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The zebrette goby in Tenerife harbour.

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The zebrette goby *Tigrigobius zebrellus* (Robins 1958): a new colonizer of Tenerife harbour (Canary Islands)

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Abstract

The presence of the zebrette goby (*Tigrigobius zebrellus*) is reported for the first time in the Canary Islands, as well as in the eastern Atlantic. A new established colony around the floating docks of the Marina Santa Cruz de Tenerife harbour has been studied. Over two hundred individuals at different developmental stages have been counted. Its restricted distribution and population characteristic show that it has an established population but with no evidence of expansion to its vicinity. Our study indicates that the population of this exotic species could be easily eradicated to avoid any possible negative impact on local benthic communities. However, if such measures are not soon implemented by the local government this study can also be used as the early invasion stage of an exotic fish species across the Canary Islands.

Introduction

During recent years, the astonishing increase of marine species invasions and its ecological impact around the world have aroused much attention (Molnar et al. 2008; Ben Rais Lasram and Mouillot 2009; Sardain et al. 2019; Hulme 2021). This is due to the introduction and spread of non-native or exotic species (NNS), which are considered one of the main threats to biodiversity in the marine realm (Diagne et al. 2021; Lockett and Gomon 2001; Mack et al. 2000; Peyton et al. 2019; Simberloff 2005). Although not all NNS will have such direct negative impacts in their recipient systems (Goodenough 2010), some fishes are considered as one of the most important invasive species worldwide (Albins and Hixon 2013; Sala et al. 2011). For instance, along the Central American Atlantic coast, species such as the lionfish (*Pterois volitans*) have been observed to disrupt and negatively impact native fish communities (Albins and Hixon 2008). Therefore, every case of NNS first records deserves further attention.

The checklist of littoral fish species registered for the Canary Islands has increased in recent decades due to the large number of new arrivals. Most of these benthic or benthopelagic species are from nearby tropical regions. Several of these new fishes have entered the Canaries from the more meridional islands, which have warmer waters, and can be interpreted as an extent of their distribution range related with natural dispersion processes, such as current larvae drag, adult movement or rafting. However, important number of them have been found for the first time inhabiting the main harbours of Santa Cruz de Tenerife (SCT) and Las Palmas de Gran Canaria (LPG) (Brito et al. 2011; González et al. 2025; Triay-Portella et al. 2015). A recent study by Falcón et al. (2023) has analysed each of the NNS arrival cases, and they have concluded that there are two clearly distinguished invasion periods. From 1980 to 2010, most of the arrivals, 46 species in total, are due to natural geographic expansion, with just 11 species related to ballast water or to releases from aquaria. Since then to 2023, 13 species have presumably arrived by their own natural ways; however, the number of introduced species of tropical origin have increased to 26. This boom coincides in time with an increase of oil platform arrivals to SCT and LPG main harbours, which have been recently pointed out as the main transport vector of marine non-native fish species (Falcón et al. 2015; González et al. 2025: Pajuelo et al. 2016).

We present here the results of a population study of a new colonizer of SCT harbour, the fish *Tigrigobius zebrellus* (Robins 1958). The genus *Tigrigobius* (Fowler, 1931) encompasses various small-sized gobies, with vibrant colours and native to the warmer regions of the eastern Pacific and western Atlantic, including the Gulf of California and the Caribbean (Taylor and Hellberg 2005). This species has a compressed body, with the largest specimens reaching a length

