New records of non-indigenous fishes (Perciformes and Tetraodontiformes) from the Canary Islands (north-eastern Atlantic)

by

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ABSTRACT. – We report the collection of specimens of *Paranthias furcifer* (Serranidae), *Abudefduf hoefleri* (Pomacentridae), *Acanthurus bahianus*, *A. chirurgus*, *A. coeruleus* (Acanthuridae), and *Cantherhines pullus* (Monacanthidae) as first records for these tropical and subtropical species from the Canary Islands (north-eastern Atlantic). Most of these records coincide with the presence of oil platforms towards and within the Port of Las Palmas. Regarding the management of the arrival of warm-affinity fish species, it would be necessary to implement control and monitoring measures to avoid they become invaders, displacing indigenous species and changing the ecosystems.

RÉSUMÉ. - Premier signalement d'espèces non-indigènes (Perciformes et Tetraodontiformes) aux îles Canaries (Atlantique nord-est).

La capture de spécimens de *Paranthias furcifer* (Serranidae), *Abudefduf hoefleri* (Pomacentridae), *Acanthurus bahianus*, *A. chirurgus*, *A. coeruleus* (Acanthuridae) et *Cantherhines pullus* (Monacanthidae) représente le premier signalement pour ces six espèces tropicales et subtropicales aux îles Canaries (Atlantique nord-est). Les zones autochtones de ces espèces coïncident avec les zones d'origine et l'arrivée de plates-formes pétrolières au Port de Las Palmas. Le contrôle et le suivi de l'introduction d'espèces ayant des affinités avec les eaux chaudes devraient être mis en œuvre pour éviter qu'elles deviennent invasives, déplaçant les espèces indigènes et modifiant les écosystèmes.

Key words
Serranidae
Pomacentridae
Acanthuridae
Monacanthidae
Eastern Atlantic
Canary Islands
New record
Oil platforms

Many authors have postulated on a tropicalization process of fish assemblages in temperate biogeographic transition zones, including the Macaronesian region and some parts of the Mediterranean Sea (Brito *et al*., 2005; Wirtz *et al*., 2008; Afonso *et al*., 2013; Horta Costa *et al*., 2014), associated with global warming in many cases (Brito *et al*., 2005; Perry *et al*., 2005; Occhipinti-Ambrogi, 2007). A recent review by Vergés *et al*. (2014) accounts for this topic in temperate marine ecosystems, emphasizing that climate-driven changes in biotic interactions can profoundly alter ecological communities, particularly when they impact foundation species.

During the last thirty years, ichthyologists have reported the presence (and sometimes establishment) of non-indigenous marine fish species around the Canary Islands (Fig. 1), generally arriving from subtropical and tropical nearby areas (i.e. the north-western African coasts and the Cape Verde Islands) (e.g. Brito, 1991; Brito *et al*., 2002, 2005). Within the Macaronesian archipelagos, this phenomenon has also been reported at Madeira (e.g. Wirtz *et al*., 2008) and Azores (e.g. Afonso *et al*., 2013).

Early examples of these findings from the Canaries include *Lutjanus goreensis* (Valenciennes, 1830) (Lutjanidae) (González and Santana, 1986), *Corniger spinosus* Agassiz, 1831 (Holocentridae) (Lozano and Brito, 1989), *Epinephelus itajara* (Lichtenstein, 1822) (Serranidae), *Argyrosomus regius* (Asso, 1801) (Sciaenidae), *Dentex canariensis* Steindachner, 1881, *Pagrus africanus* Akazaki, 1962 (Sparidae), *Trachurus trecae* Cadenat, 1950 (Carangidae), *Chaetodon hoefleri* Steindachner, 1881, *Prognathodes marcellae* (Poll, 1950) (Chaetodontidae), *Abudefduf saxatilis* (Linnaeus, 1758) (Pomacentridae), *Acanthurus monroviae* Steindachner, 1876 (Acanthuridae), *Aluterus monoceros* (Linnaeus, 1758) (Monacanthidae), *Orcynopsis unicolor* (Geoffroy Saint-Hilaire, 1817), *Scomberomorus tritor* (Cuvier, 1832) (Scombridae) (Brito, 1991), *Dentex angolensis* Poll & Maul, 1953 (Sparidae) (Rico *et al*., 1995) or *Holocentrus adscen-*

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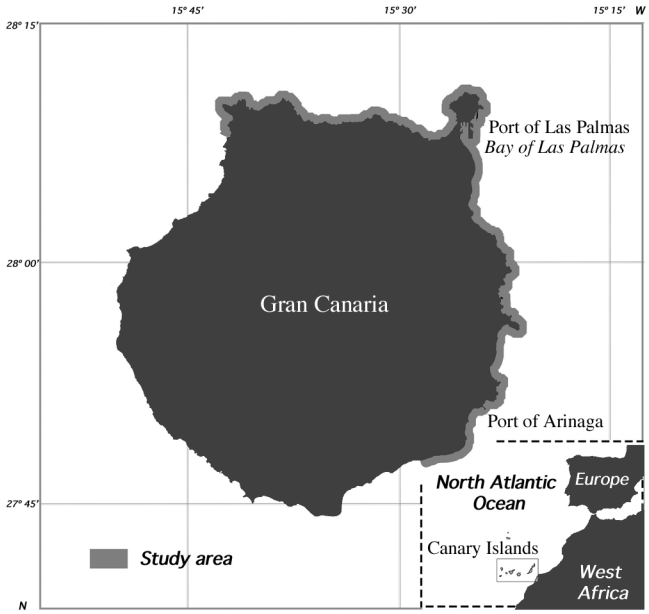

Figure 1. - The Canary Islands and the study area.

