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Rapid Communication

Caesio varilineata Carpenter, 1987 (Osteichthyes: Caesionidae) a new alien fish in the southeastern Mediterranean Sea

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Abstract

The variable-lined fusilier *Caesio varilineata* Carpenter, 1987 is firstly reported from the northwestern coast of Egypt in February 2018, constituting the first record in the Mediterranean Sea. Several dozen of individuals were encountered at two fish landing sites in Alexandria suggesting that this species may have an established population in the southeastern Mediterranean Sea. Considering the nearness of the Suez Canal, it is likely that this new alien fish migrated through the canal.

Key words: Egypt, invasive species, Lessepsian migration, Red Sea, Suez Canal

Introduction

The opening of the Suez Canal in 1869, initiated an unprecedented migration of marine organisms from the Red Sea to the Mediterranean Sea (Galil 2009; Coll et al. 2010). A wide range of taxa including seagrass (Gambi et al. 2009), sea cucumbers (González-Wangüemert and Borrero-Pérez 2012), and fishes (e.g. Bariche 2011; Bariche et al. 2013; Fricke et al. 2015) have been reported to migrate through the Suez Canal or invaded the Mediterranean Sea by means of ballast water from cargo vessels (Wonham et al. 2000; Davidson et al. 2018). Many of the early migrants have become successful invaders with well-established populations in the Mediterranean Sea. Nevertheless, the number of Lessepsian migrants has continuously increased and may even have accelerated in recent years (Arndt and Schembri 2015). Although many alien fishes were reported during the centennial following the opening of the Suez Canal, new records of Lessepsian fishes continue to be published (e.g. Golani and Sonin 2006; Bariche 2011; Seyhan et al. 2017). By the year 2014, 101 fish species of Indo-Pacific origin had been reported from the Mediterranean Sea (Arndt and Schembri 2015).

The fish family of the Caesionidae is distributed throughout the Indian and Pacific Oceans and presently contains 23 recognized species (Froese and Pauly 2018). Seven caesionids, including five representatives of the genus *Caesio*, are known from the Red Sea, the northwestern corner of their natural biogeographical distribution areas. In August 2017 however, several individuals of the caesionid *Dipterygonotus balteatus* were caught off the coast of Lebanon (Bariche and Fricke 2018), making it the first representative of the Caesionidae reported from the Mediterranean Sea. The present communication reports the occurrence of a new alien fish, the variable-lined fusilier *Caesio varilineata* Carpenter, 1987, collected along the northwestern coast of Egypt.

Methods

Several dozen individuals of the variable-lined fusilier *Caesio varilineata* were encountered at the fish landing site "Al Max" in Alexandria, Egypt (approx. 31º09′4.1″N; 29º50′30.2″E) on 8 February 2018. One day later, another dozen was found at the landing site "El Anfoshy" in Alexandria, Egypt (approx. 31º12′36.6″N; 29º52′48.9″E). Both landing

Figure 1. Individual of *Caesio varilineata* (202 mm Standard Length) collected at a fish landing site along the shore of Alexandria, Egypt on 8 February 2018. Photograph A.R. Bos.

Table 1. Selected meristic counts, body measurements (mm) and mass (g) of six individuals of *Caesio varilineata* collected at a fish landing site in Alexandria, Egypt on 8 February 2018. Ranges provided if applicable.

Counts		Body Measurements	
Dorsal spines	X	Standard length	180–202
Dorsal rays	15	Caudal length	47–54
Anal spines	III	Head length	47–57
Anal rays	12	Snout length	10–14
Pelvic spines	I	Eye diameter	12–14
Pelvic rays	5	Body depth	51–57
Pectoral rays	20–22	Pectoral fin length	48–64
Gill rakers	24–26	Body mass	144.3–184.9

sites are situated along the Mediterranean shore and fish are sold directly to private customers. Fishermen and vendors confirmed that the caesionids had been caught off the northern coast of Egypt west of Alexandria.