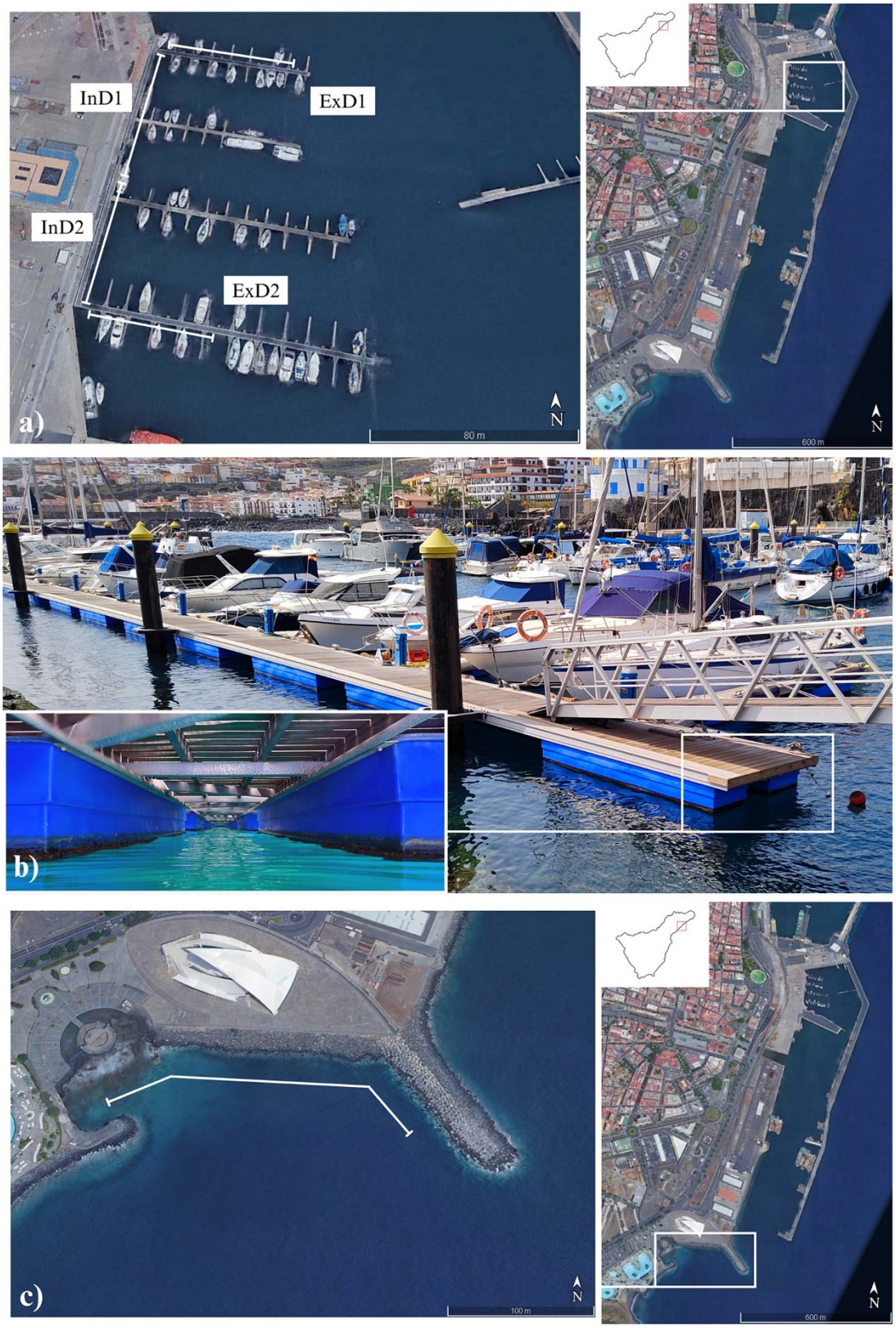

Figure 1. (a) Satellite image showing harbour Marina Santa Cruz and the different sampled docks: interior dock 1 (InD1), interior dock 2 (InD2), exterior dock 1 (ExD1), and exterior dock 2 (ExD2). *Source*: Google Earth (2022). (b) Interior section of the harbour docks considered during the study. (c) Satellite image showing the area of Castillo de San Juan Bautista (black circle) and the Auditorium Adán Martín (white triangle). The white line indicates the sampled path. *Source*: Google Earth (2022).

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of 2.1 cm and distinctive colouration pattern characterized by narrow dark stripes along its body (Robertson et al. 2019). Unlike other species in the *Tigrigobius* genus, *T. zebrellus* displays 13 prominent vertical dark stripes extending from its pectoral fin to the caudal fin, which can sometimes be wider than the pale intermediate spaces (Robins 1958; Taylor and Akins 2007). The native distribution of this species is restricted to the Caribbean Sea, specifically the area from the Gulf of Venezuela to Trinidad, where it typically inhabits shallow coastal areas associated with reefs, macroalgae, and rocky formations (Pezold et al. 2015). The present study reports the presence of *T. zebrellus* in an area distant from its natural distribution range and in a relatively different environment than usual. Within this study, the species distribution, the population characteristics, as well as possible introduction mechanisms and management of this exotic fish are discussed.

Materials and methods

The study was carried out in the Marina SCT (28°27′59.9″ 16°14′37.3″ W), located in the northeastern part of the Tenerife Island, situated in the subtropical region of the central-eastern Atlantic Ocean, and belonging to the Spanish autonomous community of the Canary Islands (Figure 1).

