

## Database and WebGIS: tools for integration and access to biodiversity information of invertebrates of the marine reserve 'El Pelado' (REMAPE)

Gabriela Agurto, Elizabeth Andrade, Cecilia Tomalá, Cristóbal Domínguez, Paúl Guillén, Karla Jaramillo, Antonella Lavorato, Báslavi Condor-Lujan, Bolívar Chalén, Karen Avellaneda, Olivier Thomas, Stanislaus Sonnenholzner, Aminael Sánchez-Rodríguez, Diego Pacheco, Francisco Choez & Jenny Rodríguez

To cite this article: Gabriela Agurto, Elizabeth Andrade, Cecilia Tomalá, Cristóbal Domínguez, Paúl Guillén, Karla Jaramillo, Antonella Lavorato, Báslavi Condor-Lujan, Bolívar Chalén, Karen Avellaneda, Olivier Thomas, Stanislaus Sonnenholzner, Aminael Sánchez-Rodríguez, Diego Pacheco, Francisco Choez & Jenny Rodríguez (2018) Database and WebGIS: tools for integration and access to biodiversity information of invertebrates of the marine reserve 'El Pelado' (REMAPE), *Neotropical Biodiversity*, 4:1, 172-177

To link to this article: <https://doi.org/10.1080/23766808.2018.1553380>



© 2018 Escuela Superior Politécnica del Litoral



Published online: 14 Dec 2018.













Submit your article to this journal [↗](#)



View Crossmark data [↗](#)

## Database and WebGIS: tools for integration and access to biodiversity information of invertebrates of the marine reserve ‘El Pelado’ (REMAPE)

Gabriela Agurto <sup>a</sup>, Elizabeth Andrade<sup>a</sup>, Cecilia Tomalá<sup>a</sup>, Cristóbal Domínguez <sup>a</sup>, Paúl Guillén <sup>a,b</sup>, Karla Jaramillo <sup>a,c</sup>, Antonella Lavorato<sup>a</sup>, Báslavi Condor-Lujan <sup>a</sup>, Bolívar Chalén <sup>a</sup>, Karen Avellaneda<sup>a</sup>, Olivier Thomas <sup>b</sup>, Stanislaus Sonnenholzner <sup>a</sup>, Aminaél Sánchez-Rodríguez<sup>d,e</sup>, Diego Pacheco <sup>d,e</sup>, Francisco Choez<sup>a</sup> and Jenny Rodríguez <sup>a</sup>

<sup>a</sup>Programa de Biodiversidad, Escuela Superior Politécnica del Litoral (ESPOL), Centro Nacional de Acuicultura e Investigaciones Marinas (CENAIM), Guayaquil, Ecuador; <sup>b</sup>Marine Biodiscovery, School of Chemistry and Ryan Institute, National University of Ireland Galway (NUI Galway), University Road, Galway, Ireland; <sup>c</sup>Zoology, School of Natural Science and Ryan Institute, National University of Ireland Galway (NUI Galway), University Road, Galway, Ireland; <sup>d</sup>Departamento de Ciencias Naturales, Universidad Técnica Particular de Loja, Loja, Ecuador; <sup>e</sup>Programa de Biodiversidad, Instituto de Estudios de Régimen Seccional del Ecuador (IERSE), Universidad del Azuay Cuenca, Guayaquil, Ecuador

### ABSTRACT

The marine biodiversity program of CENAIM-ESPOL focuses on sessile invertebrates from the “El Pelado” marine reserve. The present study aims at understanding the different hierarchical levels of biodiversity found at the “El Pelado” and to guide biodiversity initiatives. Generated biodiversity data were systematized in a database (Darwin Core standard) and integrated into a geographic information system that uses webGIS as a search engine. In this way, the information becomes available to the academy and entities involved in the management of coastal resources.

### RESUMEN

El programa de biodiversidad de CENAIM-ESPOL trabaja en el estudio de la biodiversidad marina, focalizando en invertebrados sésiles de la Reserva marina El Pelado. El estudio busca profundizar en distintos niveles jerárquicos de biodiversidad y en el biodescubrimiento. Los datos generados se están sistematizando en una base de datos, la misma que está integrada a un sistema de información geográfica y utiliza una webGIS como motor de búsqueda. De esta manera la información generada está disponible para la academia y entidades implicadas en el manejo de recursos costeros.

