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First record of *Scomber scombrus* Linnaeus, 1758 from the central Atlantic coast of Morocco

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Abstract

The present study reports a new record of Atlantic mackerel *Scomber scombrus* Linnaeus, 1758, in the central Atlantic coast of Morocco. While this species is widely distributed on both sides of the North Atlantic, its occurrence in Moroccan waters has not been previously reported and only the species *Scomber colias* (Gmelin, 1789) has been reported from Atlantic coast of Morocco. In March 2018, 30 specimens of *Scomber colias* were sampled from the fishing port of Agadir Bay. Among them three individuals were identified as *Scomber scombrus*. Their otoliths were analysed for morphology and shape using a binocular microscope. The occurrence of *S. scombrus* in the area may indicate extension of its distribution to the central Atlantic coast of Morocco, possibly linked to spawning migration. This finding highlights the need for more focused research on this species in Moroccan waters.



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The North-east Atlantic mackerel *Scomber scombrus* (Linnaeus 1758) is a pelagic and migratory species. It has a large distribution on both sides of the North Atlantic [the North-West Atlantic (NWA) and the North-East Atlantic (NEA)] (ICES, 2011; Jansen and Gislason, 2013). The species widely distributed in Moroccan waters is the chub mackerel *Scomber colias* (Gmelin, 1789), which is reported to form a single stock occurring on both sides of the Atlantic coast and the Mediterranean Sea (INRH, 2017). The core biomass of *S. colias* is concentrated in the central and southern Moroccan waters (ICES, 2020). A recent study reported that a single stock of *S. colias* was recorded in the NEA, especially in Portugal (Matosinhos, Sesimbra and Portimao) and in the Atlantic Oceanic Islands (Azores, Madeira and Canaries) (Correia *et al.*, 2021). This species was previously described as *Scomber japonicus* (Houttuyn, 1782) in the Atlantic waters; later, genetic studies confirmed that *S. colias* belongs to the Atlantic and *S. japonicus* belongs to the Pacific (Infante

et al., 2007; Trucco and Buratti, 2017). Moreover, a recent morphometrical study mentioned that considerable morphological variability was found in the *S. scombrus* population along the Atlantic coast of Morocco (Bouzzammit and El Ouizgani, 2019). These findings aim to propose probable hypotheses for the distribution and the migration of *S. scombrus* to the central Atlantic coast of Morocco.

A total of 30 chub mackerel individuals were collected from small traditional purse seine fleets in the fishing port of Agadir, located on the central Atlantic coast of Morocco (Fig. 1). These artisanal fleets mainly target small pelagic species using purse seine gear. These small artisanal boats have a capacity of 3 t or less and the purse seines are deployed at depths ranging from 30 to 40 m. The fishing site is located 7 miles from the port. Each specimen was measured for total length (TL, mm) and total weight (W_t , g) and the sex as well as maturity stage were determined (Table 1).

Table 1. Details of samples (TL: Total length; W_t : Total weight; W_g : Gonadal weight; M: Males; F: Females) of *S. scombrus* and *S. colias*

Samples	Species	Total length TL (mm)	Total weight W_t (g)	Sex	Gondal weight W_g (g)	Maturity stage
Sample 01	<i>S. scombrus</i>	275	168	M	6.03	Actively spawning
Sample 02	<i>S. scombrus</i>	236	116	F	1.03	Actively spawning
Sample 03	<i>S. scombrus</i>	258	240	F	4.33	Actively spawning
Sample 04	<i>S. colias</i>	229	102	F	4.19	Actively spawning
Sample 05	<i>S. colias</i>	260	148	F	0.51	Regressing
Sample 06	<i>S. colias</i>	235	110	F	0.3	Regressing

