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ARTÍCULO ORIGINAL

FISHES BIODIVERSITY IN LA SIGUANEA INLET, CUBA

Biodiversidad de peces en la ensenada de La Siguanea, Cuba

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ABSTRACT

La Siguanea inlet, one of the two inlets present in the Gulf of Batabanó, contains essential habitats such as seagrass beds and mangroves. However, it has been poorly studied and currently there is little information about the biological diversity in the area. The aim of this study was to make the first check list of fishes on this region of the Cuban archipelago. We used complementary methodologies such as multiple seine nets, gill net, drum lines, visual census and underwater video census. The inventory recorded 122 species of fishes distributed in 53 families. The best represented families were Haemulidae, Lutjanidae, Scaridae, Carangidae, Monacanthidae and Gerreidae. This finding coincided partially with similar studies done in other Cuban shelf areas, although the order of these may vary. During the surveys a high proportion of juvenile fishes was found, which suggests a possible nursery site that could be playing an important role in fish stocks in the area. This result contributes to raise the knowledge about marine biodiversity in Cuba and also for the Caribbean, providing a baseline of fish for the area. In this work we found a high diversity of fishes in La Siguanea inlet, as well as a high proportion of juveniles. Future studies that explore the composition and structure of fish stocks in the area are required; as well as studies on the possible connectivity between this area and the reefs in Punta Francés. Allowing a better understanding of ecological processes in the area, and in turn a better use and management of these natural resources.

KEY WORDS: Cuba, diversity, fishes, inventory, La Siguanea inlet.

RESUMEN

La Ensenada de la Siguanea es una de las dos ensenadas presentes en el Golfo de Batabanó, en la cual se pueden encontrar importantes hábitats para el desarrollo de los peces como son los pastizales y los manglares. No obstante, esta ensenada ha sido poco estudiada y se cuenta con poca información sobre la diversidad biológica en el área. El objetivo de este estudio fue realizar, por primera vez para el área, un inventario de las especies de peces. Se emplearon diferentes metodologías de muestreo como redes de pesca, palangres, censos visuales y videos bajo

el agua. Se inventariaron 122 especies de peces distribuidas en 53 familias. Las familias más diversas fueron Haemulidae, Lutjanidae, Scaridae, Carangidae, Monacanthidae y Gerreidae, coincidiendo parcialmente con resultados previos en otras regiones del país, aunque su orden puede variar. En los muestreos se encontró una alta proporción de juveniles de peces, sugiriendo que esta es una zona de crianza, que puede tener un rol importante en las poblaciones de peces en el área. Estos resultados contribuyen al conocimiento de la diversidad marina en Cuba y el Caribe, proporcionado una línea base de la ictiofauna para la Ensenada de la Siguanea. En este trabajo se encontró una alta diversidad de de peces en la Siguanea, así como un elevada proporción de juveniles. Se requieren de estudios futuros que exploren la composición y estructura de las poblaciones de peces en el área, así como la posible conectividad entre esta área y el Parque Nacional Punta Francés. Esto permitirá un mejor entendimiento de los procesos ecológicos en el área, y un mejor uso y manejo de los recursos naturales.

PALABRAS CLAVE: *Cuba, diversidad, Ensenada de la Siguanea, inventario, peces.*

INTRODUCTION

The south platform of Cuba has been the scene of numerous researches because of its commercial importance (Arriaza *et al.* 2008; Rodriguez-Viera *et al.* 2012; González-Díaz *et al.* 2012; Pina-Amargós *et al.* 2012a, b). The Gulf of Batabanó has, particularly, been the one most studied due to its commercial importance, mainly because important lobster fisheries (Claro *et al.* 2001; Lopeztegui *et al.* 2012). Today there are several studies in the Gulf of Batabanó covering topics such as sediment (Alonso-Hernández *et al.* 2011), abiotic factors (Arriaza *et al.* 2008), macrofauna (Gómez *et al.* 1980; Arias-Schreiber *et al.* 2008) and ecology of different taxa (Armenteros *et al.* 2012). However, La Siguanea inlet, one of the two inlets present in the Gulf of Batabanó has been poorly studied. To our knowledge, only studies on manatee populations (Alvarez-Alemán 2010; Navarro-Martínez 2012; Hernández *et al.* 2013; Alvarez-Alemán *et al.* 2016) and one about macroalgaes characterization (Suárez 2011) have been carried out.

La Siguanea inlet includes protected areas with different levels of protection (CNAP 2013). A complementary protection existed when the former Ministry of Fisheries (MIP) created an Area under Special Regime of Use and Protection (ASRUP) in 1996, where finfish fishing was banned. Additionally La Siguanea inlet contains essential habitats for the occurrence of fishes, such as seagrass beds and mangroves. These habitats are undisputed nursery habitats for fishes and other marine organisms (Velde *et al.* 1992; Adams *et al.* 2006). They contribute to the presence, abundance and distribution of fishes (González-Sansón *et al.* 2008) and also, an important component in vital ecological processes (Harborne *et al.* 2006; Mumby *et al.* 2008).

