Plan of the Northern Cays **(Omacha Foundation—Coralina, 2013).**

Figure 2. Birds with reproductive colonies in northern cays. Brown booby (*Sula leucogaster*),brown noddy (*Anous stolidus*)and scooty tern (*Onychoprion fuscatus*).

Onychoprion fuscatus
Photo:Erika Ortiz



Anous stolidus.
Photo:Erika Ortiz

Leiothlypis peregrina
Photo:Erika Ortiz

26
Birds species

For her part, Pacheco (2012) reported the presence of 156 species in the reserve, of which 140 are boreal migratory species and 16 are endemic species of San Andrés and Providencia Islands **(McNish, 2003)**. **62% of the recorded species correspond to birds of marine-coastal habits** that use remote cays as feeding and reproduction areas. This is the case of the brown booby (*Sula leucogaster*), the scooty tern (*Onychoprion fuscatus*) and the brown noddy (*Anous stolidus*), which are wide-spreading species that usually have reproductive colonies in insular zones, from where they travel long distances at the end of the reproductive season **(Naranjo *et al.*, 2012) (Figure 3)**. Thanks to their wide spreading, they can be indicators of productive areas; moreover, they intervene in the cycle of the elements and indicate ecosystem changes, since their multiple specializations make them sensitive to changes **(Piatt *et al.*, 2007).**

The remaining 38% corresponds to migratory continental birds, mainly warblers, which were observed using these islands as resting and feeding areas Their presence confirms the importance of these cays in their life cycles and as part of the migration corridors, whose itinerary has been described from the north, through the prairies, the costs of the Gulf of Mexico towards Central America or crossing over the major islands of the Caribbean, to arrive in Colombia around the Sierra Nevada de Santa Marta **(Naranjo *et al.*, 2012).**

Setophaga palmarum.
Photo:Erika Ortiz

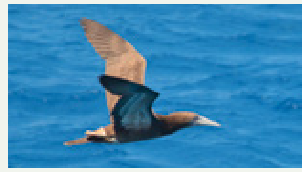
Petrochelidon pyrrhonota.
Photo:Nathalia Prada

Figure 3. Some migratory species recorded in the northern cays: Tennessee warbler (*Leiothlypis peregrina*), palm warbler (*Setophaga palmarum*), barn swallow (*Hirundo rustica*) and American cliff swallow (*Petrochelidon pyrrhonota*).

Hirundo rustica.
Photo:Erika Ortiz

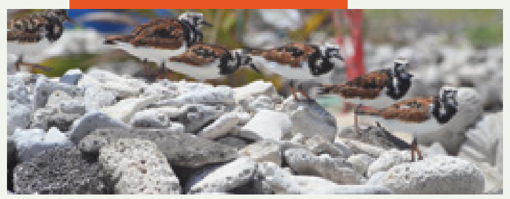
The results suggest that the cays are very likely to be a part of this corridor and provide shelter to the birds during their journeys, especially during adverse climatic events such as hurricanes and tropical storms that occur regularly in the zone and affect the journey of these individuals for some time **(Wiley y Wunderle, 1993).**

According to Ainley (1980), **sonly nine of the 156 families of birds of the world are seabirds.** In the Seaflower Biosphere Reserve, there are three orders (Procellariiformes, Pelecaniformes and Charadriiformes), represented by 11 families (Procellariidae, Phaethontidae, Pelecanidae, Sulidae, Phalacrocoracidae, Fregatidae, Charadriidae, Recurvirostridae, Scolopacidae, Laridae and Stercorariidae), and 50 species **(García, 2004).**

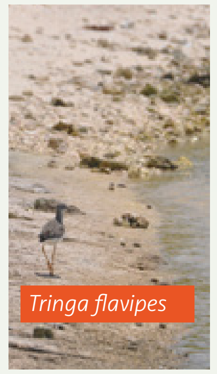


Sula leucogaster

Tringa semipalmata



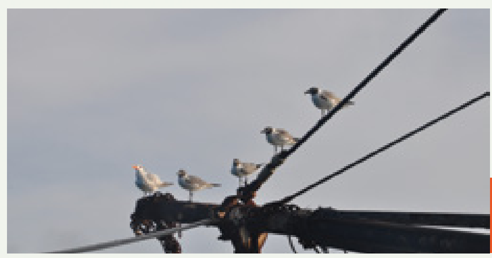
Arenaria interpres

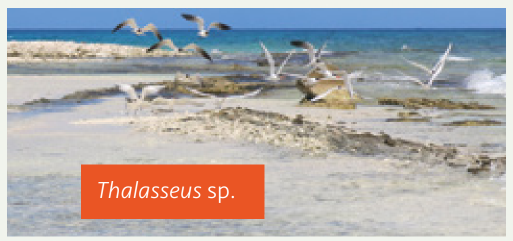


Tringa flavipes

Fregata magnificens

Leucophaeus atricilla





Thalasseus sp.

Leucophaeus atricilla

Thalasseus maximus

Sula dactylatra.

Figure 4. Seabirds of the Seaflower Biosphere Reserve.

These families share characteristics typical of seabirds: they obtain all their food from the sea, dispose of practically all their waste in the sea, die in the sea and always take part in the energy cycles of the marine ecosystem. As marine organisms, their spatial and time distribution is directly affected by the abiotic characteristics of the oceanic habitat, such as temperature, salinity, turbulence, winds, among other conditions **(Pocklington, 1979; Hunt y Schneider, 1987; Schlatter y Simeone, 1999).**

As for their trophic relationships, almost all of them are secondary or tertiary carnivores **(Hunt *et al.*, 1990).** They eat between 20% and 35% of the production of marine prey, being schools of crustaceans, cephalopods and fish the most common prey. Their high rate of food, energy requirements, metabolism, as well as the large quantities of nutrients that they return to the marine environment indicate that seabirds are key components of pelagic ecosystems **(Furness, 1978).**

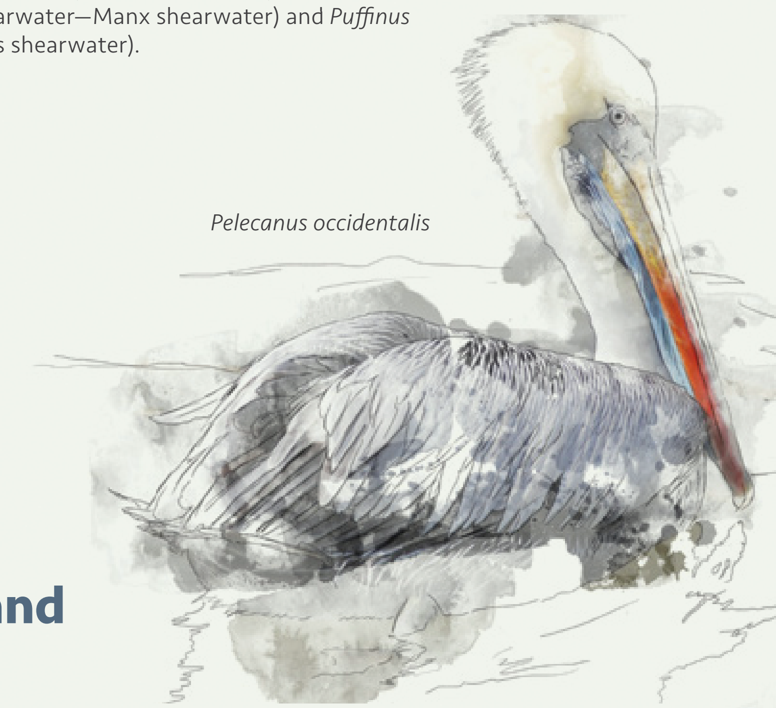
Seabirds are characterized for nesting in colonies and for being monogamous, philopatric and quite long-lived individuals of reduced positions and delayed sexual maturitys **(Lack, 1967; 1968).** The variations in their patterns of life history are related according to trophic strategies, and, with that, to costs of reproduction **(Furness y Monaghan, 1987; Lack, 1968)**. Seabirds are key components of pelagic ecosystems **(Furness, 1978)**, nest typically in coastal sectors difficult to access to, such as islands and islets **(Lack, 1967; 1968)**, and can drink seawater since they have physiological adaptations to eliminate salt excess.

The main classification criterion to determine whether a bird is a seabird is the obtention of food directly from the marine environment. In that way, there are species that feed exclusively or partially at the shores, breaking wave zones, marshes and littoral swamps, but do not venture the sea to eat **(Croxall *et al.* 1984; Wynne Edwards, 1985)**. On the other hand, there are species that—although they feed at the shores and breaking wave zones—are able to venture offshore; they are classified as coastal birds (e.g. Laridae).

Shearwaters, petrels, puffins and their relatives

Birds classified under the family Procellariidae (shearwaters, petrels, puffins and their relatives) are open-sea tubenose birds, similar to seagulls but with a different flight. Shearwaters quickly graze the surface alternating a few wingbeats with long directional soars; they take food directly from the surface or by diving shallowly. Petrels flap and soar like shearwaters, but keep the wings slightly folded in the carpus, not straight; they often turn erratically, rising. Birds of this family are mainly nocturnal and feed on squid that they take from the surface. Most members of this family stay from five to six months nesting in dens or holes of scarps of oceanic islands. There are three species of this group in the reserve: *Puffinus griseus* (*sooty shearwater—Sooty shearwater*); *P. puffinus* (Manx shearwater—Manx shearwater) and *Puffinus lherminier* (Audobon´s shearwater).

Puffinus griseus



Pelecanus occidentalis

Pelicans

Pelicans (family Pelecanidae) are large birds with long bills and huge gular pouches. They generally fly in formation with slow wingbeats and short soars. Flying or resting, their heads remain retracted and their bills rest over their necks. They catch fish by diving or by submerging their heads and necks while swimming **(Hilty y Brown, 2001)**. In the reserve, the brown pelican (Pelecanus occidentalis) and, occasionally, the American white pelican (*P. erythrorhynchos*) can be found.

Boobies and gannets

They are large, social, angular-like seabirds with sharp bills, narrow and pointed wings and cuneiform tails (family Sulidae). Boobies are found in warm tropical oceans, whereas gannets are found mainly in temperate and cold oceans. Both species feed by obliquely diving from considerable heights to catch fish that sometimes they chase and swallow underwater. Boobies have distendable featherless gular pouches and they nest in colonies on the ground or in low trees **(Hilty y Brown, 2001).**

Three species of boobies can be found in the reserve: the red-footed booby (*Sula sula sula*), Masked Booby (*Sula dactylatra*) and the Brown Booby (*Sula leucogaster*); two of them nest in the northern cays.

Sula sula sula

Cormorants

Phalacrocorax auritus

Cormorants, belonging to the family Phalacrocoracidae, are an ancient and widely spread group of totipalmate aquatic birds. They are found in coastal waters and in internal lagoons, where they feed mainly on fish that they chase underwater. They are social birds nesting in colonies, often in big flocks at coastal scarps, on the ground or in small trees. They are the great producers of guano in the Peruvian coast and they are trained for fishing in the Eastern world **(Hilty y Brown, 2001)**. Two species of cormorants are permanent residents of the reserve: the neotropic cormorant (*Phalacrocorax olivaceus*) and the double-crested cormorant (*Phalacrocorax auritus*).

Fregata magnifecens

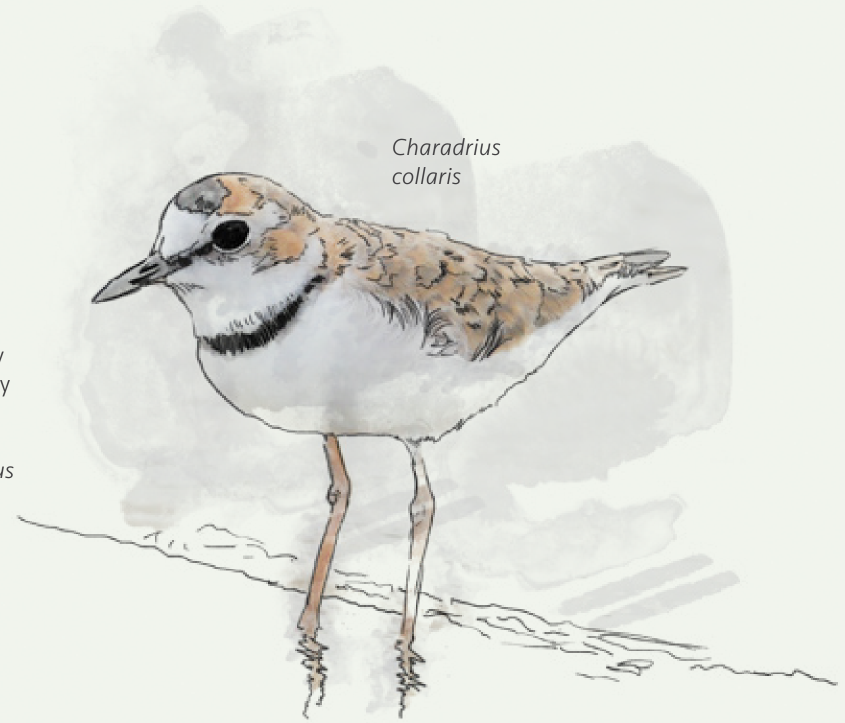
Frigatebirds

Frigatebirds are a small group of seabirds of warm oceans (family Fregatidae). They are the only seabirds that never alight intentionally on water. They are exceptionally buoyant and agile to fly and have the greatest wingspan in relation to their weight. Frigatebirds nest in colonies in oceanic islands. The prevailing characteristic of males is their ability to inflate and exhibit a ball-shaped red gular pouch **(Hilty y Brown, 2001)**. The species magnificent frigatebird (*Fregata magnifecens*) lives in our archipelago.