### ARTICLE HISTORY

Received 16 August 2018  
Accepted 26 November 2018

### KEYWORDS

Databases; Marine biodiversity; sessile invertebrates; Tropical Eastern Pacific Ecoregion; webGIS

The documentation of biodiversity data is an important step toward a wise, sustainable practice of conservation and management, which is an emerging global priority [1]. To make an effective use of existing biodiversity data, information must be in a digital, accessible, discoverable and integrated form, e.g. with other information layers. However, this task remains challenging, particularly in the lesser studied ecoregions, such as the Tropical Eastern Pacific Ecoregion (TEP) [2]. The TEP constitutes a geographical gap in biodiversity studies, in comparison to hot-spots of biodiversity like the Central Indo-Pacific, with a notable exception of the Galapagos Islands. Within the TEP, the Ecuadorian coastal marine region is a privileged location for the study of biodiversity, due to its oceanographic conditions. In effect, this area is characterized by the transition between warm tropical waters, with low salinity of the north, and cold waters, of greater salinity, rich in nutrients due to the upwellings of the Humboldt current [3]. The confluence of these waterbodies gives rise to the Equatorial Front, characterized by a marked thermohaline gradient. The periodic arrival of the “El Niño” and “La Niña” events modifies the temperature and salinity of the ocean in the Equatorial Front.

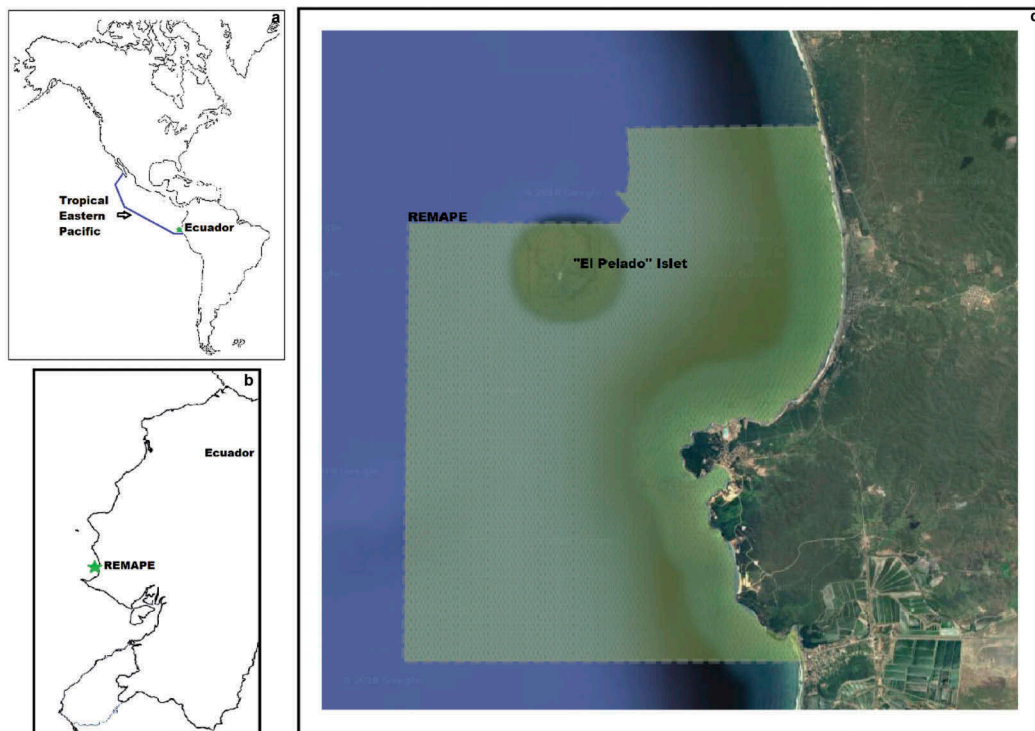
These fluctuating conditions make the Ecuadorian coastal marine region an ideal laboratory for studies of biogeography, climate change, functional biodiversity and biodiversity. However, the marine-coastal region of the Equatorial Front is the least studied area of the TEP.