Fish are important components in marine ecosystems because of their role in trophic webs (Scheffer *et al.* 2005; Mumby *et al.* 2006; Hughes *et al.* 2007), their sensibility as diversity indicators (Beger *et al.* 2003) and coral reefs health indicators (Graham *et al.* 2008: Pratchett *et al.* 2014). Their abundance and diversity have been accepted as an index of marine protected area effectiveness (Micheli *et al.* 2004; Alcala *et al.* 2005). Also, fishes can be crucial in the selection of areas to conduct recreational SCUBA diving (Williams and Polunin 2000; Angulo-Valdés 2005; Figueredo-Martín *et al.* 2010). It is therefore important and necessary to develop a baseline of the icthyofauna components

in La Siguanea inlet to contribute to the current knowledge of marine biodiversity in the area, which is why the aim of this study was to make the first check list of fishes for La Siguanea inlet.

MATERIALS AND METHODS

Study area

La Siguanea inlet is located in the Gulf of Batabanó, southwest of the Isle of Youth, Cuba, between 21° 38' 00" N and 83° 05' 00" W, from Punta Buenavista to Punta Francés covering an area of 348 km^2 in total , with 179 km of coastline (Fig. 1). The topography is very uniform, with an average depth of 7 m and maximum depth of 13.4 m to the center of the inlet (Lorenzo-Sanchez *et al.* 2006). This cove is characterized, among others, by mangrove habitats, muddy, medium gray sediments, low particulate organic matter (POM), however the area closer to the coastline is characterized by intermediate to high seagrass biomass, dark gray sediments, high POM (Claro *et al.* 2001). The tidal range is very low (< 0.4 m), as reported to the Caribbean islands (Claro *et al.* 2001). The coastline itself is covered mostly by mangrove (Red Mangrove, *Rhizophora mangle*), but we can also find sandy beaches and many channels connected to internal lagoons, becoming more complex in the San Pedro river area. Also mangrove keys can be found in the area near the coastline. In the area they are also located the Ecological Reserve "Los Indios", the National Park "Punta Francés", the Fauna Refuge "Ciénaga de Lanier", and the Managed Resource Protected Area (MRPA) "Sur de la Isla de la Juventud". Despite some differences, these categories correspond to Wilderness Area (Ib), National Park (II), Habitat/Species Management Area (IV), Protected area with sustainable use of natural resources (VI) according to the International Union for Conservation of Nature (IUCN), respectively.

Survey methods

Due to the extension of the region and logistics availability, in this first approach to the diversity of fishes in the area, we focused on a network of 24 stations (Fig.1). The habitats were characterized by white sandy-muddy bottoms, organic content, seagrasses and mangrove. Surveys were conducted close to the mangrove roots, seagrass beds, sandy bottom and a temporary lagoon. The average depth of the stations sampled was 0.88 m, whose range was 0.30 m to 3.50 m (except for shark stations).

Sampling was conducted from June to August in 2014, 2015 and 2016, using different methodologies. Three seine nets were used which varied in length. The largest net was 25 m and the medium net was 9 m, but the most used was a smaller 6 m net. The nets hit a max height of 1.80 m across all of the 3 nets. Each net had a lead line attached along its base in order to keep it smoothly running along the seabed and help to reduce the number of species to escape under the net. The top of the nets had a line of floats to keep the net taut. A lineal transect was conducted by running parallel to the coast line or following the differing seabed. Transects were also performed through pivoting the net against the shoreline. The smaller net was more moveable so could be used to effectively move close to the coast line and change direction quicker depending on the habitat and seabed stability. The seine nets itself was a finer mesh ensuring (5 mm) that all the fishes that entered the net would not be able to escape through it. The net had attached to either end larger

