



New record of *Azurina intercrusma* (Evermann & Radcliffe, 1917) (*Ovalentaria incertae sedis*, Pomacentridae) and confirmation of *Scuticaria tigrina* (Lesson, 1828) (Anguilliformes, Muraenidae) in the Galápagos Islands

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Abstract. Herein we provide the first published records for *Azurina intercrusma* and a correction of previous *Scuticaria tigrina* records within the Galápagos Marine Reserve. The former had not previously been reported north of the southern Ecuadorian coastline and represents a significant step outside of its known distribution for this cold-water species. *Scuticaria tigrina* had been mentioned in previous literature as present, but its inclusion appears to have been in error; we confirm its presence as a vagrant and provide evidence of live observations in different parts of the archipelago.

Keywords. Citizen science, Eastern Tropical Pacific, new record, reef-eel, reef-fish, scuba diving, subtidal monitoring

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Introduction

The Galápagos are famous for their abundant native and endemic marine wildlife (Bustamante et al. 2000) and the dangers of introduction of non-native species through anthropogenic vectors (Keith et al. 2016; Carlton et al. 2019); however, what is less well-documented is the flux of “vagrant” marine species through the islands’ waters (McCosker and Rosenblatt 2010). Much of the ocean’s fauna and flora have a pelagic larval stage during their development (Orton 1953; Strathmann 1993) and this, combined with the oceanic currents interacting with the Eastern Tropical Pacific (ETP) (Kessler 2006), occasionally leads to rare or previously unseen species appearing in the archipelago. These “vagrant” species are usually unable to establish

populations and are just temporary residents on the islands, such as the butterflyfish of the Indo-Pacific which can be observed sporadically along the reefs of Darwin and Wolf (Fig. 1) (Robertson and Allen 2015). However, occasionally sufficient individuals of a given species arrive, find each other, and establish a long-lasting breeding population, the likelihood of which is also dependent on the adaptability of the species to the seasonally changing habitats in the Galápagos (Houvenagel 1984; Kessler 2006).

Azurina D.S. Jordan & McGregor in Jordan & Evermann, 1898, belonging to the subfamily Chrominae, is a genus which has undergone several taxonomic revisions over the past decade and a half. Originally containing only two species, it was considered endemic to the ETP (Robertson and Allen 2015) and comprised of

normal range extending from the southern coast of Ecuador south to Chile between depths of 0 and 35 m (Robertson and Allen 2015).

On 7 April 2022, W. Bensted-Smith observed a single juvenile of *A. intercrusma*, ~7 cm long, swimming amongst the rocks (Fig. 2A, B) at a depth of 6 m during a Subtidal Ecological Monitoring (Banks 2014) scuba dive at the tourist site of Punta Moreno on the southwest coast of Isabela Island (Fig. 1A). It was noted that this individual was swimming alongside a similar-looking *A. atrilobata*, and it could be differentiated from this species due to the lack of a prominent white spot just below the end of the base of the soft dorsal fin, which is characteristic of *A. atrilobata* (Fig. 2C). No other individuals were noted at any of the other 52 dive sites along the coastlines of western Isabela or the neighbouring island of Fernandina during that monitoring effort.

The morays of the world (Muraenidae) are divided into two subfamilies, Muraeninae and Uropterygiinae, the latter of which contains five genera (Loh et al. 2008). All five can be found within Pacific waters, but only *Anarchias*, *Uropterygius*, and *Scuticaria* are present in the ETP (GBIF 2023; OBIS 2023). The genus *Scuticaria* Jordan & Snyder, 1901, originally a subgenus of *Uropterygius* Rüppell, 1838, was only recognised as its own genus in 1997 (Böhlke and McCosker 1997) and includes just two species, *S. tigrina* (Lesson, 1828) and *S. okinawae* (Jordan & Snyder, 1901). *Scuticaria tigrina* is a widely distributed species, spanning the Indo-Pacific, and yet relatively little is known about its population trends, ecology, and natural history due to its nocturnal nature. In fact, no *S. tigrina* leptocephali were identified until 2012, when a genetic and morphometric analysis of several collected from southern Japan revealed they pertained to this species (Tawa et al. 2012).