Lapwings and plovers

The family Charadriidae is distributed all around the world. Its members are individuals with more robust bodies than those of Scolopacidae (common sandpipers, Wilson's snipes and related); they also have shorter and thicker pigeon-like bills. They can be found in littorals and in shores of bodies of water, but they usually do not wade through. Many of them are found in meadows and dry savannas **(Hilty y Brown, 2001)**. Six species have been reported in the archipelago: the black-bellied plover (*Pluvialis squatarola*); the American golden plover (*Pluvialis dominica*); the killdeer (*Charadrius vociferus*); the semipalmated plover (*Charadrius semipalmatus*); the Wilson's plover (*Charadrius wilsonia*) and the collared plover (*Charadrius collaris*).

Charadrius collaris



Stilts and avocets

Himantopus mexicanus

Stilts and avocets are part of the family Recurvirostridae, consisting of a small group of long-legged thin-billed slender wading birds, spread locally in both warm and temperate regions around the world. All family members exhibit outstanding patterns in black and white, although frequently with several plumage hues in their heads and necks. In Colombia, there is only one of the three species of the New World **(Hilty y Brown, 2001)** the black-necked stilt (*Himantopus mexicanus*).

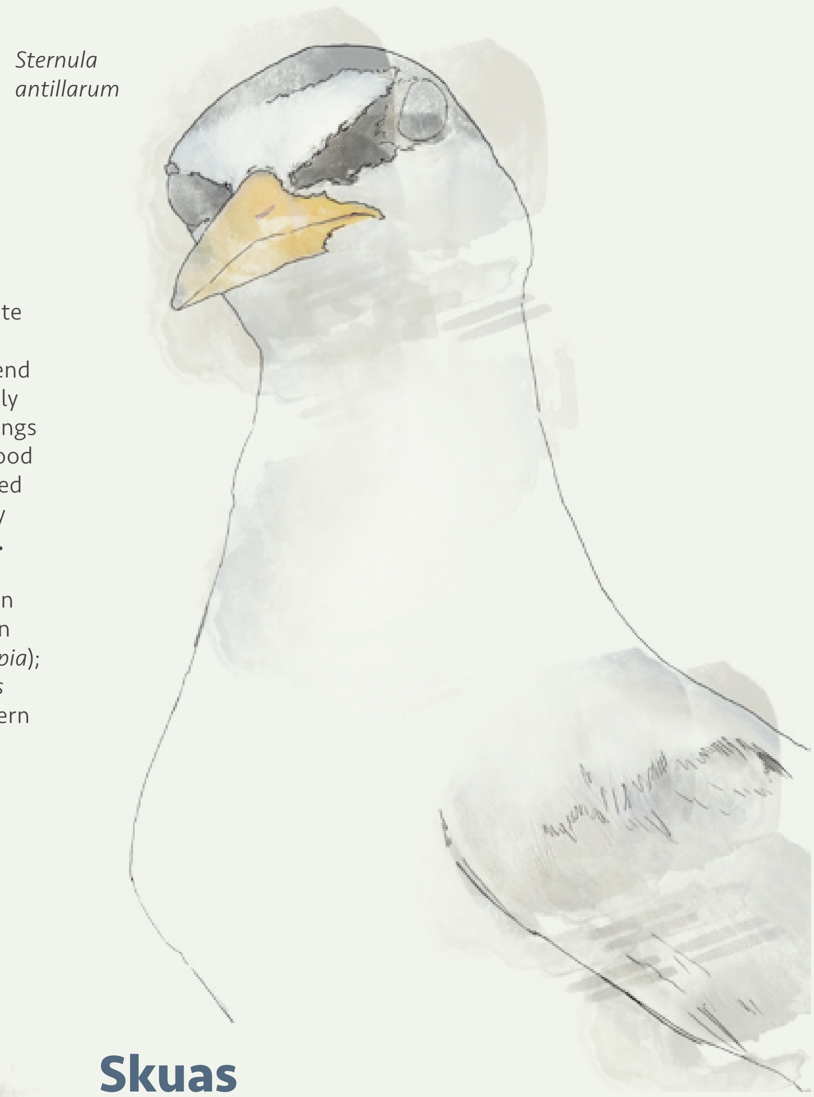
Wading birds

The Scolopacidae is a large worldwide-spread family closely related to plovers, from which they differ, among other characteristics, for having slenderer proportions, longer legs and necks and, sometimes, bent bills or slightly folded downwards at the end. Most of the family members are more gregarious during migration; in their hibernating areas, they are closer to water. They are found mainly in low lands and some of them are found in small numbers, even at great heights. First-year individuals of many species stay in the hibernating areas during summer **(Hilty y Brown, 2001)**. The 18 species visiting the archipelago **(Tabla 1)**, have their offspring in temperate or arctic zones and pass through or reside in the islands during winter. Individuals visiting the archipelago generally do not have their reproductive plumage, frequently making their identification difficult.

SCIENTIFIC NAME	COMMON NAME (ENGLISH)	COMMON NAME (SPANISH)
Actitis macularia	Spotted Sandpiper	Playero manchado Andarríos maculado
Calidris minutilla	Least Sandpiper	Playerito menudo
Calidris melanotos	Pectoral Sandpiper	Playerito pectoral
Calidris mauri	Western Sandpiper	Playerito occidental Correlimos picudo
Calidris alba	Sanderling	Chorlo
Calidris pusilla	Semipalmated Sandpiper	Playerito gracioso o semipalmeado
Tringa melanoleuca	Greater Yellowlegs	Gran playero patiamarillo
Tringa solitaria	Solitary Sandpiper	Playero solitario
Tringa flavipes	Lesser Yellowlegs	Playero patiamarillo chico
Arenaria interpres	Ruddy Turnstone	Revuelvepiedras
Numenius phaeopus	Whimbrel	Playero pico curvo
Bartramia longicauda	Upland Sandpiper	Correlimos batitú
Gallinago delicata	Common Snipe	Becasina—Caica
Tringa semipalmatus	Willet	Playero aliblanco
Limnodromus griseus	Short-Billed Dowitcher	Chorlo picocorto—Becasina piquicorta
Limnodromus	Long-Billed Dowitcher	Chorlo picolargo
scolopaceus		
Steganopus	Wilson´s Phalarope	Falaropo tricolor
(Phalaropus) tricolor Steganopus	Red Phalarope	Falaropo rojo
(Phalaropus) fulicarius		

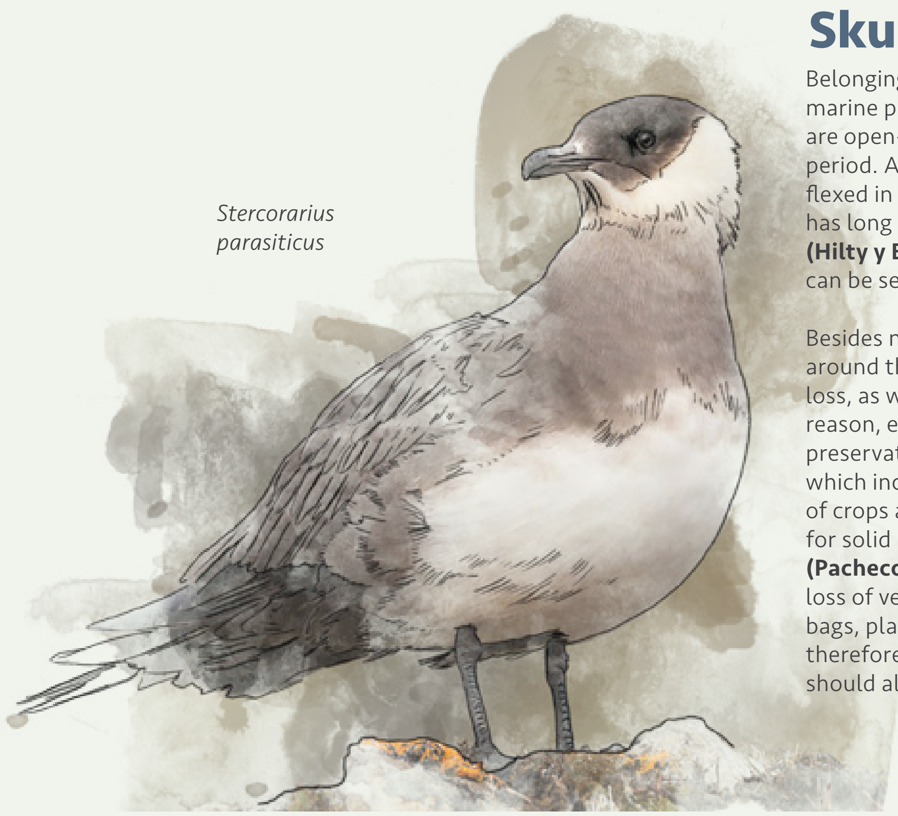
Table 1. *List of species of the family Scolopacidae, typical of the area of the reserve.*

Seagulls and terns



They are typical birds of the coasts worldwide; and, to a lesser extent, they are found inland or offshore. They have gray and white plumage, buoyant flights and gregarious habits. Most Colombian species (family Laridae) grow in the northern hemisphere and spend the boreal winter offshore or along the coasts. Seagulls are usually bigger and heavier than terns and have thick bills and rounded wings and tails. They swim frequently and, whenever possible, search food among waste. In contrast, terns have thin and sharp beaks, pointed wings and, usually, forked tails. They seldom swim; however, they capture their prey plunging into the water **(Hilty y Brown, 2001).**

Ten species, among seagulls, terns and their relatives, are found in the reserve: the laughing gull (*Leucophaeus atricilla*); the European herring gull (*Larus argentatus*); the caspian tern (*Hydroprogne caspia*); the least tern (*Sternula antillarum*); the Sandwich tern (*Thalasseus sandvicensis*); the royal tern (*Thalasseus maximus*); the common tern (*Sterna hirundo*); the sooty tern (*Onychoprion fuscatus*); and the brown noddy (*Anous stolidus*).



Skuas

Belonging to the family Stercorariidae, skuas are big and powerful marine predators, well known because of their air piracy. All of them are open-sea migratory birds in seasons outside their reproduction period. Although similar to seagulls, skuas have wings strongly flexed in the carpus. *Stercorarius* sp. reproduces in the High Arctic, has long falcon-like wings, short tail and central elongated rectrices **(Hilty y Brown, 2001)**. The parasitic jaeger (*Stercorarius parasiticus*) can be seen in the archipelago.

Besides natural phenomena, the avifauna visiting and living all around the archipelago constantly faces threats related to habitat loss, as well as pollution and environmental changes. For that reason, entities such as CORALINA and Proaves have proposed preservation plans focused on birds and their critical ecosystems, which include avoiding native forest logging, decreasing the presence of crops and domestic species in forest areas and campaigning for solid and liquid waste management, among other measures **(Pacheco, 2012).** As for the northern cays, it was observed that the loss of vegetation, as well as the waste brought by tides, especially bags, plastic lids, fishing lines and hooks, are constant problems; therefore, measures to avoid damage of ecosystems in those cays should also be developed.