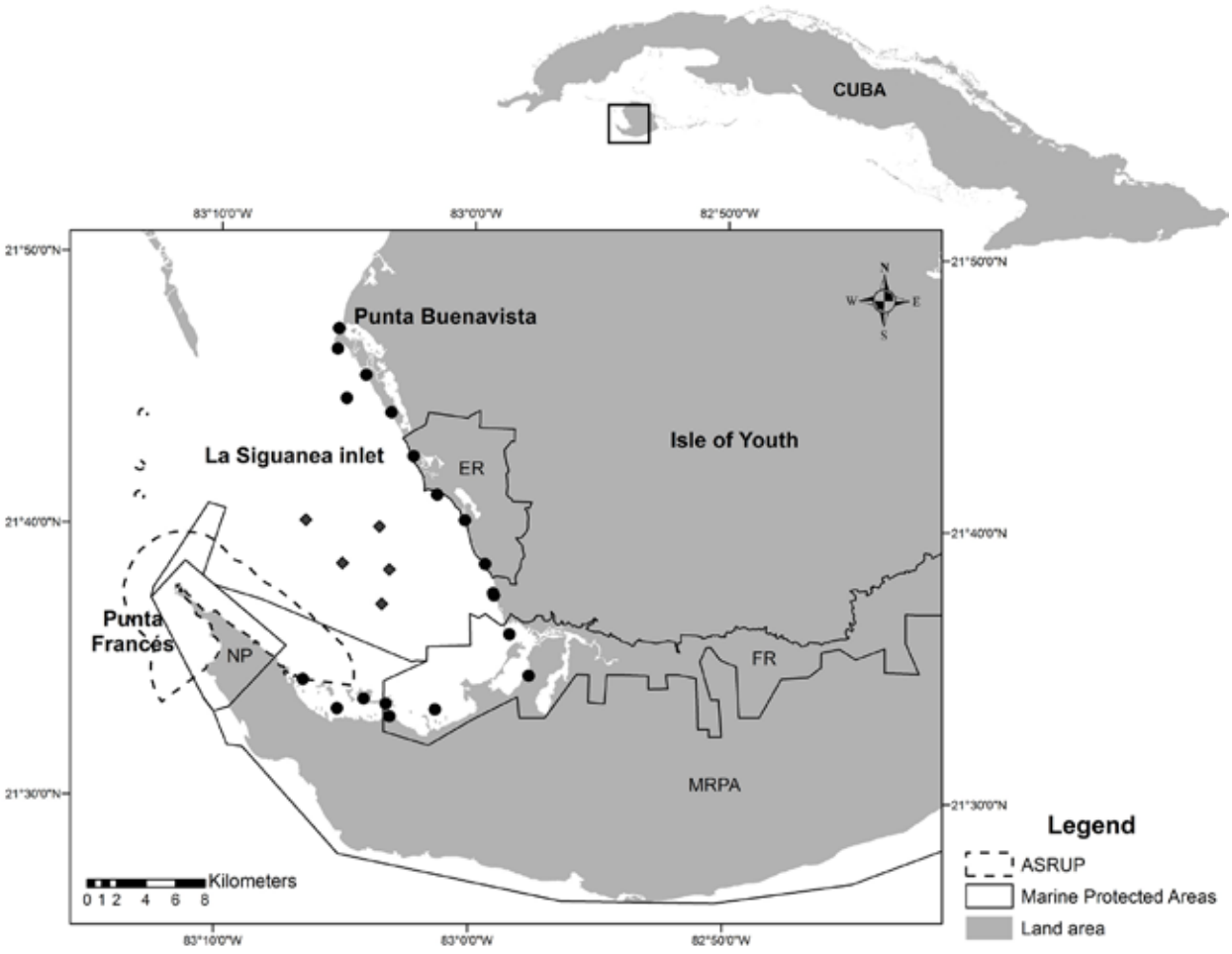

Fig. 1. Map showing the study area in La Siguanea inlet, the fishes survey sites (●) and the sharks survey sites (◆). (ER) Ecological Reserve "Los Indios", (NP) National Park "Punta Francés", (FR) Fauna Refuge "Ciénaga de Lanier", (MRPA) Managed Resource Protected Area "Sur de la Isla de la Juventud" and (ASRUP) Area under Special Regime of Use and Protection.

sticks; these were used to help maneuver the net more effectively.

A 100 m length gill net (1 m height, 140 mm mesh) was also used; soaking time was 2 hours with 30 minutes checking intervals to reduce the risk of damaging the fish. The net was set up through attaching one end to the mangroves or along a solid object. Other sampling method used was the drum lines with a soaking time raged between 3 to 12 hours always during sunset or overnight. This gear was specially used for sampling shark or other big predators. The gear consist in an anchor (heavy weight) attached to a rope as long as the depth site. At the end of this rope there are a buoy and a 10 m of polyurethane rope with other buoy at the end. The gangions are 1.5 m length the fishing depth to avoid killing animals that breathe air in the surface (*i.e.*: turtles, manatees, dolphins) until you check the gear to release them. They are attached to the weight with a swivel and a shackle to allow the shark to swim

around (in circle) and stay alive until you check the line. Circular and ecological hooks (one per gear) are used to avoid choking and die, increasing the survival of the animal. Two additional non-fishery dependent sampling methods were used, random swing visual (Jones and Thompson 1978) and underwater video methods (Mallet and Pelletier 2014).

Although most of the samples were conducted during daylight hours (7:00 h to 19:00 h), also nocturnal sampling were performed. The identification of the organisms was carried out *in situ* and samples were collected only in case of doubt for further analysis. All the organisms were classified to the lowest possible taxonomic level (species or genus). The classification of fishes was done according to the criteria of Guitart (1985), Bölke and Chaplin (1993), Richards (2005), Human and Deloach (2008) and Froese and Pauly (2015). This checklist is arranged evolutionarily at the ordinal and familial levels following Nelson (2006). Valid species names and genera are arranged in alphabetical order.

