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PENSOFT

Acanthurus mata (Cuvier, 1829), Elongate Surgeonfish (Acanthuridae), newly recorded in the Tropical Eastern Pacific

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Abstract

The reef-fish fauna of the Tropical Eastern Pacific (TEP) includes 12 species of surgeonfishes (Acanthuridae), five of them in the genus *Acanthurus*. Recent recreational scuba diving at Isla Darwin in the Galapagos archipelago produced photographs of adults of an additional species of *Acanthurus*, *A. mata* (Cuvier, 1829), for which there are no previous records in the TEP. This species may have escaped previous notice due to its semi-pelagic habitat preference and its resemblance to *Acanthurus xanthopterus* Valenciennes, 1835, which occurs throughout much of the Galapagos.

Keywords

Citizen science, Galapagos, new record, oceanic island, reef-fish, scuba diving

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Introduction

Twelve species of surgeonfishes (Acanthuridae) belonging to four genera are currently known from the Tropical Eastern Pacific (TEP) biogeographic region (Robertson and Allen 2015), which stretches from the Gulf of California to northern Peru and includes five isolated oceanic islands: the Revillagigedo archipelago, Clipperton Island, Cocos and Malpelo islands, and the Galapagos archipelago. Those fishes include only one species endemic to the TEP, *Prionurus laticlavius* (Valenciennes, 1846), while the remainder also inhabit various parts of the Indo-central Pacific. They include five *Acanthurus* species, *A. achilles* Shaw, 1803, *A. guttatus* Forster, 1801, *A. nigricans* (Linnaeus, 1758), *A. triostegus* (Linnaeus, 1758), and *A. xanthopterus* Valenciennes, 1835; one *Ctenochaetus* species, *C. marginatus* (Valenciennes, 1835); and five *Naso* species, *N. annulatus* (Quoy & Gaimard, 1825), *N. brevirostris* (Cuvier, 1829), *N. hexacanthus* (Bleeker, 1855), *N. lituratus* (Forster, 1801), and *N. vlamingii* (Valenciennes, 1835). Only four of those 12 (the *Prionurus* and three *Acanthurus*) are widely distributed in the region on the mainland and various islands. The remainder are known only from one or two of the oceanic islands (all the *Naso* species and two *Acanthurus* species), or a small part of the mainland as well as one of more of the islands (*C. marginatus* and *A. achilles*). Information on many of the species restricted to the ocean islands has only become available in the last few decades due to an increase in scientific expeditions by diving biologists and underwater photographers acting as citizen scientists.

Here we report on the addition of *A. mata* (Cuvier, 1828), Elongate Surgeonfish or Yellow-mask Surgeonfish, to the TEP fauna. This resulted from a recent recreational photographic excursion to the Galapagos by two citizen scientists who specialize in the photography of Neotropical reef fishes.

Acanthurus mata is widely distributed in the Indo-central Pacific (ICP). Its range extends from East Africa and the Red Sea through the Indian Ocean and across the tropical Pacific to the Line and Marquesas islands at the eastern edge of the central Pacific (Randall 2001; Abesamis et al 2012). However, it does not occur in the Hawaiian Islands (Randall 2001, 2007). This species has never been recorded in the Galapagos (McCosker and Rosenblatt 2010; Ruiz et al 2011) or elsewhere in the TEP (Robertson et al. 2004; Robertson and Allen 2015), and there are no records of it from that region in any of the major aggregators of biogeographic data on that species (FishNet 2 2021; GBIF 2021; OBIS 2021).

During a diving excursion to the Galapagos in July 2021, CJE and AME observed and photographed a surgeonfish that they initially thought was *Acanthurus xanthopterus* Valenciennes, 1835. Being unfamiliar with the TEP fish fauna they misidentified that fish due to its resemblance to *A. xanthopterus*, which is widely distributed in the Galapagos and other parts of the TEP. They photographed this species while making a safety stop at 5 m depth in open water away from the edge of the reef at the end of each of two dives at the same site, Arco Darwin, at Isla Darwin (Fig. 1). Subsequent comparison of those images with images of *Acanthurus* species found in the Indo-Central Pacific (Randall 2001; Randall 2005) showed that they are of *A. mata*. AM-E took a total of 20 photographs of *A. mata*, one of which, by chance,

