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Helminth parasites of the oceanic horse mackerel *Trachurus picturatus* Bowdich 1825 (Pisces: Carangidae) from Madeira Island, Atlantic Ocean, Portugal

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Abstract

The helminth parasite fauna of the oceanic horse mackerel *Trachurus picturatus* Bowdich 1825, caught off the Madeira Islands was composed of six different taxa. Prevalence and abundance of larval *Anisakis* sp. (Nematoda: Anisakidae) and *Nybelinia lingualis* (Trypanorhyncha: Tentaculariidae), the most common parasite taxa, were 24.3%, 0.9 and 37.9%, 0.7, respectively. *Bolbosoma vasculosum* (Acanthocephala: Polymorphidae) and the monogeneans *Heteraxinoides atlanticus* (Monogenea: Heteraxinidae) and *Pseudaxine trachuri* (Monogenea: Gastrocotylidae) were comparatively rare. The depauperate helminth fauna of the oceanic horse mackerel at Madeira compared to other geographical regions of the north-eastern Atlantic, namely the Azores banks and the West African coast, may be attributed to the paucity of nutrients off oceanic islands and to a low density of the fish population.

Introduction

The oceanic horse mackerel *Trachurus picturatus* Bowdich 1825 (Pisces: Carangidae) is distributed throughout the north-eastern Atlantic, the eastern central Atlantic, Mediterranean and Black Sea, generally confined to the neritic zones and island shelves, banks and seamounts (Smith-Vaniz, 1986). Its vertical distribution reaches a depth of 370 m. Feeding is mainly on crustaceans and planktonic copepods, but fish and cephalopods are also of importance in their diet (Gaevskaya & Kovaleva, 1985; Smith-Vaniz, 1986; Jesus, 1992). Extensive parasitological surveys were done by Gaevskaya & Kovaleva (1980, 1985) from the Azores banks and Western Sahara Atlantic region, which reported the occurrence of several helminth species and the myxosporean *Kudoa nova* Najdenova, 1975. These authors found variations in prevalence of several of the parasite species between the regions sampled. Parasites have often proved to be good markers of fish populations (MacKenzie, 1990; George-Nascimento & Arancibia, 1992; MacKenzie *et al.*, 2008). To implement the principles of the use of parasites as biological indicators of fish populations recommended by MacKenzie (1987) and MacKenzie & Abaunza (1998), we need to have a detailed account of the parasites infecting a given fish species in the study area(s). The aim of this paper was to assess the parasitism of *T. picturatus* off Madeira Island, and to compare its parasite composition with those of *T. picturatus* from other Atlantic regions, in view of suggesting suitable parasites for use as biological indicators of population units.

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Materials and methods

Samples of *T. picturatus* ($n = 103$) caught at Madeira Island, Atlantic Ocean (32°22′20″N and 16°16′30″W),

Table 1. Prevalence, mean intensity and mean abundance of helminth parasites found infecting 103 *Trachurus picturatus* from Madeira Island, examined in January and February 2005.

Parasite species	Prevalence (%)	Confidence limits	Mean intensity (range)	Mean abundance
Monogenea				
Heteraxinoides atlanticus	1.0	–	1.0	1.0
Pseudaxine trachuri	1.9	–	1.0	1.9
Digenea				
Unidentified	1.0	–	1.0	1.0
Cestoda				
Nybelinia lingualis	37.9	28.5–48.0	2.0 (1–5)	0.7
Nematoda				
Anisakis sp.	24.3	16.4–33.7	3.8 (1–57)	0.9
Acanthocephala				
Bolbosoma vasculosum	1.9	–	1.0	1.9