In order to investigate the presence of the goby *T. zebrellus* in the harbour environment, a sampling methodology focused on the submerged portion of the floating docks used for the mooring and unmooring of vessels has been designed. The sampling was carried out during August 2022. For this purpose, four docks within the harbours have been selected: two docks adjacent to the wall considered 'interior' docks (InD1 and InD2), and two protruding docks considered 'exterior' docks (ExD1 and ExD2) (Figure 1).

In each of the docks, a linear transect was conducted along its inner part (Figure 1), covering a distance of 60 m within a time span of 45 min. The sampling was carried out using snorkelling equipment and consisted of a visual census to obtain direct observations of the individuals. In addition to tallying the number of observed individuals, a preliminary classification based on their size was performed: small (<1 cm), medium (between 1 and 2 cm), and large (≥2 cmr). This classification was conducted through direct visual measurement by calibrated observers using photo quadrats with scales to ensure accuracy. A statistical descriptive analysis was carried out by calculating the mean and standard deviation of the number and sizes of individuals recorded in the different studied zones.

Due to the high number of individuals recorded during the study, subsequently, an additional sampling was carried out in the area closest to the mouth of the marina, specifically in the zone of Castillo de San Juan Bautista, also known as 'Castillo Negro' (Figure 1). In this additional sampling, a 90-min survey was conducted using the same methodology described earlier, covering an approximate distance of 240 meters, but considering a broader range of observation in terms of depth, spanning from the intertidal zone (0–1 m) to 10 m. Various habitat types were considered, encompassing both natural and artificial hard substrates as well as the nearest sandy bottoms.

In addition to visual sampling, photographs of some of the observed specimens were taken during the sampling and afterwards in the laboratory. These images were examined based on morphological characteristics, such as the number of pectoral fin rays and the number of scales at the base of the caudal peduncle, and compared with existing scientific descriptions to confirm the identification of *T. zebrellus*.

Table 1. Number of observed individuals of *Tigrigobius zebrellus* in the different sampled docks, classified by size: small (<1 cm), medium (1–2 cm), and large (>2 cm)

	Number of individuals observed			
	Small (<1 cm)	Medium (1–2 cm)	Large (>2 cm)	Total
Exterior dock 1 (ExD1)	6	12	2	20
Exterior dock 2 (ExD2)	3	4	3	10
Interior dock 1 (InD1)	41	44	20	105
Interior dock 2 (InD2)	38	37	22	97

Data were collected in August 2022 from four transects within Marina Santa Cruz de Tenerife, each 60 m long and surveyed for 45 min by two observers.

Table 2. Mean and standard deviation of the number of *Tigrigobius zebrellus* observed in exterior and interior docks, categorized by size: small (<1 cm), medium (1–2 cm), and large (>2 cm)

	Number of individuals observed		
	Small (<1 cm)	Medium (1– 2cm)	Large (>2 cm)
Exterior dock (Mean ± Standard deviation)	5 ± 2.1	8 ± 5.7	3 ± 0.7
Interior dock (Mean ± Standard deviation)	40 ± 2.1	41 ± 4.9	21 ± 1.4

Data were collected in August 2022 from four transects within Marina Santa Cruz de Tenerife, each 60 m long and surveyed for 45 min by two observers.

Results

A total of 232 individuals of the goby *Tigrigobius zebrellus* (Table 1) were counted during four transects conducted within Marina SCT in August 2022. Among these, 202 were found in the inner docks (InD1 and InD2), while 30 were found in the outer docks (ExD1 and ExD2). Specimens of *T. zebrellus* in all three sizes – small (<1 cm), medium (between 1 and 2 cm), and large (≥2 cm) – were observed in all docks (Table 1). In the three sizes considered, the mean number of observed individuals was higher in the interior docks than in the exterior ones (Table 2). In relation to size, approximately 38% of the individuals were small (<1 cm), around 42% were medium-sized (between 1 and 2 cm), and only 20% were larger (≥2 cm). One of the 'large' sized individuals observed exhibited the first ray of the dorsal fin clearly elongated, a characteristic of males during the breeding period. Photographs of some observed specimens were taken during sampling and later in the laboratory (Figure 2), providing morphological data such as 13 vertical stripes extending from behind the pectoral fin to the caudal fin, 18 rays in the pectoral fins, and 4 large scales at the base of the caudal peduncle, among others. Other fish species observed during the sampling at the docks included the goby *Gobius xanthocephalus* and the blennies *Hypleurochilus pseudoaequipinnis* and *Microlipophrys velifer*.