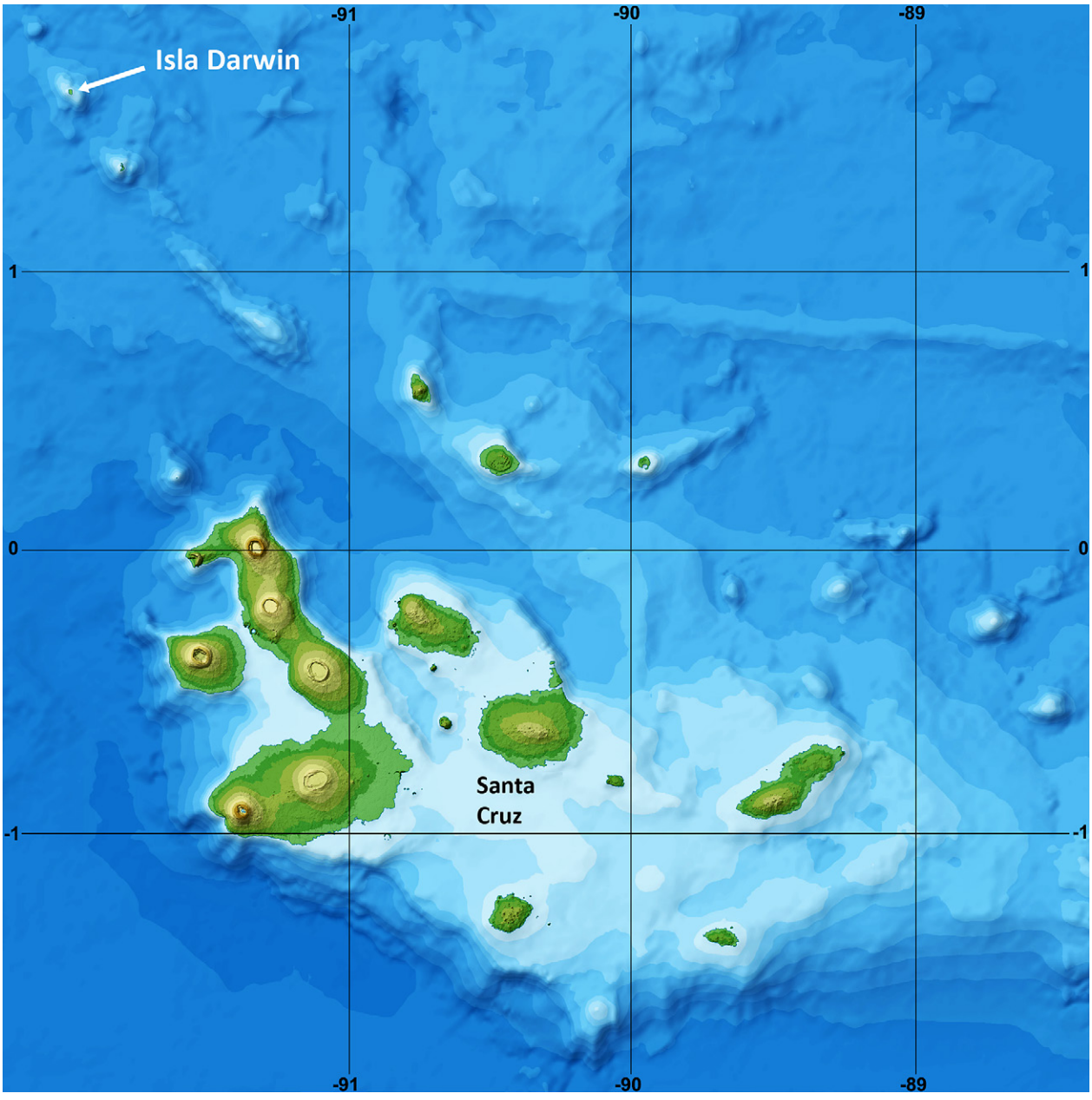

Figure 1. Location of Isla Darwin, the northernmost of the Galapagos Islands. Base map by Eric Gaba, Wikimedia, CC SA-BY 3.0

included four similar-sized individuals of that species. They estimated those fish were about 40 cm total length. Since they were not aware of the identity of these fish at that time no more information is available. Two of those photographs, each of a different individual of *A. mata*, are included here.