The knowledge gap in the marine biodiversity of the Equatorial Front is increased by poor results diffusion efforts. On the one hand, the few studies that are carried out are not published in scientific documents and on the other hand, the data generated remain in institutional reports and are difficult to access. In Ecuador, up until now, the information of national biodiversity organized in databases available to the scientific community is scarce. Since 2016, the data on biodiversity are shared through Global Biodiversity Information Facility (GBIF). In the marine context, the last record from Ecuador in Ocean Biogeographic Information System (OBIS) [4] was in 2010, when *Chrysopathes formosa* (Hexacorallia-Cnidaria) was recorded. This simple fact shows that Ecuador has not generated enough information on marine biodiversity.

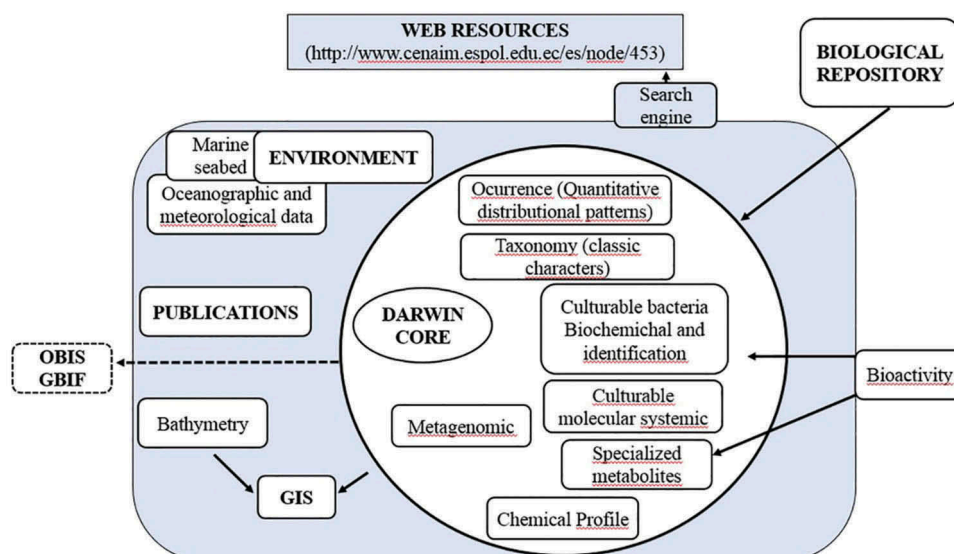
Marine invertebrates comprise about 60% of the diversity of animals. The few studies on sessile

invertebrates of the Equatorial Front are focusing in taxonomic diversity, indicating a great diversity of cnidarians, particularly octocorals [5–11]. Other hierarchical levels of biodiversity, such as metabolomics, microbiomes associated to organisms, functional biodiversity and biodiscovery remain largely ignored. Invertebrate marine biodiversity offers a wide range of opportunities for scientific development and biotechnological applications as a genetic reservoir for biodiscovery. The few marine biodiscovery studies reported in the area of the Equatorial Front before 2016 involved the isolation of bacteria

associated with wild shrimp [12] and sponges [13] of the “El Pelado marine Reserve” (REMAPE), with the goal of discovering probiotics of marine origin to be applied in aquaculture. Taking into account this context, we started a basic and applied research project with the aim to characterize different hierarchical levels of the biodiversity of sessile invertebrates at the REMAPE, marine reserve located under the direct influence of Equatorial Front (Figure 1), with the goals to protect and to implement sustainable use of natural resources for use in human and animal health.



**Figure 1.** Study area: (a) Tropical Eastern Pacific in America; (b) Location of the Marine Protected Area El Pelado (REMAPE) In Ecuador; (c) “El Pelado” Islet in Protected Area El Pelado (Google Satellite).



**Figure 2.** The approach followed to organize the database of biodiversity of CENAIM-ESPOL and the web resources. The blue square indicates the information available through the web resources. The database includes the required fields of Darwin Core (DC) Standard, in order to share data with international databases (OBIS, GBIF).

Taking advantage of recent developments in the omics technologies, this project studies metabolome [14,15], taxonomic diversity [14] and spatial distribution [16] of sessile invertebrates. In some organisms, the study of microbial composition through metagenomics and the isolation of bioactive culturable bacteria is underdeveloped. This multidimensional project serves as a model for the study, diffusion and management of marine biodiversity of the Equatorial Front, for future academic research, and to contribute to the construction of the Ecuadorian research strategy on marine and aquatic resources. This approach includes one of the most important aspects when addressing biodiversity as a multidimensional issue, that is, the organization, systematization and access to information (Figure 2). In this document, we present the creation of the biodiversity database of sessile invertebrates of REMAPE. The information is open to the public through the web resources of CENAIM-ESPOL site ([www.cenaim.espol.edu.ec](http://www.cenaim.espol.edu.ec)).