Regarding the additional sampling carried out in the Castillo de San Juan Bautista area, no individuals of *T. zebrellus* were recorded. However, species from the Blenniiformes order were observed, such as *Parablennius goreensis, Tripterygion delaisi*, and *Ophioblennius atlanticus*, as well as the cling fish *Lepadogaster candolii*.

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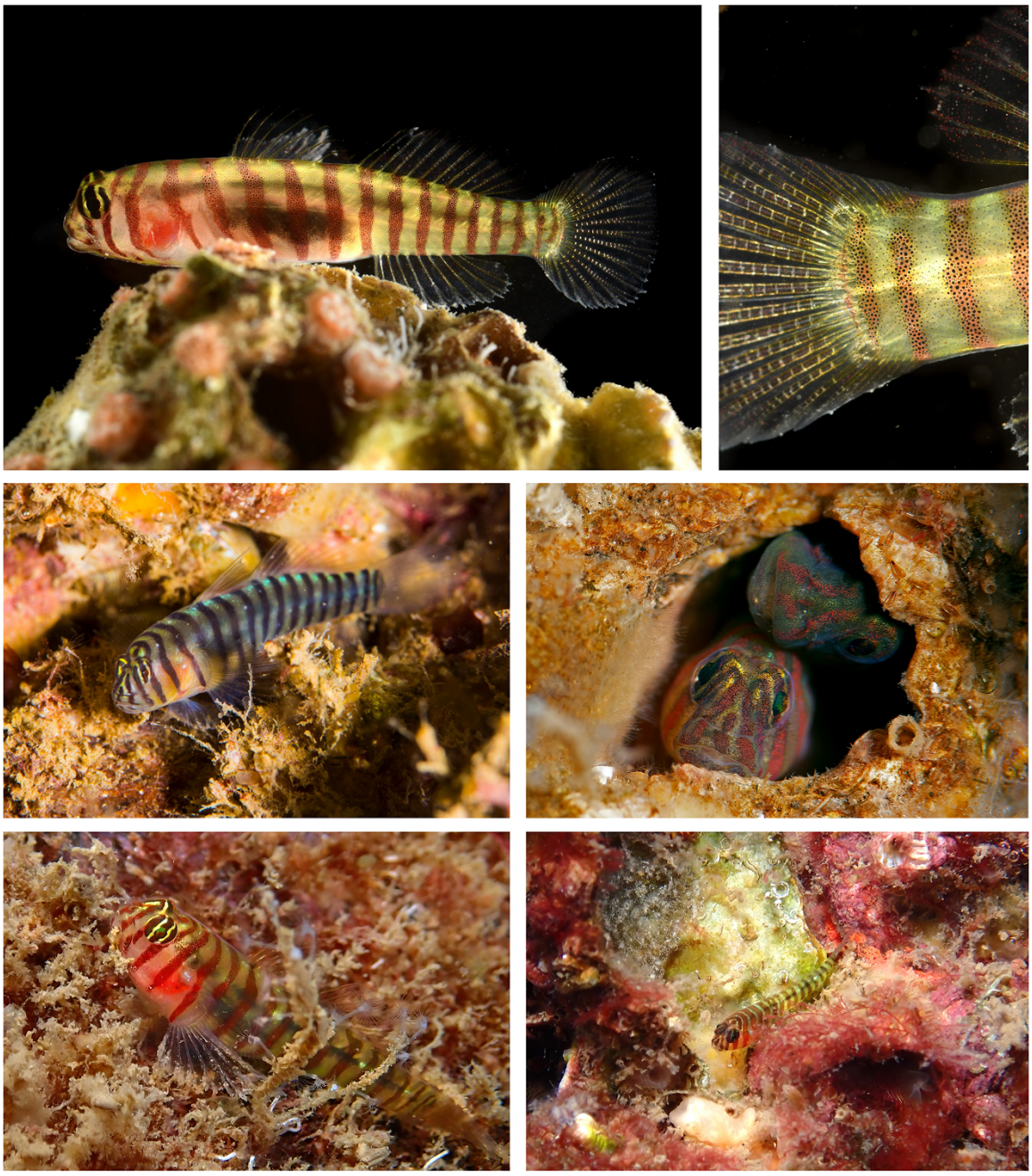

Figure 2. Photographs of different specimens of *Tigrigobius zebrellus* observed in the harbour Marina Santa Cruz. The first two images were taken in the laboratory, while the remaining images were captured *in situ*. Authors: Leopoldo Moro, Juan Carballo, María Belén Caro, and Marc Martín.