The known range of this species within the ETP stretches from the southwestern Gulf of California to the coast of Panama (López and Bussing 1964; Rosenblatt et al. 1972; McCosker and Rosenblatt 1995; Robertson and Allen 2015). Its presence has also been reported on several oceanic islands closer to the GMR, such as Cocos Island (Robertson and Allen 2015) and possibly Malpelo (Bessudo 2021; Robertson pers. comm. 2022). However, excluding a perhaps mistaken record by Grove and Lavenberg (1997), which appears to have led to its inclusion in the publications of McCosker and Rosenblatt (2010) and, by extension, Dale et al. (2021), there is no published evidence for the occurrence of the species in the Galápagos Archipelago.

The first photographic record of *S. tigrina* in the Galápagos Islands (Fig. 3C) was by S. Tonge on 11 August 1988, of a dead individual on a beach of Rábida Island (Fig. 1). When alive, the species is known to inhabit rocky and rubble bottoms on reefs (Robertson and Allen 2015), which is indeed where it was encountered by W. Bensted-Smith on 28 March 2021 near Punta Moreno, Isabela Island, at a depth of 15 m (Fig. 3A), whilst the third encounter was in the crevasse of a lava

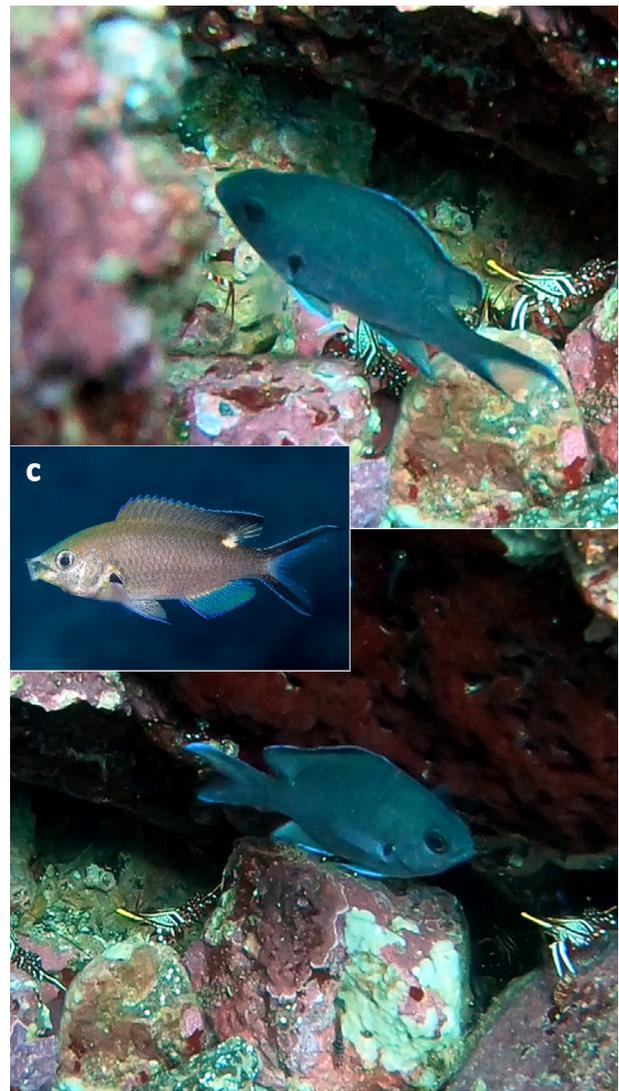


Figure 2. *Azurina* species in the Galápagos. **A, B.** *A. intercrusma*. Side view of juvenile at Punta Moreno, Isabela Island, Galápagos on 7 April 2022 at a depth of 6 m. Screenshots of video by W. Bensted-Smith. **C.** *A. atrilobata*. Side view for comparison; photo taken by Allison Estape.

rock wall on Champion Island off the coast of Floreana by N. Tirado on 31 March 2022 (Fig. 3B). The latter two observations were both made during the Charles Darwin Foundation Subtidal Ecological Monitoring Program and are recorded within the datasets. No further sightings of the species have been reported despite extensive monitoring efforts each year.