RESULTS

A total of 122 fish species were recorded. These were distributed in 18 orders, 53 families and 86 genera (Table 1). Of the 122 species found 7 belong to the class Chondrichthyes (subclass Elasmobranchii), while the remaining 115 belong to the Actinopterygii class. The most diverse families were Haemulidae with eight species, Lutjanidae, Scaridae and Carangidae with seven, and Monacanthidae and Gerreidae with six (Fig. 2).

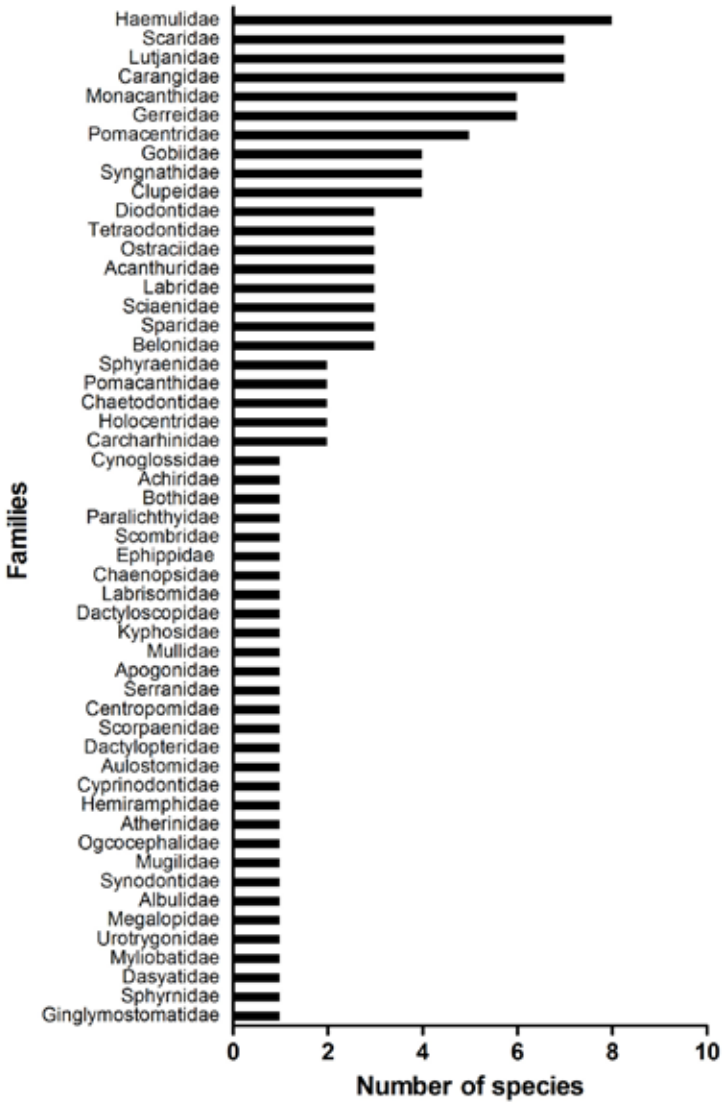

Fig. 2. Number of species of marine fishes by family recorded in La Siguanea inlet, Cuba from 2014 to 2016.

Table 1. Systematic inventory of marine fishes found in La Siguanea inlet, Cuba from 2014 to 2016, fallowing the taxonomy of Nelson (2006).

