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Rapid Communication

The first record of the *Sargocentron* genus from the Maltese Islands (Central Mediterranean) - who will unravel the current conundrum?

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Abstract

The squirrelfish genus, *Sargocentron*, is reported for the first time from Maltese coastal waters within the Central Mediterranean. The record is based on two individuals caught at two different coastal locations in the Maltese Islands within the space of a few days of each other, through the same fishing technique (trammel nets). In view of the impossibility to collect meristic, morphometric and molecular data from the recorded individuals, and due to the close similarity between a number of *Sargocentron* congeners, the exact taxonomic identity of the captured individuals could not be conclusively confirmed, although the livery on the two caught individuals resulted to be consistent with that of *S. rubrum* and *S. hastatum*.

Key words: squirrelfish, Maltese Islands, Central Mediterranean

Introduction

The squirrelfish genus (Holocentridae: Holocentrinae) *Sargocentron* is diverse and currently comprises 33 species (Froese and Pauly 2016), eight of which were recognized from the Red Sea (Golani and Bogorodsky 2010). The red coat *Sargocentron rubrum* (Forskkal, 1775), one of the oldest Red Sea immigrants to have entered the Mediterranean (Golani and Ben Tuvia 1985), has, up till recently, been considered to be the only representative of the Holocentridae family in this Basin. A recent barcoding study (Bariche et al. 2015), however, revealed a high degree of genetic diversity for squirrelfishes collected in the eastern Mediterranean; suggesting that species complexes occur within this taxon and/hinting at the possibility of previous misidentification of the Mediterranean squirrelfish.

The red coats have a very broad, global native distribution, extending from the Red Sea to Indo-Pacific waters, such as those around Indonesia (e.g. Allen and Erdmann 2009), off the southeast coast of India (Prakash et al. 2012), within the South China Sea (Adrim et al. 2004), and off Mozambique (Gell and Whittington 2002). Despite being first recorded from the Mediterranean Sea from Israel in 1947 (Haas and Steinitz 1947), *S. rubrum* has almost exclusively been recorded from eastern areas of the Basin (Golani and Ben Tuvia 1985, and references contained therein), including Rhodes (1948) and Turkey (1950), with a single record from Libyan waters (Stirn 1970). Most recently, the species has been recorded from the island of Lipsi in the eastern Aegean Sea (Zenetos et al. 2015). Up to the late 1960's, this squirrelfish was considered uncommon in its exotic range (Ben-Tuvia 1966) but now it is considered to be one of the most successful fish invaders in the eastern Mediterranean (Azzurro et al. 2014). For example, *S. rubrum* appears to comprise up for 3% of the total fisheries landings in Lebanon

Table 1. Observation details of two *Sargocentron* sp. individuals from Maltese coastal waters. Both the specimens were captured by local fishermen through the use of trammel nets.

Sargocentron sp. individual reference	Capture location	Location coordinates		Depth of capture	Estimated date of capture
		°N	°E		
A (see Figure 1)	off the northern coast of island of Gozo	36.076769	14.260949	40m	First week of January 2015
B (see Figure 2)	off the western coast of the island of Malta	35.856121	14.348959	25m	First week of January 2015

(Carpentieri et al. 2009). The colour pattern and external morphology of squirrelfish can be very similar among the different species, and this makes the identification of members of this group particularly challenging. In particular, the Atlantic *Sargocentron hastatum* (Cuvier, 1829), widely distributed from Portugal to Morocco and from Mauritania to Angola (Ben-Tuvia 1990), can be easily confused with the Indo-Pacific *S. rubrum*, but to date this species has never been reported from the Mediterranean.

Materials and methods

During the first week of January 2015, two of the co-authors (S. Attard and J. Vella Gaffiero) were approached by a fisherman who claimed to have caught a new fish species. The specimen was photographed by the fisherman, subsequently preserved through taxidermy and held in a private collection. This novel capture was featured on social media and this prompted a second fisherman (M. Camilleri) to approach two of us (A. Deidun and A. Said) with details of a second capture of a squirrelfish. Unfortunately, this second specimen was not preserved but sold to third parties. Only a photograph, taken by the same fisherman with a mobile phone, was available for taxonomical identification. Details of these two squirrelfish records are summarised in Table 1.