obtained from purse seining catches in January and February 2005, were purchased at the Fish Landing Auction in the city of Funchal, Madeira Island. In order to examine fresh fish, subsamples of ten fish were obtained and brought to the laboratory at the Marine Biological Station of Funchal, until the total sample number was reached. The total sample consisted of fish ranging in length from 18 to 35 cm (mean ± standard deviation: 22.1 ± 1.9 cm) and in weight from 49.2 to 314.7 g (92.8 ± 27.7 g). All fish were measured in centimetres (cm) and weighed in grams (g). Gills were removed and examined under a binocular microscope for monogeneans and crustaceans. The body cavity was exposed and viscera removed and placed in Petri dishes. Stomachs and intestines were cut into small portions and examined for the presence of cestodes, nematodes, digeneans and acanthocephalans. Body cavities were also examined for parasites. All helminths recovered were fixed in 70% ethanol, cleared in glycerin or lactophenol, and identified according to the relevant literature (Berland, 1961; Yamaguti, 1963; Khalil *et al.*, 1994; Amin, 1998). Prevalence and abundance descriptors were calculated according to Bush *et al.* (1997). The significance of the relationships between prevalence or abundance of infection and fish length were studied with univariate ANOVA and Spearman's correlation coefficient, using the statistical package SPSS 11.0 (SPSS Inc., Chicago, Illinois, USA). The calculation of the variance/mean ratio (s^2/x), index of dispersion (D) of Poulin (1993) and confidence limits of prevalence and abundance of infection were done using the program QP 3.0 (Rozsá *et al.*, 2000).

Results

Two monogenean species were found in the gills of three fish, one with a single specimen of *Heteraxinoides atlanticus* (Gaevskaya & Kovaleva, 1979) (Monogenea: Heteraxinidae) and two other fish with one specimen each of *Pseudaxine trachuri* (Parona & Perugia, 1890) (Monogenea: Gastrocotylidae). Two juveniles of the acanthocephalan *Bolbosoma vasculosum* (Rudolphi, 1819) Porta, 1908 (Acanthocephala: Polymorphidae); 94 L3 larvae of *Anisakis* sp. type I (Nematoda: Anisakidae) and 75 postlarvae of *Nybelinia lingualis* Cuvier, 1817 (Trypanorhyncha: Tentaculariidae) were recovered from the 103 fish examined (table 1). One unidentified digenean was found in the visceral cavity of one fish. The two helminth parasites with higher prevalence were the larval *Anisakis* sp. and the postlarvae of *N. lingualis*. Table 1 summarizes the results of prevalence, intensity and abundance of the helminth parasites in *T. picturatus*, whereas table 2 shows the prevalence of *Anisakis* sp. and *N. lingualis* in different fish length classes. Estimations of the aggregation indices, variance/mean ratio (s^2/x) and index of discrepancy (D) for *Anisakis* sp. and *N. lingualis* suggested that the distribution of *Anisakis* sp. was overdispersed ($\chi^2 = 25.5$, df = 7, $P = 0.05$, $s^2/x = 35.1$; $D = 0.9$), whereas *N. lingualis* seemed to be randomly distributed ($\chi^2 = 8.2$, df = 3, $P = 0.05$, $s^2/x = 1.7$, $D = 0.7$). The relationships between fish length and abundance of *Anisakis* sp. and *N. lingualis* were significant at the 0.01 and 0.05 levels ($r_s = 0.3$, $P = 0.000$; and $r_s = 0.2$, $P = 0.04$, respectively). Prevalence of *N. lingualis* increased significantly with fish length ($F = 4.5$, df = 1, $P = 0.04$), with mean length of infected fish of 22.6 cm ($n = 39$) and mean length of uninfected fish of 21.8 cm ($n = 64$). Similarly, a positive significant relationship was found between prevalence of *Anisakis* sp. and fish length ($F = 12.8$, df = 1, $P = 0.001$), with mean length of infected fish of 23.2 cm ($n = 25$) against 21.8 cm ($n = 78$) for the uninfected fish.

Discussion

The helminth parasite fauna of the oceanic horse mackerel, *T. picturatus* from Madeira Island (present results)

Table 2. Prevalence of *Anisakis* sp. and *Nybelinia lingualis* found in 103 *Trachurus picturatus* from Madeira Island, according to fish length.