Methods

The species listed within this paper were all observed during subtidal surveys as part of the Subtidal Ecological Monitoring program which is undertaken annually across the different bioregions of the Galápagos Marine Reserve (Edgar et al. 2004; Kislik et al. 2017) with the aim of examining trends in subtidal communities during the warm season months experienced by the archipelago between diagnostic sites and years. This effort is undertaken by trained researchers of the



Figure 3. *Scuticaria tigrina*. **A.** Head, frontal and side view. **B.** Head and frontal view. At Punta Moreno of Isabela Island, Galápagos on 28 March 2021, at a depth of 15 m. Screenshots of video by W. Bensted-Smith. **C.** Full-body side view at Rábida Island off Santiago Island, Galápagos on 11 October 1988, onshore, photo by S. Tonge. **D.** Body side view at Champion Island off Floreana Island, Galápagos on 31 March 2022, at a depth of 15 m, photo by N. Tirado.

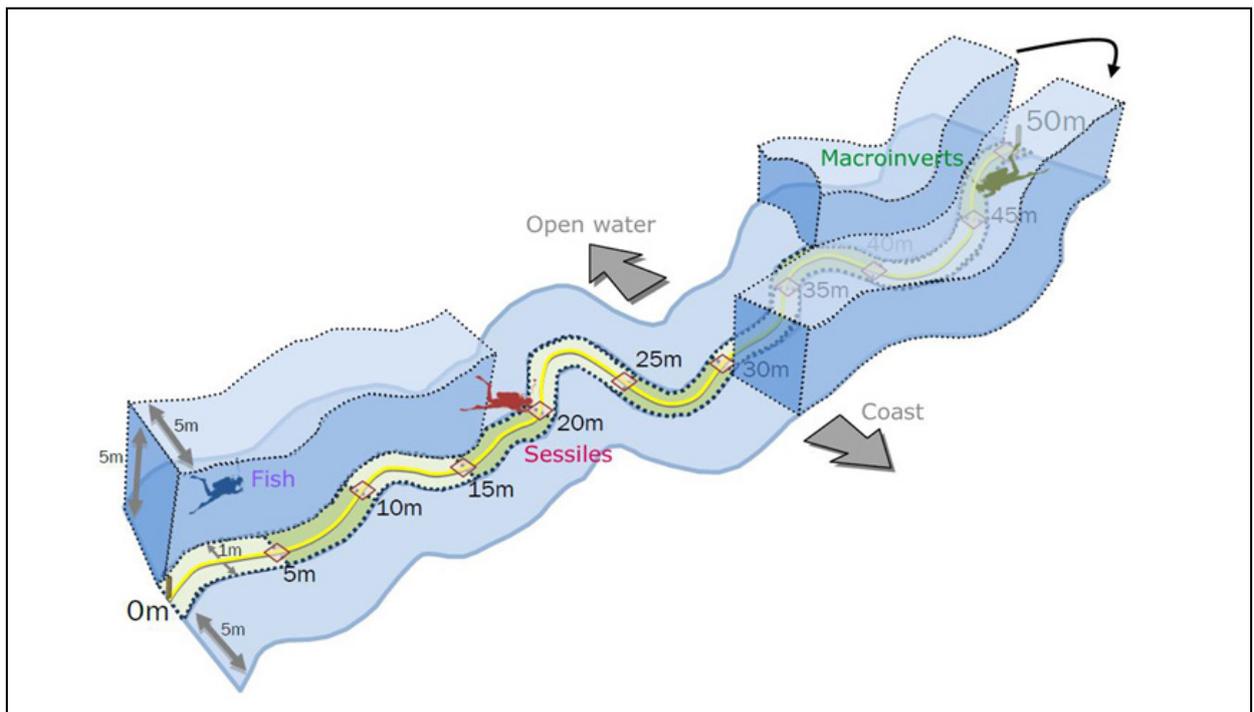


Figure 4. Schematic of a 50 m subtidal transect analogous to the Reef Life Survey methodology with the difference that sessile biota point interception quadrats are scored in-situ (Banks 2014).

