

## New and confirmed records of fishes from the Cabo Verde archipelago based on photographic and genetic data

RUI FREITAS, J.M. FALCÓN, J.A. GONZÁLEZ, K.A. BURNETT, M. DUREUIL, J.H. CARUSO, H.J.T. HOVING & A. BRITO



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In recent decades the Cabo Verde ichthyofauna has been studied more extensively, and nowadays photo-recording is employed as a valuable asset under special caution and consideration. Four species reported here are new records for Cabo Verde: *Carliarius* sp., sea catfish; *Serranus cabrilla*, comber; *Branchiostegus semifasciatus*, African tilefish and *Lutjanus dentatus*, African coastal snapper. The presence in Cabo Verde of *Glaucostegus cemiculus*, blackchin guitarfish, *Elops senegalensis*, Senegalese ladyfish, *Lophius* spp., bathydemersal monkfishes, *Rachycentron canadum*, cobia, *Pagrus auriga*, African seabream, *Lutjanus dentatus*, African coastal snapper and *Mugil cephalus*, mullet, was re-confirmed by photo-records. *Squalus megalops*, cosmopolitan spurdog, was identified by genetic fingerprinting. The two littoral species, *P. auriga* and *M. cephalus*, are firmly established in the archipelago and additional information on their occurrence is given. The findings reported in the present contribution may well be the result of a wider sharing of information between fishermen and other seafarers and scientists, rather than an indicator of recent faunal changes.

Key words: Marine fishes, new photo-records, Cabo Verde Islands, Eastern Atlantic.

Rui Freitas (email: rui.freitas@docente.unicv.edu.cv) Faculdade de Engenharia e Ciências Marinhas, Universidade de Cabo Verde, CP 163 Mindelo, Cabo Verde & Facultad de Ciencias del Mar, Universidad de Vigo, ES-36310 Vigo, Spain; J.M. Falcón, A. Brito, Grupo de investigación BIOECOMAC, Unidad Departamental de Ciencias Marinas Facultad de Ciencias, Universidad de La Laguna, ES-38206 La Laguna (Tenerife), Spain; J.A. González; Ecología Marina Aplicada y Pesquerías, i-UNAT, Universidad de Las Palmas de Gran Canaria (ULPGC), ES-35017 Las Palmas de Gran Canaria, Spain; K.A. Burnett, Sharks of the Atlantic Research and Conservation Centre SHARCC, B3L2Y5 Halifax, Canada; M. Dureuil, SHARCC and Dalhousie University, B3H 4R2 Halifax, Canada; J.H. Caruso, Department of Ecology and Evolutionary Biology, Tulane University, New Orleans, Louisiana 70118, USA; H.J.T. Hoving, GEOMAR, Helmholtz Centre for Ocean Research Kiel, Düsternbrooker Weg 20, DE-24105 Kiel, Germany.

### INTRODUCTION

The Cabo Verde archipelago is located in the tropical Eastern Atlantic 570 km west of Senegal (Fig. 1), and is composed of 10 volcanic islands and islets, with a total area of 4,033 km<sup>2</sup> (Medina et al. 2007). This archipelago and the Sahelian Upwelling zone are rooted in the province of 'West African Transition' as a peripheral marine

ecoregion (Spalding et al. 2007). The ichthyofauna of Cabo Verde has been a subject of prolific research in the past 20 years and publication of books, taxonomic revisions, descriptions of new species and new records have increased significantly over the last years (Freitas, 2014 and references therein). Reiner (1996) is an important publication with meritorious data on Cabo Verde fishes. However, it also includes

many erroneous and unconfirmed records from the archipelago based on documented sources for a larger Atlantic area (Fischer et al. 1981). The most recently updated catalogue, by Wirtz et al. (2013) lists 315 coastal fish species, mainly tropical, with more than twenty species endemic from the Cabo Verde Islands. An alternative interpretation of this list deleted 33% of these species as not being strictly coastal (i.e. oceanic-pelagic and/or bottom-deep-water). This resulted in a list of only 185 reef-associated teleost species, with at least half labelled as commercial species (Freitas 2014). González et al. (2010, 2014) listed

new and rare deep sea records of teleost fishes based on exploratory trapping surveys, while Hanel & John (2015) revised disregarded literature and included mesopelagic species in their inventory. Wirtz et al. (2013) and Hanel & John (2015) pointed out species which are doubtful or in need of confirmation, as well as synonymies, misidentifications or misspellings from the older literature. Recently, photography-based descriptions have increased, and extensively updated the knowledge about coastal fish species in the area (Brito et al. 2013, 2017; Wirtz et al. 2013; González et al. 2014).

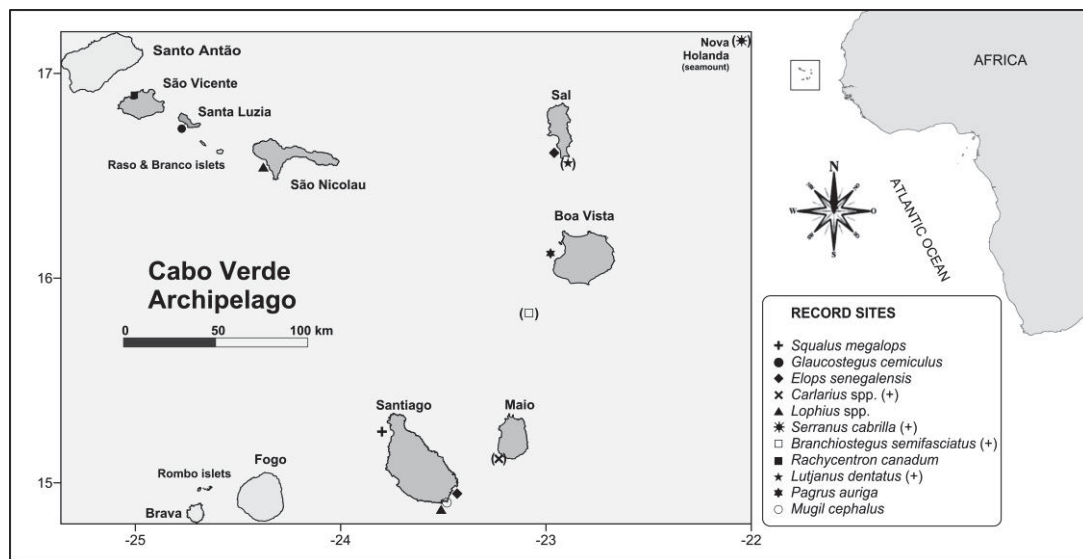


Fig. 1. Map showing the geographical position of the Cabo Verde Islands in West Africa, and the reported sites per species; (+) new records.

Valid confirmation of occurrence of one elasmobranch species by genetic fingerprinting, and one elasmobranch and nine teleost fishes by photographic record from the shores of the Cabo Verde archipelago is given herein. Relevant notes on insular and regional biogeography and species expansion out of their known range of occurrence are also discussed.

## MATERIAL AND METHODS

The fishes were captured and/or photographed in

the field. The location of all reported findings is shown in Figure 1. The photo-identification of the species was possible due to the distinctive species-specific features. The external well-visible morphology was compared to data from the literature (Carpenter & De Angelis 2016; Froese & Pauly 2017) or revised and compared to the available checklist per group (Reiner 2005; Wirtz et al. 2013; Hanel & John 2015). The type of material examined (e.g. individuals or tissue samples) is described in the Results section, below the name of the species. Whenever possible, a repository and catalogue number has

been provided. The systematic listing of the present account follows Eschmeyer et al. (2017) and nomenclatural revision of species is based on Wirtz et al. (2013).

