

**FIRST RECORD OF *EPINEPHELUS COSTAE* (ACTINOPTERYGII: PERCIFORMES: EPINEPHELIDAE) FROM GALICIAN WATERS (NORTH-WESTERN SPAIN): EXPLORING THE NORTHWARD RANGE EXPANSION**

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**Abstract.** The first record of the goldblotch grouper, *Epinephelus costae* (Steindachner, 1878), from Galician waters is reported. Two specimens were recorded in the south of Galicia but only one of them was retained. Morphometric and meristic parameters, along with DNA barcoding, confirmed the identification of the preserved specimen whereas the other was identified based on a photograph. Results of the histological examination of the gonads of *E. costae* are also reported, showing a mature female at the beginning of the reproductive cycle. In addition, a review of the northern limit of distribution for the species is carried out.

**Keywords:** NE Atlantic, tropicalisation, morphology, DNA barcoding, fish identification

## INTRODUCTION

Although groupers have traditionally been included in the family Serranidae, they are now included in its own family Epinephelidae (see Smith and Craig 2007, Neubert et al. 2016, Tucker et al. 2016). The genus *Epinephelus* Bloch, 1793 comprises 90 species worldwide distributed in tropical and subtropical latitudes, including the Mediterranean Sea (Heemstra 1991). Only four *Epinephelus* species have been recorded in Atlantic European coastal waters (Quéro et al. 2003): *Epinephelus costae* (Steindachner, 1878), *Epinephelus caninus* (Valenciennes, 1843), *Epinephelus aeneus* (Geoffroy Saint-Hilaire, 1817), and *Epinephelus marginatus* (Lowe, 1834).

*Epinephelus costae* is a marine demersal fish species inhabiting sandy, muddy, and rocky bottoms, from the shore down to the depth of 300 m, although it is the most abundant in shallow waters. It is native to eastern Atlantic Ocean, from Portugal coasts (ca. 40°N) to Angola (ca. 13°S), and from the Mediterranean Sea (Craig et al. 2011, Heemstra and Anderson 2016).

The goldblotch grouper is a protogynous hermaphrodite species (Bouain unpublished\*\*, Sembène unpublished\*\*\*). Unfortunately, only few observations on the reproductive cycle and fecundity of goldblotch grouper from Tunisian waters have been reported in scientific literature (Bouain and Siau 1983).

## MATERIAL AND METHODS

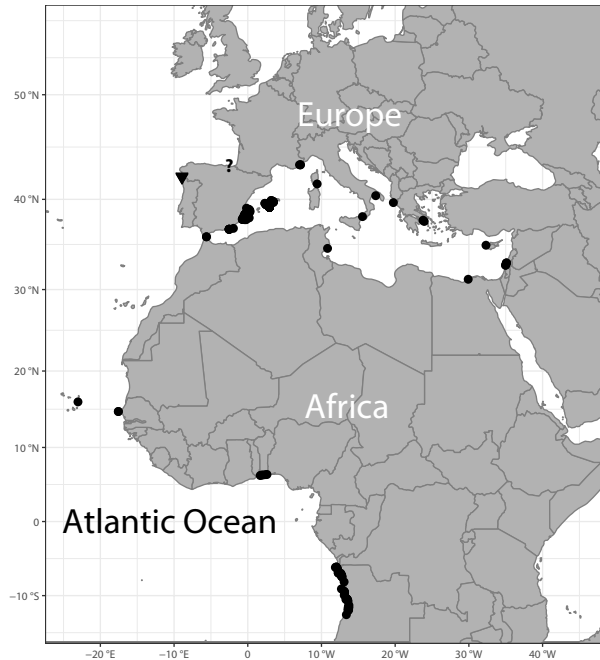
Two specimens of *Epinephelus costae* were captured close to each other (~10 km) in the south of the Galician coast during a short period of time (five days). A dot distribution map was created based on georeferenced data reported in online marine biogeographic databases (OBIS and GBIF) including the present records (Fig. 1). The first specimen, weighing 1200 g, was caught on 22 April 2018 by local fishermen using trammel nets, off the Cíes Islands (42°15.007' N, 8°55.449' W), at 20 m depth. The individual was sold in the fresh fish market in Cangas (Ria de Vigo), but it was photographed before the sale (Fig. 2). The second specimen

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\*\* Bouain A. 1984. Moronidés et Serranidés (Poissons Téléostéens) du golfe de Gabès. Ecobiologie et halieutique. PhD thesis, Tunisia University, Tunisia.