Charles Darwin Research Station (CDRS) together with Galápagos National Park Rangers and covers 63 diagnostic coastal sites, across nine islands, at which non-fixed 50 m transects are laid along two standard depth strata (15 m and 6 m) usually parallel to the coastline (Banks 2014). The subtidal monitoring process follows the methods set out by Edgar et al. (2004) and Banks (2014b), with four monitored groups surveyed by three trained divers each performing an authorised non-invasive visual census.

Within the demersal fish and coastal vertebrates group, the diver must complete an along-track visual census which encompasses a 1250 m³ volume of water on each side of the transect and is repeated for both depths (Fig. 4) (Banks et al. 2016). During the return-pass (coastal side of transect in Fig. 1) of each transect, special focus is given to small and cryptic species which may not have been detected in the first pass (Banks 2014); it was during these return passes when the presence of *Azurina intercrusma* and *Scuticaria tigrina* were observed and recorded.

Results

Azurina intercrusma (Evermann & Radcliffe 1917)

Photographic record. ECUADOR – Galápagos • Isabela, Punta Moreno; 00.703°S, 091.331°W; 6 m depth; 07.IV.2022; W. Bensted-Smith obs.; 1 individual photographed.

Identification. *Azurina intercrusma* is a relatively large damselfish with a maximum known length of 290 mm, although individuals of ~150 mm TL are more commonly observed (Prado and Béarez 2004; Robertson and Allen 2015). It can often be confused with the similar-looking *Chromis crusma* (Valenciennes, 1833), which inhabits the same regional coastal waters; however, these two species can be readily differentiated by several morphological differences, including the number of dorsal spines, XIII (rarely XIV) on *C. crusma*, with the rear shorter than the middle, compared to *Azurina intercrusma*'s XII, all equal in length. In addition, *A. intercrusma* has distinctly angular ends of the

soft dorsal and anal fins, whereas *C. crusma*'s soft dorsal and anal fins are broadly rounded (Chirichigno Fonseca and Vélez Dieguez 1998) and the former's pectorals are of moderate size, often less than or equal to the length of the head, while the latter's are always longer (Evermann and Radcliffe 1917). The colouration is blue-grey on the upper half, fading to paler grey further down the flanks, whilst the fins are also of a dark-grey shade.

The juvenile stage of this species has a similarly grey-coloured head, body, and fins as the adult. However, the iridescent blue outer edges of the dorsal, pelvic, and anal fins, as well as the upper and lower edges of the caudal fin (Fig. 5A), make it stand out from other species such as *C. crusma* with black edges to the dorsal and anal fins, and a dark tail fin (Fig. 5B). This can cause some confusion since the outer third of *A. intercrusma*'s dorsum is also black. Both juveniles also have a black spot at the base of the pectoral fin (Robertson and Allen 2015). The congener *A. atrilobata* also shows a similar body shape and the black spot at the base of the pectoral fin; this species is commonly found in Galápagos waters as well as throughout the ETP, partially overlapping with the range of *A. intercrusma* (Robertson and Allen 2015; OBIS 2023). Furthermore, *A. atrilobata* is known to occasionally have faint blue edges to its dorsal, anal, and pelvic fins, adding to the similarities between both species. These two species can be differentiated by the presence of an intensely blackish streak on the lobe of each caudal fin of *A. atrilobata* and the prominent white spot just below the end of the base of the soft dorsal fin also present on this species (Fig. 2C), both of which are lacking on both adults and juveniles of *A. intercrusma* (Robertson and Allen 2015).

