Zoodiversity, **55**(6): 505–518, 2021
DOI 10.15407/zoo2021.06.505

UDC 595.132: 597.5(262:65)|

METAZOAN PARASITES INFECTING *XIPHIAS GLADIUS* FROM THE EASTERN COAST OF ALGERIA (SW MEDITERRANEAN SEA)

S. Ramdani[1*], J.-P. Trilles[2], Z. Ramdane[1]

[1]Laboratoire de la zoologie appliquée et de l'écophysiologie animale, université Abderrahmane Mira-Bejaia, Algérie
[2]Université de Montpellier, 34000 Montpellier, France
[*]Corresponding author
E-mail: sousane.green@gmail.com; souhila.ramdani@univ-bejaia.dz

Souhila Ramdani (https://orcid.org/0000-0003-4436-2620)

Metazoan Parasites Infecting *Xiphias gladius* from the Eastern Coast of Algeria (SW Mediterranean Sea). Ramdani, S., Trilles, J.-P., Ramdane, Z. — Five specimens of *Xiphias gladius* Linnaeus, 1758 were sampled from the eastern coast of Algeria and examined for their metazoan parasites. Pathological effects of the collected parasites were examined for the whole body of *X. gladius*. Four metazoan parasites species were collected: two monogeneans (*Tristoma coccineum* Cuvier, 1817; *T. integrum* Diesing, 1850), one copepod (*Pennella instructa* (Wilson, 1917)) and one parasitic nematode (*Hysterothylacium aduncum* (Rudolphi, 1802)). We report here for the first time a symbiotic species, *Conchoderma virgatum* Spengler, 1789 (Cirripedia) fixed on *P. instructa*. Collected monogenean and the copepod species are newly recorded for Algerian coast. *Xiphias gladius* is a new host for *H. aduncum* in the studied region. All examined specimens were infected (P = 100 %). The collected copepod parasite, *P. instructa* (P = 60 %) induces serious pathological effects to its host (necrosis and hemorrhage particularly). Histological sections showed that this copepod causes skin lesions, deteriorations on the dermal and muscle tissue.
Key words: *Xiphias gladius*, parasitic fauna, Algerian coasts.

Introduction

Xiphias gladius Linnaeus, 1758 is the only member of the family Xiphiidae, with a worldwide distribution (Muscolino et al., 2012) extending from tropical to cold-temperate oceans, including the Mediterranean Sea (Nakamura 1985). This species is a pelagic and migratory fish, which can grow up to more than 3 m in length (Tserpes & Tsimenides, 1995; Sun et al., 2002). This fish species represents one of the most important fish resources for the North Atlantic and the Mediterranean fisheries (Mattiucci et al., 2005).

Metazoan parasites infecting *X. gladius* were previously studied in the North Atlantic (Castro-Pampillon et al., 2002; Garcia et al., 2011; Mattiuci et al., 2014; Llarena-Reino et al., 2019) and in the Mediterranean Sea, (Mattiucci et al., 2005; Öktener et al., 2007; Mattiucci et al., 2014). But several further studies were conducted in other geographical areas: in the Pacific Ocean, Smith et al. (2007) and Muñoz et al. (2012) worked on both mesoparasites and ectoparasites (crustaceans, digeneans, monogeneans, nematodes), in the Indian Ocean, Karthick Rajan et al. (2018) focused their investigations on crustaceans, while studies from the Eurasian south Sea and Baltic Sea reported especially cestodes and nematodes (Bacevičius & Karalius, 2005; Varghese & Unnikrishnan, 2015). Overall, Cestoda and Nematoda are the most dominant parasite groups recorded from *X. gladius* though, their high diversity especially in the Atlantic Ocean may be explained by the high number of conducted studies in this region.

Many studies focused on the taxonomical identification of parasites infecting *X. gladius* while some works used selected parasites as biological tags (Castro-Pampillón et al., 2002 b) and for the stock characterization (Mattiucci et al., 2014). Pathological effects caused by single parasites (*Penella instructa*) in *X. gladius* were studied at the macroscopic level (Llarena-Reinoa et al., 2019).

Available scientific data on *X. gladius* taken off the Algerian coast focused especially on the presence of toxic metals and the development of the catch and landing statistics of this commercially important species (Kouadri Krim et al., 2017; Kouadri Krim & Bouhadja, 2019; Mehouel et al., 2019). To our knowledge, no previous studies on the metazoan parasite communities infecting swordfish have been conducted in this region. One of the reasons for it could be the difficulty to obtain the whole specimens of this high valued commercial species for such kinds of studies.

The aim of this study is to identify the parasitic fauna infecting *X. gladius* collected off the eastern coast of Algeria, to report the observed pathological impact related to the parasitism, and to establish the checklist of all known parasite species infecting *X. gladius* from the world.

Material and methods

A total of 5 specimens of *Xiphias gladius* Linnaeus, 1758 were obtained in the harbor from commercial boats fishing in the Gulf of Bejaia (fig. 1) from February to May 2019. My general thesis project was focused on the study of pathological effects caused by parasites on their hosts. This comprises several fish species inhabiting the Gulf of Bjaia, and samples were often dependent on the availability of fishes especially those rarely captured such as *X. gladius*. Fish specimens were transported in the cooler container to the laboratory (University of Bejaia).

All fish individuals were completely necropsied and the examination of the fishes was realized with assistance of two master students. Prior to examination, the total length (LT) was measured to the nearest 1 cm. The sampling period (months) and sex of each fish specimen were noted (table 1).

Xiphias gladius body surface (flanks, fins, mouth) was visually and carefully examined by naked eye and magnifying glass for ectoparasites. The gills were dissected to survey all the gill arches and filaments separately under the binocular stereoscopic microscope for parasites. The peritoneal cavity, the internal organs (digestive tract (intestines, stomach, pyloric caeca), liver, gonads, swim bladder, kidney and muscle tissue) were examined for endoparasites under the binocular stereoscopic microscope.