MARINE MAMMALS

126 Species

Marine mammals do not have a common ancestor, as other groups of animals do; however, they have been grouped because their food comes from aquatic environments. Nowadays, 126 species are recognized in the world, which belong to the orders Carnivora, including seals, sea lions, otters and polar bears (33 species); Cetacea, covering whales and dolphins (89 species); and Sirenia, to which manatees and dugongs belong (four species) (Committee on taxonomy, 2014). Organisms belonging to this group have developed different adaptations to the aquatic environment, including hydrodynamic body shapes, modifications of limbs and thermoregulatory adaptations **(Perrin *et al.*, 2009)**.

In Colombia, 41 species of aquatic mammals have been recorded, 32 in the Caribbean region distributed as follows: six species belonging to the suborder Mysticeti (whales); 24 species, to the suborder Odontoceti (dolphins); one species, to the order Sirenia (West-Indian manatee); and one extinct pinniped **(Debrot *et al.*, 2013).** In the insular regions of the Colombian Caribbean, the information is limited due to logistic reasons; nevertheless, the presence of all the species reported for other Caribbean regions can be proved.

For the area of the Seaflower Biosphere Reserve, a biological characterization was carried out in 2011 on board the Capitanese boat. Such characterization included recording these individuals, in which 31 sightings of cetaceans occurred **(Omacha Foundation—INVEMAR, 2011)**. In 2013, as part of the activity of submarine cable laying, two sightings of dolphins were recognized within the reserve **(Omacha fundation—INVEMAR, 2011)**. In 2013, as part of the activity of submarine cable laying, two sightings of dolphins were recognized within the reserve **(Omacha fundation, 2013)** and 10 sightings of the same group were recorded in the Seaflower Scientific Expedition 2014 **(Omacha Foundation, 2014)**. Additionally, there are isolated reports of beachings and sightings by CORALINA, diving centers and fishers that, in total, correspond to 55 official records of 11 species of cetaceans in the region.

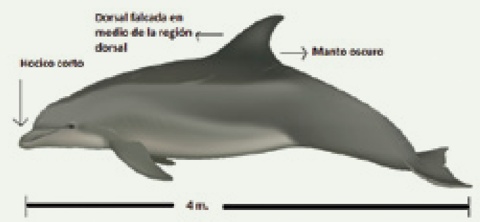
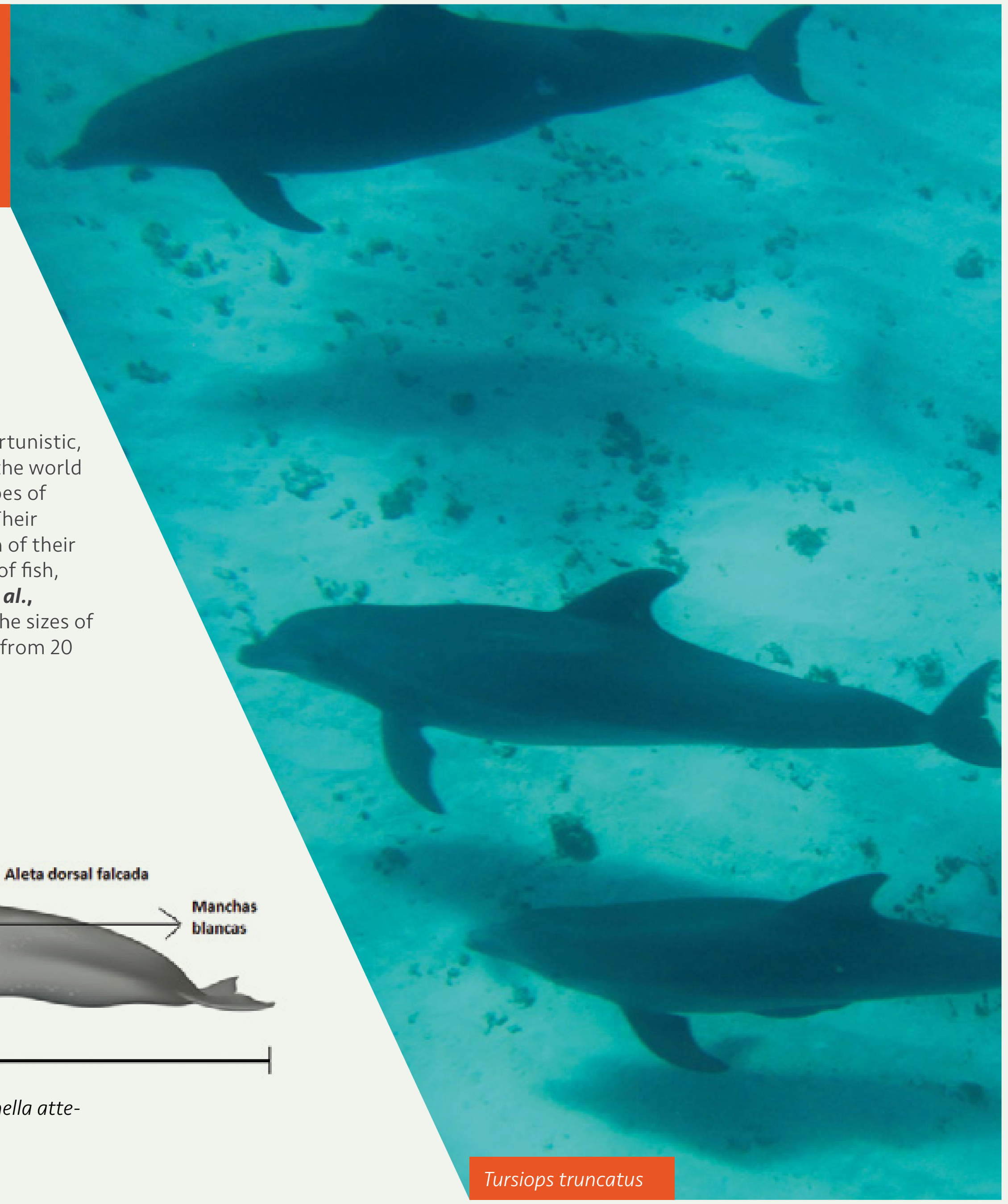


Figure 5. General drawing of a *Tursiops truncatus*. Ilustración: Uko Gorter

The most sighted species was *Tursiops truncatus (common bottlenose dolphin), representing* **58%** of the records. This species is a robust animal with short snout and falcate dorsal fin located in the middle of the dorsal region. Its color varies from light to dark gray, depending on the population and the age phase; it has a darker mantle in the dorsal region and its ventral region is light or white. It has between 18 and 26 teeth in each jaw; it reaches up to 4 m long and it can weigh up to 650 kg **(Jefferson *et al.*, 2008).**

It is the most common dolphin in the Caribbean, and two morphotypes have been identified: the first one is associated with coastal populations that inhabit shallow waters, bays, estuaries, lagoons or even rivers; and the second onw, the oceanic morphotype, that lives in open seas and deep waters **(Würsig *et al.*, 2000)**. The sightings described in this document correspond to the oceanic morphotype, given the characteristics of the reserve. The greatest concentration took place in Serranilla Bank, Alicia Shoal and Bajo Nuevo Bank, where groups up to 20 individuals were observed in depths of around 5 m and 1,000 m **(Omacha Foundation—INVEMAR, 2011; Omacha Foundation, 2013; Omacha Foundation, 2014) (Figure 5).**

Figure 6. Sightings of *Tursiops truncatus* in the Seaflower Biosphere Reserve by members of the Omacha Foundation in Bajo Nuevo Bank.



[According to different reports, the sizes of the groups of this species usually range from 20 to 100 individuals]

It is known that these animals are opportunistic, are widely distributed in all the seas of the world and can be associated with different types of bottoms **(Rossbach y Herzing, 1999).** Their distribution depends on the distribution of their prey that include more than 60 species of fish, molluscs and crustaceans **(Reynolds *et al.*, 2000).** According to different reports, the sizes of the groups of this species usually range from 20 to 100 individuals **(Bearzi, 2005).**

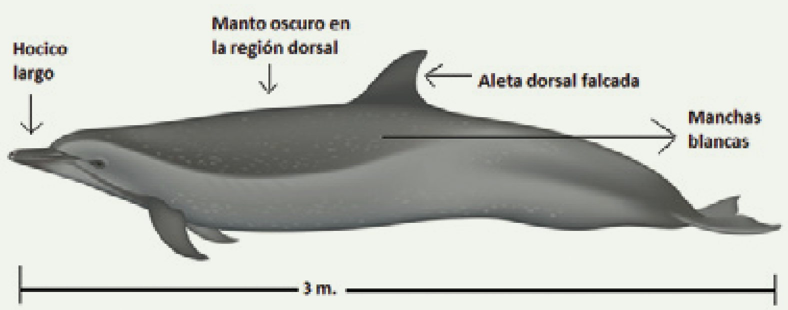


Figure 7. General drawing of a *Stenella attenuata*. Illustratión: Uko Gorter.

In August and October, 2011; as well as in April, 2014, the presence of juveniles within the groups was noticed and their most frequent behaviors were exhibition of the dorsal fin and bowriding . Although the mother-offspring bond seems to be strong, their societies seem to be open; dynamic associations are observed in periods shorter than one day. Moreover, they seem to adapt easily to artificial conditions and to the presence of boats. They have an active behavior on the surface, which makes their detection and identification easy **(Bearzi, 2005).**

[*Stenella attenuata*, or the pantropical spotted dolphin, represented 15% of the sightings]

In addition, the specie *Stenella attenuata*, or the pantropical spotted dolphin, represented 15% of the sightings. This dolphin is characterized for being slender and having a long snout. It has a falcate dorsal fin and a prominent dark mantle in the dorsal region. In its adulthood, it can have white spots on the sides and in the anterior region of the snout (Figura 7). It reaches up to 3 m long, can weigh up to 120 kg and has from 36 to 48 teeth in each jaw **(Jefferson *et al.*, 2008).**

Organisms belonging to this species were observed in August, October and November, 2011 and in April, 2014 between 10 m and 650 m deep in groups ranging from 3 to 20 individuals in Serranilla Bank, Alicia Shoal, Bajo Nuevo Bank and close to San Andrés Island. The most common activity observed was their fast traveling **(Omacha Foundation—INVEMAR, 2011; Omacha Foundation, 2013; Omacha Foundation, 2014)** (Figure 8).

Stenella attenuata
2,5
million individuals.

It is known that they are oceanic organisms and fast swimmers and that they generally travel in groups of more than 100 individuals; so the groups observed are considered to be small **(Pryor y Kang-Shallenberger, 1991).** Today, it is estimated that the world population of Stenella attenuata reaches more than 2.5 million individuals.

Figura 8. Sightings of Stenella attenuata by researchers of Omacha Foundation in 2011 and 2014 in the reserve.

7.2% of the records of cetaceans in the Seaflower Biosphere Reserve correspond to individual sightings of *Globicephala macrorhynchus*

(short-finned pilot whale), *Megaptera novaeangliae* (humpback whale), *Physeter macrocephalus* (sperm whale) and *Steno bredanensis* (rough-toothed dolphin), oceanic species that have been reported in different areas of the Wider Caribbean Region **(Ward *et al.*, 200).** Additionally, six beachings have been reported, which correspond to 11% of the records of the species *Delphinus delphis short-beaked common dolphin), Kogia* sp. (dwarf sperm whale), *Pseudorca crassidens* (false killer whale), *Stenella frontalis* (Atlantic spotted dolphin) and *Ziphius cavirostris* (Cuvier's beaked whale) in San Andrés Island (unpublished reports of CORALINA, diving centers and fishers)

Although there are records and sightings of marine mammals in the area of the reserve, these data are not enough to determine the status of the populations. It is then necessary to join forces in these areas to get information that supports the true areas of distribution.