Scuticaria tigrina (Lesson 1828)

Photographic records. ECUADOR – Galápagos • Rábida Island; 00.406°S, 090.716°W; 0 m a.s.l.; 11.VIII.1988; S. Tonge obs.; 1 dead individual photographed • Isabela, Punta Moreno; 00.691°S, 091.318°W; 15 m depth; 28.III.2021; W. Bensted-Smith obs.; 1 individual photographed • Floreana, Champion; 01.236°S, 090.387°W;

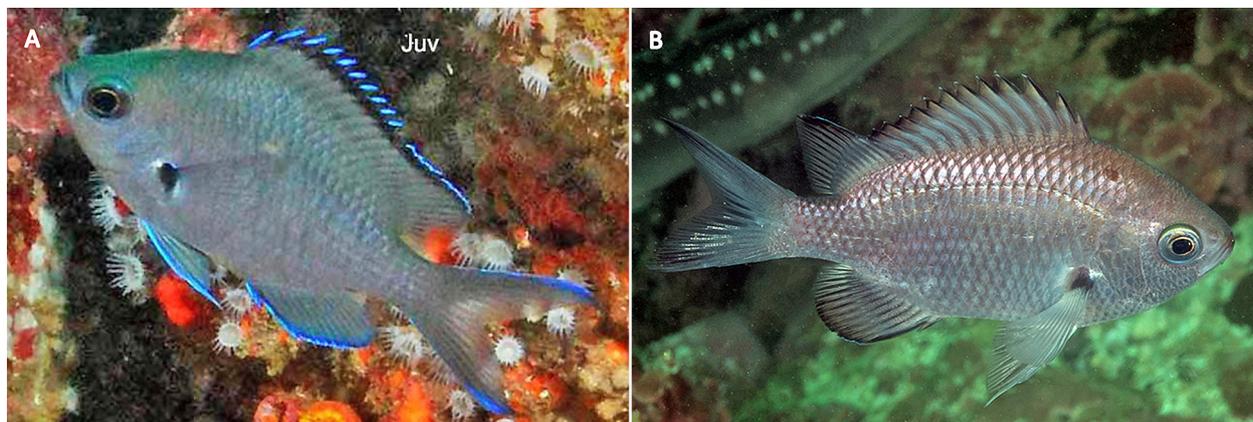


Figure 5. Juveniles, in side view, of *Azurina intercrusma* and *Chromis crusma*. **A.** *A. intercrusma*, photo by Graham Edgar. **B.** *Chromis crusma*, photo by Rick Stuart-Smith.



Figure 6. *Scuticaria tigrina* and *Uropterygius polyspilus*. **A, B.** *S. tigrina*: **(A)** in side view showing spotted pattern on the body, photo by Carol Cox; **(B)** close-up of head features, photo by Allison Estape. **C, D.** *U. polyspilus*: **(C)** side and front view of head and body; **(D)** close-up of head features, photos taken by David Rolla.

15 m depth; 31.III.2022; N. Tirado obs.; 1 individual photographed.

Identification. *Scuticaria tigrina* is known to reach sizes of 140 cm and inhabits coastlines between depths of 5 and 25 m (Allen and Erdmann 2012; Robertson and Allen 2015). It has been confused at times with a similar species, *Uropterygius polyspilus* (Regan, 1909); both species have an elongate, almost cylindrical, snake-like body with similar body colouration and pattern: pale yellowish grey to russet and covered in yellow-edged dark blotches along the body and smaller black spots on the rounded snout and jaws (Fig. 6) (Böhlke and McCosker 1997; Kuitert and Tonzuka 2001; Robertson and Allen 2015). In addition, both species have short fins restricted to the tail tip (Böhlke and Randall 2000), and these similarities have led to these species being confused in at least one case (Gosline 1958). Nevertheless, there are some key differences which readily separate the two species; the position of the anus of *S. tigrina* is the clearest identifier, far behind the mid-body compared to around the mid-body for *U. polyspilus*. Identification underwater can be aided by the shorter snout and jaw equipped with large, swollen and olive-shaped posterior nostril tubes on adults of *U. polyspilus* (Fig. 6D) compared to smaller, straight, and tubular nostrils on *S. tigrina* (Fig. 6B) (Böhlke and McCosker 1997).