Discussion

In the present study, we confirm the presence of *Tigrigobius zebrellus* in the Canary Islands and Eastern Atlantic waters, and it has also been reported a population of over 232 individuals in a relatively confined habitat, specifically concentrated in the inner sections of floating docks within the harbour. It has also been observed that there are differences in the abundance of *T. zebrellus* depending on the area of the port. The 'interior' docks show a higher quantity of individuals compared to the 'exterior' docks. This phenomenon could be attributed to the reduced exposure to light and wave action in the 'interior' docks, which promotes a greater development of their fouling community (Glasby 1999; Jessen et al. 2014), mainly invertebrates that serve as a refuge for the species. As noted in other studies, submerged artificial structures, including those located in ports, provide suitable habitats to be colonized by various organisms (Airoldi et al. 2015; Mineur et al. 2012). However, it has been demonstrated that exotic species often outperform native species in colonizing these substrates, appearing in higher proportions in these artificial environments (Airoldi et al. 2015; Glasby et al. 2007; Megina et al. 2016; Ruiz et al. 2009). The described population of *T. zebrellus* in the Marina de Santa Cruz serves as a clear example of an exotic species that has found the optimal habitat for its development within a harbour environment in the Canary Islands.

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In its natural region, the species tends to be associated with reef areas, where it can survive in different habitats such as those consisting of macroalgae, soft or hard corals, and large rocky formations. However, it has also been observed in areas of rocky or sandy rocky coastline with small loose rocks and algae (Pezold et al. 2015). Regarding its natural biogeographical distribution, it is observed about 5000 km away from its native distribution and in such a restricted environment on the island suggests that it is an introduced species through maritime traffic. Maritime traffic is considered the primary pathway for the introduction of exotic species worldwide, acting as vectors for transporting organisms mainly through ballast water or hull fouling on ships (Carlton 1996; Hewitt et al. 2009). In the Canary Islands, a relevant vector linked to the introduction of exotic species is also the arrival of oil platforms at major ports, most of them coming from tropical regions of the Atlantic such as Brazil, the Caribbean, or the Gulf of Guinea (Falcón et al. 2015; Pajuelo et al. 2016). These platforms, due to their slow movement, facilitate the survival of some of their associated organisms during the journeys (Creed et al. 2017; López et al. 2019). This implies that large ports, including those receiving oil platforms, are considered hotspots for exotic species and, at the same time, priority areas for the early detection and management prior to the spread of potential marine biological invasions (Lehtiniemi et al. 2015; Romeo et al. 2015; Tempesti et al. 2020).

Photographic records of some observed individuals during sampling, combined with a detailed examination of a specimen in the laboratory, revealed key morphological traits of the species, including 13 vertical stripes extending from behind the pectoral fin to the caudal fin, 18 rays in the pectoral fins, and 4 large scales at the base of the caudal peduncle. These characteristics align with the existing descriptions of the species (Robertson et al. 2019; Robins 1958), further confirming its identification. Despite the large number of specimens recorded within the harbour, their presence was not detected in the shallow seabeds closest to the harbour environments. In the area around Castillo de San Juan several introduced fish species have been recorded, such as *Pomacanthus maculosus* (Brito et al. 2002), *Abudefduf saxatilis, Acanthurus coeruleus* (Falcón and Monterroso 2018), and *Acanthurus monroviae* (Falcón et al. 2023). Despite the absence of *T. zebrellus* during the sampling in the surroundings, this area remains important for their early detection in the event of potential expansion beyond the harbour. On the other hand, this suggests that, despite having successfully developed within the harbour environment, the species has not been able to thrive on its own in its immediate vicinity yet. Among other factors, this could be due to the limited dispersal capacity exhibited by certain goby species (Taylor and Hellberg 2003). There are similar cases of introduced fish species in the Canary Islands that have used port environments as their initial settlement sites. For instance, the case of the tropical blenny, *Hypleurochilus pseudoaequipinnis*, which was recorded in Gran Canaria in 2013 (Falcón et al. 2015) and later in Tenerife in 2016 and El Hierro in 2019 (Falcón et al. 2023). In this case, despite not being considered a species with high invasive potential, it could be potentially competing with similar native species occupying the same ecological niches, such as *Gobius niger, Vanneaugobius canariensis*, or *Parablennius pilicornis*. However, the process of tropicalization could favour, in a future scenario, some of the marine species considered exotic (Brito et al. 2017) that are currently classified as non-invasive or have insufficient data.