Abbreviations used: EOL: Encyclopedia of Life, FishBase: A Global Information System on Fishes, GBIF: Global Biodiversity Information Facility, GEOMAR: Helmholtz Centre for Ocean Research Kiel, ICCM: Instituto Canario de Ciencias Marinas, IGFA: International Game Fish Association, INDP: Instituto Nacional de Desenvolvimento das Pescas, OFCF: Overseas Fishery Cooperation Foundation, ULPGC: Universidad de Las Palmas de Gran Canaria.

## RESULTS

### ELASMOBRANCHII

**Squalidae:** *Squalus megalops* (Macleay, 1881), shortnose spurdog

Material examined: tissue sample, preserved and deposited at the ULPGC (ICCM\_*Squalus* cf. *megalops*-01-CV).

Remarks: *Squalus megalops* has a pantropical distribution (western and eastern Atlantic Ocean, western Mediterranean, western Pacific Ocean, and south-western Indian Ocean) where regional forms may represent different species complexes (Compagno 2016: 1162). In waters of the subtropical-temperate Canary Islands, where it was erroneously cited as *S. blainvillei* until 1990, this benthic species is abundant at depths between 20 and 460 m, predominantly at 200-350 m (Brito et al. 2002; Pajuelo et al. 2011). Although its total length (TL) is less than 1 m, the species presents considerable interest to fisheries (Pajuelo et al. 2011). One exploratory fish-trapping survey (cruise ‘Taliarte 2003-08’) of the bottom dwelling fauna of the Cabo Verde Islands was carried out off the islands of Boa Vista and Santiago (10-23 August 2003) at depths between 435 and 975 m (González et al. 2004; 2014). During this cruise one male squalid (89.5 cm TL) was caught in a benthic trap at 15°14'N 23°47'W, off Tarrafal Bay, northwest of Santiago Island at a depth of 730-764 m. Based on the literature review and its morphological similarity to species living off the

Canary Islands (Pajuelo et al. 2011), it was initially identified as *Squalus* cf. *megalops*. A tissue sample was taken and preserved, and the specimen stored on board of the R/V ‘Taliarte’ for further identification at the laboratory. Unfortunately, the vessel sank in September 2003 and most of the biological samples collected during the surveys were lost. Consequently, this specimen was not reported by González et al. (2004; 2009). Twelve years later during a genetic/taxonomic study of the deep sea *Squalus* sharks in the Gulf of Mexico, specifically *S. mitsukurii* vs *S. megalops*, Toby S. Daly-Engel and Mariah Pfleger from the University of West Florida (USA) confirmed the preliminary identification of the Cabo-Verdean *Squalus* specimen based on the tissue sample (unpubl. data, J.A. González). Recently, Compagno (2016) suggested that the local form is possibly not conspecific with *S. megalops* (type locality from Australia). Until further research is done, *Squalus megalops*, shortnose spurdog, is here recorded for the first time from the Cabo Verde archipelago, based on DNA barcoding from the preserved tissue sample.

**Glaucostegidae:** *Glaucostegus cemiculus* (Geoffroy St Hilaire, 1817), blackchin guitarfish

Remarks: The only species of the genus *Glaucostegus* that occurs in West African waters. Its range has been given from Portugal to Angola, including the Mediterranean Sea (Last et al. 2016a), but is now believed to be extinct in some parts of the Mediterranean Sea (Notarbartolo di Sciara et al. 2016). *Glaucostegus cemiculus* lives on sandy and muddy bottoms to a depth of at least 80 m. It is a large guitarfish attaining 265 cm TL, with females reaching maturity at about 153-164 cm TL (Last et al. 2016a). This guitarfish is targeted by artisanal fisheries for its fins and meat and is highly prized in West Africa (Notarbartolo di Sciara et al. 2016; Moore 2017). Recently *G. cemiculus* was placed in the family of Glaucostegidae, giant guitarfishes, while all other West African guitarfish remain in the family Rhinobatidae (Last et al. 2016b). Records of *G. cemiculus* in Cabo Verde have been considered questionable (Hanel & John 2015). However, this species has been previously listed by Reiner (1996), and Wirtz et al. (2013) based on specimens referred by Troschel (1866). During an

expedition to Santa Luzia in 2017, three female *G. cemiculus* were captured, tagged, photographed and released. The sizes ranged from 117,5 to 147 cm TL. They were identified as *G. cemiculus*, confirming the presence of this species in Cabo Verde Islands based on morphological features. The families Rhinobatidae and Glaucostegidae can be differentiated by their nasal openings with the latter having rectangular shaped nasal openings (Fig. 2a) as opposed to the circular nasal

openings of Rhinobatidae. Furthermore, Glaucostegidae have sharply demarcated margins separating the cranial cartilages from the much paler snout (Fig. 2b). *Glaucostegus cemiculus* can be visually identified from all other species within the family Glaucostegidae, they both have an elongated and pointed snout and narrowly separated rostral ridges. A black spot on the tip of the snout is often only present in young individuals (Last et al. 2016a).



Fig. 2. Blackchin guitarfish *Glaucostegus cemiculus*, specimen captured in Santa Luzia, Cabo Verde, above sandy bottom and within 10 m water depth; a) ventral view showing the rectangular shaped nasal openings, b) dorsal view showing the sharp colour differentiation on the snout (Photos: M. Dureuil, 30 May 2017).

#### ACTINOPTERYGII

**Elopidae:** *Elops senegalensis* Regan, 1909,  
Senegalese ladyfish

Remarks: *Elops senegalensis* and *Elops lacerta*, are the only two species of the family within the area. They have been frequently misidentified due to their overlapping distributions and morphological similarities and as a result records may often be misidentifications (Ferraris 2016: 1585). The key morphological distinctions between the two species are gill-raker counts (11-15 on *E. senegalensis* vs 17-19 on *E. lacerta*) and scales in the lateral line (92-100 vs 72-83). Moreover, the length of pectoral fin and maxilla can also be used to distinguish the two species.

Two individuals of *Elops* were caught at Sal island (Fig. 3b) and Santiago island (Fig. 3a) in 2016. Photometry and the original description by Regan (1909) allowed us to identify them as *E. senegalensis* by measuring the pectoral fin, which is 3/5 the length of head (Fig. 3b) (nearly 1/2 in *E. lacerta*), along with the characteristic prominent maxilla extending further beyond the eye in comparison to *E. lacerta*. Wirtz et al. (2013) listed *E. senegalensis* from the Cabo Verde Islands based on a record by Franca & Vasconcelos (1962) without any further remarks. Here the presence of this species in Cabo Verde, far away from the mainland habitats is confirmed.



Fig. 3. Two specimens of Senegalese ladyfish *Elops senegalensis*, captured in Cabo Verde at the nearest location to the continent (ca. 640 km); a) São Francisco beach, east coast of Santiago Island (photo Z. Lopes, 14 October 2016); b) Bikini Beach Club, southeast Sal Island (Photo: M. Soares, 29 October 2016).