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Birds

Phylum Chordata

C	O	F	S						
Aves	Charadriiformes	Charadriidae	*Charadrius collaris* Vieillot 1818	16	C	as	LC	Mc	SA, BR
			Charadrius semipalmatus Banaparte 1825	7, 8, 10, 11, 14, 15, 16, 17, 18, 19	C	as	LC	Mc	IN, SA
			Charadrius vociferus Linaeus 1758	11, 15, 16, 19	C	as	LC	Mc	SA, ARC, IR
			Charadrius wilsonius Linnaeus 1758	7, 11, 16, 19	C	as		Mc	RB
			Pluvialis dominica Statius Muller 1776	20, 16	C	as	LC	Mc	SA
			Pluvialis squatarola Linaeus 1758	11, 14, 15, 16, 17, 18, 19	C	as	LC	Mc	SA
		Laridae	*Anous stolidus* Linnaeus 1758	2, 5, 7, 10, 12, 14, 16	C	as	LC	Mc	ARC, CS, BR
			Chlidonias niger Linnaeus 1758	8, 11, 12, 16, 18	C	as	LC	Mc	SA, CS, BS
			Hydroprogne caspia Pallas 1770	2, 8, 16	C	as	LC	Mc	SA, CS
			Larus argentatus Pontoppidan 1763	8, 8, 16	C	as	LC	Mc	SA, CS
			Larus atricilla Linnaeus, 1758	8, 10, 14, 16, 18, 20	M	ap	LC	Mc	SA
			Onychoprion fuscatus Linnaeus 1766	4, 4, 5, 7, 10, 12, 16, 17	M	ap	LC	Mc	SA
			Sterna hirundo Linnaeus 1768	8, 13, 13, 12, 8, 16, 18	C	as	LC	Mc	SA
			Sternula antillarum Lesson 1847	8, 16	C	as	LC	Mc	SA
			Thalasseus sandvicensis Latham 1787	8, 16, 14	C	as	LC	Mc	SA
		Recurvirostridae	*Himantopus mexicanus* Statius Muller 1776	11, 14, 16, 17, 19	C	as	LC	Mc	SA, CS
		Scolopacidae	*Arenaria interpres interpres* Linnaeus 1758	7, 8, 11, 15, 16, 17, 19, 20	C	as	LC	Mc	SA, BR
			Bartramia longicauda Bechstein 1812	16	C	as	LC	Mc	SA, CS, BR
			Calidris alba (Pallas, 1764)	7, 11, 14, 15, 16, 17, 19	C	as	LC	Mc	SA, CS, BR
			Calidris mauri (Cabanis, 1857)	14, 16, 17	C	as	LC	Mc	SA, CS, BR
			Calidris melanotos Vieillot 1819	16	C	as	LC	Mc	SA, BR
			Calidris minutilla Vieillot 1819	7, 15, 16, 20	C	as	LC	Mc	IN, SA, IR
			Calidris pusilla (Linnaeus, 1766)	7, 10, 11, 14, 15, 16, 17, 19	C	as	NT	Mc	SA, BR
			Calidris himantopus (Bonaparte, 1826)	18	C	as	LC	Cm	SA
			Calidris melanotos (Vieillot, 1819)	18	C	as	LC	Cm	SA
			Calidris minutilla (Vieillot, 1819)	18, 14	C	as	LC	Cm	IN, SA, IR
			Gallinago delicata Ord 1825	8, 16, 18	C	as	LC	Cm	SA, BS
			Limnodromus griseus (Gmelin, 1789)	11, 12, 14, 15, 16, 17, 18, 19	M	ap	LC	Mc	SA
			Limnodromus scolopaceus (Say, 1822)	11, 14, 15, 16, 17, 18, 19	M	ap	LC	Cm	SA
			Numenius phaeopus (Linnaeus, 1758)	11, 14, 16, 17, 18, 19, 20	C	as	NT	Mc	SA
			Steganopus fulicarius Linnaeus 1758	16	C	as		Mc	SA
			Steganopus tricolor Vieillot 1819	16, 8	C	as	LC	Mc	SA
			Tringa semipalmata Gmelin 1789	7, 11, 14, 15, 16, 17, 18, 19	M	ap	LC	Mc	SA
			Tringa flavipes (Gmelin, 1789)	11, 15, 16, 17, 18, 19	M	ap	NT	Mc	SA
			Tringa melanoleuca Gmelin 1789	11, 14, 15, 16, 19	M	ap	LC	Mc	SA
			Tringa solitaria A. Wilson, 1813	11, 14, 15, 16, 18, 19	M	ap	LC	Mc	SA
		Stercorariidae	*Stercorarius pamarinus* Temminck 1815	16, 8	C	as		Mc	SA
			Stercorarius parasiticus Linnaeus 1758	16, 8, 18	C	as	LC	Mc	SA
	Pelecaniformes	Fregatidae	*Fregata magnificens* Mathews 1914	2, 5, 7, 8, 10, 12, 15, 16, 19, 20	C	as	LC	Mc	SA, BR
		Pelecanidae	*Pelecanus erythrorhynchos* Gmelin, 1789	8, 6, 16	C	as	LC	Mc	SA
			Pelecanus occidentalis Linaeus 1766	2, 5, 11, 14, 15, 16, 17, 18, 19	M	ap	LC	Mc	SA
		Phaethontidae	*Phaethon aethereus* Linaeus 1758	16, 18	C	as	LC	Mc	SA
		Phalacrocoracidae	*Phalacrocorax auritus* Lesson 1831	8, 13, 16	C	as	LC	Mc	SA
			Phalacrocorax olivaceus Gmelin 1789	8, 16	C	as		Mc	SA
		Sulidae	*Sula dactylatra* Lesson, 1831	3, 4, 5, 7, 8, 10, 16	C	as	LC	Mc	SA
			Sula leucogaster Boddaert 1783	4, 5, 7, 8, 9, 10, 15, 16, 18	C	as	LC	Mc	SA
			Sula sula (Linnaeus, 1766)	4, 20, 10, 15, 16, 18	C	as	LC	Mc	SA
	Procellariiformes	Procellaridae	*Puffinus griseus* Gmelin 1789	15, 8, 16	C	as	LC	Mc	SA
			Puffinus lherminieri Lesson 1840	10, 14, 16, 10	C	as		Mc	SA
			Puffinus puffinus Brunnich 1764	8, 16	C	as	LC	Mc	SA
	Accipitriformes	Pandionidae	*Pandion haliaetus* (Linnaeus, 1758)	18, 14	C	as		Mc	SA
	Anseriformes	Anatidae	*Anas discors* Linnaeus, 1766	18, 14	C	as	LC	Cm	SA
			Aythya affinis (Eyton, 1838)	14	C	as	LC	Mc	SA
			Aythya collaris (Donovan, 1809)	14	C	as	LC	Mc	SA
			Mareca strepera Linnaeus, 1758	18, 14	C	as	LC	Cm	SA
			Spatula clypeata (Linnaeus, 1758)	14	C	as	LC	Mc	PSC, SA
	Caprimulgiformes	Caprimulgidae	*Chordeiles acutipennis* (Hermann, 1783)	18	C	as	LC	Mc	SA
			Chordeiles minor (J. R. Forster, 1771)	18, 14	C	as	LC	Mc	SA
		Trochilidae	*Anthracothorax prevostii* (Lesson, 1832)	14	C	as	LC	Mc	SA
			Anthracothorax prevostii hendersonii (Cory, 1887)	18	C	as		Mc	SA
			Archilochus colubris (Linnaeus, 1758)	14	C	as	LC	Mc	RB
	Charadriiformes	Charadriidae	*Charadrius vociferus* Linnaeus, 1758	18, 14	C	as	LC	Mc	SA
		Laridae	*Thalasseus maximus* Boddaert, 1783	2, 8, 10, 12, 13, 14, 16, 18, 20	C	as	LC	Mc	SA
		Scolopacidae	*Actitis macularius* Linnaeus, 1766	5, 11, 14, 15, 16, 17, 18, 19	C	as	LC	Cm	SA, C, CS, BR
			Arenaria interpres Linnaeus, 1758	18, 14	C	as	LC	Mc	SA, CS, BR

Interactive table

C	O	F	S						
Aves	Columbiformes	Columbidae	*Columba livia* Gmelin, 1789	18	C	as	LC	Mc	SA
			Columbina passerina (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
			Leptotila jamaicensis (Linnaeus, 1766)	18, 14	C	as	LC	Mc	SA
			Patagioenas leucocephala (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
			Zenaida asiatica (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
	Coraciiformes	Alcedinidae	*Megaceryle alcyon* (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
	Cuculiformes	Cuculidae	*Coccyzus americanus* (Linnaeus, 1758)	18, 14	C	as	LC	Cm	SA
			Coccyzus minor (Gmelin, 1788)	18, 14	C	as	LC	Mc	SA
			Crotophaga ani Linnaeus, 1758	18, 14	C	as	LC	Mc	SA
	Falconiformes	Falconidae	*Falco columbarius* Linnaeus, 1758	18, 14	C	as	LC	Cm	SA
			Falco peregrinus Tunstall, 1771	14	C	as	LC	Mc	SA
			Falco sparverius Linnaeus, 1758	18, 14	C	as	LC	Mc	SA
	Gruiformes	Rallidae	*Fulica americana* Gmelin, 1789	14	C	as	LC	Mc	SA
			Gallinula galeata (Lichtenstein, 1818	14	C	as	LC	Mc	SA
			Porphyrio martinicus (Linnaeus, 1766)	18, 14	C	as	LC	Mc	SA
			Porzana carolina (Linnaeus, 1758	18, 14	C	as	LC	Cm	SA
	Passeriformes	Cardinalidae	*Pheucticus ludovicianus* (Linnaeus, 1766)	18, 14	M	ap	LC	Cm	SA
			Piranga olivacea (J. F. Gmelin, 1789)	18	C	as	LC	Cm	SA
			Piranga rubra (Linnaeus, 1758)	18	C	as	LC	Cm	SA
			Spiza americana Gmelin, 1789	18, 14	C	as	LC	Cm	SA
		Coerebidae	*Coereba flaveola* (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
		Emberizidae	*Passerculus sandwichensis* (J. F. Gmelin, 1789)	14	C	as	LC	Mc	SA
			Passerina caerulea (Linnaeus, 1758	18, 14	C	as	LC	Cm	SA
			Passerina ciris (Linnaeus, 1758)	18	C	as	LC	Cm	SA
			Passerina cyanea (Linnaeus, 1766)	18, 14	C	as	LC	Cm	SA
			Tiaris bicolor (Linnaeus, 1766)	18, 14	C	as	LC	Mc	SA
		Hirundinidae	*Hirundo rustica* Linnaeus, 1758	18, 14	C	as	LC	Cm	SA, CS
			Petrochelidon pyrrhonota Vieillot, 1817	14	C	as	LC	Mc	SA
			Progne subis (Linnaeus, 1758	14	C	as	LC	Mc	SA
			Riparia riparia (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
		Icteridae	*Dolichonyx oryzivorus* (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
			Icterus galbula (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
			Icterus leucopteryx (Wagler, 1827)	18, 14	C	as	LC	Mc	SA
			Quiscalus mexicanus (Gmelin, 1788)	18, 14	C	as	LC	Mc	SA
		Mimidae	*Dumetella carolinensis* (Linnaeus, 1766)	18, 14	C	as	LC	Cm	SA
			Mimus gilvus (Vieillot, 1808)	14	C	as	LC	Mc	SA
			Mimus gilvus magnirostris Cory, 1887	18	C	as	LC	Mc	SA
		Motacillidae	*Anthus rubescens* (Tunstall, 1771)	14	C	as	LC	Mc	RB
		Parulidae	*Dendroica caerulescens* (J. F. Gmelin, 1789)	18	C	as	LC	Cm	SA
			Dendroica castanea (A. Wilson, 1810)	18	C	as	LC	Cm	SA
			Dendroica cerulea (A. Wilson, 1810	18, 10, 11	C	as	VU*	Cm	SA
			Dendroica coronata (Linnaeus, 1766)	18	C	as	LC	Cm	SA
			Dendroica discolor (Vieillot, 1809)	18	C	as	LC	Cm	SA
			Dendroica dominica (Linnaeus, 1766)	18	C	as	LC	Cm	SA
			Dendroica fusca (Statius Müller, 1776)	18	C	as	LC	Cm	SA
			Dendroica magnolia (A. Wilson, 1811)	18	C	as	LC	Cm	SA
			Dendroica palmarum (J. F. Gmelin, 1789)	18	C	as	LC	Cm	SA
			Dendroica pensylvanica (Linnaeus, 1766)	18	C	as	LC	Cm	SA
			Dendroica petechia aestiva (J. F. Gmelin, 1789)	18	C	as	LC	Cm	SA
			Dendroica petechia petechia (Linnaeus, 1766)	18	C	as	LC	Mc	SA
			Dendroica striata (J. R. Forster, 1772)	18	C	as	LC	Cm	SA
			Dendroica tigrina (J. F. Gmelin, 1789	18	C	as	LC	Cm	SA
			Dendroica virens (J. F. Gmelin, 1789)	18	C	as	LC	Cm	SA
			Geothlypis trichas (Linnaeus, 1766)	18, 14	C	as	LC	Cm	SA
			Helmitheros vermivorum Gmelin, 1789	18, 14	C	as	LC	Cm	RB
			Leiothlypis peregrina Wilson, 1811	1	M	ap		Mc	SA
			Limnothlypis swainsonii (Audubon, 1834)	18, 14	C	as	LC	Cm	SA
			Mniotilta varia (Linnaeus, 1766)	18, 14	C	as	LC	Cm	SA
			Oporornis formosus (A. Wilson, 1811)	18	C	as	LC	Cm	SA
			Oporornis philadelphia (A. Wilson, 1810)	18	C	as	LC	Cm	SA
			Oreothlypis peregrina (A. Wilson, 1811)	14	C	as		Mc	SA
			Oreothlypis ruficapilla (A. Wilson, 1811)	14	C	as		Mc	SA
			Parkesia noveboracensis (J. F. Gmelin, 1789)	14	C	as	LC	Mc	SA
			Parula americana (Linnaeus, 1758)	18	C	as	LC	Cm	SA
			Protonotaria citrea (Boddaert, 1783)	18, 14	C	as	LC	Cm	SA
			Seiurus aurocapillus (Linnaeus, 1766)	18, 14	C	as	LC	Cm	SA