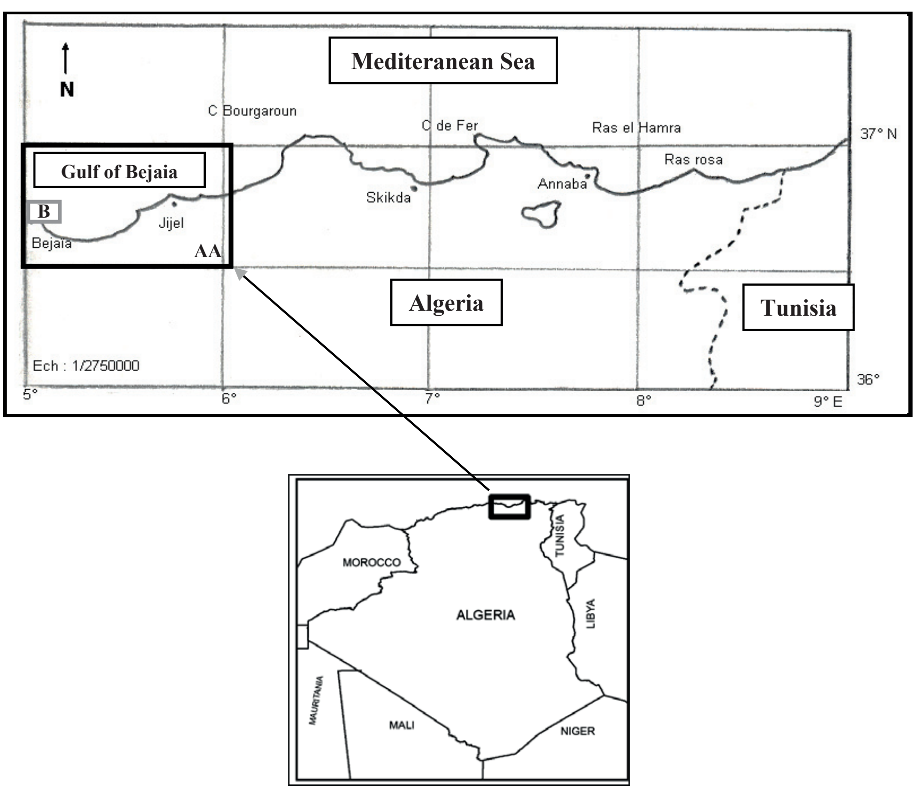

Fig. 1. Location of the study area (A) and sampling site (B).

Table 1. Parasitological indexes per months, size classes and sex of *X. gladius*

Parameters	NEF	NIF	NP	P (%)	Im	Am
Months						
February 2019	02	02	12	100	06	06
March 2019	01	01	04	100	04	04
April 2019	01	01	06	100	06	06
May 2019	01	01	03	100	03	03
Sizes classes, cm						
[100–120]	03	03	18	100	06	06
[120–140]	02	02	07	100	3.5	3.5
sex						
Females	03	03	15	100	05	05
Males	02	02	10	100	05	05

Note. NEF — number of examined fishes; NIF — number of infested fishes; NP — number of parasites; P (%) — prevalence; Im — Mean intensity; Am — mean abundance.

Copepods were removed from the fish muscle, their number and any potential damage were recorded and photographed (*in situ*). The copepods were washed and cleaned in a water, then cleared in 85 % lactic acid for 1 to 2 h and stored in 98 % alcohol for further examination. Length measurements of copepod individuals were done by a ruler. Monogenean and nematode parasites were cleared with lactophenol (Carbonell et al., 1999) and stored in pure alcohol (98 %) for further examination. Measurements under the microscope were realized using a graduated eyepiece.

The parasites were photographed under the light microscope and identified using identification keys (Hogans et al., 1985; Hogans, 1986; Williams & Lucy Bunkley-Williams, 1996; Ichaalal et al., 2015). The number of parasites and their attachment sites were noted for each fish. Parasitological indexes were calculated according to Bush et al. (1997).

A histological study was performed in order to evaluate the potential pathological impacts induced by copepods *Pennella instructa* (Wilson, 1917). Therefore, infected muscle tissue was cut out (fixing site) dehydrated in a graded series of (70 to 95 %), embedded in paraffin, cut into 1 µm-thick serial sections using a microtome, and stained with Mayer's haematoxylin and eosin. Thereafter, the sections were examined using light microscopy and photographed (using the LEICA DM300 microscope camera).

Results

Overview of the general morphology of the collected parasites

Four adult specimens of the ectoparasite *Tristoma coccineum* Cuvier, 1817 (Capsalidae Baird, 1853), were collected from the gill arches of *X. gladius* (fig. 2, A, B). This parasite presents a circular form with the length varying from 10.5 to 16.0 mm (13.7 ± 2.3). It has a haptor divided into 7 large alveoli around the border and 1 in the middle (fig 2, C, D). The margins of the body present rows of minute papillae radiating outward. Three adult specimens of *Tristoma integrum* Diesing, 1850 is a congener of *T. coccineum* from the same family (Capsalidae Baird, 1853) collected on the gill arches of *X. gladius* (fig. 2, A, B). This monogenean is morphologically similar to the adult specimen (4) of *T. coccineum* (circular form, haptor divided into 7 large alveoli around the border and 1 in the middle, and the body present rows of minute papillae), but the here measured size is smaller, varied from 6 to 12.6 mm (9.36 ± 3.3) in length and its margins of the body have rows of minute papillae, tiny and very tight radiating also outward (fig. 2, E, F). Under the stereomicroscope no damages on the gill lamellae or filaments could be observed potentially being caused by both monogenean species.