**Ariidae:** *Carlarius* spp., sea catfish

Remarks: On 31 July 2017 at Porto Inglês harbour, Maio Island, an unknown fish was captured, without resistance, by hook-and-line at a depth of 13 m on sandy bottom, using a ghost-crab as bait (E. Querido pers. comm.). This teleost fish, measuring 83 cm TL, was later identified from a photograph as an ariid catfish, common in continental waters, but not yet reported from the Cabo Verde archipelago. The species identification was almost unsolved because the head, one of the most important diagnostic parts in this group of fish due to the characteristic pattern of palatal teeth, had been discarded by the fisherman. However, tissue samples were preserved by a local NGO (Maio Biodiversity Foundation) allowing future scrutiny. Six species of sea catfish from two genera naturally occur along the Western coast of Africa (Acero & Betancur-R 2016). The following three species of the genus *Carlarius* have a probability of occurring in Cabo Verde: *Carlarius heudelotii*, *C. latiscutatus*, and *C. parkii*, all occur along the coast of West Africa from Cape Blanc (Mauritania) to Angola (perhaps

also farther north/south, but their distribution overlaps in the coastal waters) (Acero & Betancur-R 2016). They are naturally found along shallow coasts and estuaries, sometimes entering freshwater basins (Marceniuk & Menezes 2007). Several external features are not entirely clear from the available photograph (Fig. 4). However, an illustration from an FAO guide (Acero & Betancur-R 2016: 1747) allowed us, with a certain degree of confidence, to identify this exceptional specimen as *Carlarius* cf. *latiscutatus*. The following morphological evidence was found to differentiate *C. latiscutatus* from the other two species in the genus *Carlarius*: humeral process pointed, following the triangular to elongated shape of the *Carlarius* genus; *C. latiscutatus* has a more rounded head rather than sharp as in *C. parkii*; the specimen found was bigger than the normally reported length for *C. parkii* (max. 75 cm; common 40 cm); dorsal and pectoral fin pattern/shape more similar to *Carlarius latiscutatus* according to revised FAO illustrations; maxillary barbel appears not to reach beyond the pectoral fin base, as in *C. heudelotii*.



Fig. 4. Sea catfish *Carlarius* spp. (83 cm TL) captured in Maio Island at Porto Ingles harbour (Photos: E. Querido & R. Moreno, 31 July 2017). Remarks: total fish length was estimated based on the reported length of the piece of wood, as shown in the photo.

**Lophiidae:** *Lophius* spp., Monkfishes

Remarks: Three species of *Lophius* occur in the Eastern Atlantic off Africa, *L. budegassa*, *L. piscatorius*, and *L. vaillanti*. The Cabo Verde Islands are thought to be near the extreme southern limit of the ranges of *L. budegassa* and *L. piscatorius*, and near the extreme northern edge of the range of *L. vaillanti*. The latter occurs on the continental slope at depths ranging from 200 to nearly 800 m (Caruso 2016: 2050). During a survey in 2000, it was frequently caught with bottom longlines at depths of 550 to 700 m (Menezes et al. 2004). Based upon the uniform grey or dark brown dorsal surface pigmentation (Fig. 5a, as opposed to the mottled grey characteristic of *L. budegassa* and *L. piscatorius*

in the area) and especially the short head and snout length (Fig. 5b), the specimen is tentatively identified as *Lophius* cf. *vaillanti*. Unfortunately, the colouration of the peritoneum, number of pectoral-fin rays and relative length of the third dorsal-fin spine were not noted. This particular specimen was captured by an artisanal fisherman near Praia lighthouse on the southern point of Santiago Island in inshore waters at a depth of approximately 50 m. This record, could represent a new upper depth limit for this species. More recently a specimen tentatively identified as *Lophius* cf. *budegassa* was found dead on the shore of Tarrafal bay (São Nicolau island), and again, it was only possible to obtain a photo of the specimen (Fig. 5c).



Fig. 5. *Lophius* cf. *vaillanti* a) dorsal view photographed at Quebra Canela beach, south Santiago Island; b) fisherman holding the same specimen (photo H.P. Monteiro, 5 January 2017); c) *Lophius* cf. *budegassa* e at Tedja beach in Tarrafal, São Nicolau Island (Photo: A. Silva, 9 August 2017).

**Serranidae:** *Serranus cabrilla* (Linnaeus, 1758), Comber

Eight species of the genus *Serranus* occur in coastal waters of Western Africa (Heemstra & Anderson Jr. 2016), including the recently described comber of São Tomé and Príncipe (*Serranus pulcher* Wirtz & Iwamoto 2016). Cabo Verde Islands are at the distribution limits of two of them, i.e., the southern limit of *Serranus atricauda*, blacktail comber, a typically temperate species, and the northern limit of the tropical *Serranus heterurus*. Guinean comber. Wirtz et al. (2013) considered *Serranus cabrilla*, assigned to Cabo Verde by mistake. However, the recent FAO guide (Heemstra & Anderson Jr. 2016), referred this species to Cabo Verde based on historical observations of Vaillant (1888), who mentioned 4 specimens of *S. cabrilla* and 3 of *S. hepatus* caught in 1883 at Cabo Verde islands with a bottom trawl, between 75 and 90 m depth (São Vicente-Santo Antão channel). A recent re-examination

of this material, deposited in the National Natural History Museum in Paris (Fig. 6 a, b, MNHN 1887 - 0365-8), by Samuel P. Iglésias (pers. comm.), revealed that Vaillant's specimens are in fact *S. atricauda* and *S. heterurus*. Our recent finding of *Serranus cabrilla* in Cabo Verde waters, at the summit of Nova Holanda Seamount at 119 m depth, is confirmed by photo-identification (Fig. 6c) *S. cabrilla*, ranges from the Straits of Gibraltar to Angola, including the Mediterranean and the Black Sea, Azores, Madeira, Canary Islands and São Tomé and Príncipe. It usually occurs on rocky bottoms on the shelf and upper slope, ranging from the shore down to 450 m of depth (Carpenter & De Angelis 2016). The body of *S. cabrilla* shows 2 or 3 white or bluish, horizontal stripes from head to tail and orange stripes below and behind the eye, while *S. atricauda* commonly has a series of 4 or 5 larger, square - formed dark blotches alternating with narrow vertical dark bars (Heemstra & Anderson Jr. 2016).

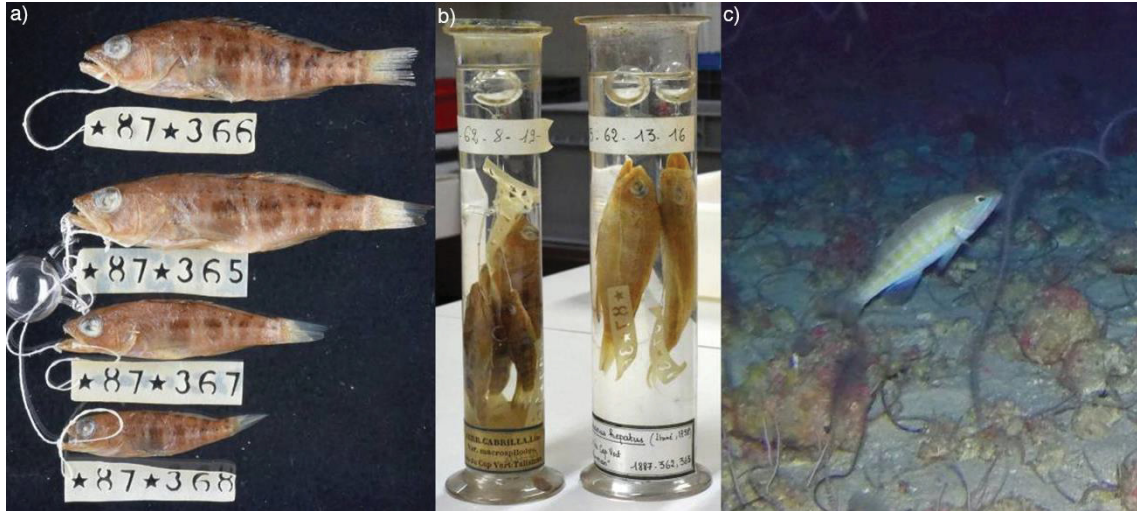


Fig. 6. a) Blacktail comber *Serranus astricauda*, b) *S. heterurus*, specimens re-identified at the Natural History Museum in Paris (photos S.P. Iglésias, 21 November 2017); c) Comber *Serranus cabrilla* photographed from a Bottom Lander (GEOMAR, Kiel) on the summit (119 m depth; 17° 10.41'N 21° 56.82'W) of Nova Holanda Seamount off Cabo Verde waters (Photography in 24h time lapse mode, September 2017).