Birds

Phylum Chordata

Class	Order	Family	Species						
Aves	Passeriformes	Parulidae	*Seiurus noveboracensis* (J. F. Gmelin, 1789)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Parulidae	*Setophaga americana* (Linnaeus, 1758)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga caerulescens*(J. F. Gmelin, 1789)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga castanea* (A. Wilson, 1810)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga cerulea* (A. Wilson, 1810)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga citrina* (Boddaert, 1783)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga coronata* (Linnaeus, 1766)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga magnolia* (A. Wilson, 1811)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga palmarum* Gmelin, 1789	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga pensylvanica* (Linnaeus, 1766)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga petechia* Linnaeus, 1766	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga ruticilla* (Linnaeus, 1758)	18, 14	C	as	LC	Cm	SA
Aves	Passeriformes	Parulidae	*Setophaga striata* (J. R. Forster, 1772)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga tigrina* Gmelin, 1789	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Setophaga virens* (J. F. Gmelin, 1789)	14	C	as		Mc	SA
Aves	Passeriformes	Parulidae	*Vermivora chrysoptera* (Linnaeus, 1766)	18	C	as	LC	Mc	SA
Aves	Passeriformes	Parulidae	*Vermivora peregrina* (A. Wilson, 1811)	18	M	ap	LC	Cm	SA
Aves	Passeriformes	Parulidae	*Vermivora pinus* (Linnaeus, 1766)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Parulidae	*Vermivora ruficapilla* (A. Wilson, 1811)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Parulidae	*Wilsonia canadensis* (Linnaeus, 1766)	18	C	as	LC	Mc	SA
Aves	Passeriformes	Parulidae	*Wilsonia citrina* (Boddaert, 1783)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Turdidae	*Catharus fuscescens* (Stephens, 1817)	18, 14	C	as	LC	Cm	SA
Aves	Passeriformes	Turdidae	*Catharus minimus* (Lafresnaye, 1848)	18	C	as	NT	Cm	SA
Aves	Passeriformes	Turdidae	*Catharus ustulatus* (Nuttall, 1840)	18, 14	C	as	LC	Cm	SA
Aves	Passeriformes	Turdidae	*Hylocichla mustelina* (Gmelin, 1789)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Tyrannidae	*Contopus sordidulus* P. L. Sclater, 1859	18	C	as	NT	Cm	SA
Aves	Passeriformes	Tyrannidae	*Contopus virens* (Linnaeus, 1766)	18, 14	C	as	LC	Cm	SA
Aves	Passeriformes	Tyrannidae	*Elaenia martinica* (Linnaeus, 1766)	18, 14	C	as	VU	Mc	SA
Aves	Passeriformes	Tyrannidae	*Empidonax alnorum* Brewster, 1895	18	C	as	LC	Mc	SA
Aves	Passeriformes	Tyrannidae	*Empidonax minimus*(W. M. Baird & S. F. Baird, 1843)	18, 14	C	as	LC	Cm	SA
Aves	Passeriformes	Tyrannidae	*Empidonax traillii* (Audubon, 1828)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Tyrannidae	*Empidonax virescens* (Vieillot, 1818)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Tyrannidae	*Myiarchus crinitus* (Linnaeus, 1758)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Tyrannidae	*Tolmomyias flaviventris* Wied-Neuwied, 1831	1	C	as	LC	Mc	SA
Aves	Passeriformes	Tyrannidae	*Tyrannus dominicensis* (Gmelin, 1788)	18, 14	M	ap	LC	Cm	SA
Aves	Passeriformes	Tyrannidae	*Tyrannus melancholicus* Vieillot, 1819	14	M	ap	LC	Mc	SA
Aves	Passeriformes	Tyrannidae	*Tyrannus savana* Vieillot, 1808	1	M	ap	LC	Mc	SA
Aves	Passeriformes	Tyrannidae	*Tyrannus tyrannus* (Linnaeus, 1758)	14	C	as	LC	Mc	SA
Aves	Passeriformes	Vireonidae	*Vireo altiloquus* (Vieillot, 1808)	18, 14	C	as	LC	Mc	SA
Aves	Passeriformes	Vireonidae	*Vireo caribaeus* Bond & Meyer de Schauensee, 1942	18, 14, 11,22	C	as	CR*	Mc	SA
Aves	Passeriformes	Vireonidae	*Vireo crassirostris* (H. Bryant, 1859)	14	C	as	LC	Mc	SA
Aves	Passeriformes	Vireonidae	*Vireo flavifrons* Vieillot, 1808	18	C	as	LC	Cm	SA
Aves	Passeriformes	Vireonidae	*Vireo flavoviridis* (Cassin, 1851)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Vireonidae	*Vireo griseus* (Boddaert, 1783)	18, 14	C	as	VU	Cm	SA
Aves	Passeriformes	Vireonidae	*Vireo olivaceus* (Linnaeus, 1766)	18	C	as	LC	Cm	SA
Aves	Passeriformes	Vireonidae	*Vireo philadelphicus* (Cassin, 1851)	18	C	as	LC	Cm	SA
Aves	Pelecaniformes	Ardeidae	*Ardea alba* Linnaeus, 1758	18, 14	C	as	LC	Mc	SA, IR, BQ, BR
Aves	Pelecaniformes	Ardeidae	*Ardea herodias* Linnaeus, 1758	18, 14	C	as	LC	Mc	SA
Aves	Pelecaniformes	Ardeidae	*Bubulcus ibis* Linnaeus, 1758	14	C	as	LC	Mc	SA, BR
Aves	Pelecaniformes	Ardeidae	*Butorides striata* (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
Aves	Pelecaniformes	Ardeidae	*Butorides virescens*(Linnaeus, 1758)	18	C	as	LC	Cm	SA
Aves	Pelecaniformes	Ardeidae	*Egretta caerulea* (Linnaeus, 1758)	18, 14	C	as	LC	Cm	SA
Aves	Pelecaniformes	Ardeidae	*Egretta thula* Molina, 1782	18, 14	C	as	LC	Mc	SA, BR
Aves	Pelecaniformes	Ardeidae	*Egretta tricolor* (Statius Muller, 1776)	18, 14	C	as	LC	Mc	SA
Aves	Pelecaniformes	Ardeidae	*Nyctanassa violacea* Linnaeus, 1758	18, 14	C	as	LC	Mc	SA
Aves	Pelecaniformes	Threskiornithidae	*Plegadis falcinellus*(Linnaeus, 1766)	14	C	as	LC	Mc	SA
Aves	Piciformes	Picidae	*Sphyrapicus varius* (Linnaeus, 1766)	18, 14	C	as	LC	Cm	SA
Aves	Podicipediformes	Podicipedidae	*Podilymbus podiceps*(Linnaeus, 1758)	14	C	as	LC	Mc	SA
Aves	Psittaciformes	Psittacidae	*Eupsittula pertinax* (Linnaeus, 1758)	18, 14	C	as	LC	Mc	SA
Aves	Strigiformes	Tytonidae	*Tyto alba* (Scopoli, 1769)	18	C	as	LC	Mc	SA

Interactive table

SPAW The following species are included in Annex II of the SPAW Protocol.

Limnodromus griseus
Tringa semipalmata
Tringa flavipes
Pelecanus erythrorhynchos
Pelecanus occidentalis
Phalacrocorax auritus
Pheucticus ludovicianus
Vermivora peregrina
Tyrannus savana

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Turtles

Phylum Chordata

C	O	F	S						
Reptilia	Testudines	Cheloniidae	*Caretta caretta*	(Linnaeus, 1758)	1, 2, 3, 4	P	ca	VU	PSC, SA, CS, BS, BR, CB, CA
			Chelonia mydas	(Linnaeus, 1758)	1, 2, 3, 4	P	ca	EN	PSC, SA, CS, BS, BR, CB, CA
			Eretmochelys imbricata	(Linnaeus, 1766)	1, 2, 3, 4	P	ca	CR	PSC, SA, CS, BS, BR, CB, CA
		Dermochelyidae	*Dermochelys coriacea*	(Vandelli, 1761)	1, 2, 3, 4	P	ca	VU	SA, BR

All turtle species are included in Appendix I of the CITES Convention.

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Interactive table

Mammals

Chordata

C	Sc	O	F	S				
Mammalia	Theria	Cetartiodactyla	Delphinidae	*Delphinus delphis*	*Linnaeus, 1758*	2	*PSC, SA*	
				Globicephala macrorhynchus	*Gray, 1846*	2	*CB*	
			Physeteridae	*Physeter macrocephalus*	*Linnaeus, 1758*	2	*SA*	Appendix I
			Delphinidae	*Pseudorca crassidens*	*Owen, 1846*	3	*SA*	
				Sotalia guianensis	*(Van Beneden, 1864)*	2	*PSC*	
				Stenella attenuata	*(Gray, 1846)*	1	*IR, PSC, SA, N, C*	
				Stenella frontalis	*(Cuvier, 1829)*	2	*SA*	
				Tursiops truncatus	*(Montagu, 1821)*	1	*IR, IN, N, C, S*	Appendix II

Conservation status

LC	VU	DD
Delphinus delphis *Stenella attenuata* *Tursiops truncatus*	*Physeter macrocephalus*	*Sotalia guianensis* *Stenella frontalis* *Globicephala macrorhynchus*

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Interactive table

A CONSERVATION APPROACH

according to the intrinsic biodiversity

Luis Chasqui Velasco[1], David A. Alonso Carvajal[1], Nacor Bolaños Cubillos[2], Erick Richard Castro Gonzalez[2]

Gecarcinus ruricola, cangrejo negro

1 José Benito Vives de Andréis Marine and Coastal Research Institute (INVEMAR)

2 Corporation for the Sustainable Development of the Archipelago of San Andrés, Providencia and Santa Catalina (CORALINA)

Local context

During the last 45 years, numerous efforts for cultural conservation, social development and environmental diversity have been made in the area of the Archipelago of San Andrés Providencia and Santa Catalina. In 1970, INDERENA founded the San Andrés Bay National Reserve Zone (ZRN) in the archipelago in response to a petition of the National Tourism Institute through the Agreement No. 28 of the same year, ratified today with the Executive Resolution 023171 of CORALINA.

Later, in 1995, the Old Providence McBean Lagoon National Natural Park was declared by the Resolution 1021 of September 13, 1995; which, with 995 hectares, includes the biggest and best preserved mangrove swamp of Providencia Island, the internal lagoon of the barrier reef, the Three Brothers Cays and the Crab Cay.

In November 9, 2000, the UNESCO declared the archipelago as Seaflower Biosphere Reserve; it was the first reserve created in the country by legal mandate (paragraph 2, Article 37 of Law 99 of 1993). Nowadays, it is one of the largest marine and insular reserves of the planet.

In 2001, the Board of Directors of CORALINA established the Johnny Cay Regional Natural Park (by the Agreement 041 of 2001 and the Resolution 161 of 2002); that same year, the Old Point Regional Mangrove Park was declared in San Andrés Island (by the Agreement 042 of September 18 of 2001). These areas have a mosaic of ecosystems favorable for preserving many species. The objective of their designation is to safeguard their natural, cultural and socioeconomic values, planning the sustainable use of resources and adopting strict measures that enable the perpetuation and protection of fauna and flora associated.

In October, 2003, BirdLife International and the Alexander von Humboldt Biological Resources Research Institute declared the Seaflower Biosphere Reserve as an Important Bird and Biodiversity Area (IBA).