sionis (Osbeck, 1765) (Holocentridae) (Castro-Hernández and Martín-Gutiérrez, 2000). Many other records of subtropical and tropical fish species in waters of the Canary Islands were compiled by Brito *et al*. (2002), for instance *Rhincodon typus* Smith, 1828 (Rhincodontidae), *Grammonus longhursti* (Cohen, 1964) (Bythitidae), *Antennarius striatus* (Shaw, 1794) (Antennariidae), *Myripristis jacobus* Cuvier, 1829 (Holocentridae), *Epinephelus caninus* (Valenciennes, 1843) (Serranidae), *Priacanthus arenatus* Cuvier, 1829 (Priacanthidae), *Caranx hippos* (Linnaeus, 1766), *C. latus* Agassiz, 1831, *C. lugubris* Poey, 1860, *Decapterus punctatus* (Cuvier, 1829), *Elagatis bipinnulata* (Quoy & Gaimard, 1825), *Selene dorsalis* (Gill, 1863), *Seriola carpenteri* Mather, 1971 (Carangidae), *Erythrocles monodi* Poll & Cadenat, 1954 (Emmelichthyidae), *Lobotes surinamensis* (Bloch, 1790) (Lobotidae), *Mulloidichthys martinicus* (Cuvier, 1829) (Mullidae), *Microlipophrys velifer* (Norman, 1935) (Blenniidae), *Gnatholepis thompsoni* Jordan, 1904 (Gobiidae), *Balistes punctatus* Gmelin, 1789, *Canthidermis sufflamen* (Mitchill, 1815), *Melichthys niger* (Bloch, 1786) (Balistidae), *Chilomycterus reticulatus* (Linnaeus, 1758) or *Diodon hystrix* Linnaeus, 1758 (Diodontidae). In recent years, other subtropical and tropical fish species have been reported from the Canaries, including *Cephalopholis taeniops* (Valenciennes, 1828) (Serranidae) (Brito *et al*., 2011), *Echiophis punctifer* (Kaup, 1859) (Ophichthidae), *Hypleurochilus* sp. (Blenniidae) (Espino *et al*., 2014), and *Lutjanus dentatus* (Duméril, 1861) (Lutjanidae) (García-Mederos and Tuset, 2014).

It is also noteworthy that some of these non-native species have been found in port waters (mainly in the Port of Las Palmas, Gran Canaria Island, and in the Port of Santa Cruz de Tenerife, Tenerife Island) or in their vicinity (Fig. 1). Some examples are *Cephalopholis nigri* (Günther, 1859), *Epinephelus costae* (Steindachner, 1878) (Serranidae) (Brito, 1991), *Chaetodon sanctaehelenae* Günther, 1868 (Chaetodontidae) (Brito and Falcón, 1996) or *Monodactylus sebae* (Cuvier, 1829) (Monodactylidae) (Brito *et al*., 2002).

Out of these fish species having warm water affinity, at least *Caranx crysos* (Mitchill, 1815), *Decapterus macarellus* (Cuvier, 1833) (Carangidae), *Lutjanus goreensis* (Brito *et al*., 2002), *Diodon eydouxii* Brisout de Barneville, 1846 (Diodontidae) (Brito *et al*., 2005), *Gnatholepis thompsoni*, *Chilomycterus reticulatus* (Espino *et al*., 2014), *Canthidermis sufflamen* and *Abudefduf saxatilis* (author obs.) seem to have currently well-established populations around the Canary Islands.

The presence of non-native marine fish species in biogeographical regions well separated from their donor regions has been related with the natural population extensions, in many cases associated with climate change (e.g. Brito *et al*., 2005; Perry *et al*., 2005; Occhipinti-Ambrogi, 2007). In response to warmer conditions, marine fishes tend to shift their distributions to higher latitudes (Perry *et al*., 2005; Spencer 2008; Nye *et al*., 2009; Lucey and Nye, 2010; Horta Costa *et al*., 2014). However, in the case of human-caused factors, the arrival areas are linked to transport vectors (shipping) of non-native fish species (e.g. Vitousek *et al*., 1997). In the context of the Canary Islands, the transport vector has been mainly associated with ballast waters [Brito *et al*. (2011), *C. taeniops*] and, to a lesser extent, with aquarium trade [Brito *et al*. (2002), *Pomacanthus maculosus* (Forsskål, 1775) (Pomacanthidae)]. However, Pajuelo *et al*. (unpubl. data) have video-recorded, for the first time from the Canaries, that oil platforms are an important vector for the translocation and introduction of non-native species.

Once verified that, in the last five years, oil rigs operating in West Africa and South America have increasingly consolidated the Port of Las Palmas as the most important base for oil platforms in the north-eastern Atlantic, a network of volunteer observers has reported sightings and/or catches of non-indigenous species. Following this strategy, useful information was gathered and several specimens of different non-native species were collected and taxonomically identified.

The present paper describes the records, for the first time, of six teleost fishes from the Canary Islands: *Paranthias furcifer* (Valenciennes, 1828) (Serranidae), *Abudefduf hoefleri* (Steindachner, 1881) (Pomacentridae), *Acanthurus bahianus* Castelnau, 1855, *Acanthurus chirurgus* (Bloch, 1787), *Acanthurus coeruleus* Bloch & Schneider, 1801 (Acanthuridae), and *Cantherhines pullus* (Ranzani, 1842) (Monacanthidae) (Fig. 2). Moreover, the presence of five tropical or subtropical non-native fish species previously recorded from the

Canaries is confirmed: *Holocentrus adscensionis* (Holocentridae), *Cephalopholis taeniops* (Serranidae), *Prognathodes marcellae* (Chaetodontidae), *Abudefduf saxatilis* (Pomacentridae), and *Acanthurus monroviae* (Acanthuridae) (Fig. 2). Biogeographical data on these species have been gathered and they are provided herein.

MATERIAL AND METHODS

Volunteer observers (SCUBA divers, professional and recreational fishermen) reported sightings and/or catches of non-native fish species along the north, east, and south-east coasts of Gran Canaria (Fig. 1). The number of sightings/catches and the total number of individuals are given for each non-indigenous fish species. For each fish (observed or caught), collection information (locality, coordinates, date, depth, type of substratum, among others) was recorded.

Most non-native specimens collected by spearfishing or professional fishing gear were examined at the laboratory for taxonomic identification and determination of sex and maturity condition. Just two specimens of two non-indigenous species were identified from photographs of freshly caught animals; in these cases, the size of specimens was indirectly estimated. Meristic and morphometric measurements (in mm) were made following Hubbs and Lagler (1958): TL, total length and SL, standard length.