Access to specimen 'A' was afterwards granted and this allowed us to measure a number of morphometric attributes (Table 2). Unfortunately, the lateral line of the specimen (an important diagnostic) was barely discernible.

Identification was made on the available photographs (Figures 1 and 2) and by a closer examination of specimen 'A' (preserved for taxidermy). To appropriately conclude the taxonomic identification through the sole examination of images, we provide and evaluation of three main characteristics colour patterns of the genus *Sargocentron* (Table 3). This screening exercise was then conducted on 33 different species of *Sargocentron*.

Table 2. Values for selected morphometric characters of Specimen 'A'.

Feature	Length (mm) or counts
Total length	197.5
Standard length	162.0
Head length	53.0
Body depth	52.0
Upper jaw length	16.5
LL scales	52
No of transverse scales above LL	3
No of transverse scales below LL	7
Anal fin	5 spines, no rays
Dorsal fin	11 spines, 8 rays

Figure 1. *Sargocentron* sp. individual caught off the northern coast of the island of Gozo in the Maltese archipelago. Photo: Joe Vella Gaffiero.

Figure 2. *Sargocentron* sp. individual caught off the western coast of the island of Malta in the Maltese archipelago. Photo: Melchiore Camilleri.

Table 3. Comparative analyses of 33 different *Sargocentron* species on the basis of three colour characters based on images published in Froese and Pauly (2016). Note: n.d. means not determined.

Species	Body stripes	Spiny dorsal fin: whitish blotches in middle of each membrane	Spiny dorsal fin: black markings on membrane of anterior spines
Present study specimen 'A'	+	+	+
Present study specimen 'B'	+	n.d.	n.d.
Sargocentron bullisi (Woods, 1955)	+	+	+
Sargocentron cornutum (Bleeker, 1854)	+	+	+
Sargocentron coruscum (Poey, 1860)	+	+	+
Sargocentron diadema (Lacepède, 1802)	+	+	-
Sargocentron ensifer (Jordan & Evermann, 1903)	+	-	-
Sargocentron hastatum (Cuvier, 1829)	+	+	+
Sargocentron hormion Randall, 1998	+	+	-
Sargocentron ittodai (Jordan & Fowler, 1902)	+	+	-
Sargocentron melanospilos (Bleeker, 1858)	+	+	-
Sargocentron microstoma (Günther, 1859)	+	+	+
Sargocentron poco (Woods, 1965)	+	-	+
Sargocentron praslin (Lacepède, 1802)	+	-	-
Sargocentron rubrum (Forsskål, 1775)	+	+	+
Sargocentron seychellense (Smith & Smith, 1963)	+	+	-
Sargocentron spinosissimum (Temminck & Schlegel, 1843)	+	-	-
Sargocentron tiereoides (Bleeker, 1853)	+	-	-
Sargocentron vexillarium (Poey, 1860)	+	-	-
Sargocentron wilhelmi (de Buen, 1963)	+	-	-
Sargocentron xantherythrum (Jordan & Evermann, 1903)	+	-	+
Sargocentron caudimaculatum (Rüppell, 1838)	-	-	-
Sargocentron dorsomaculatum (Shimizu & Yamakawa, 1979)	-	-	-
Sargocentron inaequalis Randall & Heemstra, 1985	-	-	-
Sargocentron iota Randall, 1998	-	-	-
Sargocentron lepros (Allen & Cross, 1983)	-	-	-
Sargocentron macrosquamis Golani, 1984	-	-	-
Sargocentron marisrubri Randall, Golani & Diamant, 1989	-	-	-
Sargocentron megalops Randall, 1998	-	-	-
Sargocentron punctatissimum (Cuvier, 1829)	-	-	-
Sargocentron shimizui Randall, 1998	-	-	-
Sargocentron spiniferum (Forsskål, 1775)	-	-	-
Sargocentron suborbitale (Gill, 1863)	-	-	-
Sargocentron tiere (Cuvier, 1829)	-	-	-
Sargocentron violaceum (Bleeker, 1853)	-	-	-