The declaration of the Seaflower Biosphere Reserve is added to the declaration of the Seaflower Marine Protected Area (MPA) in 2005 (Resolution 0107 of January 27, 2005), which protects an area of 61,018 km². This is the largest MPA of the Americas and a groundbreaking experience in Colombia.

In 2007 the Board of Directors of CORALINA, simultaneously to the declaration of The Peak Regional Park in Providencia Island, postulated the Seaflower MPA to the UNESCO's World Heritage Site tentative list to be declared natural heritage, which is still being evaluated.

Biodiversity and conservation instruments

Despite the fact that this sector of the western Caribbean has being considered as an important site of diversity of corals and fish and a hot spot of biodiversity worldwide **(Williams *et al.*, 2011)**,we are still far from reaching an extensive knowledge of marine biodiversity in the archipelago, since the research efforts have been focused on shallow environments until 60 m deep and on the most conspicuous groups of organisms. The environments of seabeds within the reserve are, to date, practically unknown; nonetheless, it is known that the continental margins are characterized by a great variety of geological processes that favor the settlement of different communities consisting mainly of cnidarians, bivalves, bryozoans, sponges and marine worms (vestimentiferans).

Such communities have very different life-forms from those most common and found in the surface; they are characterized for their low growth rate and reproduction, their genetic isolation and the possibility of them being a connection bridge with other ecosystems. These characteristics make deep-water animals especially vulnerable to human actions. For that reason, they have been considered a preservation priority by international instruments such as the Convention on Biological Diversity.

In the field of biodiversity preservation management, there are several mechanisms or instruments that work internationally and that have been adopted at the national level. Some of them are binding mechanisms and others are tools widely accepted among scientists, decision-makers and the community in general.

Red lists of threatened species

The latter is the case of the red lists of threatened species, in which each species is assigned a threat category: **Critically Endangered (CR), Endangered (EN) or Vulnerable (VU),** through the evaluation of established criteria and based on the best scientific information available.

The categories indicate the level of risk of extinction in the near future that wild populations of a determined species face in a given area **CR** implies a higher risk of extinction than **EN**,and this, in turn, higher than **VU**.

The risk classification system includes other categories, which do not imply that the species is threatened, such as **Deficient Data (DD) and Near Threatened (NT)**. A species is categorized in DD when information is insufficient to make a proper assessment of its preservation status, but future researches could show a threat category. Finally, species are considered NT when evaluation does not meet the criteria to be included in a category of threat (i.e. **CR, EN, VU**), but is considered to be close to meet them in the near future.

Globally, there is the Red List of Threatened Species™ of the International Union for Conservation of Nature (IUCN) that currently collects information on the conservation status (i.e. distribution, population status, threats, etc.) of almost 80,000 species among vertebrates, invertebrates and plants. This process began more than 50 years ago. In Colombia, the preparation of red lists of threatened species began more than 30 years ago. However, the Series of Red Books of Threatened Species appeared just in 2002. In total, they were 15 books showing the results of the evaluation of the risk of extinction of 1,117 species distributed in Colombia and using the same methodology of the IUCN's Red List.

These lists are used with the purpose of handling and managing the species conservation. For that reason, they become official and legal by resolutions of the Ministry of Environment. To date, the resolution in force is the Resolution 192 of 2014 of the Ministry of Environment and Sustainable Development (MADS), "by which the list of threatened wild species of the Colombian biological diversity found on national territory is established and other provisions are pronounced" **(MADS, 2014).**

EX Extinct

EW Extinct in the wild

CR Critically endangered

EN Endangered

VU Vulnerable

NT Near threatened

LC Least concern

NE Not evaluated

DD Deficient data

CITES Convention

The Convention on International Trade in Endangered Species of Wild Fauna and Flora known as CITES aims to protect the wild fauna and flora populations worldwide against excessive exploitation derived from their international trade. The CITES has three appendices: Appendix I includes all the endangered species that are or may be affected by trade; the international move of specimens of these species is subject to strict regulations, and it is only permitted in exceptional circumstances and with non-trading purposes. Appendix II includes species that—although they are not—could be endangered, unless their trade is strictly controlled to avoid uses incompatible with their survival; the international trade of these species requires export permits or re-export certificates. Appendix III includes species whose exploitation and trade is ruled in any of the countries that are part of the convention (currently 182), and that need cooperation of the other parties to control their trade. Colombia is part of the CITES since 1981.

CITES ©

SPAW Protocol

The SPAW Protocol is a binding agreement among the signatory countries of the Cartagena Convention (25 countries), for the protection and handling of especially vulnerable areas and threatened flora and fauna in the Wider Caribbean Region. The protocol has three annexes including marine and coastal species selected by mutual agreement as endangered, likely-to-become-endangered, endemic and rare species that require protection measures, such as exploitation and trade restrictions, habitat destruction prohibitions or disturbances of key processes of their life cycles (e.g., reproduction and migration). Annex I includes species of flora, Annex II contains species of fauna and Annex III lists the agreed species of marine and coastal flora and fauna that may be utilized on a rational and sustainable basis. The protocol also indicates the need to prioritize the species included in the annexes for scientific and technical research.

The data contained in the chapters of this book and, particularly, in the lists of species of each group, has been reviewed in light of the lists of species included in each of the conservation instruments described, in order to highlight those species that, given their category of threat in the red lists and their inclusion in the CITES appendices or in the annexes of the SPAW Protocol, can be considered as focal species for conservation actions

SPAW

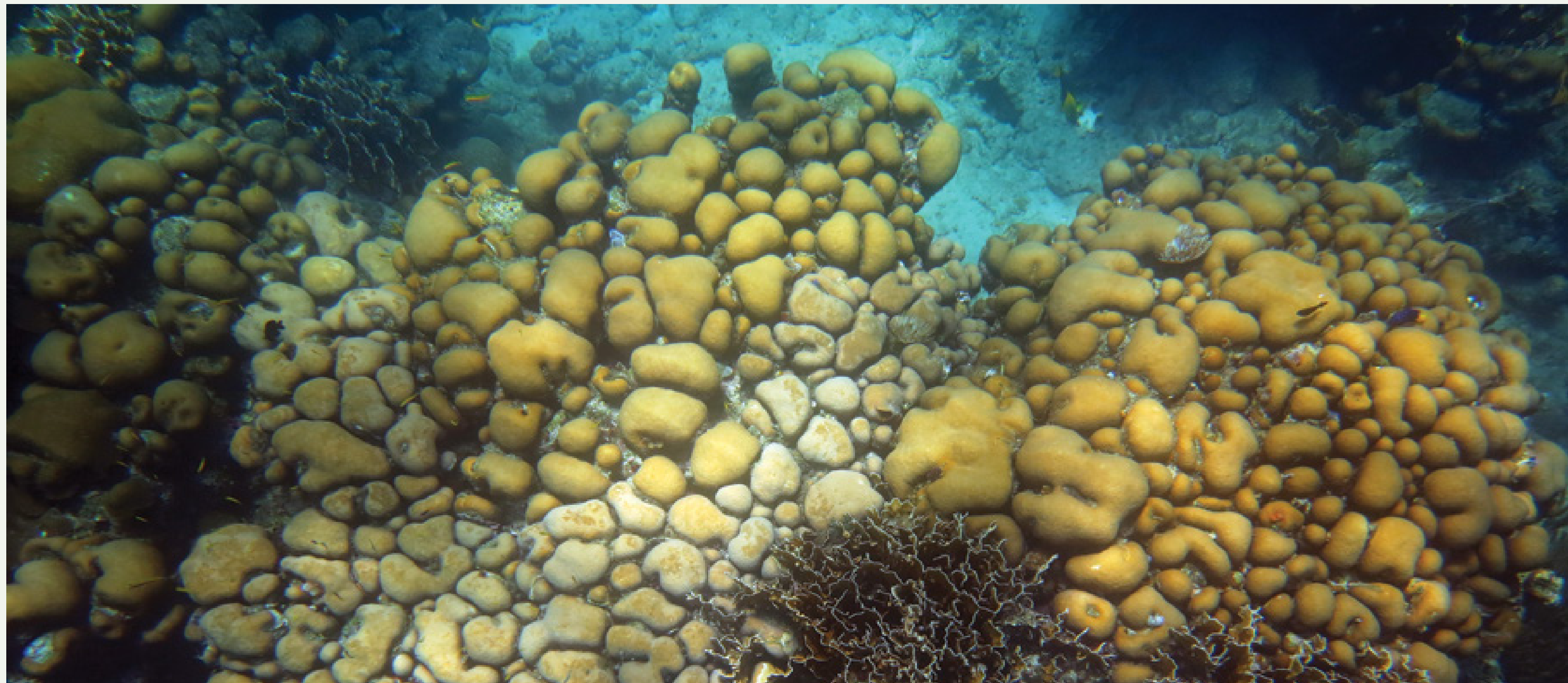
Cnidarians

Of 200 species of cnidarians recorded in the Archipelago of San Andrés, Providencia and Santa Catalina, only 57 have been assessed regarding their risk of extinction, mainly from the group of the scleractinian corals (hard corals). Thirteen of these species are considered endangered species, including major reef-building species in the Caribbean, such as *Acropora palmata* (Endangered), *Acropora cervicornis* (Critically Endangered), *Orbicella faveolata* (Endangered) and *Orbicella annularis* (Endangered). A couple of decades ago, populations of acroporid corals in general suffered major losses due to the white band disease outbreak, a disease that attacked and decimated specifically species of the genus *Acropora* throughout the Caribbean, leaving a distressing scene of rubble and standing skeletons where once great elkhorn and staghorn coral barrier reefs flourished.

Orbicella faveolata and *O. Annularis*, part of the genus *Montastraea*, until recently, are perhaps the main reef builders in many parts of the Caribbean, since they form huge colonies that, for its particular architecture, represent habitat and shelter for many species of fish and invertebrates. These species, as other scleractinian corals, are victims of the considerable deterioration process suffered by coral reefs worldwide, even more evident in the last three decades. Deterioration factors such as massive and widespread coral bleaching, outbreak of new coral diseases, alteration of the trophic dynamics of reefs due to overfishing and algae proliferation that limit coral recruitment because of excessive nutrients, among other factors, are leading to an eventual disappearance of coral reefs, and with them, species that build them and inhabit them **(Wilkinson, 2008).**

The sea fan *Gorgonia ventalina* is also considered as a vulnerable species at a national level, as it has suffered a massive die-off since the 80's, mainly due to a condition caused by a fungus of the genus *Aspergillus*, which significantly reduced its wild populations **(Ardila *et al.*, 2002).**

All species of antipatharians (black corals) and scleractinians (hard corals) are included in the CITES Appendix II, which gives them some protection against possible threats resulting from international trade. Both black and hard corals have skeletons that are used to make handicrafts and other items that are in demand in local and international markets; it has caused overexploitation of wild populations in some regions.



Crustaceans

Of 248 species of crustaceans recorded in the Archipelago of San Andrés, Providencia and Santa Catalina, only 13 have been assessed regarding their risk of extinction. Four species have been assessed at a national level **(Ardila *et al.*, 2002; MADS, 2014)**,and are considered Vulnerable (VU). Among the threats identified by Ardila *et al.* (2002), which affect wild populations of these species, there are:

Carpilius coralinus: it is captured with nets and traps together with the lobster *Panulirus argus* and in industrial trawling **(Rodriguez y Hendrickx, 1992)**; It also faces habitat destruction problems (reefs and coral formations).

Cardisoma guanhumi: it is used for human consumption. It is also massively captured in breeding seasons, which endangers the resource. Coastal development has caused the destruction of this species' habitat, which increases their risk even more.

Mithrax spinosissimus: a strong fishing pressure and a low growth rate have reduced this species' populations, putting it at risk. Additionally, in the Colombian Caribbean, this species seems to be scant, with a low capture probability and a limited geographical distribution.

Panulirus argus: commercially, it is one of the most important species of crustaceans. It is exploited for commercial purposes, both in the archipelago and throughout the Colombian Caribbean. Its high commercial value and high demand caused the reduction of its natural populations.

