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Rapid Communication

New records of smallscale codlet, *Bregmaceros nectabanus* Whitley, 1941 (Gadiformes: Bregmacerotidae), in the Adriatic Sea

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Abstract

Six specimens of *Bregmaceros nectabanus* were collected during the acoustic survey MEDIAS in two consecutive years, off Termoli (Italy) in 2020 and in Albanian waters in 2021, during two night shallow hauls. We report the northernmost record of the alien species in the Mediterranean Sea (Northern Adriatic Sea, FAO fishing area 37.2.1) and one of the highest number of individuals caught in a single haul. This finding testifies a recent geographical spread to the eastern Mediterranean Sea from its distribution area in the Indo-Pacific Ocean and Red Sea, reaching the Adriatic Sea during the 2019. Our records support the hypothesis of a possible establishment of *B. nectabanus* in this basin.

Key words: alien species, Mediterranean Sea, spatial spreading, Lessepsian migrant, acoustic survey

Introduction

In the past few years, the Mediterranean Sea has undergone rapid biotic changes. In particular, warmer water temperatures are favouring the northward spread of native as well as alien species inhabiting the southern areas of the basin. Six alien fish species—of the 165 such species from the Red Sea and the Atlantic Ocean that have been recorded in the Mediterranean (Golani et al. 2021)—have been described on the Italian side of the Adriatic up to 2019 (Servello et al. 2019). Most are Lessepsian migrants and this is probably also the case of *Bregmaceros nectabanus,* Whitley, 1941. Since 2002, this species has been firstly recorded in the Mediterranean by Yılmaz et al. (2004), who however misidentified it as *Bregmaceros atlanticus,* Goode & Been, 1886. Yet, according to Harold and Golani (2016), all such records were actually smallscale codlet. *B. nectabanus* has previously been described in Turkish, Greek, Syrian and Israeli waters (Yılmaz et al. 2004; Filiz et al. 2007; Aydin and Akyol 2013; Dogrammatzi and Karachle 2015; Harold and Golani 2016; Ketsilis-Rinis and Dimitriou

2018; Othman and Galiya 2019) and recently it has been reported in Southern Adriatic Sea (Dulčić et al. 2020). Of the three possible explanations for its presence in the Mediterranean Sea—transport in ballast water (Dogrammatzi and Karachle 2015) or entry through the Strait of Gibraltar (Turan et al. 2011) or the Suez Canal (Goren and Galil 2006)—the latter is the most accredited hypothesis.

So far a total of 15 species of Codlets (Bregmacerotidae) have been described (Ho et al. 2020). These are mesopelagic and epipelagic fishes characterized by an elongated and slightly compressed body with two nearly identical long-based dorsal and anal fins (Cohen 1986, 1990). *Bregmaceros nectabanus* differs from the other species of the genus by a distinctive body pigmentation pattern, a typically greater body depth, a fimbriate opercular spine termination and the number of fin rays (Masuda et al. 1986; Harold and Golani 2016). It is a rare and little studied species (Xiong et al. 2017), likely because its body size and shape hamper catchability and because of its limited commercial interest. Although its depth distribution range is unknown, *B. nectabanus* has been suggested to inhabit continental shelf waters up to a depth of 120 m (Yılmaz et al. 2004; Turan et al. 2011; Othman and Galiya 2019; Dulčić et al. 2020). Its native range encompasses tropical and temperate waters in the Indian Ocean, the south-western Atlantic, the eastern Atlantic from Morocco to Namibia, and the Red Sea (Froese and Pauly 2019). Its distribution in the Red Sea is uncertain, due to possible confusion with other species of the same genus (Bogorodsky et al. 2014).

Materials and methods

The specimens described herein were caught in the Italian waters of the Northern Adriatic Sea in July 2020, and along the Albanian coast in June 2021, during the yearly acoustic surveys conducted by the Marine Acoustics Research Group of CNR IRBIM (Ancona, Italy) in Northern and Southern Adriatic Sea. The design of these surveys—which assess small pelagic fish in the framework of the EU MEDiterranean International Acoustic Surveys (MEDIAS) action (Leonori et al. 2021)—consists of a parallel grid of transects perpendicular to the coastline (inter-transect distance, 10 nautical miles) over a bathymetric range from 10 to 200 m. Acoustic monitoring is conducted onboard the R/V Dallaporta in the daytime, whereas CTD and plankton net samplings are performed at night. The survey in Albania was done in the framework of MarE project, fully following MEDIAS methodology. Biological sampling is carried out with a mid-water trawl (18 mm codend mesh size). Its main purpose is to catch samples from schools or layers visualized on the screen of SIMRAD EK80 scientific echo sounder in order to allocate the acoustic raw density into species; it is also a fundamental tool to collect biological information on fish target species. Morphometric and meristic measurements of the *B. nectabanus*