This study follows the best practices approach to overcoming unverified and unverifiable "first records", as proposed by Bello *et al*. (2014). Voucher specimens were deposited in the collections of the Tenerife Museum of Natural History (TFMC, Spain) and the Funchal Natural History Museum (MMF, Portugal). Muscle tissue samples taken from each specimen, as well as some voucher specimens, were stored at ICCM (Initiative for Marine Science Collections, in English) from the Department of Biology of the University of Las Palmas de Gran Canaria.

The systematic arrangement of the present account of species followed Nelson (2006), and their taxonomical status was assigned according to Eschmeyer and Fong (2015) and Froese and Pauly (2015).

RESULTS

***Holocentrus adscensionis* (Osbeck, 1765), squirrelfish**

Material examined. – ICCM399, one resting male, 219 mm TL, 167 mm SL, off La Laja Beach, 28°03'N 15°25'W, 15–24 m, 15 Feb. 2015, rocks with sand (Fig. 2A).

Sightings and catches. – Once, n = 1, same locality (Fig. 3).

Remarks. – A tropical and subtropical reef-associated species, living from the shoreline to 180 m of depth (Smith, 1997), usually at 8-30 m (Wyatt, 1983). It occurs in shallow coral reefs as well as deeper offshore waters (Woods and Greenfield, 1978). A nocturnal species, hiding in deep crevices or under coral ledges during the day; at night, it usually moves over sand and seagrass beds, taking mainly crabs and other small crustaceans (Greenfield, 1981). Maximum length published is 610 mm TL. An amphi-Atlantic species. In the West Atlantic, it ranges from North Carolina, USA and Bermuda to Brazil (Woods and Greenfield, 1978; Robins and Ray, 1986; Greenfield, 2003). In the mid-Atlantic: St. Paul's Rocks, Ascension and St. Helena Islands (Wirtz *et al*., 2007). In the East Atlantic, it is known from Annobón Island (Wirtz *et al*., 2007) and São Tomé Island (Osório, 1898; Afonso *et al*., 1999; Wirtz *et al*., 2007), and from Gabon to Angola (Greenfield, 1981); absent from the Cape Verde Islands (Wirtz *et al*., 2013; Hanel and John, 2015).

H. adscensionis was first reported from the Canaries by Castro-Hernández and Martín-Gutiérrez (2000) based on one individual caught off Castillo del Romeral, south-eastern coast of Gran Canaria. Brito *et al*. (2002) reported on a total of nine individuals all collected at the eastern coast of Gran Canaria. One more individual was sighted and photographed alive off Punta de La Sal, eastern coast of Gran Canaria (Espino *et al*., 2014). Another individual (220 mm TL, 168 mm SL) caught at the Port of Santa Cruz de Tenerife (rocky breakwater, 20-30 m) in October 2014 was identified by the second author and deposited as a museum voucher (TFMCBM-VP/1949).

***Cephalopholis taeniops* (Valenciennes, 1828), African hind or blue-spotted seabass**

Material examined. – ICCM404, one resting male, 390 mm TL, 325 mm SL, off Baja de Melenara (Melenara reef), 27°59'N 15°22'W, 15-24 m, 15 Oct. 2014, rocks with sand (Fig. 2B).

Sightings and catches. – Twice, n = 3: Melenara reef, 15-24 m, rocks with sand; off the Port of Agaete, 28°06'N 15°42'W, 20-30 m, rocks with sand (Fig. 3).

Remarks. – A demersal species, found on shallow tropical rocky reefs and sandy bottoms up to 200 m depth in the eastern Atlantic from the Western Sahara to Angola, including Cape Verde and São Tomé and Príncipe Islands (Rocha *et al*., 2008; Craig *et al*., 2011; Tariche *et al*., 2014). This is a large-sized carnivorous species (Tariche 2002; Brito *et al*., 2011). Maximum length published is 700 mm TL.

C. taeniops was first reported from the Canaries by Brito *et al*. (2011) based on one individual caught at the Port of Las Palmas.

***Paranthias furcifer* (Valenciennes, 1828), creole-fish**

Material examined. – MMF44365, one post-spawning male, 340 mm TL, 264 mm SL, old dike of Arinaga, 27°51'N 15°23'W, 6-8 m, 16 Apr. 2015, rocky substrate (Fig. 2C).