Pennella instructa (Wilson, 1917) (Pennellidae Burmeister, 1835) is an ectoparasite copepod with long cylindrical cephalothorax (from 14 to 16 cm in length) collected on *X. gladius*. Only the parasitic females were collected while males are free swimming. This copepod was collected from several swordfish body parts (on the dorsal, lateral, and ventral surfaces, pectoral and pelvic fins), penetrating through the skin and embedded in the musculature (fig. 3, A). The visible part, outside the host, may be only half the size. The whole evokes a black dart planted in the fish specimens of *X. gladius* ending with brush arranged in two rows composed of feathery plume. The cephalothorax is anchored in the body of the host.

This parasite is characterized by the presence of a long trunk; abdominal brush in the axis of the trunk, covered with plumes; two lateral horns (lh) protrude from the head and extend parallelly to the neck; the surface of the head is covered with central and lateral papillae (fig. 3, C).

This parasite causes serious damages to its host. Skin sections from attachment sites of *P. instructa* on the fish body show damages in the structure of the skin (epidermis, dermis and hypodermis) and muscles related to the mechanic effects caused by the parasite during its infiltration in the host tissues (fig. 3, B). Formation of the connective tissue around the parasite as a host reaction to the infection by this parasite (fig. 3, B) and cystic forms were found in the host's musculature (fig. 3, D).

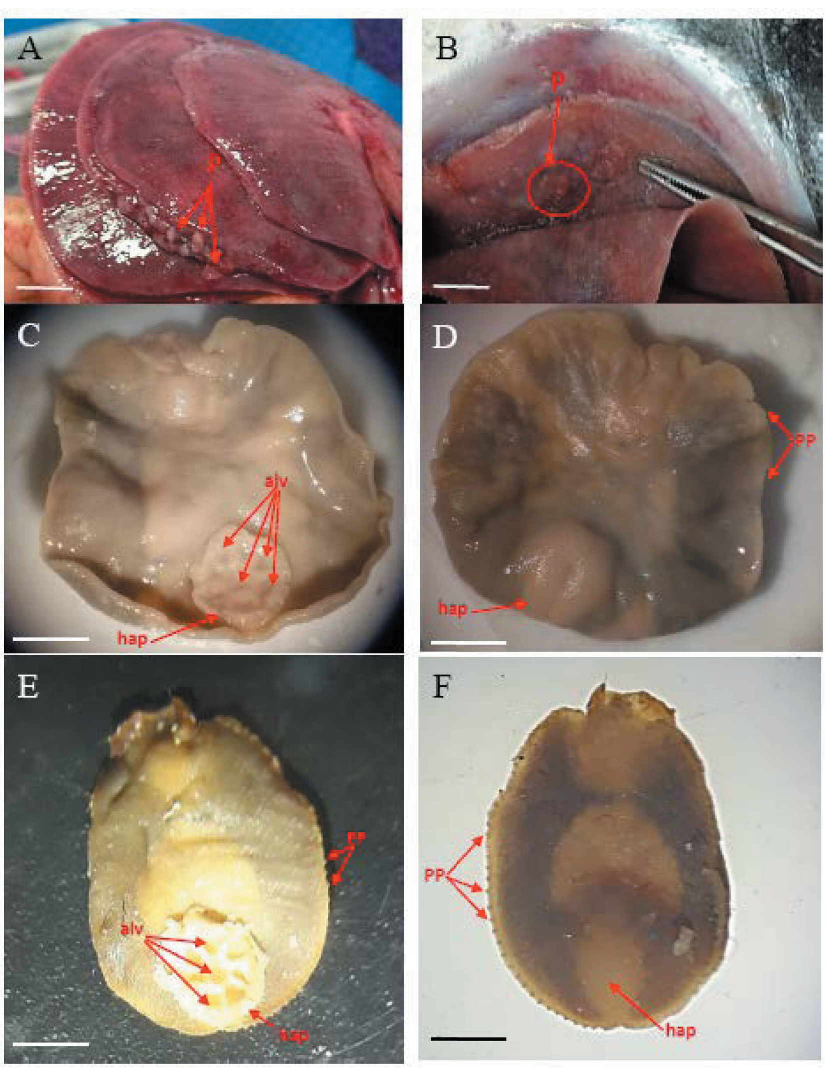

Fig. 2. A, B — *Tristoma coccineum* Cuvier, 1817 and *Tristoma integrum* Diesing, 1850 (see red circles) attached to gills of *X. gladius*: C — ventral view and D — dorsal view, of General morphology of the species *Tristoma coccineum* Cuvier, 1817; E — ventral view and F — dorsal view of General morphology of the species *Tristoma integrum* Diesing, 1850 observed under binocular magnifying glass: P — parasite, hap — haptor, alv — alveoli, pp — papillae. Scale bars: A, B — 2 cm; C, D, E, F — 2 m.

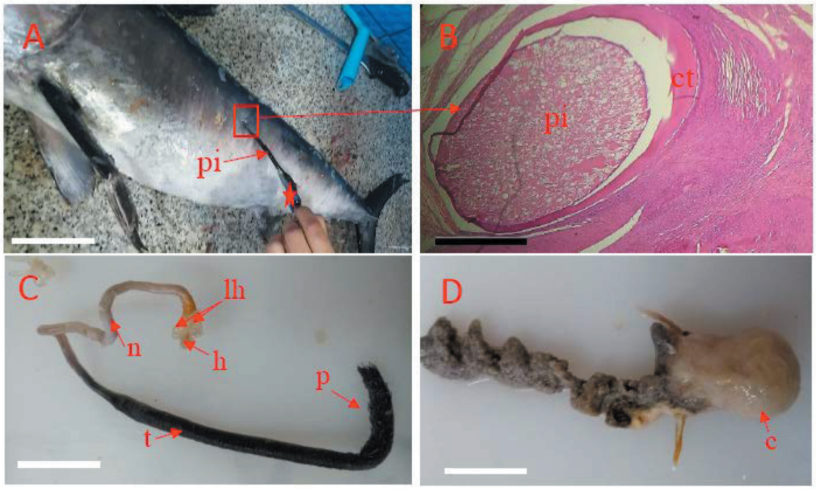

Fig. 3. A — *Pennella instructa* (Wilson, 1917) attached to the host's body with *Conchoderma virgatum* (red star); B — section of *P. instructa* surrounded by connective tissue; C — general morphology of parasite *P. instructa* (female); D — cystic forms found into the musculature: n — neck; lh — lateral horns; t — trunk; p — plumes; (ct) — connective tissue and (pi) — *P. instructa*. Scale bars: , C, D = 2 cm; B— x4 = 300 µm.