\*\*\* Sembène B. 1995. Contribution à la connaissance de l'écobiologie de trois espèces de mérus des côtes sénégalaises (Serranidae, Poissons téléostéens). Mémoire DEA en Biologie et physiologie animales. [MSc Thesis.] Cheikh Anta Diop University, Dakar, Senegal.

(Fig. 2) was caught on 27 April 2018, with a trammel net, off the Onza Island (42°20.3893'N, 8°56.2216'W), at 15 m depth. The fish was landed at the Port of Bueu (Ría de Pontevedra) and was retained for a detailed study.



**Fig. 1.** Distribution map showing georeferenced location points of *Epinephelus costae* (black circles), the present records in Galician waters (black triangle) and Ibañez (1987) record (question mark)

The main morphometric and meristic characters of the preserved specimen were recorded in fresh following Heemstra (1991). The specimen measured 465 mm in total length and was preserved in 70% ethanol and deposited in the fish collection of the “Museo Luis Iglesias de Ciencias Naturais” in Santiago de Compostela with the reference number MHNUSC 25104.

A muscle sample was collected in order to extract DNA and sequence the standard 5' barcoding region of the mitochondrial *COI* gene, following procedures described elsewhere (Bañón et al. 2016). A 652 nucleotide-long barcode sequence was deposited in the Barcoding of Life Database (process ID FIGAL001-18) and GenBank repositories (accession No. MH308028) and can be found under the project name Marine fishes from Galicia (code FIGAL).

Three serial portions from the gonad were extracted, dehydrated, embedded in paraffin, and sectioned at 3 µm and stained with haematoxylin–eosin for histological examination. The specimen was sexed and its maturity phase was determined using histological criteria (Brown-Peterson et al. 2011).

## RESULTS

The body of the collected specimen of *Epinephelus costae* was elongated (Fig. 2); body depth less than head length, contained 3.4 times in standard length; head length contained 2.9 times in standard length; pectoral fins longer

than pelvic fins, pectoral-fin length contained 1.8 times in head length; preopercle serrate, with 3 greatly enlarged serrae at the angle; head and body brownish, the fins darker; a large, vaguely defined golden-yellow blotch on body below spinous dorsal fin is apparent in the not preserved specimen. Table 1 shows the main morphometric and meristic characters determined. Meristic and biometric measures are in agreement with previous diagnoses and descriptions of *E. costae* and the molecular identification supports the reliability of the morphological one.

The barcode of the specimen was subjected to query using the BOLD TaxonID Tree tool, resulting in the best identification in favour of *E. costae* (99.85%). GenBank non-redundant nucleotide sequence database was tracked with the same sequence using the BLAST alignment tool, obtaining a 99% identity with the same species.

The fish examined was a mature female in developing phase (Fig. 3), as revealed by the presence of cortical alveoli oocytes in the ovary (Brown-Peterson et al. 2011). The presence of a cytoplasmic vacuolisation, preceding oocyte vitellogenesis, indicates that the examined specimen was at the beginning of the reproductive cycle (Bouain and Siau 1983).

**Table 1**

Morphologic characteristics of *Epinephelus costae* from Galician waters compared to those of the previous report from the Cantabrian Sea (Ibañez 1987)

Character	This study		Ibañez 1987
	[mm]	%SL	[mm]
<b>MORPHOMETRICS</b>			
Total length	465		407
Standard length (SL)	382		—
Head length	132	34.6	127
Preorbital length	36	9.4	—
Eye diameter	18	4.7	16
Postorbital length	78	20.4	—
Interorbital distance	27	7.1	—
Maxillar length	55	14.4	—
Maxillar width	13	3.4	—
Predorsal length	125	32.7	—
Dorsal fin base length	210	55.0	—
Preanal length	252	66.0	—
Anal fin base length	59	15.4	—
Prepectoral length	123	32.2	—
Pectoral length	74	19.4	—
Prepelvic length	135	35.3	—
Pelvic length	68	17.8	—
Caudal depth	37	9.7	—
Body depth	111	29.1	105
Body width	59	15.4	—
<b>MERISTICS</b>			
No. of dorsal fin rays	XI + 15		X + 16
No. of anal fin rays	III + 8		III + 8
No. of pectoral fin rays	18		—
No. of caudal fin rays	18		—
Lateral scale series	125		—
Branchiostegal rays	7		—
Gill rakers	9 + 18		—