The success of the species in reproducing and dispersing depends on various factors. However, observations like these underscore the need to address the issue, especially in cases like the current study, where the population of the introduced species is geographically confined, making its management relatively straightforward. Since *T. zebrellus* is restricted to the harbour, targeted eradication measures could be considered. Chemical treatments such as clove oil or rotenone have been effective in removing non-native fish in controlled environments (Ling 2003; Rytwinski et al. 2019), though their potential impact on native species must be carefully assessed. Alternatively, non-chemical methods like manual removal with nets, selective traps, or habitat modification may offer viable solutions depending on logistical feasibility and ecological considerations. Furthermore, the present study highlights the importance of initiating long-term monitoring in the main harbour environments of the Canary Islands. This monitoring would allow for both, tracking of exotic species inhabiting these environments and the early detection of newly arrived species, such as the current case study of *T. zebrellus*.

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References

Airoldi L, Turon X, Perkol-Finkel S and Rius M (2015) Corridors for aliens but not for natives: Effects of marine urban sprawl at a regional scale. *Diversity and Distributions* **21**, 755–768. doi:10.1111/ddi.12301

Albins MA and Hixon MA (2008) Invasive Indo-Pacific lionfish *Pterois volitans* reduce recruitment of Atlantic coral-reef fishes. *Marine Ecology Progress Series* **367**, 233–238. doi:10.3354/meps07620

Albins MA and Hixon MA (2013) Worst case scenario: Potential long-term effects of invasive predatory lionfish (*Pterois volitans*) on Atlantic and Caribbean coral-reef communities. *Environmental Biology of Fishes* **96**, 1151–1157. doi:10.1007/s10641-011-9795-1

Brito A, Clemente S and Herrera R (2011) On the occurrence of the African hind, *Cephalopholis taeniops*, in the Canary Islands (eastern subtropical Atlantic): Introduction of large-sized demersal littoral fishes in ballast water of oil platforms? *Biological Invasions* **13**, 2185–2189. doi:10.1007/s10530-011-0049-0

Brito A, Moreno-Borges S, Escánez A, Falcón JM and Herrera R (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.

Brito A, Pascual P, Falcón JM, Sancho A and González G (2002) In *Peces de Las Islas Canarias. Catálogo Comentado E Ilustrado*. La Laguna: Francisco Lemus Editor, 419.

Carlton JT (1996) Pattern, process, and prediction in marine invasion ecology. *Biological Conservation* **78**, 97–106. doi:10.1016/0006-3207(96)00020-1

Creed JC, Fenner D, Sammarco P, Cairns S, Capel K, Junqueira AO, Cruz I, Miranda RJ, Carlos-Junior L, Mantelatto MC, Oigman-Pszczol S (2017)The invasion of the azooxanthellate coral *Tubastraea* (Scleractinia: Dendrophylliidae) throughout the world: History, pathways and vectors. *Biological Invasions* **19**, 283–305. doi:10.1007/s10530-016-1279-y.

https://doi.org/10.1017/S0025315425100453 Published online by Cambridge University Press

Diagne C, Leroy B, Vaissière AC, Gozlan RE, Roiz D, Jarić I, Salles JM, Bradshaw CJ, Courchamp F (2021) High and rising economic costs of biological invasions worldwide. *Nature* **592**, 571–576. doi:10.1038/s41586-021-03405-6.

Falcón JM, Brito A, Herrera R, Ayza O, Moro L and Caro B (2023) Peces marinos tropicales exóticos de Canarias. Consejería de Transición Ecológica, Lucha contra el Cambio Climático y Planificación Territorial del Gobierno de Canarias, Ed. 247 pp.

Falcón JM, Herrera R, Ayza O and Hernández AMB (2015) New species of tropical littoral fish found in Canarian waters. Oil platforms as a central introduction vector. *Revista de la Academia Canaria de Ciencia* **27**, 67–82.