A cirripede species (Cirripedia, Lepadidae), *Conchoderma virgatum* Spengler, 1789, was found attached to the collected copepod parasite, *P. instructa* (fig. 3, A). The base stem (peduncle) and body (capitulum) of this epibiont are blended together without forming a distinct separation; its size varied from 7.3 to 25.2 mm (n = 8).

One species of parasitic Nematoda, *Hysterothylacium aduncum* (Rudolphi, 1802) was identified. These nematodes were collected in their pre-adult stages, freely within in the lumen of the stomach without cysts. Whitish nematodes of medium to large size (varied from 9.4 to 16 mm, mean = 12.7 ± 4.66); anterior end with 3 lips, esophagus long, slightly

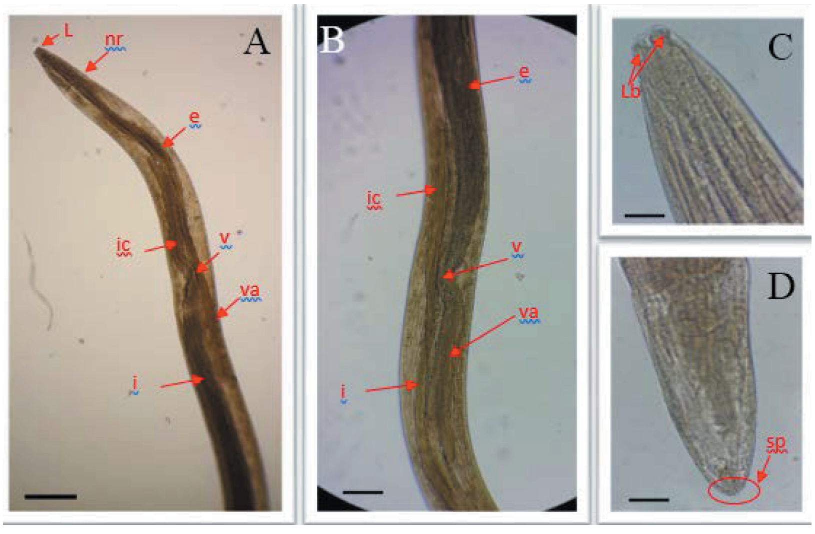

Fig. 4. General morphology of the species *Hysterothylacium aduncum* (Rudolphi, 1802) observed under an optical microscope. A — anterior part showing lips (l); nerve ring (nr); oesophagus (e); intestinal caecum (ic); ventriculus (v); ventricular appendix (va) and intestine (i), lateral view. B — middle part showing oesophagus (e); intestinal caecum (ic); ventriculus (v); ventricular appendix (va) and intestine (i), lateral view. C — dorsal labium showing labia (lb) lateral view. D — posterior end showing spinous tail (sp); lateral view. Scale bars: A — x10 = 100 µm; B, C, D — x40 = 50 µm.

Table 2. List of parasites collected in the swordfish, *X. gladius* sampled in Algerian coasts (parasitological indexes, infection sites and life stage)

Collected species	P (%)	Im	Am	S/I	Life stage
Ectoparasites					
Monogenea					
Tristoma coccineum Cuvier, 1817*	20	04	0.80	Gi	adult
Tristoma integrum Diesing, 1850*	20	03	0.60	Gi	adult
Copepoda					
Pennella instructa (Wilson, 1917) *	60	1.67	01	Bs, Msc	adult female
Endoparasites					
Nematoda					
Hysterothylacium aduncum (Rudolphi, 1802)	20	02	0.40	Sto	pre-adult

Note. P (%) — prevalence; Im — mean intensity; Am — mean abundance; S/I — infection site; Bs — body surface; Gi — gills; Msc — muscle; Sto — stomach; * — newly collected parasites on *X. gladius* from the eastern coast of Algeria.

wider at the back than at the front (fig. 4, A, C), ventricle oval to oblong, slightly narrower than the posterior region of the esophagus (fig. 4, A, B, C), intestinal caecum slightly longer and wider than the ventricular appendage (fig. 4, A, B); the posterior end has a conical tail ornamented with spinous tail (fig. 4, D).

Recorded infection rates by the collected parasites

Among the collected parasites, *Tristoma coccineum, T. integrum* and *Pennella instructa* are new records for the parasitic fauna of *X. gladius* caught off Algeria.

Higher prevalence was observed for *P. instructa* while rather lower infection rates were noted for monogeneans and the nematode (table 2). The highest mean intensity (reaching 4 parasites per infected host) was observed in monogenean species (table 2). Infection site varies according to the parasite species. In this case, the gills, the stomach and body surface (muscle) might represent the favorable environment respectively for monogeneans, nematodes and copepods (table 2). The identified parasites infect *X. gladius* throughout the period of sampling and reveal that all sizes and both sexes are highly parasitized (P = 100 %) (table 1).

Discussion

Three parasite species were recorded for the first time off the Algerian coast: *Tristoma coccineum*, *T. integrum* and *Pennella instructa*. *Hysterothylacium aduncum* has been previously reported in several teleost fishes in the studied region (Ichalal et al., 2015; Ider et al., 2018; Saadi et al., 2020), while the epibiont, *Conchoderma virgatum* fixed on the collected parasitic copepod is reported here for the first time.

All the here detected parasite species were already reported on *X. gladius* from tropical and temperate waters all over the world, including the Mediterranean Sea (table 3).

