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Metazoan gill parasites of wild albacore *Thunnus alalunga* (Bonaterre, 1788) from the Balearic Sea (western Mediterranean) and their use as biological tags

Salvatore Mele[a,b,*], Paolo Merella[b], David Macias[c], María J. Gómez[c], Giovanni Garippa[b], Francisco Alemany[a]

[a] Instituto Español de Oceanografía, Centre Oceanogràfic de les Balears, Moll de Ponent s/n, 07015 Palma, Spain
[b] Sezione di Parassitologia e Malattie Parassitarie, Dipartimento di Biologia Animale, Università di Sassari, Via Vienna, 2, 07100, Sassari, Italy
[c] Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Puerto Pesquero s/n, Apdo. 285, 29640 Fuengirola, Málaga, Spain

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ABSTRACT

Metazoan gill parasites of 30 albacore *Thunnus alalunga* caught in the Balearic Sea (western Mediterranean) were examined for parasites with the aim to evaluate their possible use as biological tags. A total of 9 species of parasites were found: 1 capsalid monogenean, 6 didymozoid trematodes and 2 crustaceans. Most of the parasites collected were didymozoids (95.8% of all specimens) and *Didymozoon longicolle* was the dominant species. Albacore is a new host record for *Capsala paucispinosa* and *Didymozoon pretiosus*, while *Didymosulcus aahi*, *Didymosulcus dimidiatus*, *Nematobothrium latum* and *Rocinela* sp. are for the first time reported from the Mediterranean Sea. Significant differences were found grouping data by host size, with lower infection levels in the larger sized fish, whereas no differences were found between host sex. Most of the parasites showed a high site selection: *D. aahi*, *D. dimidiatus* and *D. longicolle* had significant differences of prevalence between internal and external margins of gill filaments, and almost all specimens of *Pseudocycnus appendiculatus* were attached to the gill filaments of the second and third holobranchs. The usefulness of parasites as biological tags is discussed; particularly, *D. longicolle* and *D. pretiosus* could be used to separate Mediterranean and northeast Atlantic stocks of albacore.

1. Introduction

The albacore *Thunnus alalunga* (Bonnaterre, 1788) (Teleostei: Scombridae) is a migratory cosmopolitan tuna distributed throughout tropical and temperate areas of all oceans, including the Mediterranean Sea (Collette and Nauen, 1983). It is a top level predator, and its diet varies according to size and availability of prey, e.g. pilchard, anchovy, mackerel, squid and crustaceans (Consoli et al., 2008). The populations of this fish from different oceans are managed as separate stocks, based on the available evidence of geographical separation, and distinct spawning areas and seasons (Alonso et al., 2005; Joseph, 2003). Therefore, the North and South Atlantic populations (separated by 5°North latitude), and the Mediterranean one are considered as three distinct management units (Anon, 1996). The Mediterranean populations have been separated from the North Atlantic ones by genetics (Nakadate et al., 2005), spawning areas (Dicenta et al., 1975; Duclerc et al., 1973), growth (Megalofonou, 2000), and size and age at first maturity (Arena et al., 1980). Despite this separation for management purposes, the knowledge about the extent of the transzonal migrations of this fish is meagre (Arrizabalaga et al., 2003).

Parasites have been used with success to point out differences between host populations and/or to study migrations of several fish species (Lester, 1990; Lester and MacKenzie, 2009; MacKenzie and Abaunza, 1998). Therefore, the information about the parasite fauna of albacore could be a complementary tool for stock assessment and management, as reported for other tunas, such as the southern bluefin tuna, *Thunnus maccoyi* (Castelnau, 1872), and the Atlantic bluefin tuna, *Thunnus thynnus* (Linnaeus, 1758) (Hayward et al., 2007; Nowak et al., 2006). The parasite fauna of albacore has been investigated by Jones (1991), Pozdnyakov (1990) and Schwartz (1939) in the Pacific Ocean, and by Aloncle and Delaporte (1974), Dollfus (1952), Guiart (1938), Legendre (1940), Postel (1963, 1964) and Priol (1944) in the Atlantic Ocean, while no parasitological data are available for the Mediterranean Sea. Gill parasites of tunas are often used as biological tags because gills are not affected by handling manipulation, can be easily dissected during the evisceration and do not have any commercial value (Lester et al., 1985; Rodríguez-Marín et al., 2008).