**Malacanthidae:** *Branchiostegus semifasciatus* (Norman, 1931), zebra tilefish

*Branchiostegus semifasciatus* is distributed in the eastern Atlantic from mainland Morocco to Angola including São Tomé and Príncipe (Afonso et al. 1999). It has a very characteristic pre-dorsal crest and 16-20 violet-grey crossbars along each side of the body (Fig. 7) and reaches up to 60 cm standard length (SL), but commonly 20-40 cm. *B. brachiostegus* occur at depths ranging from 50 to 200 m on sandy to muddy bottom substrates (Dooley 2016). The species was captured between 80 and 90 m of depth far south-west in the coastal waters of Boa Vista Island (Cabo Verde) during an experimental longline fishing survey in June of 2003. The photo taken by S. Fujiwara can be found in Fishbase and in the final report of this

Fisheries research project in Cabo Verde's EEZ (OFCF, Overseas Fishery Cooperation Foundation of Japan, March 2004). In recent years the species has not been listed in any of the publications from Cabo Verde Islands. Here we provide a formal record of *B. semifasciatus* as new to the waters of Cabo Verde Islands. The specimen was deposited (OFCF / INDP 0282 - 0603) in Mindelo, Cabo Verde.

Note that in May 1936 an individual was caught at the depth of 180-200 m near the Cabo Verde Peninsula in Senegal (Cadenat 1937) and erroneously assigned to the northern shelf of Maio Island, Cabo Verde Islands by online databases (e.g. GBIF, EOL, FishBase). The specimen was deposited (MNHN 1938-0010) in the Muséum national d'Histoire naturelle (Paris).





Fig. 7. Zebra tilefish *Branchiostegus semifasciatus* (53 cm SL) captured south-west of Boa Vista Island (Cabo Verde) (Photo: S. Fujiwara, 25 June 2003), and uploaded to FishBase on 20 June 2008.

**Rachycentridae:** *Rachycentron canadum* (Linnaeus [ex Garden], 1766), cobia

Remarks: *Rachycentron canadum* is distributed in tropical and subtropical waters worldwide, but absent from the central and eastern Pacific Ocean. It is epipelagic offshore, and benthopelagic in inshore waters (found over shallow coral reefs and off rocky shores), and occasionally in estuaries (Collette 2016: 2448). At the eastern Atlantic islands, it is rarely seen or captured.

In contrast, in the western Atlantic waters of United States its biology and aquaculture is better known (Brown-Peterson et al. 2001). Wirtz et al. (2013) considered the record by Reiner (1996) to be without foundation, inconsistency confirmed later (F. Reiner pers. comm.). An individual of this species weighing 10 kg was caught by spearfishing 14 June 2016 in Porto Grande Bay, São Vicente island. (Fig. 8) The unique family features leaves no doubt about the identity.



Fig. 8. a) Cobia *Rachycentron canadum* captured by spear-fishing in Porto Grande bay (São Macário Wreck spot), São Vicente island; b) front view (Photos: Anildo Silva, June 2016).

**Lutjanidae:** *Lutjanus dentatus* (Duméril, 1861), African brown snapper

Remarks: *Lutjanus dentatus* is distributed on the West coast of Africa from Senegal to Angola (Carpenter 2016a: 2540), and occurs primarily in the Gulf of Guinea. It was recorded from the Canary Islands by García-Mederos & Tuset (2014). According to Falcón (2015) the older records were misidentifications (as *Lutjanus goreensis*, Brito et al. 2002 in part for Canaries, and Wirtz et al. 2008 for Madeira). Four species of snappers occur in Cabo Verdean waters (Carpenter 2016a): *Apsilus fuscus*, *Lutjanus agennes*, *Lutjanus fulgens* and *Lutjanus goreensis*. *L. fulgens* is the smallest in size while *L. goreensis* and *L. agennes* can be much larger. The latter two species have only 5 to 7 scale rows on the cheek. *L. goreensis* has a particularly distinctive blue stripe on the head which becomes less visible in adults. Here we provide photographic evidence of the first

recorded capture of *L. dentatus* in the Cabo Verde Islands (Fig. 9a, b.) The species in the photo has the distinctive 9 to 10 scale rows on the cheek and a maximum length of 1.5 m, unlike the other local *Lutjanus* sp.. The cheek scale counts are consistent with *L. dentatus* and leave no reason to doubt its identity after examining other *Lutjanus* material from West Africa following the FAO Guide (K.E. Carpenter pers. comm.). However, a taxonomic and genetic revision of the lutjanids in the Eastern Atlantic is urgently needed. The specimen on record weighed 54 kg and was captured in offshore waters off Santa Maria beach on Sal Island by jigging in September 2015. Initially, the fisherman believed that he caught the cubera snapper (*L. cyanopterus*), common in the western Atlantic, which may have drifted from the Caribbean Sea. Surprisingly, this species has been recently captured in the Azores and confirmed by genetics (Ribeiro et al. 2017).

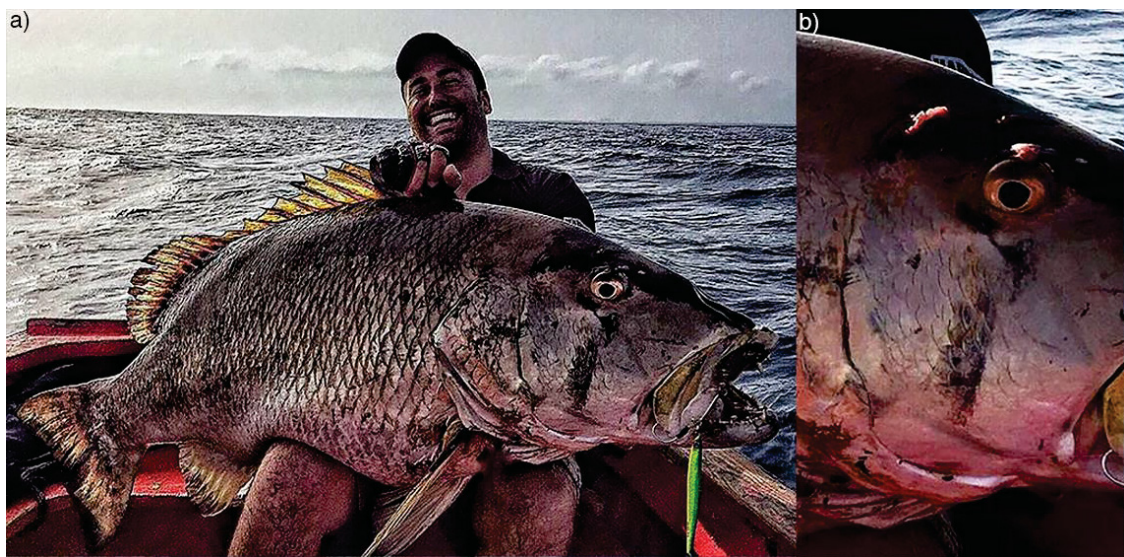


Fig. 9. a) African brown snapper *Lutjanus dentatus* captured by jigging (by Dani Güell) in Sal Island near Santa Maria beach; b) picture shows more than 7 scale rows on the cheek, confirming the identification (Photo: Juan A.R. Carrascosa, September 2015).