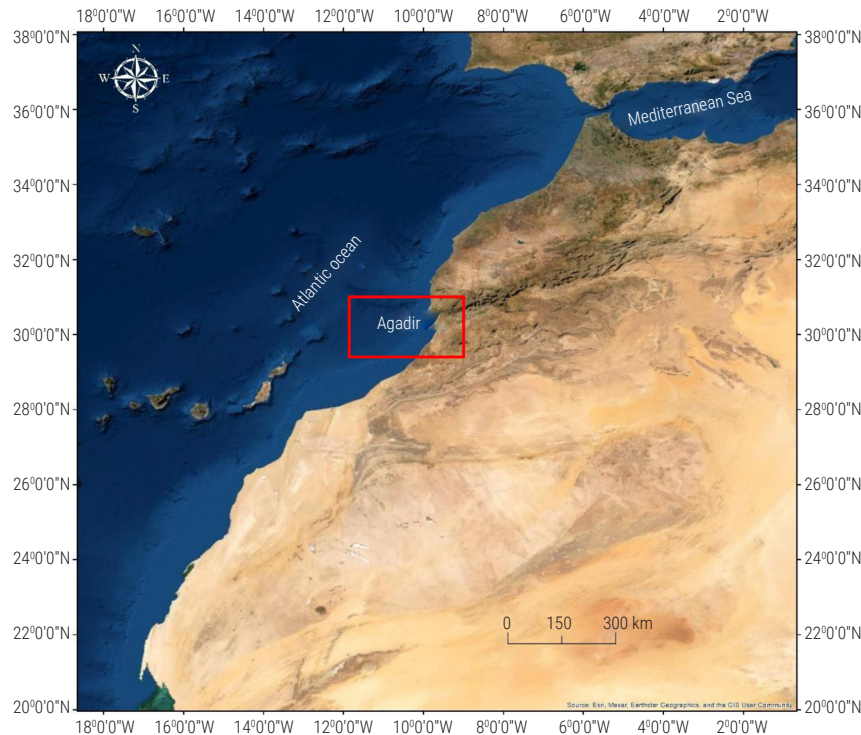


Fig. 1. Map of sampling area indicating Agadir Port on the Atlantic coast of Morocco

The *S. scombrus* species found in the samples were in actively spawning phase. According to standardised terminology established by Brown-Peterson *et al.* (2011), the actively spawning phase refers to the sexually mature individuals that are ready for spawning, while the regressing phase is related to post-spawning. As regards the otoliths, the images were captured using a binocular microscope attached to a camera. Three different pairs of otoliths were recorded while reading the age (Fig. 2). These otoliths differed in shape from those of *S. colias* (Fig. 3) and helped to differentiate the two species.

While it is difficult to distinguish between *S. scombrus* and *S. colias* based on their external morphology, the difference is clearly evident in their otoliths. The results of the study were based on the observation of variation in otolith morphology during the age reading of *S. colias*, with three otoliths differing from all the other *S. colias* otoliths (Fig. 2 and Fig. 3). The identification of *S. scombrus* was based only on otolith morphology, which was confirmed using a scanning electron microscope (Figs. 4 and 5).

The individuals of *S. scombrus* and *S. colias* collected in March 2018 were sexually mature, and most of them were ready for spawning. Therefore, we can hypothesise that the occurrence of *S. scombrus* along the central Atlantic coast of Morocco may be related to spawning migration patterns exhibited by the species. The spawning season is in turn influenced by environmental conditions such as temperature and food availability (Jansen *et al.*, 2012). The geographical distribution of mackerel is also related to water temperature, which can influence migration during the spawning season (Jansen *et al.*, 2012).

The central Atlantic coast of Morocco is characterised by the presence of an upwelling current which may very well influence the migration of *S. scombrus*. This process, where deep cold water rises to the surface, results in cold water currents along the coast that are rich in nutrients. *S. scombrus* is known to occur in the Northern Atlantic at a temperature ranging from 9 to 13°C during its summer feeding migration in North Atlantic waters. The extension of its distribution and its migration to the Southern Atlantic may be explained by the increase in sea surface temperature (SST). Villamor