Other species that have been assessed globally (*Atya innocous, Nephropsis aculeata, Macrobrachium acanthurus, Macrobrachium carcinus, Macrobrachium faustinum, Macrobrachium hancocki, Polycheles typhlops, Scyllarides nodifer* and *Xiphocaris elongata*), are shrimp or lobsters with some level of local use at a smaller scale, but not with significant levels of exploitation or targeted fishing at a large scale; moreover, they are generally widespread species. Thus, although in some cases existing information—especially population-related—is scant, evaluators found that these species do not face major threats that endanger the existence of their wild populations **(IUCN, 2015).**

As for the SPAW Protocol, only the spiny lobster (*Panulirus argus*) is included in Annex III, which demands that measures to regulate its exploitation are established in order to ensure the conservation of wild populations. In the local context, fishing for this species has several regulatory measures including: **a)** setting of annual fishing quotas, **b)** regulation of the fishing effort (number of industrial boats), **c)** prohibition of industrial fishing by diving, **d)** prohibition of fishing for berried females, **e)** establishment of a closed season that extends from April to June each year and **f)** agreement of a minimum tail size of 14 cm at capture.

Another species of crustacean that deserves special attention at the local level is the black land crab (*Gecarcinus ruricola*), Although this species is not included in the IUCN Red List, the status of its populations in the archipelago is worrying due to overexploitation, habitat degradation and possible genetic isolation. In 2002, CORALINA developed the project "Sustainable Management of the Black Land Crab, San Andrés, Archipelago, Colombia", funded by the UK Darwin Initiative, and which provided important biological and ecological information used as technical support for issuing the Resolution 1132 of 2005, which updated the existing regulations and established minimum catching sizes (carapace of 60 mm wide), a closed season during the breeding period (April to July each year) and speed limits (20 kph) for vehicles at night in areas of greater presence during reproductive migrations. Currently, conservation and protection measures, as a bastion of the Raizal culture, are being settled through a strategic alliance among CORALINA, the Ministry of Foreign Affairs, the Providencia Mayor's Office, the ACUA Foundation and Conservation International – Colombia.

So far, no crustacean species are part of the CITES appendices.

Molluscs

DOf 300 species of molluscs recorded in the archipelago, only 17 have been assessed regarding their risk of extinction; eight of them have been assessed at a national level, of which seven species were included in the Vulnerable category, and one was considered under the Data Deficient category (DD) **(Ardila *et al.*, 2002)**. In the case of vulnerable species of molluscs (*Cassis flamea, Cassis madagascariensis, Cassi tuberosa, Charonia variegata* and *Lobatus gigas*) the greatest threat is overexploitation since they are large snails highly sought for their meat, mainly locally but also internationally.

The most notorious case is that of the queen conch (*Lobatus gigas*), twhich was included in the CITES Appendix II in 1992, under the name of *Strombus gigas*. Because of the importance of this species to the archipelago as it is a species traditionally consumed and traded, it has been the subject of studies and management actions by local authorities. A regional management plan for the Wider Caribbean Region is currently under a preparation process, as well as local actions aimed at recovering the populations of queen conch. This species has also been included in Annex III of the SPAW Protocol.

In the local context, fishing for this species has several regulatory measures including: a) setting of annual fishing quotas, b) prohibition of fishing by scuba diving and/or by using air compressors, c) establishment of a closed season that extends from June to October each year, d) agreement of a minimum catching size and e) regulation of exports according to CITES procedures. Since 2008, the species is protected by a public interest ruling issued by the Administrative Court of San Andrés, Providencia and Santa Catalina, which led to the permanent closure of the fishery in the southern section (San Andrés Island, Bolivar Cay and Albuquerque Cay) and the central section (Providencia and Santa Catalina) of the Marine Protected Area. Similarly, in the northern cays, fishing is only permitted when specifically recommended by the assessments of the resource status. In the case of *Propustularia surinamensis* (formerly *Cypraea surinamensis*), it is a rare snail species with a great commercial value because, due to its beauty, it is considered a collector's item. Among the remaining nine species that have been globally evaluated, there are some snails of the genus Conus and two species of cephalopods. All of them are classified in the category of Least Concern (LC) **(IUCN, 2015).**

Echinoderms

DOf 116 species of echinoderms reported for the archipelago, only 15 have been assessed regarding their risk of extinction and none has been included in categories of threat. Among them, the cushion sea star (*Oreaster reticulatus*) and the black sea urchin (*Diadema antillarum*), have been assessed at a national level, *O. reticulatus* fbeing considered as a Least Concern species and *D. antillarum*, categorized as a Data Deficient species (DD) **(Ardila *et al.*, 2002).**

LThe remaining 13 species are sea cucumbers, which have been assessed at a global level and are categorized as Least Concern species: *Actinopyga agassizii, Astichopus multifidus, Holothuria (Cystipus) cubana, Holothuria (Halodeima) floridana, Holothuria (Halodeima) grisea, Holothuria (Halodeima) mexicana, Holothuria (Platyperona) parvula, Holothuria (Selenkothuria) glaberrima, Holothuria (Thymiosycia) thomasi, Holothuria (Vaneyothuria) lentiginosa, Isostichopus badionotus.*

In addition *Holothuria (Thymiosycia) arenicola* and *Holothuria (Thymiosycia) impatiens* are under the Data Deficient category **(IUCN, 2015)**.

Fish

Of 732 species of fish recorded in the archipelago, 646 assessments of species at risk of extinction have been conducted, 37 of which are endangered species, including the goliath grouper (*Epinephelus itajara*) and the torpedo ray (*Narcine bancroftii*), considered Critically Endangered, both at national and global levels. Moreover, there are five species of fish in the Endangered category at a national level: the tarpon *Megalops atlanticus*, the liza *Mugil liza*, the hogfish *Lachnolaimus maximus*, the queen triggerfish *Balistes vetula* and the Nassau grouper *Epinephelus striatus*.

Four other species are in the Endangered category at a global level: the scalloped hammerhead (*Sphyrna lewini*),the great hammerhead (*Sphyrna mokarran*), the American eel (*Anguilla rostrata*) and the Veracruz white hamlet (*Hypoplectrus castroaguirrei*). Nine species are in the Vulnerable category at a national level; 17 species are in the same category globally. The species *Lutjanus analis* is considered Near Threatened at a national level and 16 more species are in the same category at a global level. Four species are categorized as Data Deficient at a national level and 27 more are considered as Data Deficient species globally **(Mejía y Acero, 2002; IUCN, 2015).**

EThe goliath grouper and the hogfish are among the most threatened species of fish in the archipelago—and in the country in general. These species are increasingly scarce and are still fished since their meat is very appealing for consumption and trade, and because of the large size some individuals can reach, as is the case of the goliath grouper.

Six species of fish recorded in the archipelago are part of the CITES Appendix II, i.e., there are regulations to control their international trade. They are five species of sharks and one species of seahorses, of which the most affected in Colombia by exploitation for trading products are the oceanic whitetip shark *Carcharhinus longimanus*and the scalloped hammerhead *Sphyrna lewini*, whose fins are in high demand and value in the international trade. Since 2012, shark fishing as target catch, both in the archipelago and in the country in general, is banned and only allowed when by-catch occurs (AUNAP, 2012 Resolution 0744 of 2012).

Tetrapods

Sea turtles

All species of marine turtles are considered globally threatened species, except for the flatback sea turtle (Natator depressus), whose current category is Data Deficient (previously considered Vulnerable). Therefore, all four species reported for the reserve are globally threatened. Moreover, processes of assessment of risk of extinction in reptiles have categorized them as endangered species at a national level: *Caretta caretta*, *Eretmochelys imbricata* and *Dermochelys coriacea* Critically Endangered (CR), *Chelonia mydas* Endangered (EN) **(Castaño-Mora, 2002; MADS Resolución 192 de 2014).**

The four species of turtle are listed in the CITES Appendix I, therefore, its international trade is not allowed, nor is their products'. Additionally, these species are included in Annex II of the SPAW Protocol, which gives them special treatment as species that must be protected and managed under strict regulation by the Wider Caribbean Region countries, signatories to the Cartagena Convention.

By-catch, overexploitation of eggs, deterioration of nesting beaches and, in the case of the hawksbill sea turtle (*E. imbricata*), the hunt and catch for using its shell in manufacturing variety of crafts and ornaments, are among the major threats to the survival of sea turtles in general, both in Colombia and around the world.

Birds

Of 183 species recorded in the Archipelago of San Andrés, Providencia and Santa Catalina, there are two that are considered threatened species at a national level: the cerulean warbler *Dendroica cerulea* that is considered Vulnerable in Colombia; and the San Andrés Vireo *Vireo caribaeus*, considered Critically Endangered **(MADS, Resolución 192 de 2014)**. Other six species are considered Near Threatened globally: the semipalmated sandpiper *Calidris pusilla*, the wood thrush *Hylocichla mustelina*, the painted bunting *Passerina ciris*, the white-crowned pigeon *Patagioenas leucocephala*, the sooty shearwater *Puffinus griseus* and the golden-winged warbler *Vermivora chrysoptera* **(UICN, 2015).**

Of these species of birds, the *V. caribaeus* could be considered as the most endangered bird in the archipelago since it is an endemic species of San Andrés Island, with a rather small population and subjected to a series of threats related to human activities, such as infrastructure development that causes the fragmentation of the natural habitat of the species. In addition, predation to which they are exposed by domestic animals and other introduced species (i.e. boas, gold tegu, etc.) could be a source of pressure on natural populations of the San Andrés vireo, which is already vulnerable because of its extremely restricted distribution and its possible extinction due to disasters or extreme natural events that could occur in San Andrés Island.

POn the other hand, nine species of birds recorded in the archipelago are included in the CITES appendices. Appendix I includes the peregrine falcon *Falco peregrinus*; and Appendix II includes other four species of raptors: the merlin (*Falco columbarius*), the American kestrel (*Falco sparverius*), the osprey (*Pandion haliaetus*) and the common barn-owl (*Tyto alba*); Appendix II also includes two species of hummingbirds: the green-breasted mango (*Anthracothorax prevostii*) and the ruby-throated hummingbird (*Archilochus colubris*); and the brown-throated parakeet (*Eupsittula pertinax*). In the archipelago, the population of the green-breasted mango (*A. prevostii*) is considered a subspecies (*A. prevostii hendersonii*), which makes it even more important to advance efforts to preserve its population.

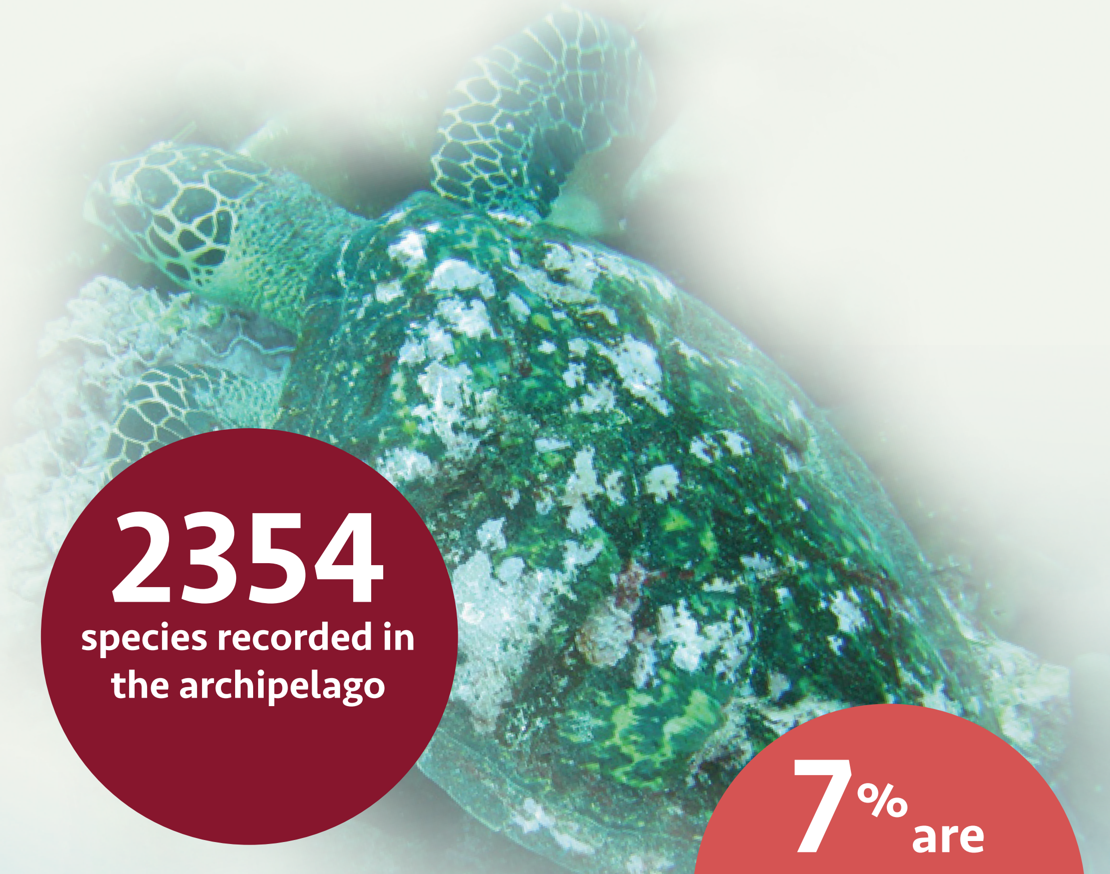
As for the SPAW Protocol, nine species of birds are included in Annex II: the peregrine falcon *Falco peregrinus*, the short-billed dowitcher *Limnodromus griseus*, the American white pelican *Pelecanus erythrorhynchos*, the brown pelican *Pelecanus occidentalis*, the double-crested cormorant *Phalacrocorax auritus*, the rose-breasted grosbeak *Pheucticus ludovicianus*, the Audubon's shearwater *Puffinus lherminieri*, the willet *Tringa semipalmata*, the lesser yellowlegs *Tringa flavipes*, the fork-tailed flycatcher *Tyrannus savana* and the Tennessee warbler *Vermivora peregrina*.