Results

***Acanthurus mata* (Cuvier, 1829)**

New record. ECUADOR – **Galapagos** • Isla Darwin, Arco Darwin; 01.674°N, 091.990°W; 5 m depth; 15.VII. 2021; A. Morgan-Estapé observer; 4 individuals photographed.

Identification. Adults of *A. mata* (Figs. 2, 3), which can reach a maximum size of about 50 cm in total length, have a relatively fusiform, compressed body with a narrow caudal peduncle and a lunate caudal fin. The snout is short and bluntly rounded, and the mouth is small and situated at mid-body level. Many long, thin, bluish-white longitudinal stripes cover the head and body. Two thin, yellow stripes extend in front of the eye and a single, broader, yellow stripe runs back from the eye to a small black spot at the corner of the operculum. The pectoral fins are grey, and, notably, the top lip is yellow. No other species of *Acanthurus* has this combination of diagnostic morphological features (Randall 2001, 2005; and see Kuiter and Debelius 2001; Allen and Erdmann 2012). In addition, there are internal characteristics, such as small, numerous teeth, that further distinguish this species from its congeners.

The only species of *Acanthurus* found in the TEP with a form and color sufficiently similar to that of *A. mata* is *A. xanthopterus*. Table 1 contains a suite of visible features that will help observers to distinguish adults and juveniles of those two species in the field. In addition to the information in that table, we note that the ground color of the bodies and tails of both species can vary from uniformly grey-brown to uniformly pale, and with the color of the caudal fin often contrasting with the body color. Adults of *A. mata*, for example, can rapidly change color to pale blue-grey when being attended by parasite-cleaning organisms on reefs (Randall 2005). The ground color of small juveniles, which have dark longitudinal stripes, also can vary from uniform brown to grey, green, or blue-grey, and with the caudal fin variable, either the same color as the body or a different color, including white, bluish or yellowish. Figures 3 and 4 show such variation and further examples can be seen in images hosted by iNaturalist (2021a) for *A. xanthopterus* and iNaturalist (2021b) for *A. mata*. Kuiter and Debelius (2001: 53) included various images of adult and juvenile *A. mata*.

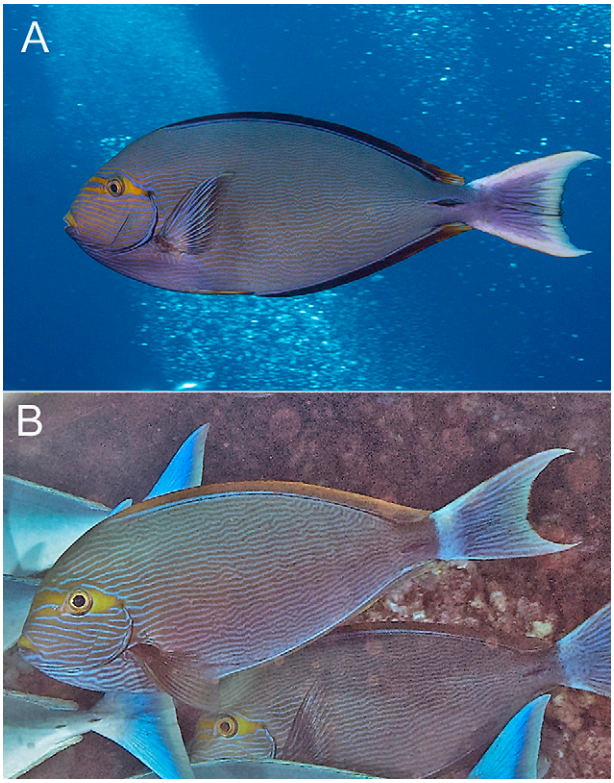

Figure 2. *Acanthurus mata*. **A.** From the Galapagos (photo Allison Morgan-Estapé). **B.** From the west Pacific (photo Kendall Clements).