Class [Subclass]	Order	Family	Scientific name	Commun name (English)	Commun name (*Spanish*)
Chondrichthyes [Elasmobranchii]	Orectolobiformes	Ginglymostomatidae	*Ginglymostoma cirratum* (Bonnaterre, 1788)	Nurse shark	Tiburón gata
	Carcharhiniformes	Carcharhinidae	*Carcharhinus leucas* (Müller & Henle, 1839)	Bull shark	Cabeza de batea, toro
			Negaprion brevirostris (Poey, 1868)	Lemon shark	Galano
		Sphyrnidae	*Sphyrna mokarran* (Rüppell, 1837)	Great hammerhead	Cornuda de ley
	Rajiformes	Dasyatidae	*Dasyatis americana* Hildebrand & Schroeder, 1928	Southern stingray	Raya americana
		Myliobatidae	*Aetobatus narinari* (Euphrasen, 1790)	Spotted eagle ray	Obispo
		Urotrygonidae	*Urobatis jamaicensis* (Cuvier, 1816)	Yellow stingray	Tembladera
Actinopterygii [Neopterygii]	Elopiformes	Megalopidae	*Megalops atlanticus* Valenciennes, 1847	Tarpon	Sábalo
	Albuliformes	Albulidae	*Albula vulpes* (Linnaeus, 1758)	Bonefish	Macabí
	Clupeiformes	Clupeidae	*Harengula humeralis* (Cuvier, 1829)	Redear sardine	Sardina de ley
			Harengula jaguana Poey, 1865	Scaled sardine	Sardina escamuda
			Jenkinsia lamprotaenia (Gosse, 1851)	Dwarf herring	Manjúa
			Opisthonema oglinum (Lesueur, 1818)	Atlantic thread herring	Machuelo
	Aulopiformes	Synodontidae	*Synodus foetens* (Linnaeus, 1766)	Inshore lizardfish	Lagarto máximo
	Lophiiformes	Ogcocephalidae	*Ogcocephalus nasutus* (Cuvier, 1829)	Shortnose batfish	Pez diablo ñato
	Mugiliformes	Mugilidae	*Mugil curema* Valenciennes, 1836	White mullet	Lisa blanca
	Atheriniformes	Atherinidae	*Atherinomorus stipes* (Müller & Troschel, 1848)	Hardhead silverside	Cabezote
	Beloniformes	Hemiramphidae	*Hemiramphus brasiliensis* (Linnaeus, 1758)	Ballyhoo halfbeak	Escribano de aletas rojas
		Belonidae	*Ablennes hians* (Valenciennes, 1846)	Flathead needlefish	Agujón de golfo
			Platybelone argalus (Lesueur, 1821)	Keeltail needlefish	Agujón aquillado
			Strongylura notata (Poey, 1860)	Redfin needlefish	Agujón de aletas rojas
	Cyprinodontiformes	Cyprinodontidae	*Cyprinodon variegatus* Lacepède, 1803	Sheepshead minnow	Pipón
	Beryciformes	Holocentridae	*Holocentrus rufus* (Walbaum, 1792)	Longspine squirrelfish	Carajuelo rufo
			Sargocentron vexillarium (Poey, 1860)	Dusky squirrelfish	Carajuelo oscuro

Class [Subclass]	Order	Family	Scientific name	Commun name (English)	Commun name (Spanish)
Actinopterygii [Neopterygii]	Syngnathiformes	Syngnathidae	*Cosmocampus brachycephalus* (Poey, 1868)	Crested pipefish	Trompetero ñato
			Hippocampus erectus Perry, 1810	Lined seahorse	Caballito erecto
			Hippocampus reidi Ginsburg, 1933	Longsnout seahorse	Caballito narizón
			Syngnathus floridae (Jordan & Gilbert, 1882)	Dusky pipefish	Trompetero prieto
		Aulostomidae	*Aulostomus maculatus* Valenciennes, 1841	Trumpetfish	Trompa
	Scorpaeniformes	Dactylopteridae	*Dactylopterus volitans* (Linnaeus, 1758)	Flying gurnard	Pez murciélago
		Scorpaenidae	*Pterois* sp.	Lionfish	Pez león
	Perciformes	Centropomidae	*Centropomus undecimalis* (Bloch, 1792)	Common snook	Robalo común
		Serranidae	*Hypoplectrus puella* (Cuvier, 1828)	Barred hamlet	Vaca barreada
		Apogonidae	*Apogon maculatus* (Poey, 1860)	Flamefish	Cardenal manchado
		Carangidae	*Alectis ciliaris* (Bloch, 1787)	African pompano	Flechudo
			Carangoides bartholomaei (Cuvier, 1833)	Yellow jack	Cibí amarillo
			Caranx hippos (Linnaeus, 1766)	Crevalle jack	Jiguagua
			Caranx latus Agassiz, 1831	Horse-eye jack	Gallego
			Caranx ruber (Bloch, 1793)	Bar jack	Cibí carbonero
			Oligoplites saurus (Bloch & Schneider, 1801)	Leather jack	Zapatero
			Trachinotus falcatus (Linnaeus, 1758)	Permit	Pámpano
		Lutjanidae	*Lutjanus analis* (Cuvier, 1828)	Mutton snapper	Pargo criollo
			Lutjanus apodus (Walbaum, 1792)	Schoolmaster	Cají
			Lutjanus griseus (Linnaeus, 1758)	Gray snapper	Caballerote
			Lutjanus jocu (Bloch & Schneider, 1801)	Dog snapper	Jocú
			Lutjanus mahogoni (Cuvier, 1828)	Mahogany snapper	Ojanco
			Lutjanus synagris (Linnaeus, 1758)	Lane snapper	Biajaiba
			Ocyurus chrysurus (Bloch, 1791)	Yellowtail snapper	Rabirrubia
		Gerreidae	*Diapterus auratus* Ranzani, 1842	Irish pompano	Patao común
			Eucinostomus gula (Quoy & Gaimard, 1824)	Silver jenny	Mojarra de ley
			Eucinostomus jonesii (Günther, 1879)	Slender mojarra	Mojarrita esbelta