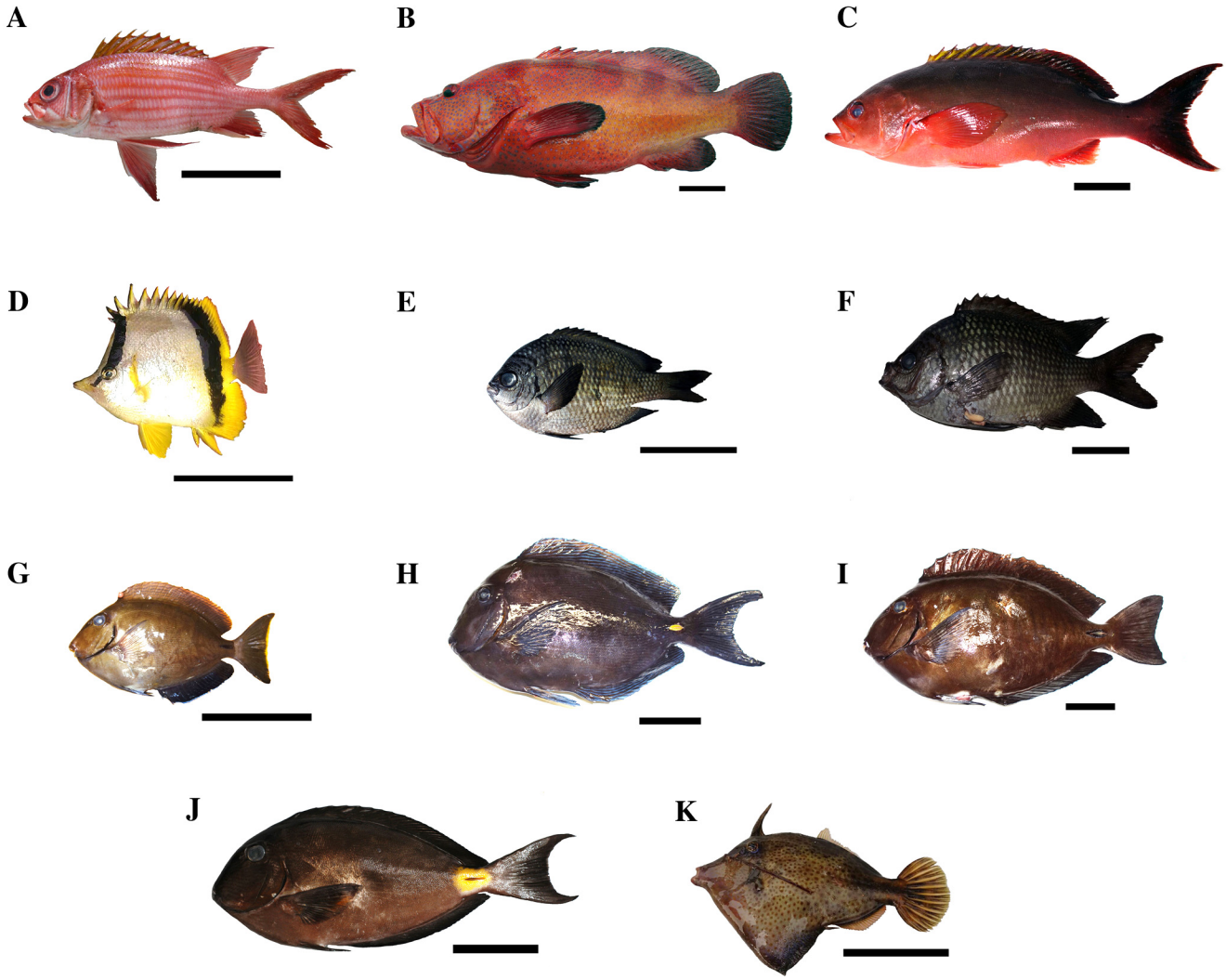

Figure 2. - Non-native species introduced to the Canaries. **A**: *Holocentrus adscensionis*; **B**: *Cephalopholis taeniops*; **C**: *Paranthias furcifer*; **D**: *Prognathodes marcellae;* **E**: *Abudefduf saxatilis*; **F**: *Abudefduf hoefleri*; **G**: *Acanthurus bahianus*; **H**: *Acanthurus coeruleus*; **I**: *Acanthurus chirurgus*; **J**: *Acanthurus monroviae*; **K**: *Cantherhines pullus*. Scale bars = 5 cm.

MMF44490, one post-spawning male, 352 mm TL, 279 mm SL, dike Reina Sofía, 28°07'N 15°24'W, 15 m over a bottom of 24 m of depth, 11 May 2015, rocks.

Sightings and catches. – Four times, n = 27: dike Reina Sofía, 12-15 m over a bottom of 21 m of depth, rocky breakwater; off La Isleta, 28°10'N 15°24'W, 19–20 m, rocks; old dike of Arinaga, 6-8 m, rocky substrate (Fig. 3).

Remarks. – A tropical and subtropical reef-associated species (Heemstra and Randall, 1993), living between 8 and 100 m of depth (Lieske and Myers, 1994), usually at 10-66 m (Randall, 1996). Inhabits coral reefs and hard bottom areas. Observed in feeding aggregations above reefs. Feeds mainly in midwater on zooplankton (copepods, pelagic tunicates, shrimps and shrimp larvae) (Heemstra and Randall, 1993; Lieske and Myers, 1994). *Paranthias* Guichenot, 1868 is a unique genus of groupers that have a small mouth [with a more protrusible upper jaw than in other groupers], small teeth, numerous [long] gill rakers, fusiform body, and deeply forked caudal fin – all representing departures from the typical grouper morphology, and all specializations for feeding in mid-water on zooplankton (Randall, 1967). *Paranthias* feed mainly on small planktonic animals that are picked individually from the water, and their shortened snout (compared to other groupers), which facilitates close-range binocular vision, is thus another specialization for this type of plankton feeding (Heemstra and Randall, 1993). Maximum length published is 300 mm SL. It seems to be primarily a western Atlantic species, distributed from Bermuda and south Florida, USA to São Paulo, Brazil (Heemstra and Randall, 1993). In the mid-Atlantic: Ascension Island (Cadenat and Marchal, 1963; Wirtz *et al*., 2014). In the East Atlantic: known from the Gulf of Guinea islands of Annobón, São