Discussion

This publication provides the first photographic evidence of the presence of the Peruvian chromis, *Azurina intercrusma*, in the Galápagos Archipelago, as well as the first confirmed published record of *Scuticaria tigrina*, whose presence in the islands can be traced back to 1988 with the first photo record, albeit of a deceased specimen. All observations of these species in the Galápagos Archipelago have been of lone individuals with substantial geographical distance between them, suggesting it is unlikely that they have yet established breeding populations in the region.

One observation of note is the morphological similarity of juvenile *A. intercrusma* with adult *A. atrilobata*, as well as the close proximity of the two species at the location where they were filmed together. Prior to the onset of the 1982–1983 El Niño, the endemic pomacentrid *A. eupalama* was most often observed in heterotypic, plankton-feeding aggregations with *A. atrilobata* (Grove and Lavenberg 1997), and Robertson et al. (2021) suggested that juveniles of *Lutjanus inermis* (Peters, 1869) in the Galápagos could possibly remain undetected in schools of *A. atrilobata* due to their semblance and only become distinguishable as adults. It is therefore possible that similar behaviours are being adopted by solitary or small groups of *A. intercrusma*

juveniles which arrive at the islands. Both species are known to have native ranges which overlap along the coastlines of southern Ecuador and northern Peru (Robertson and Allen 2015), which could suggest it is a common occurrence, but there have been no studies regarding this activity. Regardless of whether this activity is common, it is apparent that morphologically similar fish will occasionally aggregate (Parrish 1989; Croft et al. 2003; Tessier et al. 2005), which may be the case if *A. intercrusma* juveniles arrive at the Galápagos. The discovery of *A. intercrusma*, alongside the recent confirmation of the presence of *L. inermis* in the archipelago suggests more care should be taken when recording schools of Chrominae during monitoring efforts; this will help identify possible new or rare arrivals from other regions of the Pacific Ocean. The site is scheduled to be visited again for monitoring purposes in 2023, at which time the divers will look closely for this species, making sure to consider its possible aggregation with *A. intercrusma*.

The known native range of *A. intercrusma* only extends as far north as the southern coast of Ecuador, over 1,100 km from the location the juvenile was found, in an area under the influence of the Humboldt Current, Chile Coastal Current, Peru Coastal Current, and the counter currents of the latter two (Kessler 2006; Thatje et al. 2008; Chaigneau et al. 2013). During La Niña years a cold tongue of upwelled waters from the Antarctic extends offshore from northern Peru to the Galápagos Islands, advected offshore by Ekman currents due to the enhanced trade winds (Fiedler and Talley 2006; Grados et al. 2018). Increased offshore transport of larvae is thought to occur with the stronger upwelling conditions, although the effect on strong swimming larvae is diminished (Gaymer et al. 2010). The occurrence of this phenomena could create the conditions necessary for the westward transport of *A. intercrusma* larva; members of the same genus are known to have a planktonic larval duration of over 30 days (Wellington and Victor 1989; Victor and Wellington 2000) between the continental and insular coastlines. The observation was made during a La Niña event which has been ongoing since November 2021 and is the third such event in a row (Bureau of Meteorology 2022), which suggests there could be a link between the two. The fish was found at Punta Moreno along the western shore of Isabela Island (Fig. 1B), on the edge of the Canal Bolivar/Elizabeth bioregion (Edgar et al. 2004), an area known to be 5–6 °C cooler than nearby islands and highly productive due to the upwelling of the Equatorial Undercurrent (EUC) bringing colder and nutrient rich waters from the deep (Houvenaghel 1978; Eden and Timmermann 2004; McCosker and Rosenblatt 2010; Ruiz and Wolff 2011; Wolff et al. 2012).