Class [Subclass]	Order	Family	Scientific name	Commun name (English)	Commun name (Spanish)
Actinopterygii [Neopterygii]	Perciformes	Gerreidae	*Eucinostomus jonesii* (Günther, 1879)	Slender mojarra	Mojarrita esbelta
			Eucinostomus melanopterus (Bleeker, 1863)	Flagfin mojarra	Mojarra bandera
			Gerres cinereus (Walbaum, 1792)	Yellowfin mojarra	Mojarra blanca
			Ulaema lefroyi (Goode, 1874)	Mottled mojarra	Mojarrita
		Haemulidae	*Anisotremus virginicus* (Linnaeus, 1758)	Porkfish	Catalineta
			Haemulon aurolineatum Cuvier, 1830	Tomtate	Jeníguano bocón
			Haemulon carbonarium Poey, 1860	Caesar grunt	Ronco carbonero
			Haemulon flavolineatum (Desmarest, 1823)	French grunt	Ronco condenado
			Haemulon parra (Desmarest, 1823)	Sailors choice	Ronco blanco
			Haemulon plumierii (Lacepède, 1801)	White grunt	Ronco arará
			Haemulon sciurus (Shaw, 1803)	Bluestripped grunt	Ronco amarillo
			Haemulon striatum (Linnaeus, 1758)	Stripped grunt	Jeníguano rayado
		Sparidae	*Archosargus rhomboidalis* (Linnaeus, 1758)	Sea bream	Salema
			Calamus bajonado (Bloch & Schneider, 1801)	Jolthead porgy	Bajonao violáceo
			Calamus pennatula Guichenot, 1868	Pluma porgy	Bajonao plateado
		Sciaenidae	*Bairdiella ronchus* (Cuvier, 1830)	Ground croaker	Corvina espinosa
			Equetus punctatus (Bloch & Schneider, 1801)	Spotted drum	Vaqueta punteada
			Pareques acuminatus (Bloch & Schneider, 1801)	High-hat	Vaqueta rayada
		Mullidae	*Pseudupeneus maculatus* (Bloch, 1793)	Spotted goatfish	Salmonete colorado
		Kyphosidae	*Kyphosus* sp.	Yellow/Bermuda chub	Chopa amarilla/blanca
		Chaetodontidae	*Chaetodon capistratus* Linnaeus, 1758	Foureye butterflyfish	Parche ocelado
			Chaetodon striatus Linnaeus, 1758	Banded butterflyfish	Parche rayado
		Pomacanthidae	*Holacanthus ciliaris* (Linnaeus, 1758)	Queen angelfish	Isabelita reina
			Pomacanthus arcuatus (Linnaeus, 1758)	Gray angelfish	Chivirica gris
		Pomacentridae	*Abudefduf saxatilis* (Linnaeus, 1758)	Sergant major	Píntano
			Microspathodon chrysurus (Cuvier, 1830)	Yellowtail damselfish	Chopita de cola amarilla
			Stegastes leucostictus (Müller & Troschel, 1848)	Beaugregory	Chopita de cola amarilla

Class [Subclass]	Order	Family	Scientific name	Commun name (English)	Commun name (Spanish)
Actinopterygii [Neopterygii]	Perciformes	Pomacentridae	*Stegastes planifrons* (Cuvier, 1830)	Threespot damselfish	Chopita amarilla
			Stegastes adustus (Troschel, 1865)	Dusky damselfish	Chopita prieta
		Labridae	*Halichoeres bivittatus* (Bloch, 1791)	Slippery dick	Doncella rayada
			Halichoeres radiatus (Linnaeus, 1758)	Puddingwife	Doncella pudín
			Thalassoma bifasciatum (Bloch, 1791)	Bluehead	Cara de cotorra
		Scaridae	*Nicholsina usta* (Valenciennes, 1840)	Emerald parrotfish	Loro esmeralda
			Scarus iseri (Bloch, 1789)	Striped parrotfish	Loro listado
			Sparisoma atomarium (Poey, 1861)	Greenblotch parrotfish	Loro de lunar verde
			Sparisoma aurofrenatum (Valenciennes, 1840)	Redband parrotfish	Vieja lora
			Sparisoma radians (Valenciennes, 1840)	Bucktooth parrotfish	Loro dientuso
			Sparisoma rubripinne (Valenciennes, 1840)	Yellowtail parrotfish	Loro aletirojo
			Sparisoma viride (Bonnaterre, 1788)	Stoplight parrotfish	Loro
		Dactyloscopidae	*Dactyloscopus poeyi* Gill, 1861	Shortchin Stargazer	Mirón ojicorto
		Labrisomidae	*Labrisomus nuchipinnis* (Quoy & Gaimard, 1824)	Hairy blenny	Sapito cabezón
		Chaenopsidae	*Chaenopsis limbaughi* Robins & Randall, 1965	Yellowface pikeblenny	Sapito cara amarilla
		Gobiidae	*Bathygobius soporator* (Valenciennes, 1837)	Frillfin goby	Gobio mapo
			Ctenogobius saepepallens (Gilbert & Randall, 1968)	Dash goby	Gobio guión
			Evorthodus lyricus (Girard, 1858)	lyre goby	Gobio lira
			Ctenogobius boleosoma (Jordan & Gilbert, 1882)	Darter goby	Esmeralda flechera
		Ephippidae	*Chaetodipterus faber* (Broussonet, 1782)	Atlantic spadefish	Paguala
		Acanthuridae	*Acanthurus chirurgus* (Bloch, 1787)	Doctorfish	Barbero rayado
			Acanthurus coeruleus Bloch & Schneider, 1801	Blue tang	Barbero azul
			Acanthurus tractus Poey, 1860	Ocenan surgeonfish	Barbero
		Sphyraenidae	*Sphyraena barracuda* (Edwards, 1771)	Great barracuda	Picúa
			Sphyraena picudilla Poey, 1860	Southern sennet	Picudilla
		Scombridae	*Scomberomorus regalis* (Bloch, 1793)	Cero	Pintada
	Pleuronectiformes	Paralichthyidae	*Citharichthys spilopterus* Günther, 1862	Bay whiff	Lenguado pardo