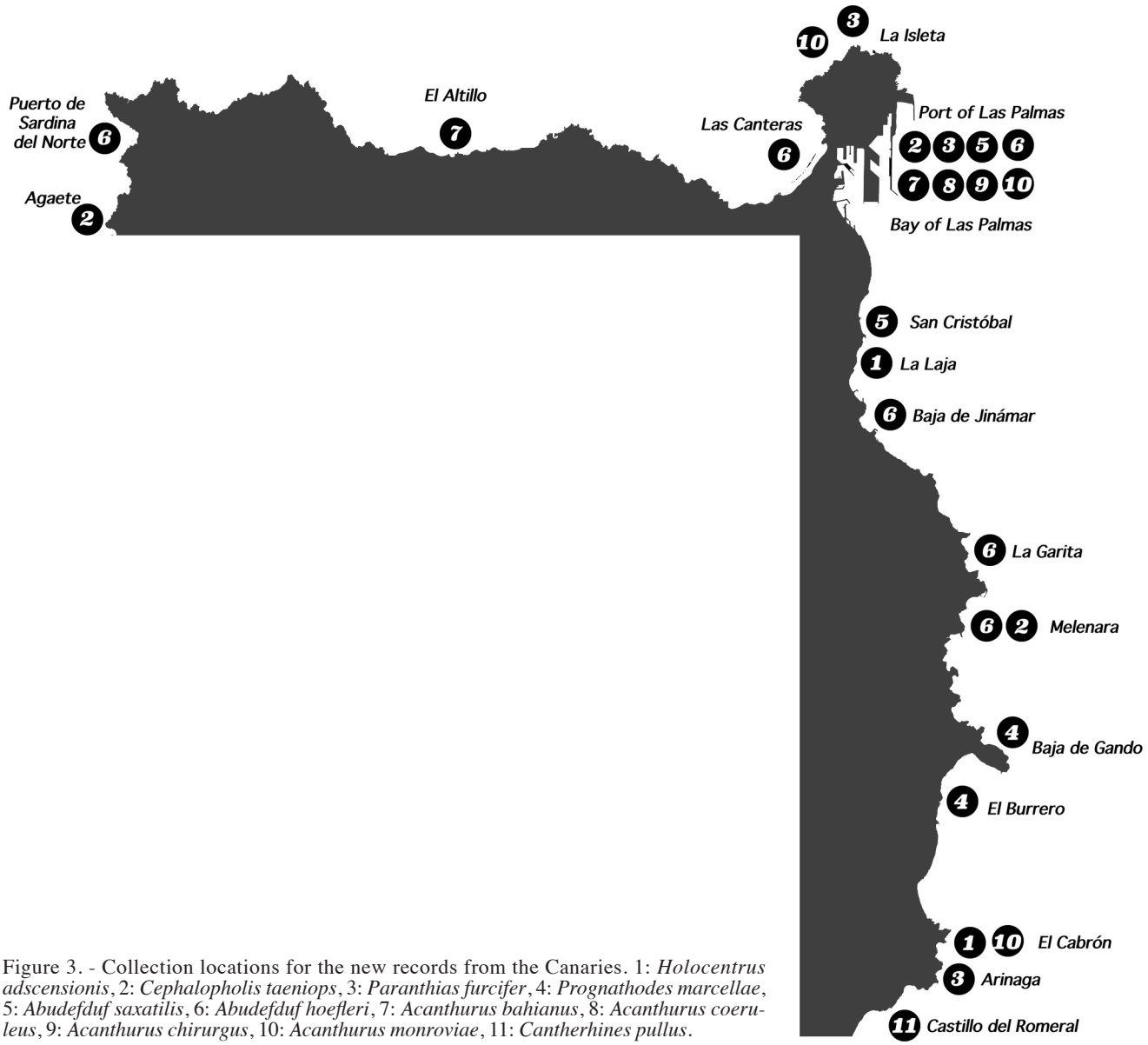

Figure 3. - Collection locations for the new records from the Canaries. 1: *Holocentrus adscensionis*, 2: *Cephalopholis taeniops*, 3: *Paranthias furcifer*, 4: *Prognathodes marcellae*, 5: *Abudefduf saxatilis*, 6: *Abudefduf hoefleri*, 7: *Acanthurus bahianus*, 8: *Acanthurus coeruleus*, 9: *Acanthurus chirurgus*, 10: *Acanthurus monroviae*, 11: *Cantherhines pullus*.

Tomé and Príncipe (Osório, 1893; Wirtz *et al*., 2007) and Bioko (Wirtz *et al*., 2007).

This is the first record for *P. furcifer* from the Canary Islands.

***Prognathodes marcellae* (Poll, 1950), French butterflyfish**

Material examined. – No voucher specimens. One individual caught on a fish-trap and photographed, and then identified by the authors. An adult, approximately 97 mm TL, off El Burrero Beach, 27°54'N 15°23'W, 40-50 m, 16 Aug. 2014, sand (Fig. 2D).

Sightings and catches. – Twice, n = 2: off El Burrero Beach, 40-50 m, sand; Baja de Gando (= Gando reef), 27° 56'N 15º21'W, 23 m, rocks (Fig. 3).

Remarks. – A tropical reef-associated species, living from 12 to 140 m of depth (Maugé, 1990). Most specimens were collected on soft bottoms (Maugé, 1990). Oviparous; form pairs during breeding (Breder and Rosen, 1966). No information exists on its feeding habits in literature. Maximum length published is 116 mm TL (Reiner, 2005). An eastern Atlantic species, known from Senegal and Cape Verde Islands (Maugé, 1990; Brito *et al*., 1999; Wirtz *et al*., 2013; Hanel and John, 2015) to Angola (Bianchi, 1986), including the Gulf of Guinea islands of São Tomé and Rolas where is common at 5-20 m (Wirtz *et al*., 2007).

P. marcellae was first reported from the Canaries by Brito (1991), as a demersal littoral species on rocky bottom, based on one individual caught in the South of Tenerife Island.

***Abudefduf hoefleri* (Steindachner, 1881), African sergeant**

Material examined. – MMF44366, one resting female, 228 mm TL, 173 mm SL, dike Reina Sofía, 28°07'N 15°24'W, 18-19 m over a bottom of 21 m of depth, 21 Mar. 2015, rocky breakwater (Fig. 2E). Four maturing males, off San Cristóbal, 28°04'N 15°24'W, 18 m, 24 Apr. 2015, rocks with sand: MMF44375, 219 mm TL, 155 mm SL; MMF44376, 220 mm TL, 155 mm SL; ICCM405, 193 mm TL, 138 mm SL; ICCM406, 195 mm TL, 144 mm SL.

Sightings and catches. – Three times, n > 100: dike Reina Sofía, 21 m, rocky breakwater; off San Cristóbal, 18 m, rocks with sand (Fig. 3).

Remarks. – A tropical reef-associated species (Allen, 1991). A littoral species that inhabits rocky reefs (Lloris and Rucabado, 1990). Oviparous, distinct pairing during breeding; eggs are demersal and adhere to the substrate; males guard and aerate the eggs (Breder and Rosen, 1966). No information exists on its feeding habits in literature. Maximum length published is 200 mm TL. An eastern Atlantic species, known from Senegal and Cape Verde Islands (Edwards, 1986; Wirtz *et al*., 2013; Hanel and John, 2015) to Benin, including São Tomé Island and Ilheu das Rolas (Osório, 1891; Lloris and Rucabado, 1990; Wirtz *et al*., 2007).

This is the first record for *A. hoefleri* from the Canary Islands.

***Abudefduf saxatilis* (Linnaeus, 1758), sergeant-major**

Material examined. – ICCM400, one resting male, 125 mm TL, 98 mm SL, off La Laja Beach, 28°03'N 15°25'W, 15-24 m, 15 Feb. 2015, rocks with sand (Fig. 2F).