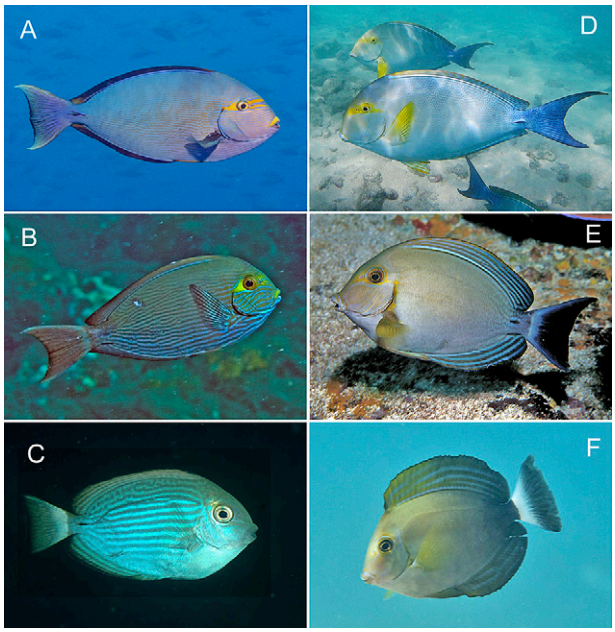

Figure 3. Adults and juveniles of *Acanthurus mata* and *A. xanthopterus*. **A–C.** *A. mata*: (**A**) adult; (**B**) large juvenile; (**C**) small juvenile. **D–F.** *A. xanthopterus*: (**D**) adult; (**E**) large juvenile; (**F**) small juvenile. Photos: A = Allison Morgan-Estapé (Galapagos), B = Kendall Clements, C = Izuki (Wikimedia, CC BY-SA 2); D = Don Loarie (Wikimedia, CC BY 4.0), E = Paul Humann, F = Michal Biniek.

Discussion

The TEP biogeographic marine region is the most isolated large biogeographic region in the tropics. As a result, it has the highest level of endemism, almost 80%, amongst its shore-fish fauna of any such region of similar size (Robertson and Cramer 2009). This isolation and level of endemism reflects combined effects of the land barrier that now separates the eastern side this region from the West Atlantic and the 4000 km wide expanse of

Table 1. Features of body form and coloration that differ between *Acanthurus mata* and *A. xanthopterus*. More conspicuous features are indicated in bold.

Characteristics	*Acanthurus mata*	*Acanthurus xanthopterus*
	Adult	
Body shape	Elongate, upper, and lower body profiles symmetrical	Less elongate, body profiles asymmetrical
Upper and lower head profiles	Symmetrical	Upper steeper
Large fish with forehead hump?	**No**	**Yes**
Snout; mouth position	Short; mouth on body midline	Longer, mouth below body midline
Caudal fin	Lunate; large fish - **short tips**	**Strongly** lunate; large fish - **long tips**
Yellow areas around eye	**Two narrow stripes before eye**; wide stripe behind eye to **black spot** at corner of opercle	**One broad stripe before eye** continues behind eye to corner of opercle
Narrow stripes/lines on head and body	**Pale blue stripes; long and well-defined; longitudinal along entire head and body**	**Dark; short, dense, fine undulating lines/network on parts of body; often indistinct**
Top lip	**Yellow**	**Grey**
Pectoral fin	**Grey**	**Yellow**
	Small juvenile	
Body shape	Elongate oval	Rounded
Dorsal and anal fins	**Pale; with dark longitudinal stripes**	**Dark; with blue-white, longitudinal stripes**
Lips protrude	**No**	**Yes**
Dark stripes along body	**Yes**	**No**
Pectoral fin	**Grey**	**Yellow**