The aim of this paper is to describe the metazoan parasites on the gills of *T. alalunga* from the Balearic Sea (western Mediterranean) and to evaluate the possible use of parasites as biological tags.

* Corresponding author. Tel.: +34 971133720; fax: +34 971404945.
E-mail address: salbad22@yahoo.it (S. Mele).

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2. Materials and methods

On July 2008, 30 specimens of albacore were caught by trolling lines in the Balearic Sea (western Mediterranean) (Fig. 1).

Immediately after landing, fish were measured (range fork length = 50–96 cm), weighed (range of total weight 3.8–16.2 kg), and sexed (sex ratio = 1:1) (Table 1). Gills were extracted, stored individually in plastic bags and frozen at −20 °C. In the laboratory, the gills were unfrozen and carefully examined for parasites. Each holobranch was numbered from 1 to 4, from the anterior-external to the posterior-internal, and their surfaces named A, B, C and D (Fig. 2).

Location and possible macroscopic pathological alterations were recorded for each parasite. All parasites found were counted and stored in 70% ethanol. For microscopical examination and species identification, parasites were processed according to standard protocols (Berland, 1984; Roberts, 1989). Fresh and mounted parasites were micrographed and measured with a digital system. Among the literature used for species identification: Bussieras (1972), Chisholm and Whittington (2007), Lamothe-Argumedo (1997), Palombi (1949) and Price (1939) for monogeneans; Ariola (1902), Guiart (1938), Ishii (1935), Legendre (1940), Pozdnyakov (1990), Pozdnyakov and Gibson (2008) and Yamaguti (1958, 1970) for didymozoids; Brian (1906), Hewitt (1969) and Kabata (1992) for copepods; Bruce (1983), Brusca and Iverson (1985), Haswell (1882) and Richardson (1905) for isopods.

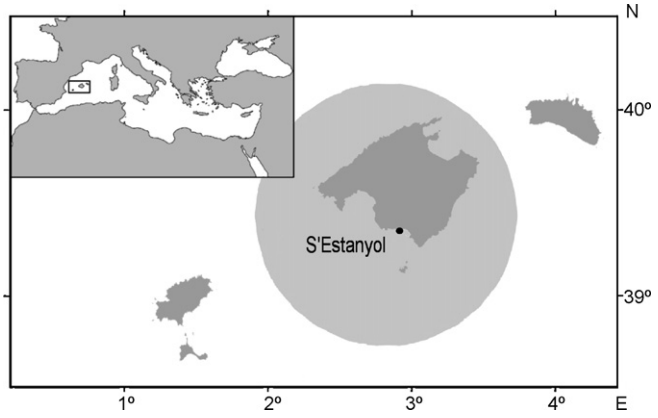

Fig. 1. Site of sampling of albacore (*Thunnus alalunga*) in the Balearic Sea (western Mediterranean).

Table 1
Sampling data of the specimens of albacore (*Thunnus alalunga*) examined, grouped according to fork length. FL = fork length; *W* = total weight.

Group of size	*N*	Mean FL ± s.d. (cm)	Mean W ± s.d. (kg)	Sex ratio F:M
FL 50–66 cm	16	62.2 (4.1)	4.9 (0.8)	1:0.45
FL 67–74 cm	6	69.8 (1.1)	6.3 (0.7)	1:2
FL 75–96 cm	8	81.7 (6.8)	10.4 (2.6)	1:1
All samples	30	68.9 (9.5)	8.5 (2.8)	1:1