Sightings and catches. – Twenty times, n > 310: dike Reina Sofía, 12 m over a bottom of 21 m of depth, rocky breakwater; off La Garita Beach, 28°00'N 15°22'W, 15-24 m, rocks with sand; off Las Canteras Beach's sedimentary reef, 28°09'N 15°28'W, 6-7 m, large rocks with sand; off Baja de Melenara (= Melenara reef), 15-24 m, rocks with sand; off Risco Verde, 27º51'N 15º23'W, 5-8 m, vertical cliff; off El Cabrón Beach, 27º52'N 15º23'W, 8-10 m, vertical cliff; off the Port of Sardina del Norte, 28º09'N 15º41'W, 5-8 m, sand with rocks; around the Kalais (33 m, sand) and Arona (27-30 m, sand), shipwrecks, in the Bay of Las Palmas near the Port of Las Palmas; Baja de Jinámar (= Jinámar reef), 28º02'N 15º 22'W, an isolated rocky outcrop (an urchin-grazed barren) 1.5 km away from the coast at ca. 39 m of depth (Fig. 3).

Remarks. – A subtropical benthopelagic reef-associated species (Allen, 1991), living from the shoreline to 20 m of depth (Feitoza *et al*., 2003). Juveniles are common in tidal pools, while adults are found over shallow reef tops. Adults frequently form large feeding aggregations of up to several hundred individuals. Food items include algae, small crustaceans and fish, and various invertebrate larvae (Emery, 1978). Adult males adopt a bluish ground colour when guarding eggs. Oviparous, distinct pairing during breeding; eggs are demersal and adhere to the substrate (Breder and Rosen, 1966). Maximum length published is 229 mm TL (Claro, 1994). It seems to be primarily an amphi-Atlantic species. West Atlantic: from Canada (Scott and Scott, 1988) to Uruguay, abundant on Caribbean reefs (Allen, 1991). In the mid-Atlantic: Ascension Island (Cadenat and Marchal, 1963; Wirtz *et al*., 2014). East Atlantic: from Senegal south to Angola, including the Cape Verde Islands (Franca and Vasconcelos, 1962; Wirtz *et al*., 2013; Hanel and John, 2015), São Tomé and Príncipe Islands (Osório, 1891; Afonso *et al*., 1999; Wirtz *et al*., 2007), Bioko Island, Annobón Island and other offshore islands (Wirtz *et al*., 2007). Also reported at Madeira (Freitas and Araújo, 2006; Wirtz *et al*., 2008) and Malta, central Mediterranean (Deidun and Castriota, 2014). Foster and Willan (1979) reported this species from the western Pacific (Solomon Islands), based on the observation of a couple of individuals adopted by a semisubmersible exploratory drilling platform in coastal waters of the Solomon Islands.

A. saxatilis was first reported from the Canaries by Brito (1991, as *A. marginatus*) based on one individual caught at the Port of Santa Cruz de Tenerife. Brito *et al*. (2002) reported on one more individual sighted in a beach near that port.

***Acanthurus bahianus* Castelnau, 1855, ocean surgeon**

Material examined. – MMF44367, one resting female, 168 mm TL, 131 mm SL, El Altillo, 28°11'N 15°33'W, 4 m, 8 Aug. 2014, reef platform (Fig. 2G).

Sightings and catches. – Once, n = 1, same locality (Fig. 3).

Remarks. – A tropical reef-associated species (Robins and Ray, 1986), living from 2 (Baensch and Debelius, 1997) to 40 m of depth (Desoutter, 1990), usually at 2-25 m, between 21 and 25°C (Baensch and Debelius, 1997). Inhabits shallow bottoms with coral or rocky formations (Cervigón, 1994). Usually occurs in groups of five or more individuals. Mainly diurnal. Feeds on algae (Robins and Ray, 1986). Maximum length published is 381 mm SL (Humann, 1994). An amphi-Atlantic species. West Atlantic: Massachusetts, USA and Bermuda southward to southern Brazil (Froese and Pauly, 2015, Anderson *et al*., 2015). In the mid-Atlantic: Ascension (Cadenat and Marchal, 1963; Wirtz *et al*., 2014) and St. Helena Islands (Desoutter, 1990). East Atlantic: off Angola (Smith, 1997).

This is the first record for *A. bahianus* from the Canary Islands.

***Acanthurus chirurgus* (Bloch, 1787), doctorfish**

Material examined. – MMF44368, one mature female, 307 mm TL, 244 mm SL, dike Reina Sofía, 28°07'N

15°24'W, 18-19 m over a bottom of 21 m of depth, 21 Mar. 2015, rocky breakwater (Fig. 2H).

Sightings and catches. – Once, n = 1, same locality (Fig. 3).

Remarks. – A subtropical reef-associated species, living from 2 (Baensch and Debelius, 1997) to 25 m of depth (Desoutter, 1990), usually at 2-15 m, between 22 and 25°C (Baensch and Debelius, 1997), ranging 37°N, 7°S, 89°W-34°W (Robins and Ray, 1986). Inhabits shallow reefs or rocky areas. Found in loose aggregations (Lieske and Myers, 1994). Mainly diurnal. Ingests sand when feeding on algae (Randall, 1996), other plants, detritus, worms, molluscs and other invertebrates (Robins and Ray, 1986). Maximum length published is 390 mm TL (male) (Figueiredo *et al*., 2002). Larvae are planktonic (Figueiredo *et al*., 2002). An amphi-Atlantic species (Robins and Ray, 1986). West Atlantic: Massachusetts, USA and Bermuda to southern Brazil. East Atlantic: Senegal, the Cape Verdes (Osório, 1909; Brito *et al*., 1999; Reiner, 2005; Hanel and John, 2015) and Ascension Island (Rocha *et al*., 2002; Bingeman and Bingeman, 2005; Wirtz *et al*., 2014; Anderson *et al*., 2015).

This is the first record for *A. chirurgus* from the Canary Islands.

Acanthurus coeruleus Bloch & Schneider, 1801, blue tang surgeonfish

Material examined. – Two specimens, dike Reina Sofía, 28°07'N 15°24'W, rocky breakwater: MMF44369, one maturing female, 237 mm TL, 188 mm SL, 12 m over a bottom of 21 m of depth, 9 Feb. 2015 (Fig. 2I); ICCM401, one immature male, 276 mm TL, 211 mm SL, 18-19 m over a bottom of 21 m of depth, 21 Mar. 2015.

Sightings and catches. – Twice, n = 2, same locality (Fig. 3).