Class [Subclass]	Order	Family	Scientific name	Commun name (English)	Commun name (Spanish)
Actinopterygii [Neopterygii]	Pleuronectiformes	Bothidae	*Bothus ocellatus* (Agassiz, 1831)	Eyed flounder	Lenguado ocelado
		Achiridae	*Achirus lineatus* (Linnaeus, 1758)	Lined sole	Acedía rayada
		Cynoglossidae	*Symphurus plagusia* (Bloch & Schneider, 1801)	Duskycheek tonguefish	Lengua de vaca parda
	Tetraodontiformes	Monacanthidae	*Aluterus schoepfii* (Walbaum, 1792)	Orange filefish	Lija anaranjada
			Aluterus scriptus (Osbeck, 1765)	Scrawled filefish	Lija trompa
			Monacanthus ciliatus (Mitchill, 1818)	Fringed filefish	Sobaco común
			Monacanthus tuckeri Bean, 1906	Slender filefish	Lija reticulada
			Stephanolepis hispidus (Linnaeus, 1766)	Planehead filefish	Lija áspera
			Stephanolepis setifer (Bennett, 1831)	Pygmy filefish	Lija ciliada
		Ostraciidae	*Acanthostracion polygonius* Poey, 1876	Honeycomb cowfish	Torito hexagonal
			Acanthostracion quadricornis (Linnaeus, 1758)	Scrawled cowfish	Torito común
			Lactophrys trigonus (Linnaeus, 1758)	Trunkfish	Chapín de lunares blancos
		Tetraodontidae	*Canthigaster rostrata* (Bloch, 1786)	Sharpnose puffer	Tamboril narizón
			Sphoeroides spengleri (Bloch, 1785)	Bandtail puffer	Tamboril manchado
			Sphoeroides testudineus (Linnaeus, 1758)	Checkered puffer	Tamboríl rayado
		Diodontidae	*Chilomycterus schoepfii* (Walbaum, 1792)	Stripped burrfish	Guanábana rayada
			Diodon holocanthus Linnaeus, 1758	Balloonfish	Pez erizo
			Diodon hystrix Linnaeus, 1758	Spot-fin porcupinefish	Puerco espín

DISCUSSION

According to the list published in this work, in La Siguanea inlet it is represented 11 % of Cuban fishes and the 15 % of coastal marine fishes reported for Cuba, according to Claro and Robertson (2010). It was found 12 % of ray species, 7 % of shark species and 11 % of bony fishes reported for Cuba (Claro and Robertson 2010). Among the species found in this work, it was relevant the occurrence in La Siguanea inlet of fishes listed in the IUCN Red List due to their threatened status (IUCN, 2015). It was the case of species: Endangered (*Sphyrna mokarran*), Vulnerable (*Hippocampus erectus*, *Lutjanus analis*, *Megalops atlanticus*) and Near Threatened (*Aetobatus narinari*, *Albula vulpes*, *Negaprion brevirostris*). These elements highlight the importance of the protection and the studies in the habitats of the area.