**Sparidae:** *Pagrus auriga* Valenciennes, 1843, redbanded seabream

Remarks: The seabream *P. auriga* occurs in the eastern Atlantic, ranging from Portugal to Angola, including in the southern parts of the Mediterranean Sea and offshore islands of Madeira, Canary Islands and the tropical Gulf of Guinea (São Tomé Island) (Russell 2014). In Cabo Verde archipelago, it had been recorded by (Reiner 1996). Wirtz et al. (2013), however noted that the presence of *P. auriga* needs confirmation. Another *Pagrus* species, the African red bream (*Pagrus africanus*), common off the West African mainland, also co-occurs in Cabo Verde, but is absent in Canary islands It was first recorded in Cabo Verde archipelago by Menezes et al.

(2004). Reiner (2005) listed *P. auriga* and *P. africanus* without verification. Here the presence *Pagrus auriga* in the archipelago is confirmed in June 2016, at the depth of 15 m. Coastal sportsfishermen captured and photographed several individuals, including a large female (Fig. 10b) with ripe gonads and a small male (Fig. 10a). The fish were caught on the Bartola reef off Boa Vista Island (D. Iacoangeli, pers. comm.). Adult *P. auriga* inhabits various hard bottom habitats over the continental shelf reaching depths up to 170 m, while juveniles are more abundant near the coast (Pajuelo et al. 2006; Carpenter 2016b: 2609). Specific body features of include 4 or 5 alternating dark red broad and narrow cross-bars, which are more prominent in juveniles than in adults (Fig. 10).

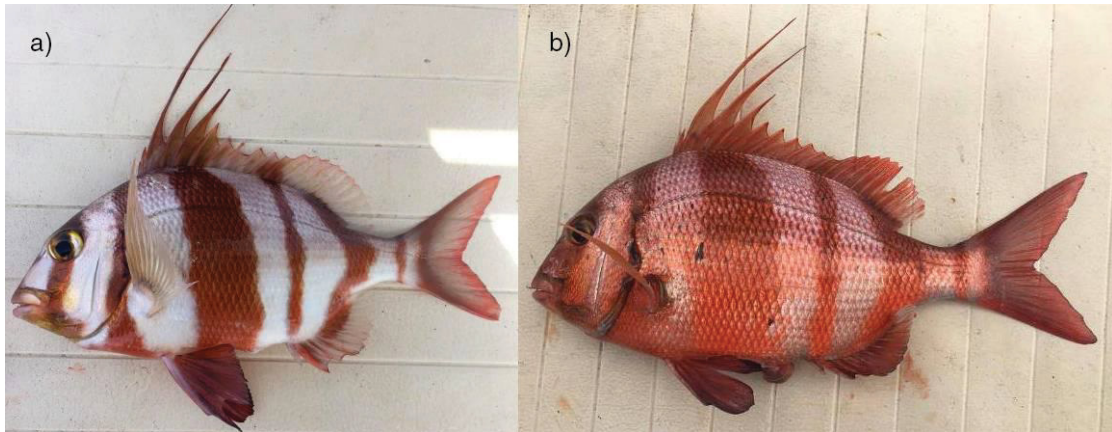


Fig. 10. Redbanded seabream *Pagrus auriga* captured off Boa Vista (Bartola reef) in Cabo Verde; a) a medium size juvenile; b) an adult female with ripe (Photos: D. Iacoangeli 9 and 29 June 2016, respectively).

**Mugilidae:** *Mugil cephalus* Linnaeus, 1758, flathead grey mullet

Remarks: *Mugil cephalus* occurs in coastal waters and estuaries of the tropical and subtropical seas of the world (Harrison 2016: 2105). The species exhibits pronounced subdivisions in population genetics (Crosetti et al. 1994). Based on the number of scales of lateral line and yellowish fins, Cadenat (1955) and Delais (1961) proposed that the mullet of the West African coast warrant recognition as a distinct subspecies, already suggested by Bleeker (1863) when he proposed

the name *Mugil cephalus ashanteensis*. This taxonomic assignation was refuted by Rossi et al. (1998). Genetic studies indicated that samples from Mauritania were more closely related to those from the Mediterranean Sea. Now it is stated that *Mugil ashanteensis*, named by Bleeker, with a holotype from Ashantee (Guinea), is a junior synonym. dark spot at the origin of a pectoral fin on *M. cephalus*, and especially yellowish pattern in the lower lobe of the caudal fin, as well as on pelvic and anal fins, show characteristics (Fig. 11) of ‘*ashanteensis*’ from the tropical Atlantic coast of Africa (Bleeker 1863).



Fig. 11 Underwater photograph of *Mugil cephalus* in the near shore waters of the Quebra Canela beach (Santiago Island): a) clearly yellowish ‘*ashanteensis*’ appearance from West Africa and a thin upper lip, indicative of the species; b) partially shown a translucent adipose eye fold not completely extending over eye of *Mugil cephalus*. (photo: H. Alain, 27 November 2015).

In fact, Cadenat & Roux (1964) recorded the species for the first time to Cabo Verde; Reiner (1996) suggested the high likelihood of this species being found in the area, and the statement of Wirtz et al. (2013) suggests the need for confirmation of this record. Here we confirm its occurrence in Cabo Verde based on the underwater photographic evidence.

## DISCUSSION

The archipelago of Cabo Verde is situated at the eastern border of the North Atlantic subtropical gyre and the southern limit of the Canary Current (Peña-Izquierdo et al. 2012). Wirtz (2009; 2012) suggested that the Sahelian Upwelling may act as a cryptic barrier for marine dispersion (especially for small fishes) between Cabo Verde and the African mainland based on dissimilarities of the composition of ichthyofauna between the archipelago and Ngor Island (Senegal). Cabo Verde Islands are considered as one of the biodiversity hotspots characterised by rich and endangered marine biodiversity, and as a centre of fish endemism in the Atlantic (Roberts et al. 2002; Brito et al. 2007; Freitas 2014). Floeter et al. (2008) proposed that such a high marine endemism could be related to the geographic isolation (between islands and/or from the mainland), complexity of submarine habitats and

warm tropical waters during glacial periods. González (2018) complement those theories by taking into consideration relatively young geological age, good bio-connection, despite its isolation, and relatively healthy state of coastal habitats. Such hypotheses could explain speciation and endemism of fish species that have lesser capacity to disperse (Wirtz et al. 2013; Falcón 2015); assumptions which were partially summarized by Brito et al. (2007) and Freitas (2014), who especially focused on paleoendemic and monotypic taxa.