Falcón JM and Monterroso O (2018) Memoria Final del estudio Caracterización y seguimiento de poblaciones de peces exóticos en el entorno del Puerto de Santa Cruz de Tenerife y áreas de la Red Natura próximas. Proyecto MIMAR (MAC/4.6D/066). Viceconsejería de Medio Ambiente del Gobierno de Canarias. Dirección General de Protección de la Naturaleza, pp. 73

Fowler HW (1931) Fishes obtained by the Barber Asphalt Company in Trinidad and Venezuela in 1930. *Proceedings of the Academy of Natural Sciences of Philadelphia* **83**, 391–410.

Glasby TM (1999) Interactive effects of shading and proximity to the seafloor on the development of subtidal epibiotic assemblages. *Marine Ecology Progress Series* **190**, 113–124. doi:10.3354/meps190113

Glasby TM, Connell SD, Holloway MG and Hewitt CL (2007) Non Indigenous biota on artificial structures: Could habitat creation facilitate biological invasions? *Marine Biology* **151**, 887–895. doi:10.1007/s00227-006-0552-5

González JA, Espino F and González-Lorenzo JG (2025) Changes in biogeographic patterns of coastal fishes: Indicators of tropicalization in the Canary Islands over the last 40 years. *Marine Environmental Research* **205**, 107002. doi:10.1016/j.marenvres.2025.107002

Goodenough AE (2010) Are the ecological impacts of alien species misrepresented? A review of the "native good, alien bad" philosophy. *Community Ecology* **11**, 13–21. doi:10.1556/comec.11.2010.1.3

Hewitt CL, Gollasch S and Minchin D (2009) The vessel as a vector–biofouling, ballast water and sediments. *Biological Invasions in Marine Ecosystems* **204**, 117–131. doi:10.1007/978-3-540-79236-9_6

Hulme PE (2021) Unwelcome exchange: International trade as a direct and indirect driver of biological invasions worldwide. *One Earth* **4**, 666–679. doi:10.1016/j.oneear.2021.04.015

Jessen C, Voolstra CR and Wild C (2014) In situ effects of simulated overfishing and eutrophication on settlement of benthic coral reef invertebrates in the Central Red Sea. *PeerJ Life & Environment* **2**, e339. doi:10.7717/peerj.339

Lehtiniemi M, Ojaveer H, David M, Galil B, Gollasch S, McKenzie C, et al. (2015) Dose of truth—monitoring marine non-indigenous species to serve legislative requirements. *Marine Policy* **54**, 26–35. doi:10.1016/j.marpol.2014.12.015.

Ling N (2003) Rotenone - A review of its toxicity and use for fisheries management. *Science for Conservation* **211**, 1–40.

Lockett MM and Gomon MF (2001) Ship mediated fish invasions in Australia: Two new introductions and a consideration of two previous invasions. *Biological Invasions* **3**, 187–192. doi:10.1023/a:1014584201815

López C, Clemente S, Moreno S, Ocaña O, Herrera R, Moro L, et al. (2019) Invasive *Tubastraea* spp. and *Oculina patagonica* and other introduced scleractinians corals in the Santa Cruz de Tenerife (Canary Islands) harbor: Ecology and potential risks. *Regional Studies in Marine Science* **29**, 100713. doi:10.1016/j.rsma.2019.100713.

Mack RN, Simberloff D, Mark Lonsdale W, Evans H, Clout M and Bazzaz FA (2000) Biotic invasions: Causes, epidemiology, global consequences, and control. *Ecological Applications* **10**, 689–710. doi:10.1890/1051-0761(2000)010[0689:bicegc]2.0.co;2

Megina C, González-Duarte MM and López-González PJ (2016) Benthic assemblages, biodiversity and invasiveness in marinas and commercial harbours: An investigation using a bioindicator group. *Biofouling* **32**, 465–475. doi:10.1080/08927014.2016.1151500

Mineur F, Cook EJ, Minchin D, Bohn K, MacLeod A and Maggs CA (2012) Changing coasts: Marine aliens and artificial structures. *Oceanography and Marine Biology* **50**, 198–243. doi:10.1201/b12157-6

Molnar JL, Gamboa RL, Revenga C and Spalding MD (2008) Assessing the global threat of invasive species to marine biodiversity. *Frontiers in Ecology and the Environment* **6**, 485–492. doi:10.1890/070064

Pajuelo JG, González JA, Triay-Portella R, Martín JA, Ruiz-Díaz R, Lorenzo JM and Luque Á (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. doi:10.1016/j.jmarsys.2016.06.008

Peyton J, Martinou AF, Pescott OL, Demetriou M, Adriaens T, Arianoutsou M, et al. (2019)Horizon scanning for invasive alien species with the potential to threaten biodiversity and human health on a Mediterranean island. *Biological Invasions* **21**, 2107–2125. doi:10.1007/s10530-019-01961-7.