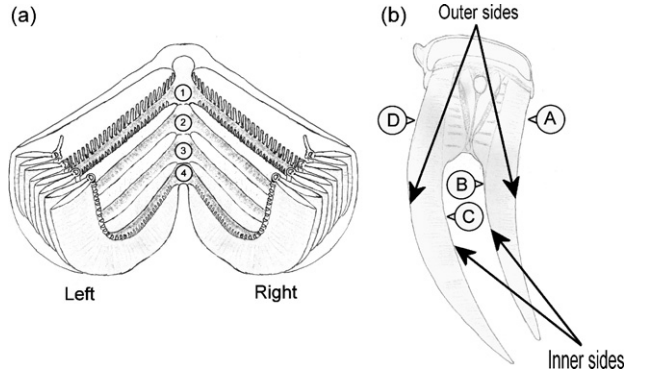

Fig. 2. Diagram of the gills of albacore (*Thunnus alalunga*) illustrating the division in microhabitats. (a) Gill holobranchs; (b) transversal section of the whole holobranch, sides (A, B, C and D); outer sides (A and D) and inner sides (B and C).

Prevalence (P%), range of intensity (IR) and mean intensity (MI) of each parasite species were calculated according to Bush et al. (1997). Confidence intervals of prevalence and of mean intensity were calculated with Sterne's exact method (Reiczigel, 2003) and Efron-Tibshirani bootstrap (Rózsa et al., 2000), respectively. The levels of infection were calculated according to site of location, host size (hosts were divided into three fork length categories: 50–66 cm, 67–74 cm, 75–96 cm), and sex. Fisher's exact test and bootstrap test were used to evaluate differences between prevalences and mean intensities (Rózsa et al., 2000). Calculations were made using the free software Quantitative Parasitology 3.0 (Reiczigel and Rózsa, 2005). To evaluate possible correlations between host size and prevalence (with previous arcsine transformation) and intensity of infection, the Spearman's rank correlation coefficient was tested with Student's *t*-test (Zar, 1996). Only species with prevalence ≥10% were considered for calculations (Bush et al., 1990).

3. Results

On the gills of examined albacores, a total of 9 species of metazoan parasites were found (Table 2): 1 capsalid monogenean (*Capsala paucispinosa* (Mamaev, 1968)); 6 didymozoid trematodes (*Didymosulcus aahi* Pozdnyakov, 1990; *D. dimidiatus* Pozdnyakov, 1990; *Didymozoon longicolle* Ishii, 1935; *D. pretiosus* Ariola, 1902; *Nematobothrium latum* Guiart, 1938; *Wedlia bipartita* (Wedl, 1855)); 2 crustaceans (*Pseudocycnus appendiculatus* Heller, 1868; *Rocinela* sp.).

Most of the parasites collected were didymozoids (95.8% of all specimens), followed by crustaceans (2.9%) and monogeneans (1.3%). *D. longicolle* was the dominant species, with 113 specimens (36.1%), and the copepod *P. appendiculatus* represented almost all crustaceans. Overall, 83.3% of all sampled tunas were infected with at least one parasite (total MI 12.5).

Prevalence and mean intensity of parasites are shown in Table 2. Grouping data according to host size, significant differences were found between total prevalences of the smaller and the larger sized fish (Table 2), but prevalence and intensity of the single parasite species were not correlated with host size. Prevalence and mean intensity according to host size are reported in Fig. 3. In general, the lower values of infection were recorded in the larger sized hosts, and two species (*D. pretiosus* and *P. appendiculatus*) were not recorded in fish of this group. *C. paucispinosa* was only found in 2 specimens of the smaller sized fish. No significant differences were recorded between host sex.

According to location, no significant differences were found between right and left gills, and between holobranchs. The first holobranch showed the higher total mean intensity of infection (4.9), and the third the higher total prevalence (73.3%), in particular: 1st holobranch, P% = 70.0%, MI = 4.9; 2nd, 63.3%, 3.4; 3rd, 73.3%, 3.3; 4th, 66.7%, 3.1. The only 4 *C. paucispinosa* specimens found in situ were located on the first three holobranchs between the gill filaments. Didymozoids had well separated location on gills (Fig. 4): *D. aahi* was found on the outer margin of gill filaments; *D. dimidiatus* on the outer side of gill arches skin; *D. longicolle* and *D. pretiosus* on the inner margin of gill filaments, on the basal and middle third of lamella, respectively; *N. latum* and *W. bipartita* on the connective tissue of the proximal and distal parts of gill arches, respectively.