Results and discussion

Taxonomical identification based on the available photographs allowed us to assign both Malta specimens (A and B) to the subfamily Holocentrinae. This was confirmed by the preopercle having a sharp angle and a single strong spine much longer than broad (Greenfield 1981). Both specimens belong to the genus *Sargocentron* since the lobes of the caudal fin were nearly equal in length; the anterior segmented dorsal-fin rays were not elongate; the dorsal-fin was separated from the first dorsal-fin ray, and the lower jaw was equal or shorter than the upper (Greenfield 1981). In one picture (Figure 2), a strong spine at the lower angle of the pre-operculum can be clearly seen. A strong spine at the lower angle of the pre-operculum, considered as a diagnostic character for *S. rubrum* (Golani et al. 2002). Both specimens show a single white vertical bar behind the eye and lack yellow stripes on the body and dorsal fin. The longitudinal white bands are much thinner than the red bands. Referring to the characters summarized by Table 2, six *Sargocentron* species possible tally with the Malta specimens. Out of these, four species can be easily excluded (*S. bullisi, S. coruscum, S. microstoma* for the peculiar shape of the black mark on dorsal spine and *S. cornutum* for a black peduncular blotch) with *Sargocentron rubrum* and *S. hastatum* remaining as the only possible candidates.

In conclusion, pictures of the two Malta squirrelfish specimens are consistent with both *S. rubrum* and *S. hastatum*. Considering both the taxonomic uncertainty on Mediterranean squirrelfish (Bariche et al. 2015) and present results, it is apparent that a species level identification cannot be concluded solely on the basis of our pictures and the same should apply for similar records made recently in the Mediterranean sea (see for example *Sargocentron rubrum* [?] individual recorded for Lipisi harbour in Greece by Zenetos et al. 2015).

The taxonomic conundrum highlighted through this study, involving two congeners hailing from regions which are, geographically, diametrically opposed in relation to the Mediterranean, is analogous to a similar situation experienced for Maltese waters for the *Abudefduf* genus (Deidun et al. 2014). In that case, *A. saxatilis* (Linnaeus, 1758) is native to the eastern Atlantic, whilst *A. vaigiensis* (Quoy & Gaimand, 1825) is native to Indo-Pacific regions: both being recorded previously from the Mediterranean. With only photographic evidence to work with, minor differences in livery only distinguished the two species.

The first record of *Sargocentron* sp. from Maltese waters adds on to a welter of Lessepsian and eastern Atlantic fish species recorded from the same waters in recent months, including *Enchelycore anatina* (Lowe, 1838) (Deidun et al. 2015a), *Lagocephalus sceleratus* (Gmelinn, 1789) (Deidun et al. 2015b), *Acanthurus coeruleus* Bloch & Schneider, 1801 and *Heniochus intermedius* Steindachner, 1893 (Evans et al. 2015), *Abudefduf* cfr *saxatilis* (Deidun et al. 2014) and *Pontinus kuhlii* (Bowdich, 1895) (Castriota and Deidun 2014). This pattern of discoveries suggests that the Maltese archipelago is well placed to track the westward expansion of Lessepsian species and the eastward expansion of east-Atlantic ingressions within the Mediterranean, and could be a vital link in a transboundary monitoring network for marine non-indigenous species advocated by Azzurro et al. (2015). The current taxonomic conundrum highlighted in the present study makes the case for a greater application of molecular tools, including DNA barcoding, for taxonomic identification purposes, especially in cases of cryptic species such as those belonging to the *Sargocentron* genus.

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