The highest prevalence was recorded for the parasitic copepod, *P. instructa*. Our results corroborate with those reported by several authors in the Mediterranean Sea (Merella et al., 2003; Mattiucci et al., 2005, 2014; Oktner et al., 2010). The recorded prevalence is similar to those obtained by Hogans et al. (1985) and Merella et al. (2003) (respectively, P = 60.1 % and P = 56.3), but remain lower than those reported by Mattiucci et al. (2014) (P = 100 %). Concerning the fixing sites, Hogans et al. (1985) and Castro-Pampillón et al. (2002 a) observed similar infection sites of this copepod particularly: the dorsal, lateral, and ventral surfaces, pectoral and pelvic fins.

The here recorded mean intensity of this copepod was globally closer to those reported by Garcia et al. (2011) in the central north and eastern tropical of the Atlantic Ocean (mean intensities vary from 1 to 2 parasite per infected host). Its pathological impacts on the parasitized fish are well known (damages, injuries and necrosis) and were recorded for many pennellid species. Damages and injuries can facilitate and even enhance the entry of many pathogens (secondary infection) such as bacteria, fungi and viruses (Ramdane et al., 2009). Mattiucci et al. (2014) and Llarena-Reino et al. (2019) reported that *P. instructa* could cause health problems for this fish species. As in our study, Cornaglia et al. (2000) and Danyer et al. (2014) observed a damage on the skin of dolphin infected with *Pennella* sp. and in the blubber and muscle of *Phocoena phocoena relicta* Abel, 1905 infected by *Pennella balaenoptera*. Our histological study reveals real damages in the structure of the epidermis, dermis, hypodermis and muscle. This may be related to the mechanic effects of the parasite during its infiltration in the host tissues. Llarena-Reino et al. (2019) reported the same cystic forms.

The association of *C. virgatum* and *P. instructa* observed in the present study is well known for a long time from different geographical areas around the world and particularly from the Mediterranean Sea (Causey, 1960; Beckett, 1968; Garibaldi & Relini, 2003; Merella et al., 2005; Massi et al., 2014) and appears to be particularly frequent on parasitic pennellids. It is commonly considered as an opportunistic settler (Relini, 1980), probably related to the characteristics of the external surface of Pennellids, that seem to be a favorable substrate for the barnacle, *C. virgatum* (Márquez, 1990; Parnell, 2001).

Each of the two collected monogenean species (*T. coccineum* and *T. integrum*) presented a relatively high mean intensity (table 2), slightly higher than values previously reported by Merella et al. (2003) (Im = 2.1–2.7) and are similar to those reported by Mattiucci et al. (2005) (Im = 3.2–3.3). However, they were lower than those reported by Oktner et al. (2010) (reaching 9 parasites infected host) in the Mediterranean Sea.

The morphological features of the collected monogeneans specimens correspond well with those reported by Euzet & Quignard (1961). High infection of these two monogeneans may damage the tissues of the respiratory organ and especially the gill filaments and thus, may cause low performance or non-functioning respiratory organ at very high infection rates by these parasites. Serious damages were observed by Kayiş et al. (2010) from *Tristomella laevis* (Monogenea, Capsalidae) from the Aegean Sea in Turkey on the gills of *X. gladius.*

Lles (1971) noted that the presence of *T. coccineum* and *T. integrum* on a swordfish from the Mediterranean suggest that these monogenetic flukes may be useful as biological tags to distinguish populations of the swordfish.

Xiphias gladius is a new host record for *Hysterothylacium aduncum* in the studied region. However, its presence in *X. gladius* from the Atlantic was already known (Hogans et al., 1983; Castro-Pampillon et al., 2002 b). A low prevalence and mean intensity were recorded for this nematode species in present study (table. 2). The here detected values for these indexes are distinctly lower to those reported by Smith et al. (2007). These authors reported a heavy intensity from *X. gladius* caught off New Zealand and New Caledonia. This low index values could be explained by an accidental infection acquired from preys, by the trophic behavior of the host (absence of preys enhancing infection by parasitic nematodes). According to Ceyhan & Akyol (2017), major prey categories in stomachs of swordfish in the Aegean Sea were 88.7 % of teleost fishes, especially *Engraulis encrasicolus*, *Sardina pilchardus* and other fish species; *Cepola macrophthalma*, *Merluccius merluccius*, *Scomber japonicus* and *Sardinella aurita*. Saadi et al. (2020) reported that those teleost fishes are potential host for Nematoda and noted a high infection by *Hysterothylacium* spp. Low infection by parasitic nematodes prevents to their damages. Additionally, in Algeria, several researchers have reported the presence of *Hysterothylacium* spp. in several teleost species (Ichaal et al., 2015, 2016; Ider et al., 2018, Saadi et al., 2020; Ramdani et al., 2020). According to Ichalal et al. (2016), the parasitic load of nematodes in female gonads of *Trachurus trachurus* can cause intersexuality. The histopathological study of the gonads in this study revealed the simultaneous presence of oocytes at different stages of development and male

Table 3. Checklist of parasites collected on *Xiphias gladius* (Linnaeus, 1758) in the different geographical localities in the world