Length class (cm)	No. of examined fish	Prevalence (%)	
		N. lingualis	*Anisakis* sp.
18–20	11	9.1	0.0
21	19	42.1	21.1
22	35	40.0	17.1
23	22	36.4	27.3
≥24	17	47.1	52.9
Total	103	37.9	24.3

was less rich in terms of species than that of the same fish species found in the Azores banks (Meteor and Irving banks), as well as from the West African coast, with only six taxa found in the present study against 17 in the Azores banks, and 15 off the West African coast (Gaevskaya & Kovaleva, 1980, 1985) (see table 3). In particular, the digenean fauna was very depauperated in the present survey, with only a single individual of an unidentified digenean recovered. Monogeneans, which were abundant on the gills of *T. picturatus* from the Azores banks and West African coast, were rare in Madeira, with only three individuals – *H. atlanticus* (1) and *P. trachuri* (2) – recovered from the gill filaments of *T. picturatus* in the present survey. The rarity of the occurrence of these monogeneans during the sampling period could be related to a seasonal effect. Cestodes were restricted to postlarvae of *N. lingualis* and acanthocephalans to cystacanths of *B. vasculosum*. *Rhadinorhynchus cadenati*, a typical acanthocephalan of *Trachurus* spp. (Gaevskaya & Kovaleva, 1985; George-Nascimento, 2000; MacKenzie *et al.*, 2008), was not found in the present survey. These results are consistent with those found in a previous survey of 304 *T. picturatus* in Madeira Island (Gonçalves, 1996).

According to Arkhipov & Mamedov (1998), the Azores banks, Meteor and Irving, are rich in nutrients, where increased concentrations of phyto- and zooplankton occur. These regions are attractive to planktophagous fish such as *T. picturatus* and *Scomber colias*. Being regions of high plankton concentration, the conditions are met for a high availability of intermediate hosts of digeneans, nematodes and acanthocephalans, thus the potential for infections of fish is expected to be higher (Marcogliese, 1995, 2002). Additionally these regions have intense mixing due to the ocean currents (Arkhipov & Mamedov, 1998), providing, for example, a higher probability for eggs of monogeneans to find new hosts to infect. Accordingly, a higher prevalence of monogeneans, as well as of other helminth parasites requiring zooplanktonic intermediate hosts, were found in *T. picturatus* from those areas compared to Madeira Island (Gaevskaya & Kovaleva, 1985; present results). Similarly, the West African coast, a shelf region with a higher input of nutrients, compared with the oceanic region of Madeira Island, supports possibly more intermediate hosts, thus enhancing the transmission success of a larger number of parasite species (Gaevskaya & Kovaleva, 1985; Marcogliese, 2002).

Although the influence of nutrients in the water could be a plausible hypothesis, differences in parasite richness between Madeira Island and the Azores seamounts could also be related to sample size and fish length.

Table 3. Prevalence of helminth parasites recovered from *Trachurus picturatus* from Madeira Island (present results), Azores banks and Western Sahara (West African Coast) (Gaevskaya & Kovaleva, 1985). The fish examined from Meteor bank, Irving bank and Western Sahara were 14–25 cm, 34–43 cm and 25–30 cm in length, respectively. When the parasite is present but prevalence was not found it is indicated with ‘Yes’.

Parasite species	Madeira Island ($n = 103$)	Meteor bank ($n = 60$)	Irving bank ($n = 60$)	Western Sahara ($n = 40$)
Monogenea				
Cemocotyle trachuri Dillon et Hargis 1965	–	6.7	–	6.8
Diplectanotrema trachuri Kovaleva 1970	–	–	–	20
Gastrocotyle trachuri van Beneden et Hesse 1863	–	66.7	–	93.3
Heteraxinoides atlanticus Gaevskaya et Kovaleva 1979	1.0	–	–	Yes
Pseudaxine trachuri Parona et Perugia 1889	2.0	33.3	–	80.0
Digenea				
Chrisomon tropicus Manter 1940	–	–	–	53.0
Ectenurus lepidus Looss 1907	–	–	–	46.0
E. virgulus Linton 1910	–	6.7	–	–
Lampritema miescheri Zschokke 1890	–	–	13.3	–
Lecithocladium excisum Rudolphi 1819	–	–	7.4	6.7
Monascus filiformis Odhner 1911	–	–	–	Yes
Paraccacladium sp. Bray et Gibson 1977	–	–	6.7	–
Podocotyloides chloroscombri Fischthal et Thomas 1968	–	–	–	Yes
Syncoelium filiferum Sars 1885	–	–	1 only	–
Tetrochetus coryphaenae Yamaguti 1934	–	6.7	–	–
Cestoda (larvae)				
Nybelinia lingualis Cuvier 1817	37.3	20	93.3	–
Pseudophyllidae	–	Yes	Yes	–
Scolex pleuronectis Müller 1788	–	6.7	6.7	86
Tentacularia coryphaenae Bosc 1802	1	–	20	–
Acanthocephala				
Bolbosoma vasculosum (cystacanth) Rudolphi 1819	1.9	–	–	–
Rhadinorhynchus cadenati Golvan et Houin 1964	–	–	13.3	6.7
Nematoda (larvae)				
Anisakis sp.	24.3	20	86.7	40
Thynnascaris (=*Hysterothylacium*) sp.	–	14.8	–	13.3
Copepoda				
Lernanthropus trachuri Brian 1903	–	26.7	–	13.3

