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# The use of parasites as biological tags for stock identification of blue jack mackerel, *Trachurus picturatus,* in the North-eastern Atlantic

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ABSTRACT

The use of parasites as biological tags for discriminating stocks of blue jack mackerel, *Trachurus picturatus* (Osteichthyes, Carangidae), in the northeast Atlantic Ocean is assessed herein. In this study the following parasites have been selected as possible biological tags: *Anisakis* spp. (Nematoda: Anisakidae), *Rhadinorhynchus* sp. (Acanthocephala: Rhadinorhynchidae), *Nybelinia* sp. (Cestoda: Tentaculariidae) and *Bolbosoma* sp. (Acanthocephala: Polymorphidae). *Anisakis* spp. was the most prevalent parasite taxon found in all localities, attaining higher values in fish from Peniche, mainland Portugal. The occurrence of *Rhadinorhynchus* sp. in fish from all studied areas was rare (prevalence <10%) but significantly different between localities, with higher values in both archipelagos. *Nybelinia* sp. specimens were only detected in fish from Madeira and cystacanths of the genus *Bolbosoma* were never detected. The distinctive pattern of infection of these parasite species points to the existence of three stocks of blue jack mackerel in the northeast Atlantic: one in Portuguese mainland waters, one in Madeira archipelago and another in the Canary archipelago. These results support the management strategy which treats the three populations studied as separate stocks.



## 1. Introduction

The blue jack mackerel, *Trachurus picturatus* (Bowdich, 1825) (Osteichthyes, Carangidae) (Fig. 1), is an oceanic pelagic species that occurs in the Eastern Atlantic (Cárdenas et al., 2005) reaching from the Bay of Biscay (France) southward to Morocco and eastward into the Mediterranean Sea (Eschmeyer, 2003; Karaiskou et al., 2003), between 100 m and 575 m depth (Menezes et al., 2006; Menezes and Giacomello, 2013). In the Northeast Atlantic, it is quite common in the Macaronesian archipelagos, constituting an important fishery resource in Madeira archipelago, although their annual landings have decreased from 2006 t in 1986 to 439 t in 2015 (data from the Fisheries Department of Funchal). Despite this wide distribution, no assessment has ever been made on the species population structure. The knowledge of the stock structure and degree of mixing among populations is important for the rational management of marine resources (Moles et al., 1998), especially when dealing with important commercial species.

Many techniques have been used to identify and discriminate stocks, including the application of artificial and natural tags (Catalano et al., 2014). Parasites have been widely used as indicators of various aspects of fish biology (Williams et al., 1992). One of their most important applications is in stock identification (Williams et al., 1992; MacKenzie and Abaunza, 1998; MacKenzie, 2002; Abaunza et al., 2008). The advantages and limitations of using

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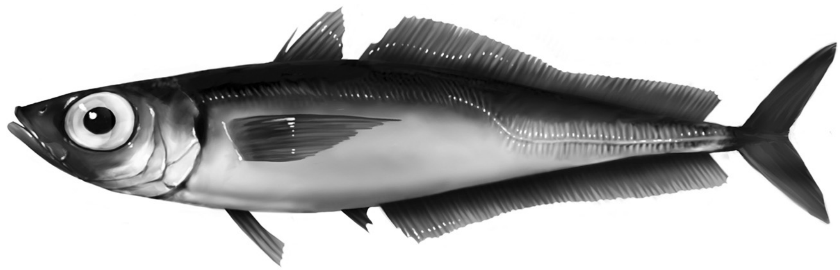

**Fig. 1.** Illustration of a blue jack mackerel, *Trachurus picturatus* (Bowdich, 1825), caught off Madeira Island (Source: DSI).

parasites as biological tags have been recognized and reported by many works (Sindermann, 1961; MacKenzie, 1987; Williams et al., 1992; MacKenzie and Abaunza, 2014; MacKenzie, 2002; Mosquera et al., 2003).

The study of blue jack mackerel parasite fauna is limited to a few papers from seamounts south of the Azores and off Western Sahara (Gaevskaya and Kovaleva, 1980, 1985), Madeira (Costa et al., 2012) and mainland Portugal (Hermida et al., 2016), highlighting regional differences in the prevalence and intensity of some helminth parasites, which may indicate the possible existence of different populations of this species. In order to evaluate the use of parasites that could be useful as biological tags of *T. picturatus*, Costa et al. (2013) examined samples from two geographic regions, Madeira and Canary Islands, for the presence of anisakids, trypanorhynchs, acanthocephalans and liver coccidians, and discuss the feasibility of using two specific parasites (a protozoan apicomplexan, *Goussia cruciata*, and an acanthocephalan, *Rhadinorhynchus cadenati*), as biological tags for the identification of populations of *T. picturatus*. These authors considered only *G. cruciata* as a useful biological tag.