Six individuals were purchased, transported to the American University in Cairo, and stored in a freezer until analysis. Morphological traits were measured and counted following Carpenter (1987) and Randall and Kulbicki (2006) while gill rakers were counted following Bos (2014). Measurements were taken with calipers (1 mm accuracy) and body mass was determined as wet weight using a balance (0.1 g accuracy).

Results

On 8 February 2018, six individuals of *Caesio varilineata* were purchased at a fish landing in Alexandria, Egypt (Figure 1). Selected meristic counts and measurements confirmed the species identification (Table 1).

Description

Individuals of *Caesio varilineata* had consistent numbers of spines and rays in the dorsal, anal and pelvic fins: Dorsal fin X,15; Anal fin III,12; Pelvic fin I,5 (Table 1). The pectoral fin ray counts were modally 21 and ranged from 20–22. The body was fusiform and moderately compressed, its depth 3.3–3.7 in Standard Length (SL). Head Length (HL) was 3.2–3.8 in SL. Snout length was 3.9–5.2 in HL. Eye diameter was 3.4–4.8 in HL. The total number of gill rakers on the first gill arch was modally 26 and ranged from 24–26 (Table 1). Pectoral fins were relatively long with 0.9–1.2 in HL. The caudal fin was deeply forked with pointed lobes.

Fresh specimens' coloration: The dorsal side of body was blue-green and the ventral side white (Figure 1). A partly fading yellow stripe ran from the dorsal side of the operculum to the dorsal end of the caudal peduncle, just dorsally of the lateral line. Traces of yellow pigmentation on scales on the lateral side of the body were found after careful observation

Figure 2. Distribution map of *Caesio varilineata* (inverted triangles) and *C. caerulaurea* (dots) in the Red Sea, Indian Ocean and western Pacific as reported by Carpenter (1987), Gumanao et al. (2016) and Froese and Pauly (2018). Red inverted triangle represents new record in the Mediterranean Sea. For details see supplementary material Tables S1 and S2.

under a dissecting microscope, confirming the presence of additional yellow stripes in live individuals. Both caudal lobes had faint grey streaks from the caudal peduncle to the black tips (Figure 1). A black blotch marked the axil of the pectoral fin resulting in a small black patch on the dorsal base of the pectoral fin (Figure 1).

Discussion

The sibling species *Caesio caerulaurea* and *C. varilineata*, existing sympatrically in the Indian Ocean and Red Sea (Figure 2), are osteologically almost identical and difficult to distinguish by meristic or morphometric characters (Carpenter 1987). The only characters that may allow differentiation are the pectoral fin ray counts and the eye diameter, but even these may vary among local populations. *Caesio caerulaurea* has slightly larger eyes with a mean diameter of 3.8 (3.3–5.1) in HL versus a mean of 4.7 (3.7–5.5) in HL in *C. varilineata*. Furthermore, *C. caerulaurea* has a modal pectoral ray count of 20 rarely overlapping with the mode of 21 in *C. varilineata* (Carpenter 1987). During the present study, specimens had an eye diameter of 3.4–4.8 in HL not clearly differentiating between the two species. However, the mode of the pectoral ray counts was 21 (only one individual had 20 rays; Table 1) supporting the identification of *C. varilineata*.

In contrast to the almost identical morphometric characters, life color patterns of *Caesio caerulaurea* and *C. varilineata* are strikingly different (Carpenter 1987). *Caesio caerulaurea* has a single yellow stripe directly above the lateral line, whereas *C. varilineata* has 3 to 6 parallel yellow stripes. Unfortunately, these markings start fading shortly after death and most yellow stripes were no longer visible in the individuals collected at the landing sites in Alexandria (Figure 1). However, traces of yellow pigmentation were found on some scales above and below the lateral line supporting the identification of *C. varilineata*. Moreover, the dark tips of the caudal fin lobes are a specific character for *C. varilineata* and are not found in *C. caerulaurea* (Carpenter 1987).