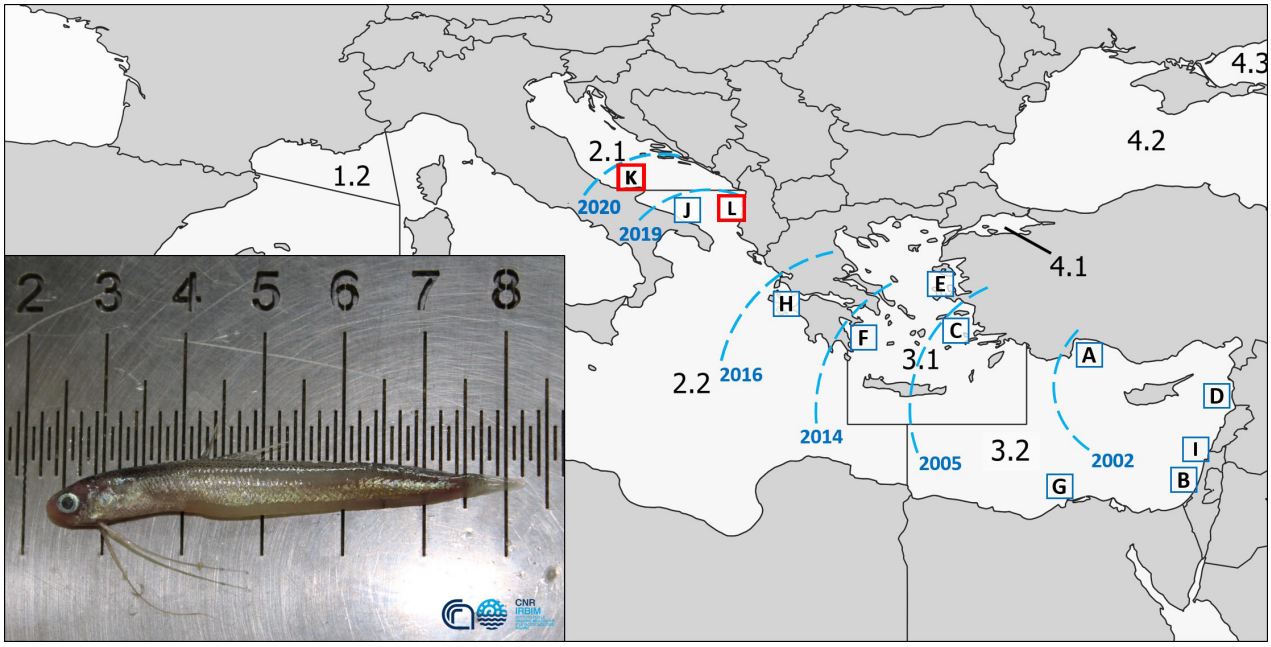

Figure 1. Specimen of *Bregmaceros nectabanus* captured on 27th July 2020, in the framework of the MEDIAS biological sampling and photographed on board. © 2020 Marine Acoustics Research Group, CNR IRBIM, Ancona, Italy. The map shows the previous records of *B. nectabanus* in the Mediterranean Sea: A) 2002, Coast of Antalya, Turkey. B) 2004-2006, Israel. C) 2005, Bay of Kusadasi, Turkey. D) 2010, Bay of Iskenderun, Turkey. E) 2011, Hekim Island, Turkey. F) 2014, Gulf of Aegina, Greece. G) 2014, Egypt. H) 2016, Gulf of Patras, Greece. I) 2018, Syria. J) 2019, Mola di Bari, Italy. Data from Yılmaz et al. 2004; Goren and Galil 2006; Filiz et al. 2007; Turan et al. 2011; Aydin and Aykol 2013; Dogrammatzi and Karachle 2015; Rizkalla and Akel 2015; Ketsilis-Rinis and Dimitriou 2018; Othman and Galiya 2019; Dulčić et al. 2020. K) 2020, Termoli, Italy. L) 2021, Durres, Albania. FAO fishing areas are shown. Further details in Supplementary material Table S1.

specimens were carried out in the laboratory according to Harold and Golani (2016) and Masuda et al. (1986). The species was identified based on the diagnostic characters described by D'Ancona and Cavitano (1965) and Harold and Golani (2016). The specimens were weighed. A Leica M205C stereoscope and a digital calliper were used to count the rays of all fins and to measure the total length (TL), standard length (SL), preanal length, predorsal length, body depth, head length, snout length, eye diameter and interorbital width. The latter measurements are reported as % standard length (SL) and % head length (HL).