The database was built in an excel spreadsheet format following two criteria: the first is to share the information by web exchange and the second to use it as an internal tool to manage the project data and the traceability of each analysis performed in each sample of invertebrate taken at REMAPE. With these criteria in mind, the database includes the eight required fields of Darwin Core (DC) standard, grouped into five classes. The DC standard allows the possibility of extracting and transforming information into XML files for web exchange (OBIS, GBIF). Besides the required fields of DC, the database contains hyperlinks that give access to two extensions approved for DC. Under the term bacterium, hyperlinks gives access to the bacterial data organized following the model Atlas of living Australia [17], and under the term systematic molecular, hyperlinks allow to access to molecular data following the Global Genome Biodiversity Network Amplification Extension model [18]. The database also includes hyperlinks to classical taxonomy data (description of taxonomic characters with photographic evidence), descriptions of the organisms, photographic material *in situ* and *ex situ* of the sampled organisms, as well as chemical analysis (metabolomic profiles of invertebrates, isolated metabolites and bioactivity). Several columns located by each research area contain the voucher data and the location of the samples (Table 1). This database is continuously updated. So far, 1446 records have been made, mainly in cnidarians (46.32%), porifera (11.58%), chordates (9.72%), molluscs (16.65%), arthropods (1.29%) and echinoderms (10.29%).

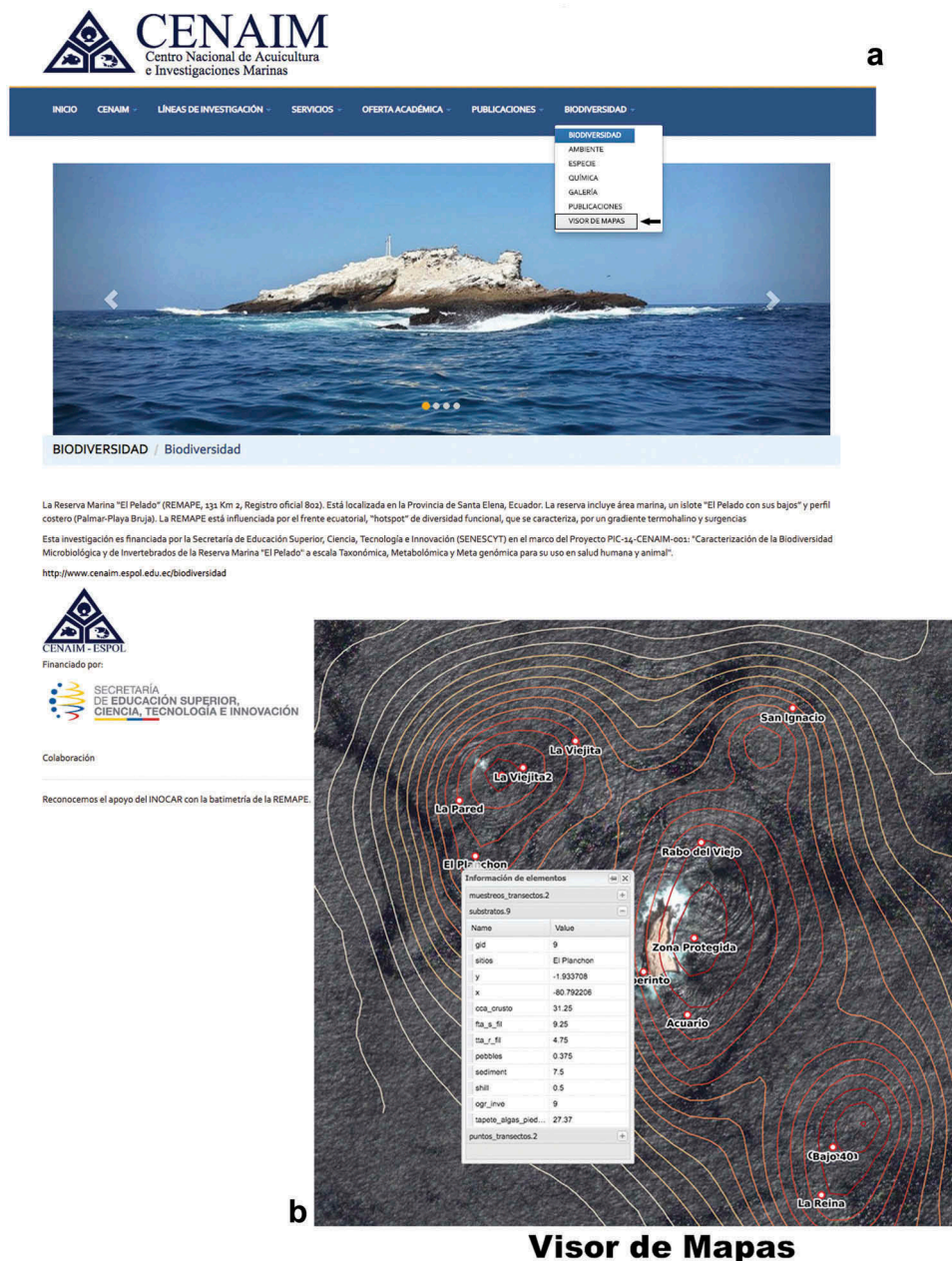
For the external users, it is already possible to access to data through the menu biodiversity ([http://www.cenaim.espol.edu.ec/remape\\_biodiversidad](http://www.cenaim.espol.edu.ec/remape_biodiversidad)) of the CENAIM – ESPOL website [19] (Figure 3(a)). This menu contains a set of seven tools to access and visualize information within the biodiversity database. Through this menu, one can perform searches, obtain the information of each