Pezold F, Van-Tassell J, Tornabene L and Aiken KA (2015) *Tigrigobius zebrellus*. The IUCN Red List of Threatened Species 2015: e.T185902A1787323.

Rais Lasram F and Mouillot D (2009) Increasing southern invasion enhances congruence between endemic and exotic Mediterranean fish fauna. *Biological Invasions* **11**, 697–711. doi:10.1007/s10530-008-9284-4

Robertson DR, Peña EA, Posada JM and Claro R (2019) Peces costeros del Gran Caribe: Sistema de información en línea. Version 2.0. Inst. Smithsonian Invest. Trop., Balboa, Panamá. https://biogeodb.stri.si.edu/caribbean/es/ (accessed 10 August 2024).

Robins CR (1958) *Garmannia zebrella*, a new gobiid fish from Trinidad, with notes on the species of the subgenus *Tigrigobius* Fowler. *Journal of the Washington Academy of Sciences* **48**, 192–198.

Romeo T, D'Alessandro M, Esposito V, Scotti G, Berto D, Formalewicz M, et al. (2015)Environmental quality assessment of Grand Harbour (Valletta, Maltese Islands): A case study of a busy harbour in the Central Mediterranean Sea. *Environmental Monitoring and Assessment* **187**, 1–21. doi:10.1007/s10661-015-4950-3.

Ruiz GM, Freestone AL, Fofonoff PW and Simkanin C (2009) Habitat distribution and heterogeneity in marine invasion dynamics: The importance of hard substrate and artificial structure. *Marine Hard Bottom Communities* **206**, 321–332. doi:10.1007/b76710_23

Rytwinski T, Taylor JJ, Donaldson LA, Britton JR, Browne DR, Gresswell RE, Lintermans M, Prior KA, Pellatt MG, Chantal V and Cooke SJ (2019) The effectiveness of non-native fish removal techniques in freshwater ecosystems: A systematic review. *Environmental Reviews* **27**, 71–94. doi:10.1139/er-2018-0049

Sala E, Kizilkaya Z, Yildirim D and Ballesteros E (2011) Alien marine fishes deplete algal biomass in the eastern Mediterranean. *PloS One* **6**, e17356. doi:10.1371/journal.pone.0017356

Sardain A, Sardain E and Leung B (2019) Global forecasts of shipping traffic and biological invasions to 2050. *Nature Sustainability* **2**, 274–282. doi:10.1038/s41893-019-0245-y

Simberloff D (2005) Non-native species do threaten the natural environment! *Journal of Agricultural and Environmental Ethics* **18**, 595–607. doi:10.1007/s10806-005-2851-0

Taylor MS and Akins L (2007) Two new species of *Elacatinus* (Teleostei: Gobiidae) from the Mexican coast of the Gulf of Mexico. *Zootaxa* **1425**, 45–51. doi:10.11646/zootaxa.1425.1.6

Taylor MS and Hellberg ME (2003) Genetic evidence for local retention of pelagic larvae in a Caribbean reef fish. *Science* **299**, 107–109. doi:10.1126/science.1079365

Taylor MS and Hellberg ME (2005) Marine radiations at small geographic scales: Speciation in neotropical reef gobies (*Elacatinus*). *Evolution* **59**, 374–385. doi:10.1111/j.0014-3820.2005.tb00996.x

Tempesti J, Langeneck J, Maltagliati F and Castelli A (2020) Macrobenthic fouling assemblages and NIS success in a Mediterranean port: The role of use destination. *Marine Pollution Bulletin* **150**, 110768. doi:10.1016/j.marpolbul.2019.110768

Triay-Portella R, Pajuelo JG, Manent P, Espino F, Ruiz-Díaz R, Lorenzo JM and González JA (2015) New records of non-indigenous fishes (Perciformes and Tetraodontiformes) from the Canary Islands (north-eastern Atlantic). *Cybium* **39**, 163–174.

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