Results

The first specimen of *B. nectabanus* was caught offshore Termoli, Italy, on 27th July 2020 in FAO fishing area 37.2.1 (Figure 1) in an area characterized by a sandy bottom during biological sampling. The haul was carried out at night, from 21:31 (42.038°N; 15.947°E) to 22:02 (42.024°N; 15.994°E) at the surface on a backdrop of 70 m, the surface water temperature was 25.8 °C. The total catch weight was 61.2 kg. A subsample of 22 kg, collected for the analyses, was mostly composed of *Engraulis encrasicolus* whose length-frequency distribution range was 3.5 to 11.5 cm (mode at 7 cm). The *B. nectabanus* specimen had a total length of 5.5 cm, which matched this length frequency distribution. The other five specimens were collected on 27th May in 2021 in FAO fishing area 37.2.2 (Figure 1) during a night haul

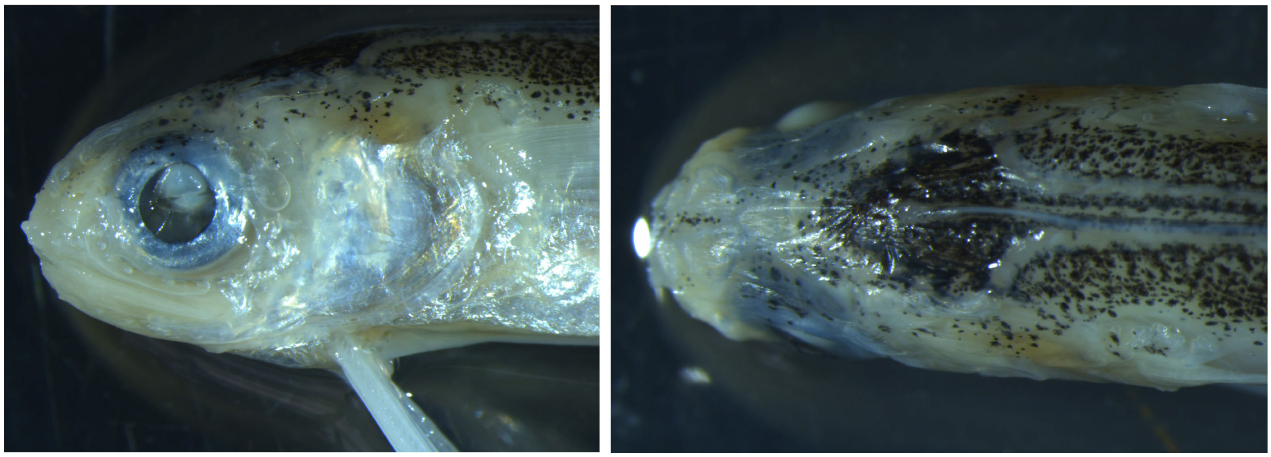

Figure 2. Dorso-lateral images of the top of *B. nectabanus* specimen (2020) that shown some important diagnostic details. Photographs by Michele Centurelli.

Table 1. Morphometric and biometric range of values of *Bregmaceros nectabanus* specimens (% standard length = % SL; % head length = % HL). See Table S2 in Supplementary material for single specimen details.

Morphometric measures	n = 6	Biometric values	
Standard length SL (mm)	45.6–60.5	Total length TL (mm)	55.1–68
D1 first dorsal fin ray count	1	Weight (g)	0.56–1.44
D2 second dorsal fin ray count	47–52		
Pelvic fin ray count	6		
Anal fin ray count	44–51		
Caudal fin ray count	25–30	Morphometric values	
Pectoral fin ray count	15–18		
Head length HL (mm)	7.9–10.5	Head length %SL	15.3–18.2
Predorsal length (mm)	18.7–23.4	Predorsal length %SL	37.6–41
Preanal length (mm)	18.4–30	Preanal length %SL	37.5–52.1
Body depth (mm)	6.5–10.2	Body depth %SL	13.7–17.7
Snout length (mm)	1.5–1.9	Snout length %HL	16.3–20.2
Eye diameter (mm)	2.7–3.4	Eye diameter %HL	27.8–32.4
Interorbital width (mm)	1.9–3.1	Interorbital width %HL	20.6–32.8