**Table 1.** Diagram of the information that the internal database includes, which is made up of five classes of Darwin Core and six extensions to new databases and additional information.

Darwin Core (class)		Hyperlink extensions and additional information						
eventID sample (repository)	Identification Remarks/ Location/Taxon	Description in Spanish or English	Photo <i>in situ</i> Photo <i>ex situ</i> Photo <i>in situ</i>	Localization samples/ areas	Taxonomy *Characters imagen	Bacteria *DC+ala.org.au/who-we-are /atlas-data/microorganism-data- schema/* <i>BioDiscovery</i>	Molecular systematic (GGBN Amplification Extension DC) *Systematic species * Systematic bacterium *Metagenomic	Chemical *Chemical profile *Chemical structure *Metabolites ( <i>BioDiscovery</i> )
eventID sample (observation)	Identification Remarks/ Location/Taxon	Description in Spanish or English	Occurrence					

*Italic texts* have extension relationships and are linked together.  
Underlined text is information located in columns of the database.





**Figure 3.** Screenshots of website CENAIME-ESPOL and geographic information system (GIS): (a) The menu "BIODIVERSIDAD" open the access to database and other environmental information of "El Pelado" marine reserve through seven tools. The tool "ESPECIE" opens access to taxonomic biodiversity. Through the tool "QUÍMICA", the user can access the information about the specialized metabolites found in the species analyzed by their metabolome. The tool "VISOR DE MAPAS" allows one to access the GIS information. To access the microbiological information associated to invertebrates, the user must enter the tool "ESPECIE". Environmental data are integrated into the web site under the tool "AMBIENTE", Other tools in the website allow access to photographic material ("GALERÍA") and scientific documents published within the framework of the project ("PUBLICACIONES"). (b) GIS, the intensity of color indicates the density of observation of Class Ascidiacea in different rocky habitats of the REMAPE. Similar information is available for other Class.

specimen (i.e. taxonomy, metabolites isolated, associated bacteria isolated, etc.) and visualize *in situ* spatial distribution of invertebrates observed at the different sampling points, as well as the geographical information associated, through a Geographic Information System (GIS) (Figure 3(b)). The web site integrates additional information, such as local environmental conditions of the REMAPE (tool AMBIENTE), paying spatial attention to water temperature and thermocline depth (option "OCEANOGRAFIA"). The option "SUSTRATOS" shows

information about the seabed of collection sites. In addition, under the same tool, the option "METEOROLOGÍA" records data in real time in the REMAPE, through Davis Vantage Pro2 (Davis instruments) using the WeatherLink software and the WeatherLinkip device. Sensitive information, such as unpublished data or distribution of deprecated organisms, is not open for the public.