## DISCUSSION

Although the northernmost Atlantic limit of *Epinephelus costae* is reported at about 40°N, the precise data of this limit has not been found in the scientific literature. The presently reported Galician findings should constitute a new northernmost record of distribution for the species. However, a bibliographic revision found a specimen reported as “*Epinephelus alexandrinus* Valenciennes, 1828”, from the Cantabrian Sea, in the Port of Fuenterrabía (Ibáñez 1987). The above-mentioned nominal species is now considered a junior synonym of *E. costae*. This record has gone unnoticed in the scientific literature, being unreported in the previous revisions of the groupers (Heemstra 1991, Heemstra and Randall 1993, Craig et al. 2011, Heemstra and Anderson 2016). The note of Ibáñez (1987) lacks an image of the specimen and has few morphological data (Table 1). However, the reported count of eight soft anal fin rays and a caudal fin truncate give credibility to this identification. In this way, considering the record of Ibáñez as valid, it would

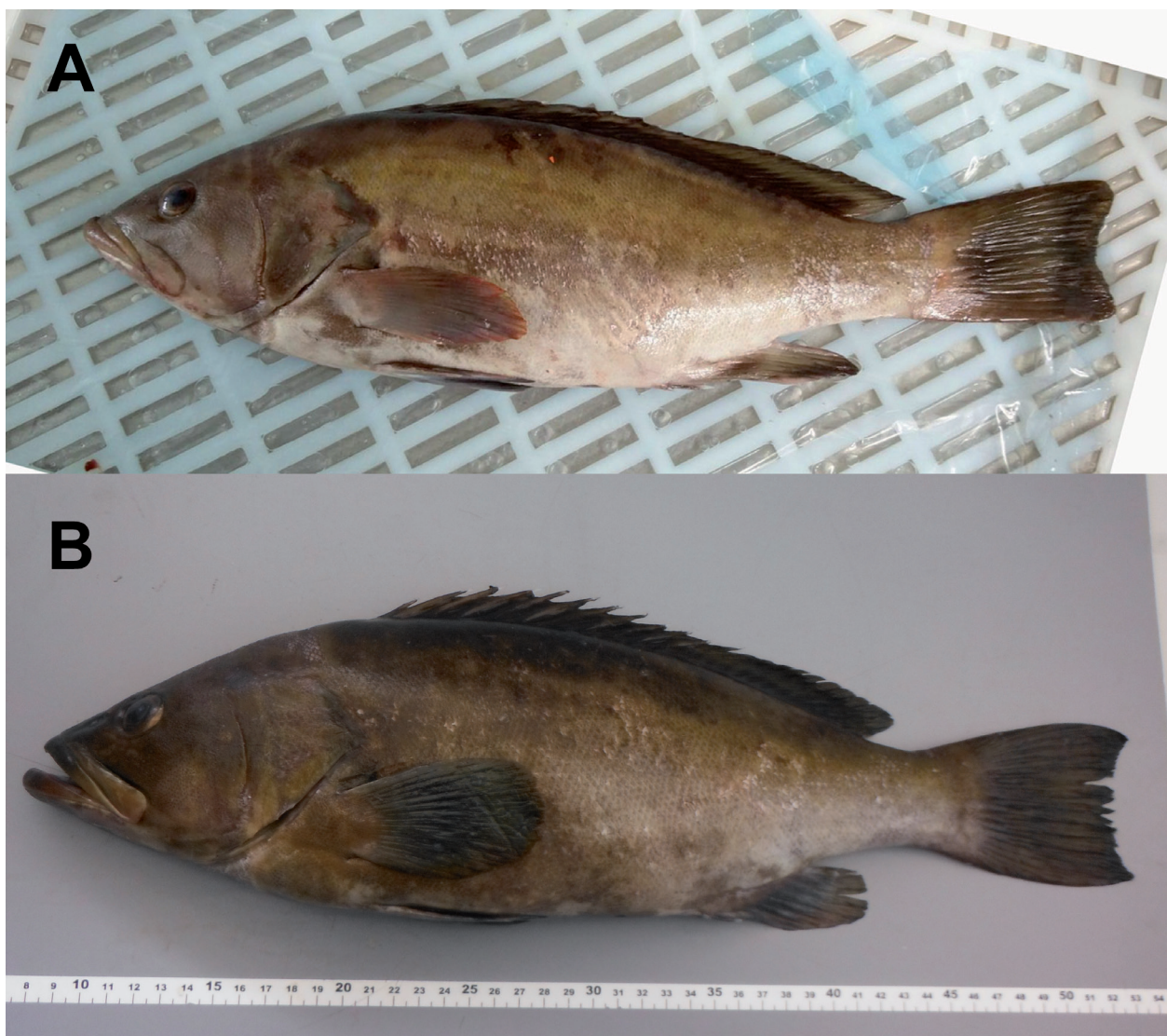
be the northernmost one in the Atlantic, expanding the distribution limit northward to 43°N.