carried out from 21:33 (41.189°N; 19.254°E) to 22:10 (41.16°N; 19.293°E) at the surface on a backdrop of 80 m and surface water temperature of 20 °C. Smallscale codlets caught in offshore Durres, Albania, range between 5.3 and 6.8 cm, in a total catch of 9.1 kg mostly composed by *E. encrasicolus* with a mean size of 12.2 cm. The net and temperature data were collected with a SIMRAD FX80 trawl sonar. After capture, the specimens were photographed and were fixed in 75% ethyl alcohol. They were stored at the CNR IRBIM Marine Acoustics laboratory. From the analysis carried out with the stereoscope it was evident the presence of a distally fimbriate opercular spine in each fish. This feature together with: body elongated, slightly compressed in its ventral part; small head with large eyes; elongated pelvic fins; long ray on top of the head; thin brown dorsolateral longitudinal stripe; lack of pigmentation on the abdomen below the second dorsal fin and the presence of 13 principal caudal fin rays led us to the species identification. Some of these dichotomous characters are visible in Figure 2, while all the other morphometric features are listed in Table 1.

Discussion

The colour pattern of pigmentation and the presence of a fimbriate opercular spine led us to assign our specimens to *B. nectabanus* rather than *B. atlanticus* although two specimens showed a small body depth of 13.7% and 14.25% on standard length (SL). The body depth values of all specimens caught felt into the range of both species following Harold and Golani 2016 (12.4–14.4% SL for *B. atlanticus* and 13.2–17.5% SL for *B. nectabanus*). Therefore, this could not be a reliable distinctive character between the two species. While, the small differences in the fin ray count (showed in Table 1) compared to the results reported in Harold and Golani (2016) and Dulčić et al. (2020), may be due to fin damages suffered by the specimens during fishing operations.

The map in Figure 1 shows the chronological records of smallscale codlet and its progressive spread through the Mediterranean. Most previous records in the Mediterranean were along the Turkish coast, the Greek Aegean Sea, the Greek Ionian coast (Dogrammatzi and Karachle 2015; Ketsilis-Rinis and Dimitriou 2018; Othman and Galiya 2019), and more recently (2019) in the Southern Adriatic Sea (Dulčić et al. 2020), suggesting a progressive expansion of *B. nectabanus* distribution along the eastern coasts of the Mediterranean and its arrival in the Northern Adriatic Sea in 2020.

As suggested by Dulčić et al. (2020), the spread towards the Adriatic Sea could be favoured by the BiOS mechanism (Bimodal Oscillating System) (Civitarese et al. 2010). This hypothesis is supported by the evidence on the influence of water mass movements in the transport of *Bregmaceros* larvae (Grabe et al. 1992). The records of 2021 led us to think that the species firstly reached the Albanian coast carried by Levantine Intermediate Water (LIW) and successively the Italian coast of Southern Adriatic through the Adriatic Deep Water (AdDW) gyre (Santinelli 2015). Conversely, the Adriatic Sea hydrography could not justify a further northwest expansion through the Italian side of the species by passive transport because of the cyclonic circulation, characterized by a flow towards the northwest along the eastern side and a return flow towards the southeast along the western side (Russo and Artegiani 1992). Therefore, the 2020 record suggest us that this secondary dispersal could be accomplished an active spread of adult individuals. The new records of five specimens in Albania in 2021 point out the continuous presence of the species for the last consecutive three years, in three different sites of the Adriatic Sea, although eight specimens are clearly insufficient to document an established population in the area (Dulčić et al. 2020). Even though its low catchability should also be considered, Ali (2018) supposed that the absence of some small species in non-native areas could be attributed to the fishing selectivity of commercial fishing gear related to the mesh diameter. Notably, the catch of all specimens during night hauls at the surface suggests a vertical migration

behaviour of the species that validate the letter of Baird et al. (1973), while it is not well described for the other species of the genus *Bregmaceros* (Baird et al. 1973). The vertical migration is probably linked to the feeding behaviour, already proved for other small mesopelagic species (Bernal et al. 2015).

This paper describes the northernmost record of *B. nectabanus* in the Mediterranean Sea and the first multiple individuals catch of the species in a single haul in the Adriatic Sea, providing further data on the distribution and spread of *B. nectabanus* in this basin, but additional records and studies are needed to assess and monitor its population.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Georeferenced locations and details of the current reports and all the other reports of *B. nectabanus* in the Mediterranean Sea.
Table S2. Morphometric characters of the specimens caught.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2022/Supplements/BIR_2022_Palermino_etal_SupplementaryMaterial.xlsx