The databases and the appropriate access mechanisms allow future scientific studies to be designed with a multidimensional focus. Among several

important topics identified, we can mention taxonomic diversity, conservation, biogeography, climate change effect and biodiscovery. In terms of conservation, in the REMAPE, we have observed the presence of the invasive organism *Carijoa riisei* [16]. This octocoral from the Caribbean [20,21] has decimated the octocorals native to the Colombian Pacific. In the REMAPE, we have not detected it at depths greater than 20 m [16], depth that coincides with the depth of the thermocline [19]. This observation suggests that temperature is a physical barrier and sets guidelines for biogeographical studies. In this context, the GIS constitutes a useful tool to design studies about interactions between *C. riisei*, parasitized octocorals and environmental condition, at the different rocky habitats at different depths of the REMAPE. The GIS also will aid the design of environmental management policies, such as the establishment of wildlife refuges, with improved control of anthropogenic disturbing activities (fishing or entertainment diving). On the same note, the database also records the status of natural stocks of predated species, such as *Spondylus* spp. and holothurians, and useful information for repopulation programs carried out by CENAIM (<http://www.cenaim.espol.edu.ec/diversificacion>). In terms of taxonomic richness, functional diversity and metabolomics, the integration of information allows valorize the richness of the biodiversity of the coastal area of the Equatorial Front. For instance, it was possible to observe that in an area as small as the REMAPE, the cnidarians of the zoantharia order are as rich as in the Galapagos Islands [5,14,22,23], taxonomic richness that goes hand in hand with metabolomic diversity. These observations set guidelines for biodiscovery and allows future studies of functional diversity to be foreseen. In conclusion, this new database will allow to fulfill several tasks, fill the knowledge gap, diffuse the information and help to design strategies for the management of marine resources, including protection, biodiscovery and sustainable use.

### Disclosure statement

No potential conflict of interest was reported by the authors.

### Funding

This work was supported by the Secretaria de Educación, Ciencia y Tecnología e Innovación of Ecuador [PIC-14-CENAIM-001].

### ORCID

Gabriela Agurto  <http://orcid.org/0000-0001-9547-8020>

Cristóbal Domínguez  <http://orcid.org/0000-0003-3204-3569>

Paúl Guillén  <http://orcid.org/0000-0001-8270-5562>

Karla Jaramillo  <http://orcid.org/0000-0002-2547-4152>

Báslavi Condor-Lujan  <http://orcid.org/0000-0001-7832-7319>

Bolívar Chalén  <http://orcid.org/0000-0002-5974-4042>

Olivier Thomas  <http://orcid.org/0000-0002-5708-1409>

Stanislaus Sonnenholzner  <http://orcid.org/0000-0002-5723-3994>

Diego Pacheco  <http://orcid.org/0000-0002-8432-0559>

Jenny Rodríguez  <http://orcid.org/0000-0002-4773-0700>

### References

- [1] Wieczorek J, Bloom D, Guralnick R, et al. Darwin core: an evolving community-developed biodiversity data standard. *PLOS ONE*. 2012;7(1):e29715.
- [2] Spalding MD, Fox HE, Allen GR, et al. Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *Bio Science*. 2007;57(7):573–583.
- [3] Cruz M, Gabor N, Mora E, et al. The known and unknown about marine biodiversity in Ecuador (continental and insular). *Gayana*. 2003;67(2):232–260.
- [4] System OBI. Ocean biogeographic information system. 2018 [cited 2018 Oct 16]. Available from: <http://www.iobis.org/>
- [5] Glynn PW. Coral communities and coral reefs of Ecuador. In: Cortés J, editor. *Latin American Coral Reefs*. Amsterdam: Elsevier Science; 2003. p. 449–472.
- [6] Gaibor N. Un océano inexplorado: las especies marinas del Ecuador. Quito: SENACYT-FUNDACYT. 2002;5:32–34. Available from: <http://repositorio.educacionsuperior.gob.ec/handle/28000/589>
- [7] Bo M, Lavorato A, Di Camillo CG, et al. Black coral assemblages from Machalilla National Park (Ecuador). *Pacific Sci*. 2012;66(1):63–81.
- [8] Sánchez JA, Ardila NE, Andrade J, et al. Octocoral densities and mortalities in Gorgona Island, Colombia, Tropical Eastern Pacific. *Revista De Biología Tropical*. 2014;62(1):209–219.
- [9] Breedy Shadid O, Cortés Núñez J. Gorgonias (octocorallia: gorgoniidae) de las aguas someras del Pacífico Norte de Costa Rica. *Revista De Biología Tropical*. 2014;62(2):43–62.
- [10] Breedy O, Guzman HM. A new *Muricea* species (Cnidaria, Anthozoa, Octocorallia) from the eastern tropical Pacific. *ZooKeys*. 2016;629:1–10.
- [11] Galvan-Villa CM, Ríos-Jara E. First detection of the alien snowflake coral *Carijoa riisei* (Duchassaing and Michelotti, 1860) (Cnidaria: alcyonacea) in the port of Manzanillo in the Mexican Pacific. *Bioinvasions Rec*. 2018;7(1):1–6.
- [12] Gullian M, Thompson F, Rodríguez J. Selection of probiotic bacteria and study of their immunostimulatory effect in *Penaeus vannamei*. *Aquaculture*. 2004;233(1):1–14.
- [13] Ardiles-Tapia VC. Análisis de la microflora asociada a *Aplysina* sp., recolectada en el islote El Pelado-Ayangue provincia de Santa Elena (Ecuador), en la búsqueda de nuevos probióticos para uso acuícola. Pontificia Universidad Católica de Valparaíso; 2015. Available from: [http://opac.pucv.cl/pucv\\_txt/txt-6500/UCE6999\\_01.pdf](http://opac.pucv.cl/pucv_txt/txt-6500/UCE6999_01.pdf)