Remarks. – A tropical reef-associated species, living from 2 to 40 m of depth (Desoutter, 1990), usually at 2-18 m, between 24 and 26°C (Baensch and Debelius, 1997), ranging 42°N, 15°S, 100°W-4°W (Robins and Ray, 1986). Inhabits coral reefs, inshore grassy or rocky areas. Forms small groups (Coupal *et al*., 1992). Mainly diurnal. Feeds entirely on algae (Böhlke and Chaplin, 1993). Maximum length published is 390 mm TL (Figueiredo and Menezes, 2000). It seems to be primarily a western Atlantic species, known from New York, USA and Bermuda to southern Brazil. Also reported from the mid-Atlantic island of Ascension (Cadenat and Marchal, 1963; Lubbock, 1980; Desoutter, 1990; Bingeman and Bingeman, 2005; Wirtz *et al*., 2014; Anderson *et al*., 2015).

This is the first record for *A. coeruleus* from the Canary Islands.

Acanthurus monroviae Steindachner, 1876, Monrovia doctorfish

Material examined. – Four specimens, dike Reina Sofía, 28°07'N 15°24'W, 21 m, 21 Mar. 2015, rocky breakwater: MMF44370, one immature female, 251 mm TL, 195 mm SL (Fig. 2J); MMF44371, one immature male, 242 mm TL, 184 mm SL; TFMCBM-VP/1950, one immature female, 235 mm TL, 176 mm SL; TFMCBM-VP/1951, one immature male, 228 mm TL, 174 mm SL. Two specimens, off La Isleta, 28°10'N 15°24'W, 20 m, rocks: ICCM402, one unsexed adult, 350 mm TL, 239 mm SL, 13 Jul. 2013; ICCM403, one spawning male, 392 mm TL, 286 mm SL, 18 Apr. 2015.

Sightings and catches. – Three times, n = 5: dike Reina Sofía, 21 m, rocky breakwater; off La Isleta, 19-37 m, rocks (Fig. 3).

Remarks. – A tropical demersal species, living from 5 to 200 m of depth (Desoutter, 1990), usually at 5-40 m, between 20 and 25°C (Baensch and Debelius, 1997). Found on rocky and coral bottoms (Schneider, 1990). It is also a brackish coastal species found in the mouth of rivers and lagoons (Desoutter, 1990). Feeds on zooplankton, phytoplankton and detritus (Diouf, 1996). Maximum length published is 450 mm SL (Randall, 1981). It is firstly an eastern Atlantic species: from Portugal (Costa and Gonçalves, 2013, at 38.43°N in December 2007) and Morocco to Angola, including the Cape Verdes (Franca and Vasconcelos, 1962; Wirtz *et al*., 2013; Hanel and John, 2015) and São Tomé Island (Osório, 1891; Afonso *et al*., 1999; Wirtz *et al*., 2007). Recently reported from the West Atlantic: Brazil (Luiz-Júnior *et al*., 2004).

A. monroviae was first reported from the Canaries by Brito (1991) based on five individuals caught at the Port of Santa Cruz de Tenerife. Brito *et al*. (2002) reported on several sightings and another four individuals caught in Gran Canaria. One more observation was reported off El Cabrón Beach in August 2014 by Espino *et al*. (2014).

Cantherhines pullus (Ranzani, 1842), orange-spotted filefish

Material examined. – No voucher specimens. One individual caught on a fish trap and photographed, and then identified by an expert. An adult, approximately 114 mm TL, off Castillo del Romeral, 27°47'N 15°27'W, 18-30 m, 14 Jan. 2015, rocks (Fig. 2K).

Sightings and catches. – Once, n = 1, same locality (Fig. 3).

Remarks. – A subtropical reef-associated species, living from 3 to 50 m of depth (Harmelin-Vivien and Quéro, 1990), usually at 3-20 m (Gasparini and Floeter, 2001). Found in shallow water and around coral and rocky reefs (Tyler, 1978). Usually remains near the bottom, hiding among gorgonians and branching coral (Lieske and Myers, 1994).

Feeds on bottom growth, primarily sponges and algae, but stomachs often contain tunicates, bryozoans and other sessile benthic invertebrates (Böhlke and Chaplin, 1993). Young are pelagic and highly important food items in the diet of large predaceous fishes such as tunas and billfishes (Tyler, 1978). Maximum length published is 200 mm TL (Robins and Ray, 1986). An amphi-Atlantic species. West Atlantic: known from Massachusetts, USA and Bermuda to southeastern Brazil (Harmelin-Vivien and Quéro, 1990), including Trindade Island (Gasparini and Floeter, 2001). East Atlantic: off some Gulf of Guinea islands (Harmelin-Vivien and Quéro, 1990), São Tomé and Príncipe (Osório, 1891; Afonso *et al*., 1999; Wirtz *et al*., 2007) and Annobón (Wirtz *et al*., 2007). Absent from the Cape Verde Islands (Wirtz *et al*., 2013).

This is the first record for *C. pullus* from the Canary Islands.

DISCUSSION

Pajuelo *et al*. (unpubl. data) have observed that the appearance of these tropical and subtropical fish species in waters of Gran Canaria Island is related to the heavy overseas traffic of oil platforms, with destination towards the Port of Las Palmas (docked). This also includes the adjacent Bay of Las Palmas (anchor area) and the auxiliary (when overbooking) Port of Arinaga (docked) located 16 nm down south on the east coast of the island. Importantly, all specimens identified in this work were caught inside port waters, in the pathway to the Port of Arinaga (eastern corridor of the island) or in adjacent waters to the main ports. *H. adscensionis* has been caught in the adjacent waters of the Bay of Las Palmas, but also in the Port of Santa Cruz de Tenerife, which also provides mooring for oil rigs. *C. taeniops* has been collected in the above mentioned pathway and it was also previously reported (Brito *et al*., 2011) from the Port of Las Palmas. *P. furcifer* has been captured in the Port of Las Palmas, and also in adjacent waters of these two ports. *P. marcellae* has been sighted at two localities in the eastern insular corridor between the two mentioned ports (Las Palmas and Arinaga). *A. hoefleri* has been caught in the Port of Las Palmas and fished off the Bay of Las Palmas. *A. saxatilis* has been fished in the adjacent waters of the Bay of Las Palmas, but has also been sighted in port waters and from several localities north- and southward from the Port of Las Palmas. *A. bahianus* has been captured in waters northward from the Port of Las Palmas. Both *A. chirurgus* and *A. coeruleus* have been caught inside the main port. *A. monroviae* has been captured in port waters, and also in adjacent waters to the North and South. Finally, *C. pullus* has been fished in the eastern pathway, slightly southward from the Port of Arinaga. So, proximity to the Port of Las Palmas is the key.