The occurrence of *Caesio varilineata* in the Mediterranean Sea may be explained by Lessepsian migration from the Red Sea. Many organisms including fishes have migrated through the Suez Canal and successfully established populations in the Mediterranean Sea (Arndt and Schembri 2015). However, ballast water used for cargo vessel stability has been another pathway of introducing alien species in aquatic environments (Davidson et al. 2018). Both pathways were considered as a possible source for the recently reported caesionid *Dipterygonotus balteatus* from Lebanon (Bariche and Fricke 2018). This caesionid was firstly caught off the coast of Lebanon relatively far from the Suez Canal. Moreover, as it does not naturally occur in the northern Red Sea (Froese and Pauly 2018), ballast water seemed the most likely means of introduction (Bariche and Fricke 2018). In contrast, *C. varilineata* does naturally occur in the Red Sea and was firstly recorded in the Mediterranean Sea relatively near to

the Suez Canal (Figure 2). Therefore, it is likely that *C. varilineata* entered the Mediterranean Sea through the Suez Canal. Belmaker et al. (2013) developed a model estimating the potential of Red Sea fishes, based on environmental traits, migrating to the Mediterranean Sea and *C. varilineata* was identified as a potential candidate.

Although fish caught in the Red Sea may be sold throughout Egypt, we consider the chance that individuals of *Caesio varilineata* were transported to Alexandria—the distance to Red Sea fishing harbors ranges from 300 to 650 km—very small. The present specimens were collected at landing sites along the shore of the Mediterranean Sea, where fishing boats anchor and fish are sold directly to private customers. Furthermore, caesionids are usually caught with congeners and no other species originating from the Red Sea were encountered at the landing sites in Alexandria. Also, when Red Sea fish are transported to other domestic destinations, fish are packaged before transportation and sold to retailers and restaurants, preferably in Cairo.

Most representatives of the Caesionidae, including *Caesio varilineata*, are reef-associated fishes that occur in multi-species schools feeding on zooplankton (Allen and Erdmann 2012). Despite the absence of coral reefs in the Mediterranean Sea, *C. varilineata* may have adapted to the new environment where rocks covered with representatives of the Anthozoa possibly resemble reef habitats (Bianchi 2007). Other reef-associated alien fishes, several Puffer fishes (Farrag et al. 2016) and the herbivores *Siganus luridus* and *S. rivulatus* (Stergiou and Karpouzi 2002) have been able to establish populations in the Mediterranean Sea. In its new environment, *C. varilineata* may not have experienced food scarcity, because zooplanktivorous fishes are the most dominant trophic group in the Mediterranean Sea (Stergiou and Karpouzi 2002). Furthermore, alien Red Sea fishes within the trophic range of *C. varilineata* (Froese and Pauly 2018) have been extremely successful in the Mediterranean Sea (Goren et al. 2016). The relatively high number of *C. varilineata* available on landing sites on two consecutive days in February 2018 suggests either that a single school was caught, or that this species established itself along the Egyptian coast. The first scenario could have resulted in a diminution of this alien fish, reducing the chances of further dispersion. However, if *C. varilineata* has an established population and individuals reproduce, then it may disperse to other regions in the Mediterranean Sea in the near future. Dispersal rate of Lessepsian fishes along the southern Mediterranean coasts was estimated at 70 km per year (Ben Rais Lasram et al. 2008). Moreover, environmental conditions may further support dispersal as they have been changing in favor of migrant fishes due to climate change (Bianchi 2007; Hiddink et al. 2012).

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Supplementary material

The following supplementary material is available for this article:

Table S1. Details of approximate localization of *Nemipterus varilineatus* in its native Indo-West Pacific range.

Table S2. Details of approximate localization of *Nemipterus caerulaurea* in its native Indo-West Pacific range.

This material is available as part of online article from:
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