- [14] Jaramillo KB, Reverter M, Guillen PO, et al. Assessing the zoantharian diversity of the Tropical Eastern Pacific through an integrative approach. *Sci Rep*. 2018;8(1):7138.
- [15] Guillen PO, Jaramillo KB, Genta-Jouve G, et al. Terrazoanthines, 2-aminoimidazole alkaloids from the Tropical Eastern Pacific Zoantharian terrazoanthus onoi. *Org Lett*. 2017;19(7):1558–1561.
- [16] Steiner SCC, Riegl B, Lavorato A, et al. Community structure of shallow water alcyonacea (Anthozoa: octocorallia) from the southern Tropical Eastern Pacific. *Ecol Res*. 2018;33(2):457–469.
- [17] Australia AoL. Microorganism data schema [cited 2018 October 16]. Available from: <https://www.ala.org.au/who-we-are/atlas-data/microorganism-data-schema/>
- [18] GBIF. GGBN amplification extension [cited 2018 Oct 16]; Available from: <https://tools.gbif.org/dwca-validator/extension.do?id=http://data.ggbn.org/schemas/ggbn/terms/Amplification>
- [19] CENAIM-Centro Nacional de Acuicultura e Investigaciones Marinas CNdAel. [cited 2018 Oct 16]. Available from: <http://www.cenaim.espol.edu.ec/>
- [20] Sánchez JA, Ballesteros D. The invasive snowflake coral (*Carijoa riisei*) in the Tropical Eastern Pacific, Colombia. *Revista De Biología Tropical*. 2014;62(1):199–207.
- [21] Kahng SE, Benayahu Y, Wagner D, et al. Sexual reproduction in the invasive octocoral *Carijoa riisei* in Hawaii. *Bulletin of Marine Science*. 2008. 1–17.
- [22] Reimer JD, Fujii T. Four new species and one new genus of zoanthids (Cnidaria, Hexacorallia) from the Galapagos Islands. *ZooKeys*. 2010;42:1–36.
- [23] Bustamante RH, Vinueza LR, Smith F, et al. Linea Base de la Biodiversidad. 2002. 119–145. Available from: [https://www.researchgate.net/profile/Vanessa\\_Francisco/publication/233390688\\_Comunidades\\_Submareales\\_Rocosas\\_I\\_Organismos\\_Sesiles\\_y\\_Mesoinvertebrados\\_moviles/links/554bb9650cf29f836c98eece/Comunidades-Submareales-Rocosas-I-Organismos-Sesiles-y-Mesoinvertebrados-moviles.pdf](https://www.researchgate.net/profile/Vanessa_Francisco/publication/233390688_Comunidades_Submareales_Rocosas_I_Organismos_Sesiles_y_Mesoinvertebrados_moviles/links/554bb9650cf29f836c98eece/Comunidades-Submareales-Rocosas-I-Organismos-Sesiles-y-Mesoinvertebrados-moviles.pdf)