Moreover, *H. adscensionis*, *P. furcifer*, *Abudefduf saxatilis*, *Acanthurus bahianus*, *A. chirurgus*, *A. coeruleus*, and *C. pullus* have been observed associated with oil platforms off the southern coast of Brazil (Barreiros *et al*., 1998; Ferreira *et al*., 2006; Anderson *et al*., 2015).

The introduced species in waters of the Canaries reported herein exhibit various feeding habits, including herbivorous, planktivorous, planktivorous-detritivore, omnivorous or carnivorous/predator fishes.

A. saxatilis seems to have a stable population around Gran Canaria Island. Two adult males of *A. saxatilis* were observed and photographed at Jinámar reef in October 2014 (with a sea temperature of 23.5ºC) exhibiting the typical dark bluish pattern which is an evidence of reproduction activity of this guarder nester species (Breder and Rosen, 1966). So, this species seems to be well suited to conditions in the Canaries. The reasons why *A. saxatilis* has recently become abundant in the Canaries may be that it has occupied vacant niches that have opened from the effects of extirpation of predators by overfishing on local fish species; it also presents low mortality and has no efficient competitors (Moyle, 1985; Liao *et al*., 2010). However, because *A. saxatilis* is larger than native pomacentrids (*Similiparma lurida* (Cuvier, 1830)), interspecific competition between this species and native pomacentrids is expected as a result of the territorial behaviour. Robertson (1996) demonstrated that interspecific competition controls abundance and habitat use by territorial Caribbean damselfishes. *A. saxatilis* has also been reported at Madeira (Freitas and Araújo, 2006; Wirtz *et al*., 2008), and more recently from the central Mediterranean (Deidun and Castriota, 2014, Malta, 6-7 individuals). This species is included in the 2015 FAO Database on Introductions of Aquatic Species (DIAS) from the Red Sea to Italy, and therefore considered as an alien/invasive species by FishBase (Froese and Pauly, 2015).

The remaining ten tropical or subtropical non-indigenous species recorded here were accounted by sporadic findings. *A. monroviae* currently inhabits Tenerife and Gran Canaria islands. This species has been included in the CIESM Atlas of Exotic Species in the Mediterranean: first recorded from southern Spain (Crespo *et al*., 1987, Almería); later from Israel (Golani and Sonin, 1996); several specimens have been sighted and photographed off the Mediterranean coast of Algeria in late 2001 and August 2002 (Hamida *et al*., 2004); more recently, it has been recorded along the coasts of Tunisia (last update of the species sheet: November 2013). Besides, this species is included in the IABIN Brazil catalogue of invasive species, and therefore considered as an alien/invasive species by FishBase (Froese and Pauly, 2015).

C. taeniops has been included in the CIESM Atlas of Exotic Species in the Mediterranean: Malta, Lampedusa Island, Libya (Ben Abdallah *et al*., 2007; Guidetti *et al*.,

2010) up to the eastern Levant (Salameh *et al*., 2009), and therefore considered as an alien/invasive species by FishBase (Froese and Pauly, 2015).

H. adscensionis and *P. marcellae* currently inhabit, at least, the central islands of Gran Canaria and Tenerife (the unique islands within the archipelago, which have received oil platforms to date).

P. furcifer, *A. hoefleri, A. bahianus*, *A. chirurgus*, *A. coeruleus*, and *C. pullus* are currently living, at least, in Gran Canaria (the island within the archipelago, which has received the vast majority of oil platforms to date).

H. adscensionis, *P. furcifer*, *A. saxatilis*, *Acanthurus bahianus*, *Acanthurus chirurgus*, *Acanthurus coeruleus*, and *C. pullus* have been observed associated with oil platforms off the southern coast of Brazil (Barreiros *et al*., 1998; Ferreira *et al*., 2006; Anderson *et al*., 2015).

There are many recent works that account for the tropicalization process of fish assemblages in temperate marine ecosystems (Vergés *et al*., 2014), particularly in biogeographic transition zones as in the case of the Macaronesian archipelagos of the Canaries, Madeira and Azores, and even some parts of the Mediterranean Sea (Brito *et al*., 2005; Wirtz *et al*., 2008; Afonso *et al*., 2013; Horta Costa *et al*., 2014), generally associated with climate-mediated changes (Brito *et al*., 2005; Perry *et al*., 2005; Occhipinti-Ambrogi, 2007). The introduction of non-native fish species is also due to several human-caused factors, and the new distribution areas are majorly linked with transport vectors (e.g. Vitousek *et al*., 1997). In waters of the Canary Islands, some fish species may have been introduced via ballast waters (mainly small species like gobiids or blenniids) or aquarium trade (mainly chaetodontids and monodactylids). Obviously, ocean warming facilitates the establishment and survival of these species once they colonize new areas out of their original ranges.

An important process driving massive introduction of non-indigenous tropical and subtropical fish species (including the families mentioned right now) is taking place, in the last five years, through oil platforms navigating along several Canary Islands coastal corridors, docking at their main commercial ports and mooring at their adjacent waters. These anthropogenic vectors of introduction of warm affinity exotic species are synergic with the natural range extensions and, therefore, all causes together are significantly reinforcing the tropical and subtropical component of their littoral and upper bathyal fish assemblages. The ecological impact of these non-indigenous fishes on the native fish community remains unknown.

In the last 30 years, around 56 fish species (including the present six new records) with warm-affinity have been observed in waters of the Canary Islands. Of them, only eight species have developed small stable populations. According to Molnar *et al*. (2008), a small proportion of the fish species introduced outside of their native distribution area is able to thrive and invade new habitats. Regarding the management of this large arrival of fish species, it would be necessary to implement control and monitoring measures to avoid these species become invaders, displacing indigenous species and changing the ecosystems. In this regard, authors have recently applied for one research project to the Spanish Government in order to study this topic. The proposal has been supported by the Port of Las Palmas Authority.

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