The diversity of taxa found in this study was higher than the reported for other areas of the northwest (González-Sansón *et al.* 1997 [92 spp.]; Aguilar *et al.* 2000 [84 spp.]; Cobián *et al.* 2013 [53 spp.]), northeast (Claro and García-Arteaga 1993 [87 spp. for mangroves]) and southeast of Cuba (Hernández-Fernández *et al.* 2013 [38 spp.]; Hernández-Fernández and Salvat-Torres 2014 [56 spp; 97 spp.]) and southwest of Cuba (Navarro-Martínez 2015 [105 spp.]). However, other studies reported higher values of diversity in other areas in the southern shelf of the country, such as the Marine National Park Guanahacabibes (Cobián *et al.* 2011 [201 spp.]); the Gulf of Ana María (Pina-Amargós *et al.* 2012a [170 spp.]) and Marine National Park Jardines de la Reina (Pina-Amargós *et al.* 2012b [283 spp.]). Differences in diversity can be caused by several factors, among others, by the sampling effort (Pina-Amargós *et al.* 2012a; Navarro-Martínez and Angulo-Valdés 2015), the high variability in sampling methods (Miloslavich *et al.* 2010), the complexity of the substrate (Hixon and Beets 1993; Claro *et al.* 2001; González-Sansón *et al.* 2009; Toller *et al.* 2010) specially because we are including habitats that belong to coral reefs or by the different actual levels of protection having the area (Miloslavich *et al.* 2010; Pina-Amargós *et al.* 2014; Navarro-Martínez and Angulo-Valdés 2015). Although, in La Siguanea inlet converge some areas under different protection levels (Fig. 1), the inlet as a whole is not under protection. However, the number of species found in this study is similar to those found in other areas under protection and with a greater complexity of the substrate (presence of reefs) as the case of Marine National Park Desembarco del Granma (Hernández-Fernández and Salvat-Torres 2014) and Marine National Park Punta Francés (Navarro-Martínez 2015). This could be caused by low or no effectiveness of protected areas in the protection of reef fishes, allowing illegal fishing (Navarro-Martínez 2015).

Previous studies on the diversity of fishes in the Gulf of Batabanó, reported lower values of diversity in most cases, for example in the mangroves of the Archipelago of Los Canarreos [82 spp.] and Punta del Este [62 spp.] (Claro *et al.* 2001), and in the northern keys in the Gulf [38 spp.] (Semidey *et al.* 2013). Nevertheless, it has been reported values of 98 spp. in the seagrass beds of the Gulf and up to 136 spp. for slope reef habitats in Los Canarreos (Claro *et al.* 2001). The best represented families of fishes coincide partially with previous studies (González-Sansón *et al.* 1997; Pina-Amargós *et al.* 2012a, b; Navarro-Martínez 2015), although the order of these may vary.

However, it draws attention to the absence of the family Serranidae (represented by only one species). Contrary this family is one of the best represented in the Marine National Park Punta Francés (Navarro-Martínez 2015) despite its proximity to La Siguanea inlet. A possible cause of this absence could be due to overfishing of these large animals (Navarro-Martínez 2015). On the other hand, the studies on the possible use of mangroves as nursery grounds for Serranidae family are inconclusive (Pina-Amargós *et al.* 2012 b).

During the surveys conducted in La Siguanea inlet a high proportion of juvenile fishes was found, which suggests that this is a nursing site that could be playing an important role for fish stocks in the area, including the Marine National Park Punta Francés. The potential connectivity between La Siguanea inlet and the Marine National Park Punta Francés, an area with importance for tourism and conservation of species (Angulo-Valdés 2005), highlight the importance of the study area. It is know the connectivity through ontogeny between habitats near to shore, essentially mangrove and coral reefs (Jones *et al.* 2010). Even, the composition of reef fish assemblages can change depending of the presence or not of habitats like mangrove that can be associated (González-Sansón *et al.* 2009; Toller *et al.* 2010).

Interestingly, in all surveys conducted close to the mangrove roots and seagrass beds, it was only observed lionfish on a single occasion. Although, these animals are observed in artificial shelters used in the lobster fishery, located in some areas in the inlet. It is known that over recent years the Indo-Pacific lionfish *Pterois volitans* and *Pterois miles* have rapidly and successfully invaded the Western Atlantic from the northeast coast of the United States to the Caribbean coasts of Colombia and Venezuela, including the Caribbean islands (Schofield 2010) and Bahamas (Pimiento *et al.* 2013). In Cuba, the presence of lionfish is documented (*e.g.* Chevalier *et al.* 2014), and indeed the abundance of these species on the reef of Punta Francés (very close to the area of this study) can be relatively high in some sites (observations made by the authors in the area). A possible explanation for the low presence of these species in this study could be their ability to camouflage or due to their limited movement behavior across habitats (Pimiento *et al.* 2013).

This research allows for the first time, an inventory of the fishes in La Siguanea inlet. That contributes to raise the knowledge about the marine biodiversity in Cuba and also for the Caribbean, providing a baseline of fishes for the area. In this work we found a high diversity of fishes in La Siguanea inlet. Moreover, due to the composition of the fishes tends to change through habitats (Mazieres and Comley 2008; Toller *et al.* 2010), examining various habitats near to the coast and using various survey methods, could provide a more comprehensive view on fish assemblages. The Siguanea inlet is a fairly large area, which has several important habitats in marine communities, such as mangroves, seagrass beds and even a complex of several internal lagoons, among others. Future studies that explore the composition and structure of fish stocks in the area are required; as well as studies on the possible connectivity between this area and the reefs in Punta Francés. Allowing a better understanding of ecological processes in the area, and in turn a better use and management of these natural resources.

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