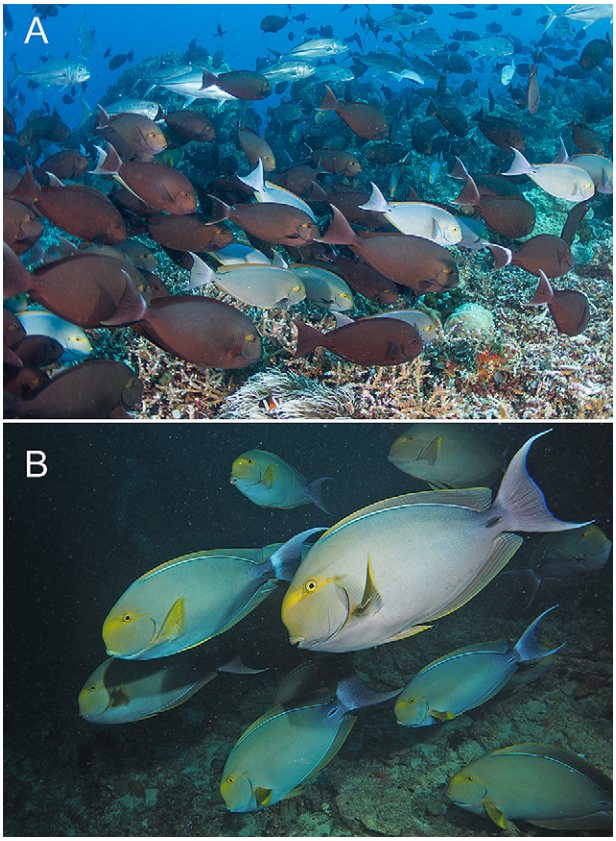

Figure 4. Variation in the appearance of *Acanthurus mata* and *A. xanthopterus,* in the Indo-Central Pacific. **A.** A school of *A. mata* that includes both dark and pale individuals (photo M. Rosenstein). **B.** A school of *A. xanthopterus* with humped foreheads that are typical of large adults of this species (photo Denis Rabeling).

deep ocean known as the Eastern Pacific Barrier (EPB) which separates the western side of the TEP from the islands of the central Pacific. While the EPB is effective as a barrier to migration of many shore-fishes, there are over 100 species found in the central Pacific that have managed to cross the EPB, and, in some cases, establish populations in the TEP. Those species constitute about 12% of the TEP fauna of shallow-living shore-fishes (Briggs 1974; Robertson et al. 2004). The surgeonfishes are one of the most successful reef-fish taxa of central Pacific species that have migrated eastwards across the EPB. Eleven of 12 species known from the TEP are such migrants and at least four of them have or appear to have resident populations in that region. *Acanthurus* is one of the most successful genera in that regard, contributing five of the 11 migrants, at least three of which are TEP residents. In contrast, it is not clear if any of the five *Naso* species has an established population in the TEP.

Acanthurus mata almost certainly represents an additional, newly identified trans-EPB migrant. It is highly unlikely that this species was introduced to the Galapagos via the aquarium trade, given the lack of inhabitants in the remote northern Galapagos. The most likely point of entry of such a species into the Neotropics via the aquarium trade would be the USA, which is the recipient of large numbers of many species of Indo-West Pacific fishes. However, *A. mata* has not been recorded among the non-native species introduced to that country (https://nas.er.usgs.gov/, accessed on 2021-11- 4-4), nor previously reported anywhere else in the Neotropics. The fact that it has never been recorded anywhere other than one of the small, isolated northern islands of the Galapagos suggests that it may be a waif in the TEP. However, one of the photographs taken at Isla Darwin, by chance, included four different adults of *A. mata*, indicating that there may be a resident population there. The Galapagos islands, 128 of which are named, have a combined area of almost 8,000 km^2 and a coastline length of almost 1,350 km. The more tropical parts of the archipelago (see Glynn and Wellington 1983) contain large areas of potential habitat for any other currently undetected *A. mata* that might exist.

While juveniles of *A. mata* feed on benthic microalgae, adults are benthopelagic zooplanktivores that feed above the bottom (Randall 2005; Abesamis et al. 2012a), including in open water away from the edge of reefs (present observations). The known depth range of *A. mata* in the ICP is 1–40 m, where it is most common below 15 m depth (Abesamis et al. 2012a). Open-water pelagic habitat adjacent to reefs is one where few recreational divers go whose attention is not focused on large pelagic fish and where fish biologists studying benthic reef fishes do not routinely collect much data, reducing the chance of *A. mata* being detected. In addition, adults of *A. xanthopterus* have a depth range of 1–120 m and are normally found on the bottom, feeding on sediment and detritus on reef and sandy substrata (Choat et al. 2004; DRR personal observations), but they are known to sometimes feed in midwater on the feces of pelagic carnivorous fishes (Randall 2005; Abesamis et al 2012b). Such behavior would place them in situations where *A mata* also feeds and could well lead to confusion of *A. mata* with *A xanthopterus*. CJE and AME photographed some large *A. xanthopterus* in midwater at Gordon Rocks in the central Galapagos, although they do not recall what those fish were doing. *A. xanthopterus* occurs throughout the warm-water reef areas of the Galapagos, including the northern islands (Robertson and Allen 2015).