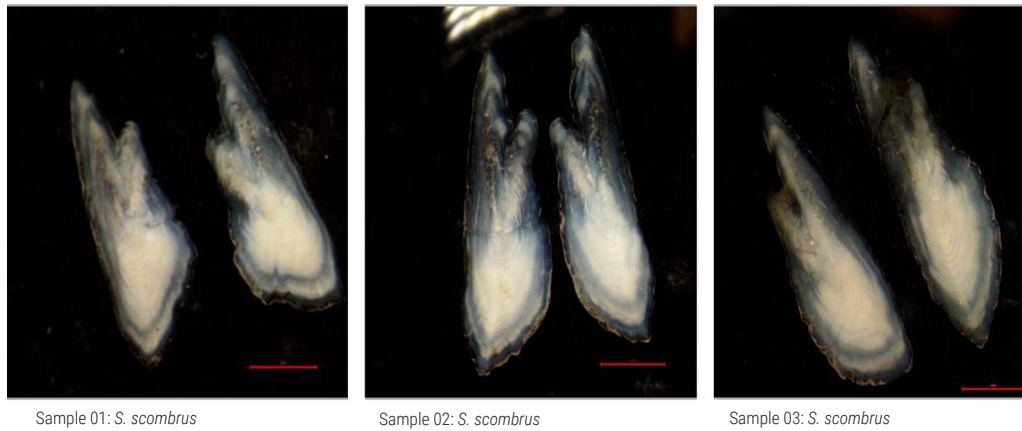


Fig. 2. Images of *S. scombrus* otoliths

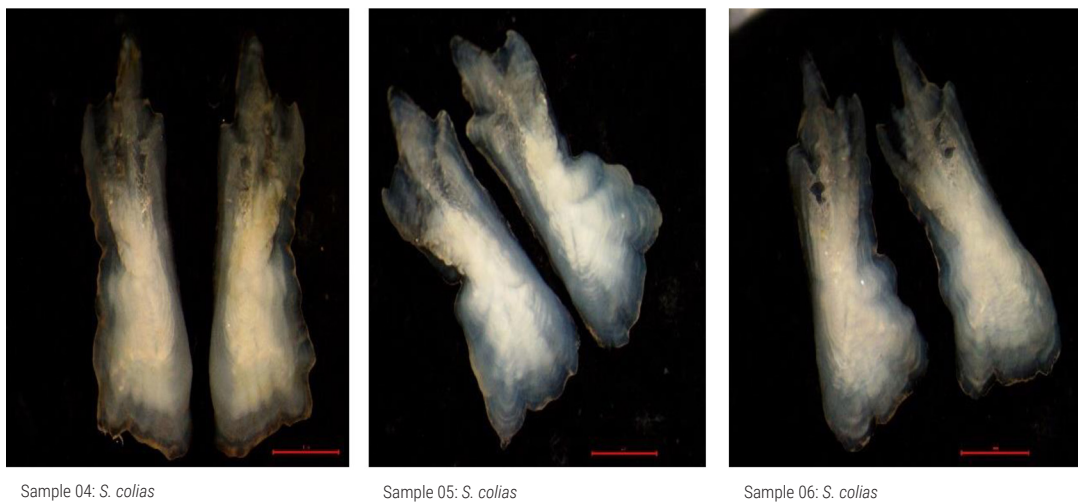


Fig. 3. Images of *S. colias* otoliths

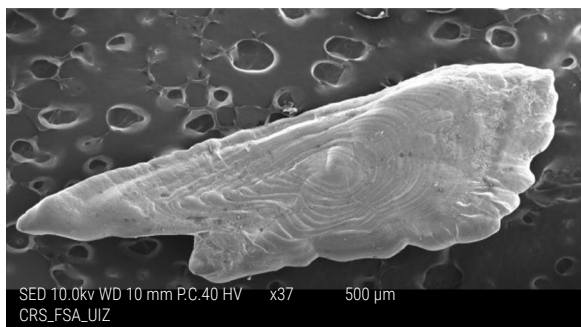


Fig. 4. Scanning electron micrograph of *S. scombrus* otolith

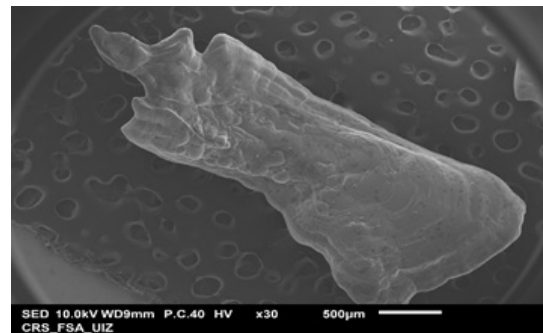


Fig. 5. Scanning electron micrograph of *S. colias* otolith

et al. (2004) and Martins *et al.* (2013) suggested that the chub mackerel (*S. colias*) may be considered the southern congener of the Atlantic mackerel (*S. scombrus*). Furthermore, both species overlap in the Iberian Peninsula, with *S. scombrus* being predominant to the north and *S. colias* to the south of Lisbon (Martins and Cardador,

1996; Martins *et al.*, 2013). Hence, in addition to the hypothesis of spawning migration, it can also be assumed that the stocks of both, *S. colias* and *S. scombrus* may overlap in Moroccan waters, or both stocks are present along the coast with a very low biomass of *S. scombrus*.

According to Fishery Committee for the Eastern Central Atlantic (CECAF) and acoustic surveys by the National Institute of Fisheries Research (INRH), *S. colias* is the most abundant species in Moroccan waters. As a result, it has been considered a single stock in both Atlantic and Mediterranean waters. However, the ICES (International Council for the Exploration of the Sea) Workshop on Atlantic chub mackerel (*S. colias*) concluded that the available information and data about the region extending from the Bay of Biscay to Senegal are insufficient to define the stocks of *S. colias*. Additionally, the dynamics, stock identity and stock status of Atlantic chub mackerel in European Atlantic waters, as well as its connectivity with populations in Atlantic African waters, are still unknown. Despite the lack of data and consistency to propose an identity for the stock, it is provisionally considered a single stock. The appearance of *S. scombrus* specimens in the commercial catches of artisanal fisheries at the port of Agadir, with 3 individuals of *S. scombrus* found in a sample of 30 individuals of *S. colias*, representing 10% of the total sample, suggests the presence of *S. scombrus* in Moroccan waters, although with very low abundance. Further studies on this species, with more samples, covering thorough otolith morphometry are necessary to evaluate its presence and estimate its abundance. The present study may thus contribute to the development of alternative approaches for assessing chub mackerel stocks and that of the congener species *S. scombrus*, in Moroccan waters.

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