Parasites species	Locality	References
Monogenea		
Capsala laevis (Verrill, 1875)	Atl, Adr, Med	Silas 1967 ; Palko et al. 1981.
Tristoma integrum Diesing, 1850	Atl, Pac, Med, **Algeria**	Palombi, 1949; Euzet and Quignard, 1961; Iles, 1971; Silas, 1967; Palko et al., 1981; Hogans et al., 1983; Di Paolo et al., 1994; Paggi et al., 1998; Merella et al., 2003; Mattiuci et al., 2005; Smith et al., 2007; Garcia et al., 2011; Mattiuci et al., 2014; **present study**
Tristoma coccineum Cuvier, 1817	Atl, Med, NwAtl, **Algeria**	Palombi, 1949; Euzet and Quignard, 1961; Iles, 1971; Silas, 1967; Palko et al., 1981; Hogans et al., 1983; Di Paolo et al., 1994; Paggi et al., 1998; Merella et al., 2003; Mattiuci et al., 2005; Smith et al., 2007; Garcia et al., 2011; Mattiuci et al., 2014; **present study**
Tristomella laevis (Verrill, 1875)	Med	Kayiş et al., 2010
Tristoma spp. Cuvier, 1817	Atl	Castro-Pampillon et al., 2002
Digenea		
Didymocystis xiphoides	Atl-wh	Silas, 1967; Palko et al., 1981
Hirudinella clavata (Menzies, 1791)	Pac, Atl	Silas, 1967; Palko et al., 1981
Hirudinella ventricosa (Pallas, 1774)	Atl, NwAtl, Eas	Silas, 1967; Palko et al., 1981; Hogans et al., 1983; Garcia et al., 2011; Mattiuci et al., 2014; Varghese and Unnikrishnan, 2015
Hirudinella marina Garsin, 1730	NwAtl	Iles, 1971
Hirudinella sp. Garsin, 1730	Atl, Pac	Castro-Pampillon et al., 2002; Smith et al., 2007
Prosorhynchoides sp. Dollfus, 1929	Med, Atl	Mattiuci et al., 2005; Mattiuci et al., 2014
Opisthodena dimidia Linton, 1910	NwAtl	Hogans et al., 1983
Cestoda		
Fistulicola plicatus Rudolphi, 1819	NwAtl, Eu, Atl, Med, Eas, Bas	Silas, 1967; Iles, 1971; Palko et al., 1981; Hogans et al., 1983; Castro-Pampillon et al., 2002; Bacevičius and Karalius, 2005; Matiuci et al., 2005; Garcia et al., 2011; Mattiuci et al., 2014; Varghese and Unnikrishnan, 2015
Grillotia erinaceus (van Beneden, 1858)	NwAtl.	Silas, 1967; Palko et al., 1981
Gymnorhynchus gigas (Cuvier, 1817)	NeAtl, Med	Silas, 1967; Palko et al., 1981; Muscolino et al., 2012
Gymnorhynchus horridus (Goodsir, 1841)	Med	Muscolino et al., 2012
Molicola uncinatus (Linton, 1924)	Atl-wh	Silas, 1967; Palko et al., 1981

Continued Table 3.

Nybelinia bisulcata (Linton, 1889)	NwAtl, Eas	Silas, 1967; Palko et al., 1981; Varghese and Unnikrishnan, 2015
Nybelinia lamonteae Nigrelli, 1938	NwAtl	Nigrelli, 1938; Silas, 1967; Palko et al., 1981; Hogans et al., 1983
Nybelinia lingualis (Cuvier, 1817)	NwAtl, Eas	Silas, 1967; Palko et al., 1981; Varghese and Unnikrishnan, 2015
Otobothrium crenacolle Linton, 1890	Atl-wh	Silas, 1967; Palko et al., 1981
Otobothrium (Pseudotobothrium) dispacum Linton, 1897	Atl	Silas, 1967; Palko et al., 1981
Pseudeubothrium sp.	Pac	Smith et al., 2007
Phyllobothrium loliginis (Leidy 1887)	NwAtl	Silas, 1967; Palko et al., 1981
Phyllobothrium delphini (Bosc, 1802)	NwAtl	Hogans et al., 1983
Scolex pleuronectis Müller, 1788	NwAtl	Silas, 1967; Palko et al., 1981
Scolex polymorphus Rudolphi, 1819	NwAtl	Hogans et al., 1983
*Tentacularia bicolor (*Bartels, 1832)	NwAtl	Silas, 1967; Palko et al., 1981
Tentacularia coryphaena Bosc, 1802	Atl, NwAtl, Pac, Eas	Nigrelli, 1938; Silas, 1967; Palko et al., 1981; Hogans et al., 1983; Castro-Pampillon et al., 2002; Muñoz et al., 2012; Varghese and Unnikrishnan, 2015
Hepatoxylon sp.	Med, Pac	Mattiuci et al., 2005; Smith et al., 2007
Hepatoxylon squali Bosc, 1811	Atl	Castro-Pampillon et al., 2002; Garcia et al., 2011
Hepatoxylon trichiuri (Holten, 1802)	Atl, Eas	Mattiuci et al., 2014; Varghese and Unnikrishnan, 2015
Hepatoxylon attenuatus Rudolphi, 1819	NwAtl	Hogans et al., 1983
Tetraphyllidea larvae	Med	Mattiuci et al., 2005
Tetraphyllidea spp.	Med, Atl	Garcia et al., 2011; Mattiuci et al., 2014
Ceratobothrium xanthocephalum Monticelli, 1892	NwAtl	Hogans et al., 1983
Dasyrhynchus variouncinnatus (Linton, 1924)	NwAtl	Hogans et al., 1983
Sphyriocephalus viridis Pintner, 1913	Atl	Castro-Pampillon et al., 2002; Garcia et al., 2011; Mattiuci et al., 2014
Pelichnibothrium speciossum Monticelli, 1889	Atl	Castro-Pampillon et al., 2002
Dibothrium plicatum Rudolphi, 1819	Atl	Nigrelli, 1938
*Dibothriorhynchus attenuatus (*Rudolphi, 1819)	Atl	Nigrelli, 1938

Continued Table 3.