The photographs of *A. mata* at Arco Darwin show them mixed in with a large midwater aggregation of the benthopelagic Pacific Creole-fish, *Paranthias colonus* (Valenciennes, 1846). *Paranthias colonus* has a form generally similar to that of *A. mata* (a reddish to grey fusiform body with a lunate tail) and a maximum size (~35 cm in total length) similar to the size of the *A. mata* seen in the Galapagos. At close range, *P. colonus* and *A. mata* are readily distinguishable. However, the surgeonfish could escape notice in Creole-fish aggregations when color differences would be less evident, such as under suboptimal visibility conditions (e.g., at depth, under overcast conditions, or in turbid water) or when viewed at a distance by observers not specifically searching for anomalous fishes. Isla Darwin is tiny (<1.5 km in diameter), uninhabited, and ~300 km from the population centers of the archipelago. Such isolation, leading to infrequent visits by knowledgeable citizen-scientist divers and professional fish biologists, also likely contributed to *A. mata* passing unnoticed there, possibly for decades (see below).

When did *A. mata* first arrive in the Galapagos and where did it come from? A growth curve derived from otolith aging of this species by J.H. Choat (pers. comm. to DRR, August 2021) indicates that *A. mata* achieves a maximum age of ~30 years and can reach close to maximum size at an age of ~6 years. Hence, if the fish photographed at Isla Darwin in July 2021 arrived there from the central Pacific their size alone can only indicate that it happened at some time during the last 5–30 years. Only a thorough assessment of the status of *A. mata* in the northern Galapagos would help resolve the question of whether the fish there now were spawned in the central Pacific and represent recent immigrants or were bred in the Galapagos. A finding of juveniles as well as adults of various sizes would indicate the latter.

There are three island groups at the eastern edge of the central Pacific and the western edge of the EPB: the Hawaiian Archipelago at 19–28°N in the north, the Line Islands at 01–06°N in the center, and the Marquesas Islands at 08–10°S in the south. Among those three, *A. mata* only occurs at the Line and Marquesas islands (Randall 2001, 2005, 2007). The general surface-current flows across the EPB are eastwards from the Line Islands to the equatorial section of the TEP and westwards from the southern edge of the TEP towards the Marquesas and from the northern edge of the TEP towards Hawaii. During the extremes of the ENSO cycle those currents strengthen, with the equatorial eastward flow vastly increased during El Niño and that of westward flow towards the Marquesas increasing during La Niña. Robertson et al. (2004) have argued that, based on the directions of these current systems, among other evidence, the most likely nearest potential source of fish migrating eastwards to the TEP is the Line Islands rather than either the Hawaiian or Marquesas islands, both of which are known to receive migrants from the TEP.

What is the zoogeographic significance of this finding of *A. mata* in the northern Islands of the Galapagos, which are very small, separated from the main group of islands by 140–180 km of open water and have the most tropical marine conditions found in the archipelago (Glynn and Wellington 1983)? Priority actions to answer that question include examining the abundance and size structure of the "population" at Isla Darwin to assess if it is a resident, determination of whether *A. mata* is present at the other northern island, Wolf Island, 38 km from Isla Darwin, and determination of whether it is elsewhere in the warmer parts of the main Galapagos islands. Perhaps it also exists unnoticed on other ocean islands or the continental shoreline of the TEP.

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Author' Contributions

Conceptualization: DRR. Visualization: AME. Writing – original draft: Writing – review and editing: DRR, A-ME, CJE. Writing – review and editing: DRR, A-ME, CJE.

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