It has been suggested that the recent expansion of some *Epinephelus* species, such as *E. marginatus*, *E. aeneus*, and *Epinephelus coioides* (Hamilton, 1822) to the Mediterranean Sea and the Atlantic Ocean is the result of the warming of these waters (Parenti and Bressi 2001, Bañón et al. 2017). This warming is evidenced by a rise of 0.24°C per decade observed since 1974 in Galician waters as well as by the presence of numerous new southern fish species (Bañón et al. 2014).

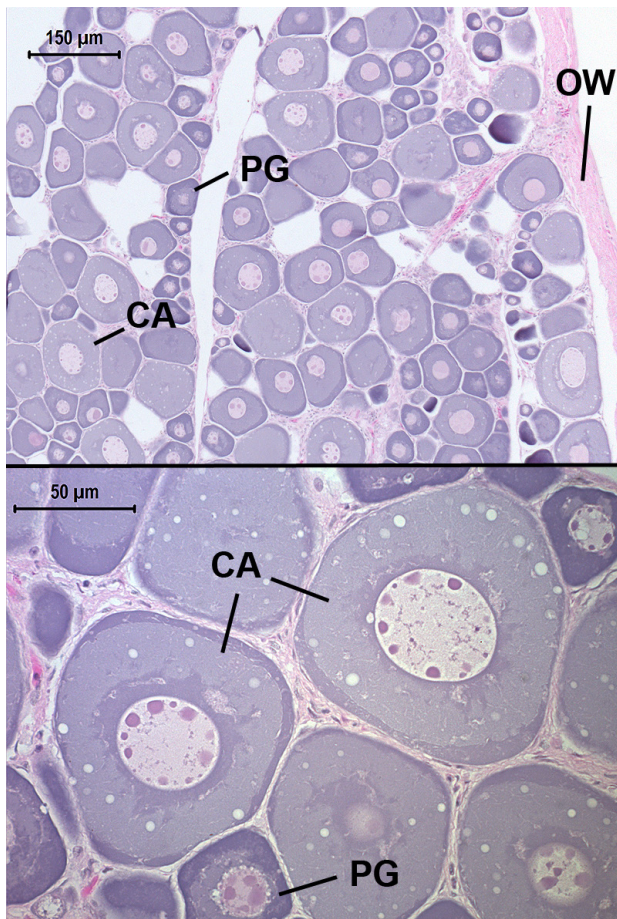
Groupers are top predator fishes in food chains and are also among the biggest fishes in coastal marine waters. Therefore, changes in their distribution, abundance, and colonisation abilities would have a significant influence on autochthonous communities (Glamuzina 1999).

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**Fig. 2.** *Epinephelus costae*; the specimen (1200 g) caught in the mouth of the Ría de Vigo (A), and the specimen (465 mm TL) caught in the mouth of the Ría de Pontevedra (B)



**Fig. 3.** Histological slide of the ovary of *Epinephelus costae* caught in Galicia in 2018; PG = primary growth oocyte; CA = cortical alveoli oocyte; OW = ovary wall

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