Nematoda		
Anisakis sp.2	Atl	Garcia et al., 2011; Mattiuci et al., 2014
Anisakis brevispiculata Dollfus, 1966	Atl	Mattiucci et al., 2007; Garcia et al., 2011; Mattiuci et al., 2014
Anisakis paggiae Mattiucci, Nascetti, Dailey, Webb, Barros, Cianchi & Bullini, 2005	Atl	Mattiucci et al., 2007; Garcia et al., 2011; Mattiuci et al., 2014
Anisakis pegreffii Campana-Rouget and Biocca 1955	Med.	Mattiuci et al., 2005; Mattiucci et al., 2007; Mattiuci et al., 2014
Anisakis physeteris Baylis 1923	Med, Atl	Mattiuci et al., 2005; Mattiucci et al., 2007; Garcia et al., 2011; Mattiuci et al., 2014
Anisakis simplex (Rudolphi, 1809)	NwAtl, Atl, Bas	Hogans et al., 1983; Bacevičius and Karalius, 2005; Mattiucci et al., 2014
Anisakis simplex (s. s.) Davey, 1971.	Atl	Mattiucci et al., 2007; Garcia et al., 2011; Mattiuci et al., 2014
Anisakis ziphidarum Paggi, Nascetti, Webb, Mattiucci, Cianchi and Bullini, 1988	Atl, Med	Mattiucci et al., 2007
Anisakis typica (Diesing, 1860)	Atl, Med	Mattiucci et al., 2007
Contracaecum incurvum Rudolphi, 1819	Atl	Nigrelli, 1938; Iles, 1971
Hysterothylacium sp.	Pac	Muñoz et al., 2012.
Hysterothylacium sp. A	Pac	Smith et al., 2007
Hysterothylacium sp. B	Pac	Smith et al., 2007
Hysterothylacium aduncum (Rudolphi, 1802)	NwAtl, **Algeria**.	Hogans et al., 1983; Castro-Pampillon et al., 2002; **present study**
Hysterothylacium incurvum (Rudolphi, 1819)	Med, Atl, NwAtl, Eas	Hogans et al., 1983; Wierzbicka and Sobecka, 2003; Mattiuci et al., 2005; Garcia et al., 2011; Mattiuci et al., 2014; Varghese and Unnikrishnan, 2015
Hysterothylacium corrugatum Deardorff and Overstreet, 1981	NwAtl, Atl, Med	Hogans et al., 1983; Mattiuci et al., 2005; Garcia et al., 2011; Mattiuci et al., 2014
Hysterothylacium petteri Sheenko, 1991	Med	Mattiuci et al., 2005; Mattiuci et al., 2014
Hysterothylacium reliquens (Norris and Overstreet, 1975)	NwAtl	Hogans et al., 1983
Oncophora melanocephala (Rudolphi, 1819)	Med, NwAtl, Atl	Hogans et al., 1983; Mattiuci et al., 2005; Garcia et al., 2011; Mattiuci et al., 2014

Continued Table 3.

Huffmanela paronai sp.	WMed	Moravec and Garibaldi, 2000
Maricostula sp.	Pac	Smith et al., 2007
Maricostula incurva Rudolphi, 1819	Atl	Castro-Pampillon et al., 2002
Nematodes (unidentified)	Eas	Varghese and Unnikrishnan, 2015
Crustacea		
Brachiella ratnosa Richiardi, 1880	NwAtl	Silas and Ummerkutty, 1967; Palko et al., 1981
Brachiella thynni Cuvier, 1830	NwAtl	Silas and Ummerkutty, 1967; Palko et al. 1981
Caligus sp.	Pac	Smith et al., 2007
Caligus chelifer Wilson C. B., 1905	NwAtl	Silas and Ummerkutty, 1967; Palko et al., 1981
Caligus elongatus Nordmann, 1832	Atl, Med	Silas and Ummerkutty, 1967; Palko et al., 1981
Caligus coryphaenae Steenstrup and Luttken, 1861	Atl	Castro-Pampillon et al., 2002
Chondracanthus xiphiae Cuvier, 1829	Atl	Silas and Ummerkutty, 1967; Palko et al., 1981
Gloiopotes sp.	Pac	Smith et al., 2007
Gloiopotes ornatus Wilson C. B., 1905	NwAtl	Silas and Ummerkutty, 1967; Palko et al., 1981
Gloiopotes huttoni (Thomson, 1890)	Ind	Karthick Rajan et al., 2018
Pennella instructa Wilson (1917)	Med, Atl, Ind, NwAtl, Atl, **Algeria**	Hogans et al., 1985; Hogans et al., 1985; Hogans, 1986; Castro-Pampillon et al., 2002; Merella et al., 2003; Mattiuci et al., 2005; Öktener et al., 2007; Öktener et al., 2010; Garcia et al., 2011; Mattiuci et al., 2014; Wunderlich and Sant'Anna, 2014; Varghese and Unnikrishnan, 2015; Llarena-Reino et al., 2019; **present stud**y
Pennella filosa Linnaeus, 1758	Atl, Med, NwAtl	Nigrelli, 1938; Hogans et al., 1985; Merella et al., 2003; Tanrıkul and Akyol, 2011
Acanthocephala		
Bolbosoma vasculosum (Rudolphi, 1819)	Atl	Hogans et al., 1985; Garcia et al., 2011; Mattiuci et al., 2014
Rhadinorhynchus pristis (Rudolphi, 1802)	NwAtl, Atl	Hogans et al., 1983; Garcia et al., 2011; Mattiuci et al., 2014
Cirripedia (barnacles)		
Conchoderma virgatum Spengler, 1789	WMed, Med, **Algeria**	Garibaldi and Relini, 2003; Merella et al., 2005; Massi et al., 2014; **present study**

Note. Atl — Atlantic Ocean; Atl-wh — Atlantic Ocean West head; NwAtl — North-west Atlantic Ocean; NeAtl — North-east Atlantic Ocean; Adr — Adriatic Sea; Med — Mediterranean Sea; WMed — West Mediterranean Sea; Pac — Pacific Ocean; Eas — Eurasian south Sea; Bas — Baltic Sea; Ind — Indian Ocean.

tissue characterized by structures similar to seminiferous tubules with the predominance of spermatogonia. The histological examination of the gonadal parenchyma of *Pagellus erythrinus* specimens infected with *Philometra filiformis* performed by Saadi et al. (2019) showed remarkable tissue damage and induces almost total replacement of the parenchyma and hemorrhagic lesions and even affects the reproductive capacity of the infected fish when a large number of oocytes are degenerated by the parasitic load of *P. filiformis*. Another study of Saadi et al. (2020) showed that parasitic nematodes can affect the physiological functions of fish.