George-Nascimento (2000), in his survey of parasites of another carangid species *Trachurus symmetricus murphyi*, found many fish infected with only one parasite taxon or uninfected (70% of the fish uninfected, sample size = 1831 fish). This means that perhaps by increasing the sample size, more parasite taxa could be found in *T. picturatus*. Is fish length an important factor? In our study we found significant positive differences in the abundance of *Anisakis* sp. and *N. lingualis* with fish length. Additionally, prevalence seemed to have a relationship with length, as fish shorter than 20 cm were not infected with *Anisakis* sp. and had lower values of prevalence of *N. lingualis* (see table 2), a trend already observed in a previous survey of parasites of *T. picturatus* (Gonçalves, 1996). The diet of this fish species is known to vary with fish length (Gaevskaya & Kovaleva, 1985); fish less than 25 cm long feed predominantly on copepods, suitable for transmission of *Scolex pleuronectis* and hemiuroid digeneans, whereas fish longer than 25 cm prefer cephalopods, which transmit anisakid nematodes and *N. lingualis*. Thus size seemed to be an important factor for intensity of infection and perhaps for parasite species richness, as evidenced by other authors (Rohde *et al.*, 1995; Brickle *et al.*, 2002; Poulin & Morand, 2004).

Parasite species richness may be related to a number of other factors, such as host diet, host population density and differences in habitat characteristics (Poulin & Morand, 2004). Looking at the landings statistics for *T. picturatus* in Madeira Island, it appeared that a sharp decrease occurred from 1985 to 2005, from more than 1500 tons to roughly 400 tons from 1996 to date (data from the Fisheries Department of Funchal, unpublished). Thus, a lower population density of this fish species could lead to decreased parasite species richness. Unfortunately, no data on the occurrence of parasites prior to 1996 were available for *T. picturatus* from Madeira Island. The observed differences in prevalence and intensity of helminth parasites could also suggest that *T. picturatus* forms local, self-reproducing populations, as already assumed by Gaevskaya & Kovaleva (1985).

Comparing the helminth parasite fauna of *T. picturatus* from Madeira Island with that found in the Azores banks and West of Africa, the following conclusions can be drawn (see table 3). Species characteristic of the genus *Trachurus*, such as *Diplectanotrema trachuri* Kovaljova, 1970, *Cemocotyle trachuri* Dillon & Hargis, 1965, *Rhadinorhynchus cadenati* Golvan & Houin, 1964, and *Lernanthropus trachuri* Brian, 1903 (Gaevskaya & Kovaleva, 1985), were absent in the present study. The generalist species *B. vasculosum* was only found in Madeira, whereas the generalists *N. lingualis* and *Anisakis* sp., were common to other Atlantic regions. It is possible that the monogeneans *P. trachuri* (with prevalence 80% in the shelf region, 33.3 and 0% in oceanic seamounts, present in Madeira), and *Gastrocotyle trachuri* (with prevalence 93.3% in the shelf region, and 66.7 and 0% in oceanic seamounts), as well as the trypanorhynch *N. lingualis* (with prevalence 93.3 and 20% in oceanic seamounts, 37.9% in the oceanic island of Madeira, 0% in the shelf region), could be useful as biological tags in future studies of ecological population structuring of this fish species. Moreover, the high prevalence of the above-mentioned monogeneans in the Azores banks indicate a higher population density of *T. picturatus* in the seamounts in comparison with Madeira Island, as expected (Stocks & Hart, 2007).

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