Puffinus griseus

MARINE MAMMALS

Of the eight species of cetaceans with a recognized presence in the archipelago, only one is considered a threatened species (VU) at global and national levels: the sperm whale *Physeter macrocephalus* **(as Physeter catodon in Rodríguez-Mahecha *et al.*, 2006; IUCN 2015).** Other species such as the short-finned pilot whale *Globicephala macrorhynchus*,the pantropical spotted dolphin *Stenella attenuata* and the common bottlenose dolphin *Tursiops truncatus* are considered Near Threatened species (NT). The false killer whale *Pseudorca crassidens*, the guiana dolphin *Sotalia guianensis* and the Atlantic spotted dolphin *Stenella frontalis* are in the Data Deficient category globally; therefore, they could become Endangered species in the future with more available information **(IUCN 2015).**

All species of cetaceans in the world are included in the CITES Appendix II, with significant exceptions that are in Appendix I (even more protected from international trade), including the sperm whale *P. macrocephalus* and the guiana dolphin *S. guianensis* with recorded presence in the archipelago. In addition, all species of the order Cetacea are also protected by the SPAW Protocol since Annex II stipulates it in that way.



Considerations

In general terms, of 2,354 species recorded in the archipelago of the Seaflower Biosphere Reserve, including fish, turtles, marine mammals and invertebrates and birds in general, 39% have been subject to assessments regarding their risk of extinction, either at a global **(IUCN 2015)** or a national level **(Series of Red Books of Threatened Species in Colombia, MADS Resolution 192 of 2014).**

Of the species assessed, 7% are threatened species (64 species), which corresponds to approximately 3% of total species recorded for the archipelago. At first, these figures may seem encouraging, especially in percentage terms, i.e., one might think that the number of threatened species is low compared to the total; but, before drawing conclusions, some considerations must be taken into account. In most cases, the reported category corresponds to the category of threat of the species on the IUCN Red List, which is not necessarily a reflection of the status of that species population in Colombia or in the archipelago. A rough analysis of the population status of widely distributed species at a global level (e.g. species of fish or birds found throughout the Western Atlantic) hardly reflects the status of all local populations, differing in a number of factors, such as differences in the pressures to which the species are subjected at a local level (e.g. fishing pressure, habitat loss, etc.).

2354
species recorded in the archipelago

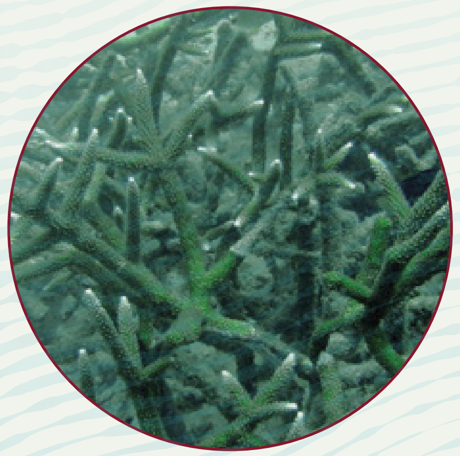
7% are threatened species

Moreover, it must be considered that the 64 threatened species are mostly threatened by use, i.e., species that have suffered significant reductions in their natural populations mainly due to overexploitation. This is the case of the four species of crustaceans, the seven species of molluscs, the 37 species of fish and the four species of sea turtles.

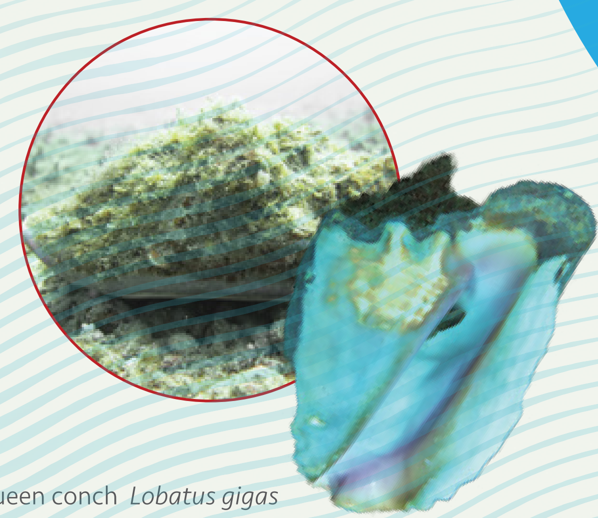
These considerations are an invitation for resource managers and entities interested in and responsible for data production, as well as for the community in general, to make further progress regarding the analysis of the risk of extinction of species and models of sustainable use of our marine biodiversity.

Conservation

Goliath grouper *Epinephelus itajara*
Main threats Overfishing, habitat loss

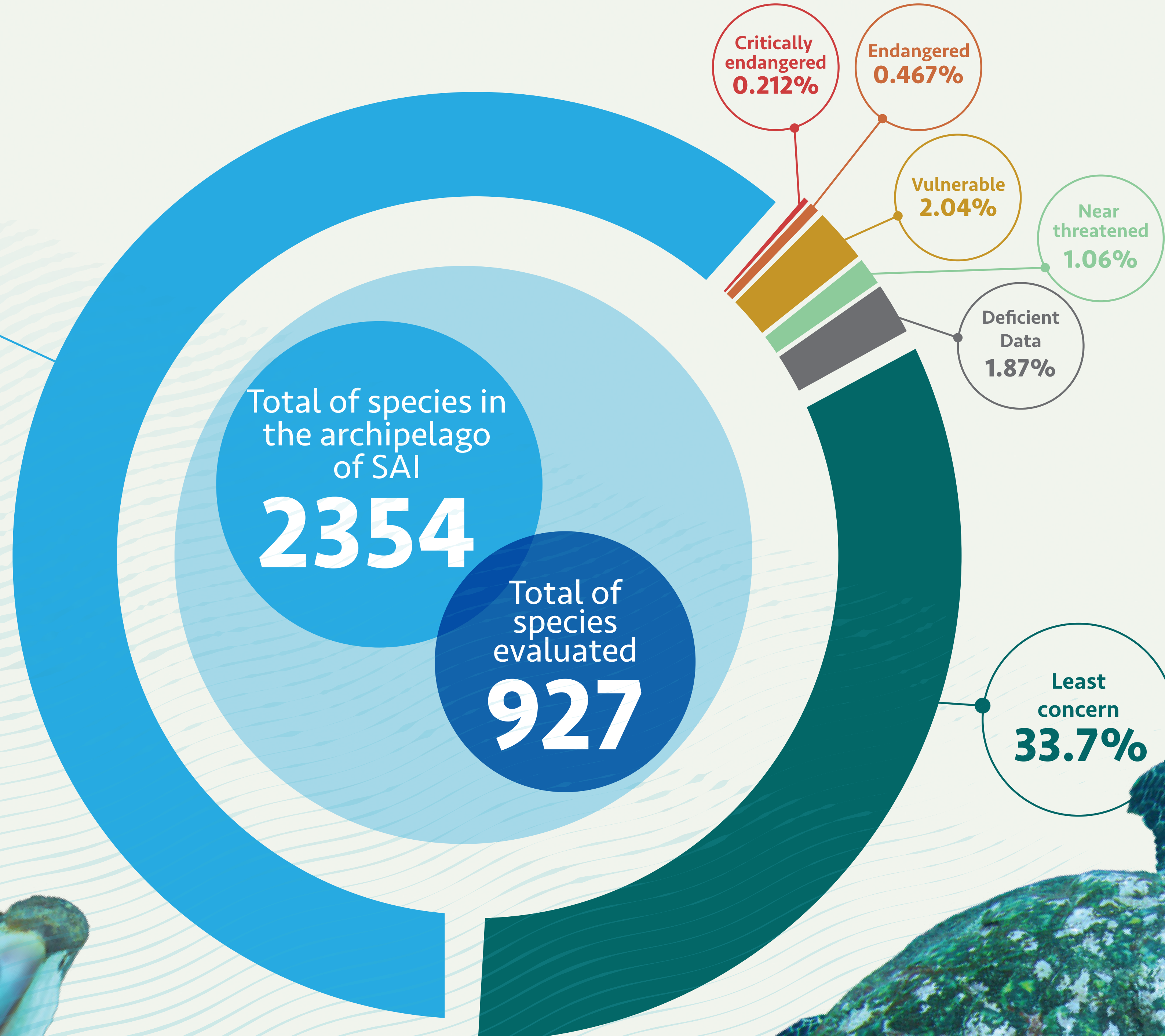


Staghorn coral *Acropora cervicornis*
Main threats Bleaching related to global warming, white band disease



Queen conch *Lobatus gigas*
Main threats Overfishing, habitat loss

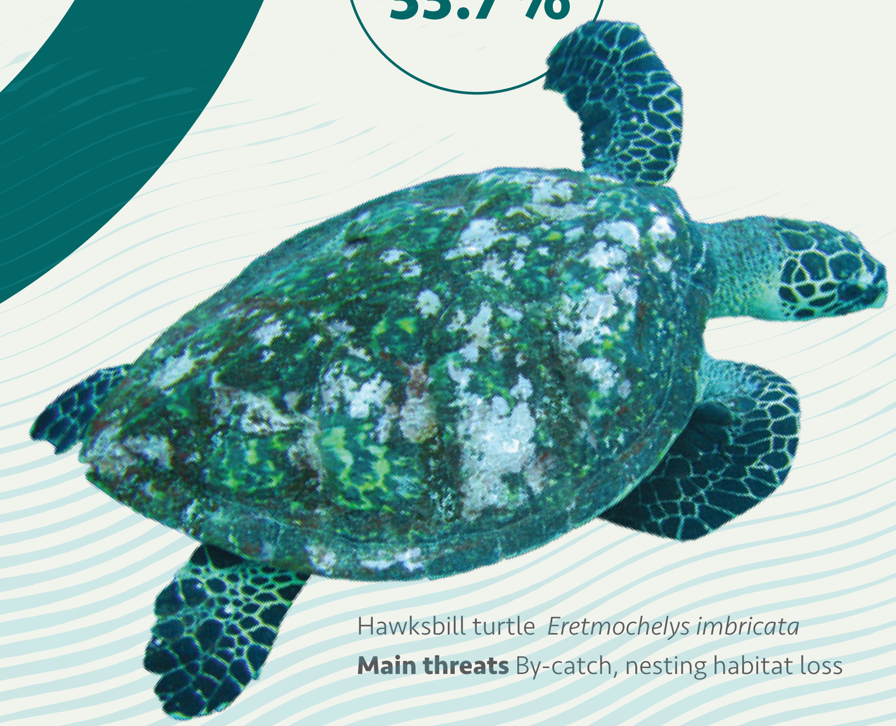
6% of the fish species of the archipelago of SAI are threatened.



Only 5% of the crustacean species and 6% of the mollusc species of the archipelago of SAI have been evaluated to determine their risk of extinction.

- Not evaluated
- Critically endangered
- Endangered
- Vulnerable
- Near threatened
- Deficient data
- Least concern

All the sea turtles recorded in the archipelago of SAI are threatened.



Hawksbill turtle *Eretmochelys imbricata*
Main threats By-catch, nesting habitat loss

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Colombia 50% Mar
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Corporación para el Desarrollo Sostenible del Archipiélago
de San Andrés, Providencia y Santa Catalina

RBSF
RESERVA DE BIOSFERA SEAFLOWER

Financed by the fund of Ambiental Compensation —FCA