A deeper insight or more robust conclusions may be gained from using a multidisciplinary approach to determine stock structure. In the present study, the use of parasites as biological tags for discriminating stocks of *T. picturatus* in three geographic regions of the northeast Atlantic Ocean (Peniche, mainland Portugal, and Madeira and Canary archipelagos) was assessed, as part of a multidisciplinary effort.

## 2. Materials and methods

A total of 607 specimens of *T. picturatus* (180 from Peniche, mainland Portugal, 207 from Madeira archipelago and 220 from Canary archipelago) (Fig. 2) were obtained quarterly from commercial catches in 2015, between January and December (Table 1). Samples from Peniche and Canary Islands were immediately frozen until parasitological examination. After thawing, basic biological information was collected from each specimen in the samples (total length, TL, in cm; total weight, TW, in g; sex and maturity stage) and subsequently they were examined for the presence of parasites. Fish from Madeira were analysed fresh.

For the selection of parasites as biological tags the criteria of MacKenzie (2002) and MacKenzie and Abaunza (2014) were followed. Suitable biological markers should show clear differences in prevalence, intensity and abundance levels among the sampled regions, should be easily detected and, ideally, should not cause disease in the host. Given this information and because small pelagic fishes have lower parasite species richness (Sindermann, 1957; MacKenzie, 1990; Abaunza et al., 1995), the use of a small number of parasites species selected according to the guidelines by MacKenzie (1983) and Sindermann (1983) was followed. As information on the parasitic fauna in this host species is already available, the following parasites were selected as possible biological tags: *Anisakis* spp. (Nematoda: Anisakidae), *Rhadinorhynchus* sp. (Acanthocephala: Rhadinorhynchidae), *Bolbosoma* sp. (Acanthocephala: Polymorphidae) and *Nybelinia* sp. (Cestoda: Tentaculariidae).

MacKenzie and Abaunza (1998, 2014) recommend that parasites used as biological tags should be easily detected and identified, otherwise time becomes a limiting factor. Although *Goussia cruciata* was previously referred as a good biological tag in *T. picturatus* (Costa et al., 2013), this parasite was not used in this study because its exact quantification is not possible and prevalence cannot be determined with certainty without observing the whole liver tissue.

For the collection of parasites in the host, the body cavity was exposed and observed and the viscera removed, placed in Petri dishes and examined for the presence of target parasites. All parasites collected were isolated, counted and preserved in 70% ethanol. The live parasites were fixed with hot 70% ethanol before storage. They were subsequently examined with the help of a binocular microscope after clearing with a suitable agent.

Prevalence (*P*), mean intensity (*I*), and mean abundance (*A*) of infection were determined according to Bush et al. (1997). Prevalence was compared among locations using the Pearsonís chi-square test. Abundances of the parasites species were compared between locations using the Kruskal-Wallis test (three samples).

Correlations between fish size and parasite mean abundance were analysed by Spearman rank correlation (Zar, 1996).

All statistical analyses were performed using R software (R Core Team, 2015). For all tests, statistical significance was accepted when $p < 0.05$.

## 3. Results

### 3.1. Length and weight data of blue jack mackerels examined

The fish length and weight varied significantly among locations (Kruskal-Wallis test: $x^2 = 421.19$, $p < 2.2 \times 10^{-16}$ and K-W: $x^2 = 426.39$, $p < 2.2 \times 10^{-16}$, respectively), with fish from Madeira and Canary Islands being the smallest, and those from Peniche the largest.

The number of females, males and fish with undifferentiated sex were significantly different in each region (K-W: $x^2 = 17.43$, $p = 0.0002$). Fish captured off Peniche were predominantly males (61%), those from Madeira females (52%) and the ones from Canaries were undifferentiated (58%).

### 3.2. Detected parasites and infection levels

Parasite of the genera *Anisakis* and *Rhadinorhynchus* were detected in all studied localities. *Nybelinia* sp. specimens were only detected in fish from Madeira, with a low prevalence (4.8%), and cystacanths of the genus *Bolbosoma* were never detected. Representatives of parasite species selected as possible biological tags and detected in this study are presented in Fig. 3. The infection levels observed in each locality for each parasite species are reported in Table 2.