Originating from the Indo-Pacific, an area known as the heat engine of the world (De Deckker 2016), *Scuticaria tigrina*'s "typical" habitat is much warmer than that of *A. intercrusma*; however, both species were found at the same location (albeit a year apart) known for its

colder waters. This can be explained by the observation occurring during the warm season of the Galápagos Archipelago in which the EUC upwelling weakens, along with the Humboldt Current, and the warmer Panama Current is dominant, raising the water temperature, even in the cold west, by several degrees Celsius (Houvenaghel 1984; Kessler 2006; Schaeffer et al. 2008; Glynn et al. 2017). Strong El Niño events, such as in 1982/83 or 1997/8, are thought to be possible vectors for the arrival of Indo-Pacific species at fringe islands of the ETP like the Galápagos, but these are often only temporary vagrants and it likely does not represent a major source of transpacific migration (Robertson et al. 2004). Another possible advection route is from the continental coastline and islands of Costa Rica, Panama, and Colombia, where this species is known to be present, with increased flow during the warmer season. As mentioned before, the Galápagos is host to nearly all species of muraenids recorded from the Indo-Pacific, be they vagrants or resident populations (McCosker and Rosenblatt 2010). The potential of muraenid arrival in the Galápagos could be aided by the greater leptocephali larvae swimming potential and larval life history of this family, which has enabled them to be highly dispersive whilst maintaining minimal genetic differentiation between populations (Grove and Lavenberg 1997; Reece et al. 2011). The sporadic observations of *S. tigrina* as well as its absence in the major fish collections carried out in the Galápagos suggest that this species is likely only a vagrant there.

The record of this species in McCosker and Rosenblatt's (2010) *The Fishes of the Galápagos Archipelago: An Update* is unclear. *Scuticaria tigrina* is mentioned in only two of the references cited (Rosenblatt et al. 1972; Grove and Lavenberg 1997), and it is unlikely the species was found during the submersible expeditions in the recent years prior to the publication, since there is no reference to *S. tigrina* being found during these as well as the study area being outside of the species' depth range (Robertson and Allen 2015). In Grove and Lavenberg (1997), *S. tigrina* (as *S. tigrinus*) is among the species which they mention has been captured in the Galápagos archipelago, stating that "only one of the muraenid eels of Indo-Pacific origin has not: *Enchelynassa canina*", which remains undetected here (GBIF 2023; OBIS 2023). Nevertheless, no mention is made of when or where it had been collected, and there appear to be no records from museum collections confirming its presence in the islands (FishNet 2 2023; GBIF 2023; OBIS 2023).

The first known photographic record of *S. tigrina* in the Galápagos Islands is from 1988 and would likely not have been known to science or species records without the help of citizen science sites such as iNaturalist (Aristeidou et al. 2021). The fact it was only uploaded in 2018 shows the importance of sharing private photo collections through these sites to help identify new species and uncommon vagrants.

Both species mentioned are also included within the recently published list of Galápagos fishes (Grove et al. 2022). *Scuticaria tigrina* is listed therein as a vagrant based upon the iNaturalist observation by S. Tonge and personal communications from us, whilst *A. intercrusma*'s inclusion as a vagrant is based solely upon the record contained herein. Despite these records, this publication provides the evidence of first live sightings of both these species in the Galápagos Islands and is therefore an important addition to the scientific literature on the fishes of the Galápagos.

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Author Contributions

Conceptualisation: WBS. Data curation: WBS. Formal analysis: WBS. Funding acquisition: IK. Investigation: WBS, IK. Methodology: SB. Resources: IK. Supervision: IK, JG, SB. Visualisation: WBS. Project administration: IK. Software: WBS. Validation: JG. Writing – original draft: WBS. Writing – review and editing: WBS, IK, JG, SB.

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