The warming of waters and the concomitant range expansion of species of tropical affinity into subtropical and warm temperate waters have been postulated to explain the arrival of new fishes of tropical affinity in the Canaries and Azores (Afonso et al. 2013, Brito et al. 2017 and references therein). The introduction of non-native species by maritime traffic in the Canaries (mainly fishes associated with oil rigs or ballast water) is linked to this severe and recent anthropogenic vector (Falcón 2015; Falcón et al. 2015; Triay-Portella et al. 2015; Pajuelo et al. 2016).

The present records of new fish species in Cabo Verde do not seem to be linked to the drivers in the Canary Islands. Until recently fish newly identified to Cabo Verde were mainly coastal cryptobenthic species (e.g. Brito & Miller 2001; Wirtz 2009; Wirtz et al. 2016), including a

new serranid of the genus *Liopropoma* (Wirtz & Schliewen 2012) or new records of deep-sea species (Vieira et al. 2013, 2016; González et al. 2014).

In fact, the target species that remained unnoticed for a long time, and now reported or confirmed are widely distributed in the Atlantic region. Some of them (e.g. *G. cemiculus*, *Carlarius* sp. *L. dentatus*, *S. cabrilla*, *E. senegalensis* or *B. semifasciatus*) recorded from tropical eastern Atlantic or West African shelf, and now their occurrence extending to the Cabo Verde archipelago is confirmed.

Throughout its distribution range *S. cabrilla* is usually caught with hand-lines and bottom trawls and is considered as a relatively sedentary continental species (Morales-Nin et al. 2005). Vieira et al. (2016) used various types of fishing gear at the summit and slopes of Nova Holanda Seamount, but no occurrence of any comber was observed. Most likely *S. cabrilla* is beyond divers or artisanal fishing gear reach in Cabo Verde islands and might be less abundant than *S. atricauda*, which was caught in the longline surveys by Menezes et al. (2004) and González et al. (2014). This may suggest that in Cabo Verde, *S. cabrilla* occurs deeper than *S. atricauda* or *Cephalopholis taeniops* (African hind), both commonly caught in the archipelago.

However, some coastal fish species appear to have difficulty reaching the islands more distant from the mainland, such as *Pagrus auriga*. This continental species, also reaches the oceanic archipelagos of Madeira (rare) and Canaries (more abundant in the eastern islands near the mainland), but not the Azores (Falcón 2015). The cosmopolitan *Rachycentron canadum* and *Glaucostegus cemiculus* were captured in the north-western islands of Cabo Verde (São Vicente and Santa Luzia Islands), a monkfish (*Lophius* spp.) was found on the shore of São Nicolau island, while all the other species were encountered in the eastern sector of the archipelago (darker grey islands, Fig. 1): Nova Holanda seamount, Sal to Maio and Santiago islands. Santiago, is the largest island, characterised by a steep, narrow shelf (Bravo de Laguna 1985), nearest to the continent and has the highest number of new findings.

Over the last years the sampling effort in the coastal zone has increased due to a combination of activities as recreational fishing by local communities, research by environmental NGOs, and higher number of fishing trips by tourist industry (i.e. diving, whale watching, and sport fishing). The fact that some species have been reported only recently, others definitively confirmed, or photographed in Cabo Verde Islands, may be the result of wider sharing of scientific work in this region and not necessarily an indication of recent migration or colonization/invasion by these species, even though such possibility cannot be excluded.

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## REFERENCES

- Aceros P., A., R. Betancur-R. 2016. Ariidae. Pp. 1742-1750 in: Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 3: Bony fishes part 1. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 914 pp.
- Afonso, P., F.M. Porteiro, R.S. Santos, J.P. Barreiros, J. Worms & P. Wirtz 1999. Coastal marine fishes of São Tomé Island (Gulf of Guinea). *Arquipelago. Life and Marine Sciences* 17: 65-92.
- Afonso, P., F.M. Porteiro, J. Fontes, F. Tempera, T. Morato, F. Cardigos & R.S. Santos 2013. New and rare coastal fishes in the Azores islands: occasional events or tropicalization process? *Journal of Fish Biology* 83: 272-294.
- Bleeker, P. 1863. Mémoire sur les poissons de la côte de Guinée. *Natuurkundige Verhandelingen van de Hollandsche Maatschappij der Wetenschappen te Haarlem* 2(18): 1-136.
- Bravo de Laguna, J. 1985. *Plates-formes insulaires et zone économique exclusive à la République du Cap-Vert*. PNUD/FAO. Projet pour le renforcement du Secrétariat d'Etat aux Pêche du Cap-Vert. CVI/82/003/ Rapport Technique 6. Praia, 28 pp.
- Brito, A., P.J. Miller 2001. Gobiid fishes from the Cape Verde Islands, including two new species of *Gobius* (Teleostei: Gobioidae). *Journal of Natural History* 35: 253-277.
- Brito, A., P.J. Pascual, J.M. Falcón, A. Sancho & G. González 2002. Peces de las Islas Canarias: Catálogo comentado e ilustrado. La Laguna, Tenerife: F. Lemus Editor. 419 pp.
- Brito, A., J.M. Falcón, & R. Herrera 2007. Características zoogeográficas de la ictiofauna litoral de las islas de Cabo Verde y comparación con los archipiélagos macaronésicos. *Revista de la Academia Canaria de Ciencias* 18: 93-109.
- Brito, A., R. Freitas, F. Espino, C. Fernández-Gil, A. Boyra & J.A. González 2013. Fishes. Pp 32-73 in: C. FERNÁNDEZ-GIL et al. *Espécies marinhas de Cabo Verde* (Biotecmar, 1ª ed), 139 pp.
- Brito, A., S. Moreno-Borges, A. Escáñez, J.M. Falcón, & R. Herrera 2017. New records of Actinopterygian fishes from the Canary Islands: tropicalization as the most important driving force increasing fish diversity. *Revista de la Academia Canaria de Ciencias* 29: 31-44.
- Brown-Peterson, N.J., R.M. Overstreet, J.M. Lotz, J.S. Franks & K.M. Burns 2001. Reproductive biology of cobia, *Rachycentron canadum*, from coastal waters of the southern United States. *Fishery Bulletin* 99: 15-28.
- Cadenat, J. 1937. Recherches systématiques sur les poissons littoraux de la côte occidentale d'Afrique. Liste des poissons littoraux récoltés par le navire "Président Théodore-Tissier" au cours de sa cinquième croisière (1936). *Revue des Travaux de l'Institut des Pêches Maritimes* v. 10 (fasc. 4, no. 40): 425-562.
- Cadenat, J. 1955. Sur les mulets de la côte occidentale d'Afrique. *Rapports Conseil Internationale pour l'Exploration de la Mer* 37: 59-62.
- Cadenat, J., C. Roux. 1964. Résultats scientifiques des campagnes de la Calypso : Iles du Cap-Vert. III. Poissons téléostéens. *Annales de l'Institut Océanographique, Monaco* 41: 81-102.
- Carpenter, K.E. 2016a. Lutjanidae. Pp. 2534-2543 in: Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 4: Bony fishes part 2. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 820 pp.
- Carpenter, K.E. 2016b. Sparidae. Pp. 2567-2620 in: Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 4: Bony fishes part 2. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 820 pp.
- Carpenter, K.E. & N. De Angelis (Eds) 2016. The living marine resources of the Eastern Central Atlantic. Vol. 3-4: Bony fishes part 1 & 2. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 3204 pp.
- Caruso, J.H. 2016. Lophiidae. Pp. 2044-2050 in: Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 3: Bony fishes part 1. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 859 pp.
- Collette, B.B. 2016. Rachycentridae. Pp 2448-2449 in: Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 4: Bony fishes part 2. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 820 pp.
- Compagno, L.J.V. 2016. Sharks. Pp. 1123-1456 in:

- Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 2. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 862 pp.
- Crossetti, D., W.S. Nelson, J.C. Avise 1994. Pronounced genetic structure of mitochondrial DNA among populations of the circumglobally distributed grey mullet (*Mugil cephalus*). *Journal of Fish Biology* 44: 47–58.
- Dooley, J.K. 2016. Branchiostegidae. Pp. 2435-2438 in: Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 4: Bony fishes part 2. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 820 pp.
- Delaís, M. 1961. Comparison entre *Mugil cephalus* Linné de Méditerranée et sa sous-espèce de l'ouest Africain (*Mugil cephalus* Linné ssp. *ashanteensis* Bleeker). *Rapport et Procès-Verbaux des Réunions de la Commission Internationale pour l'Exploration de la Mer Méditerranée* 16: 853-854.
- Eschmeyer, W.N., R. Fricke, R. van der Laan (Eds). 2017. Catalog of Fishes: Genera, Species, References. Available at <http://www.calacademy.org/scientists/catalog-of-fishes-classification/> [accessed 01 July 2017].
- Falcón, J.M. 2015. *Ictiofauna de las Islas Canarias. Análisis biogeográfico*. Tesis Doctoral (no publicada). Universidad de La Laguna. 310 pp.
- Falcón, J.M., R. Herrera, O. Ayza & A. Brito 2015. New species of tropical littoral fish found in Canarian waters. Oil platforms as a central introduction vector. *Revista de la Academia Canaria de Ciencias* 27: 67-82.
- Ferraris, C.J. Jr., 2016. Elopidae. Pp. 1584-1587 in: Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 3: Bony fishes part 1. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 914pp.
- Fischer, W., G. Bianchi, W.B. Scott (Eds) 1981. FAO Species Identification Sheets for Fishery Purposes. Eastern Central Atlantic; Fishing Area 34, 47 (in part). Canada Funds-in-Trust. Ottawa, Department of Fisheries and Oceans Canada, by arrangement with the Food and Agriculture Organization of the United Nations, Vol. 1-5: pag. var.
- Floeter, S.R., L.A. Rocha, D.R. Robertson, J.C. Joyeux, W. Smith-Vaniz, P. Wirtz, A.J. Edwards, J.P. Barreiros, C.E.L. Ferreira, J.L. Gasparini, A. Brito, J.M. Falcón, B.W. Bowen & G. Bernardi 2008. Atlantic reef fish biogeography and evolution. *Journal of Biogeography* 35: 22-47.
- Franca, M.L.P. & M.S. Vasconcelos 1962. Peixes do arquipélago de Cape Verde. *Notas Mimeografadas do Centro de Biologia Piscatória* 28: 1-85.
- Freitas, R. 2014. The coastal ichthyofauna of the Cape Verde Islands: a summary and remarks on endemism. *Zoologia Caboverdiana* 5: 1-13.
- Froese, R. & D. Pauly (Eds) 2017. FishBase. World Wide Web electronic publication. Available at [www.fishbase.org](http://www.fishbase.org) [accessed May 2017].
- García-Mederos, A.M. & V.M. Tuset 2014. First record of African brown snapper *Lutjanus dentatus* in the Canary Islands (north-eastern Atlantic Ocean). *Marine Biodiversity Records* 7. doi:10.1017/S1755267214000682
- González, J.A., A.M. García-Mederos, J.A. Pérez-Peñalvo, S. Correia, C. Monteiro, A. Medina, R. González-Cuadrado, M. Rabassó, R. Domínguez-Seoane, M. Gimeno, V.M. Tuset, L.F. López-Jurado & J.I. Santana. 2004. Prospección con nasas para crustáceos y peces en aguas profundas de las Islas Cape Verde. Resultados de la campaña “Taliarte 2003-08”. *Informes Técnicos del Instituto Canario de Ciencias Marinas* 11: 1-76.
- González, J.A., O. Tariche, J.I. Santana, A. Medina, A.M. García-Mederos, C. Monteiro, S. Jiménez, S. Correia, J.A. Pérez-Peñalvo, O. Ayza, M. Arrasate-López, M. Biscoito, M. Freitas, S.P. Iglésias, V.M. Tuset, A. Boyra & L.F. López-Jurado. 2009. Una mirada sobre la biodiversidad marina y bases para su gestión sostenible. Recursos pesqueros potenciales de profundidad de Cape Verde / Um olhar sobre a biodiversidade marinha e bases para a sua gestão sustentável. Potenciais recursos pesqueiros de profundidade de Cape Verde. González, J.A. & O. Tariche (Eds). Dirección General de Relaciones con África, Gobierno de Canarias. Las Palmas de Gran Canaria: 176pp.
- González, J.A., O. Tariche, J.I. Santana, A.M. García-Mederos, V.M. Tuset, S. Jiménez & M. Biscoito 2010. The family Moridae (Gadiformes) from the Cape Verde Islands (eastern-central Atlantic Ocean), with first record of *Physiculus cyanostrophus*. *Cybium* 34: 217-221.
- González, J.A., A. Martins, J.I. Santana, R. Triay-Portella, C. Monteiro, V. García-Martín et al. & M. Biscoito 2014. New and rare records of teleost fishes from the Cape Verde Islands (eastern-central Atlantic Ocean). *Cybium* 38: 289-300.
- González, J.A. 2018. Checklists of Crustacea Decapoda from the Canary and Cape Verde Islands, with an assessment of Macaronesian and Cape Verde biogeographic marine ecoregions. *Zootaxa* 4413: 401-448.
- Hanel, R. & H.-C. John 2015. A revised checklist of Cape Verde Islands sea fishes. *Journal of Applied Ichthyology* 31: 135-169.
- Harrison, I.J. 2016. Mugilidae. Pp. 2077-2110 in:

- Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 3: Bony fishes part 1. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 914 pp.
- Heemstra, P.C., W.D. Anderson Jr. 2016. Serranidae. Pp. 2365-2413 in: Carpenter, K.E. & N. De Angelis (Eds). The living marine resources of the Eastern Central Atlantic. Vol. 4: Bony fishes part 2. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. 820 pp.
- Last, P.R., W.T. White, M.R. de Carvalho, B. Séret, M.F.W. Stehmann & G.J.P. Naylor 2016a. *Rays of the World*. CSIRO Publishing/Comstock Publishing Associates, Clayton South. 832pp.
- Last, P.R., B. Séret & G.J.P. Naylor 2016b. A new species of guitarfish, *Rhinobatos borneensis* sp. nov. with a redefinition of the family-level classification in the order Rhinopristiformes (Chondrichthyes: Batoidea). *Zootaxa* 4117: 451-475.
- Marceniuk, A.P. & N.A. Menezes 2007. Systematics of the family Ariidae (Ostariophysi, Siluriformes), with a redefinition of the genera. *Zootaxa* 1416: 3-126.
- Medina, A., J.-C. Brêthes, J.-M. Sévigny & B. Zakardjian 2007. How geographic distance and depth drive ecological variability and isolation of demersal fish communities in an archipelago system (Cape Verde, Eastern Atlantic Ocean). *Marine Ecology* 28: 404-417.
- Menezes, G.M., O. Tariche, M.R. Pinho, P.N. Duarte, A. Fernandes & M.A. Aboim 2004. Annotated list of fishes caught by the R/V Arquipélago off the Cape Verde archipelago. *Arquipélago. Life and Marine Sciences* 21A: 57-71.
- Moore, A.B.M. 2017. Are guitarfishes the next sawfishes? Extinction risk and an urgent -call for conservation action. *Endangered Species Research* 34: 75-88.
- Morales-Nin, B., J. Moranta, C. Garcia, M.P. Tugores, A.M. Grau, F. Riera & M Cerda 2005. The recreational fishery off Majorca Island (western Mediterranean): some implications for coastal resource management. *ICES Journal of Marine Science* 62: 727-739.
- Notarbartolo di Sciara, G., M.N. Bradai, G. Morey, K. Brahim, L. Camara, F. Litvinov, N. Dulvy, F. Doubouya, M. Ducrocq, A. Heenan & N. Sidi 2016. *Glaucostegus cemiculus*. The IUCN Red List of Threatened Species 2016: eT63132A104009894. <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T63132A104009894.en>. [Downloaded on 25 September 2017].
- Pajuelo, J.G., J. Socorro, J.A. González, J.M. Lorenzo, J.A. Pérez-Peñalvo, I. Martínez & C.M. Hernández-Cruz 2006. Life history of the red-banded seabream *Pagrus auriga* (Sparidae) from the coasts of the Canary archipelago. *Journal of Applied Ichthyology* 22: 430-436.
- Pajuelo, J.G., S. García, J.M. Lorenzo & J.A. González 2011. Population biology of the shark, *Squalus megalops*, harvested in the central-east Atlantic Ocean. *Fisheries Research* 108: 31-41.
- Pajuelo, J.G., J.A. González, R. Triay-Portella, J.A. Martín, R. Ruiz-Díaz, M.J. Lorenzo & A. Luque 2016. Introduction of non-native marine fish species to the Canary Islands waters through oil platforms as vectors. *Journal of Marine Systems* 163: 23-30.
- Peña-Izquierdo, J., J.L. Pelegrí, M.V. Pastor, P. Castellanos, M. Emelianov, M. Gasser, J. Salvador & E. Vázquez-Domínguez 2012. The continental slope current system between Cape Verde and the Canary Islands. *Scientia Marina* 76: 65-78.
- Regan, C.T. 1909. A revision of the fishes of the genus *Elops*. *Annals and Magazine of Natural History* 3: 37-40.
- Reiner, F. 1996. *Catálogo dos peixes do arquipélago de Cabo Verde*. Publicações Avulsas do IPIMAR 2, Lisbon. 339 pp.
- Reiner, F. 2005. *Peixes do Arquipélago de Cabo Verde. Mindelo* (INDP). 337 pp.
- Ribeiro, P.A., J.M. Gonçalves, G. Chavan, R. Fricke, A.M. Garcia-Mederos, V.M. Tuset & J.P. Barreiros 2017. First record of the cubera snapper, *Lutjanus cyanopterus* (Actinopterygii: Perciformes: Lutjanidae), from the Azores (NE Atlantic) and possible range extension for the east Atlantic. *Acta Ichthyologica Et Piscatoria* 47: 259-263.
- Roberts, C.M., C.J. McClean, J.E.N. Veron, J.P. Hawkins, G.R. Allen, D.E. McAllister, C.G. Mittermeier, F.W. Schueler, M. Spalding, F. Wells, C. Vynne, T.B. Werner 2002. Marine biodiversity hotspots and conservation priorities for tropical reefs. *Science* 295: 1280-1284.
- Rossi, A., M. Capula, D. Crosetti, D.E. Campton, L. Sola 1998. Genetic divergence and phylogenetic inferences in five species of Mugilidae (Pisces: Perciformes). *Marine Biology* 131: 213-218.
- Russell, B. 2014. *Pagrus auriga*. The IUCN Red List of Threatened Species 2014: e.T170220A1295501. <http://dx.doi.org/10.2305/IUCN.UK.2014-3.RLTS.T170220A1295501.en>. [Downloaded on 10 September 2017].
- Schliwen, U.K., P. Wirtz, M. Kovačić. 2018. *Didogobius janetarum* sp. nov., a new cryptobenthic goby species from the Cape Verde Islands (Teleostei: Gobiidae). *Zootaxa* 4438: 381-393.



- Spalding, M.D., H.E. Fox, G.R. Allen, N. Davidson, Z.A. Ferdaña, M. Finlayson, B.S. Halpern, M.A. Jorge, A. Lombana, S.A. Lourie, K.D. Martin, E. McManus, J. Molnar, C. Recchia & J. Robertson 2007. Marine ecoregions of the world: A bioregionalization of coastal and shelf areas. *BioScience* 57: 573-583.
- Triay-Portella, R., J.G. Pajuelo, P. Manent, F. Espino, R. Ruiz-Díaz, J.M. Lorenzo & J.A. González. 2015. New records of non-indigenous fishes (Perciformes and Tetraodontiformes) from the Canary Islands (north-eastern Atlantic). *Cybium* 39: 163-174.
- Troschel, F.H. 1866. Ein Beitrag zur ichthyologischen Fauna der Inseln des Grünen Vorgebirges. *Archiv für Naturgeschichte* 32: 190-239.
- Vaillant, L.L. 1888. Poissons. in: Expéditions scientifiques du "Travailleur" et du "Talisman" pendant les années 1880, 1881, 1882, 1883. Paris, G. Masson, Editeur. 1-406, Pls. 1-28.
- Vieira, R.P., R. Thiel, B. Christiansen, R. Coelho, A. Denda & J. Gonçalves 2013. The deep-sea fish *Kali macrodon*: A new record for the tropical eastern Atlantic off Cape Verde. *Marine Biodiversity Records* 6. doi:10.1017/S1755267212001248.
- Vieira, R.P., R. Coelho, A. Denda, B. Martin, J.M.S. Gonçalves & B. Christiansen 2016. Deep-sea fishes from Senghor Seamount and the adjacent abyssal plain (Eastern Central Atlantic). *Marine Biodiversity* 1-13. doi: 10.1007/s12526-016-0548-4.
- Wirtz, P., R. Fricke & M.J. Biscoito 2008. The coastal fishes of Madeira Island: new records and an annotated check-list. *Zootaxa* 26: 1-26.
- Wirtz, P. 2009. Thirteen new records of marine invertebrates and fishes from the Cape Verde Islands. *Arquipelago. Life and Marine Sciences* 26: 51-56.
- Wirtz, P. 2012. Seven new records of fish from Ngor Island, Senegal. *Arquipelago. Life and Marine Sciences* 29: 77-81.
- Wirtz, P. & U.K. Schliewen 2012. A new species of *Liopropoma* Gill, 1862 from the Cape Verde Islands, Eastern Atlantic (Teleostei, Perciformes, Serranidae). *Spixiana* 35: 149-154.
- Wirtz, P., A. Brito, J.M. Falcón, R. Freitas, R. Fricke, V. Monteiro, F. Reiner & O. Tariche 2013. The coastal fishes of the Cape Verde Islands – new records and an annotated check-list (Pisces). *Spixiana* 36: 113-142.
- Wirtz, P., T. Iwamoto 2016. A new species of *Serranus* from São Tomé and Príncipe, eastern Atlantic (Pisces Teleostei, Serranidae). *Proceedings of the California Academy of Sciences* 63: 191-200.

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