The checklist of metazoan parasitic fauna of *X. gladius* from different localities of the world confirms that this fish is infected by numerous and various parasite species (table 3). Cestoda and Nematoda are the most diversified parasite groups in all its repartition with 29 and 23 species, respectively. The crustacean group presents 11 species and the remaining groups count less than 10 species, while the Acanthocephala parasite group represents only 2 species (table 3). Among the 79 known parasite species recorded from *X. gladius*, 61 species were recorded in the Atlantic Ocean, Pacific and Indian Oceans count only 11 and 2 respectively (table 3). The great number of works conducted on the parasite fauna of swordfish from the Atlantic Ocean may explain the recorded high parasite diversity compared to those realized in the other geographical areas, including the Mediterranean Sea (table 3). In the Mediterranean Sea 24 species were reported (approximately 1/3 of the species diversity known in the 3 Oceans: Atlantic, Pacific and Indian). This large difference in parasitic fauna diversity between *X. gladius* from Atlantic Ocean and *X. gladius* from the Mediterranean Sea may be related to the abundance of preys or intermediate hosts (food availability) enhancing infection by Cestoda and Nematoda (in Atlantic). The parasitic diversity of this fish may be also related to its migration. Its displacement from an area to another, may enhance the feeding on diverse preys (potential intermediate hosts) favoring therefore parasitism. Garcia et al. (2011) stated clearly that the parasite fauna of *X. gladius* maybe used as a potential indicator to its biological and ecological (displacements) traits.

Xiphias gladius caught off the Algerian coast is infected by 4 parasite species only of which one species, *Pennella instructa*, can be found associated with an epibiont species (Cirripedia). This association was reported only in the Mediterranean Sea (table 3). Finally, more investigation must be done on the parasitic fauna of *X. gladius* from the Mediterranean Sea and particularly in the Algerian coasts for its clearer evaluation.

We warmly thank the fishermen who helped us in our sampling survey. We thank the anonymous referees for their time in carefully reviewing our manuscript; we believe that their positive comments substantially improved this article.

References

Bacevičius, E., Karalius, S. 2005. A survey of the data on swordfish (*Xiphias gladius* L.) in the southern and southeastern Baltic Sea. *The Bulletin of the Sea Fisheries Institute*, **2** (165).

Beckett, J. S. 1968. New record of the Barnacle *Conchoderma virgatum* in the Northwest Atlantic. *J Fish Res Board Can*, **25** (12), 2707–2710.

Bush, A. O., Lafferty, K. D., Lotz, J. M., Shostak, A. W. 1997. Parasitology meets ecology on its own terms: Margolis et al. Revisited. *Journal of Parasitology*, **83** (4), 575–583.

Castro-Pampillón, J. A., Rodríguez-Domínguez, H., Soto-Búa, M., Mejuto-García, J., Arias-Femández, C., García Estévez, J. M. 2002 a. Parasites of swordfish from the Gulf of Guinea. *J. Parasitol*., **88** (1),188–189.

Castro-Pampillón, J. A., Soto-Búa, M., Rodríguez-Domínguez, H., Mejuto-García, J., Arias-Femández, C. & García Estévez, J. M. 2002 b. Selecting parasites for use in biological tagging of the Atlantic swordfish (*Xiphias gladius*). *Fish Res*, 59, 259–262.

Causey, D. 1960. Parasitic Copepoda from Mexican coastal fishes. *Bull Mar Sci Gulf Caribb*, **10** (2), 323–337.

Carbonell, E., Massuti, E., Castro, J. J., Garcia, R. M. 1999. Parasitism of dolphinfishes, *Coryphaena hippurus* and *Coryphaena equiselis*, in the western Mediterranean (Balearic Islands) and central-eastern Atlantic (Canary Island). *Sci. Mar.*, **63** (3–4), 343–354.

Ceyhan, T., Akyol, O. 2017. Preliminary study on the diet of juvenile swordfish (*Xiphias gladius*) in the Aegean Sea. *Collect. Vol. Sci. Pap. ICCAT*, **73** (3), 1103–1107.

Cornaglia, E., Rebora, L., Gili, C., Di-Guardo, G. 2000. Histopathological and immunohistochemical studies on cetaceans found stranded on the coast of Italy between 1990 and 1997. *Journal of Veterinary Medicine*. A 47, 129–142, 2000.

Danyer, E., Tonay, A. M., Aytemiz, I., Dede, A., Yildirim, F., Gurel, A. 2014. First report of infestation by a parasitic Copepod (*Pennella balaenopterae*) in a harbour porpoise (*Phocoena phocoena*) from the Aegean Sea: A case report. *Vet Med*, 59, 403–407.

Di Paolo, M., D'Amelio, S., Mattiucci, S., Paggi, L., Orecchia, L. 1994. Helminth parasites of swordfish (*Xiphias gladius* L.) caught off Ustica Island (South Tyrrhenian Sea). *Parassitologia*, 36.

Euzet, L., Quignard, J. P. 1961. Sur deux parasites de *Xiphias gladius* L. Station biologique de Sète [On two parasites of *Xiphias gladius* L. biologique station of Sète]. *CIESM Congress 1960, Monaco*, article 0073.

Garcia, A., Mattiucci, S. Damiano, S., Santos, M. N.. Nascetti, G. 2011. Metazoan parasites of swordfish, *Xiphias gladius* (Pisces: Xiphiidae) from the Atlantic Ocean: implications for host stock identification. *ICES Journal of Marine Science*, **68** (1), 175–182.

Garibaldi, F., Relini, G. 2003. Note sul ruolo di *Conchoderma virgatum* (Crustacea Lepadidae) come epibionte del pesce spada, *Xiphias gladius* L., in Mar Ligure. Biol Mar Medit 10 (2), 1093–1097.

Hogans, W. E., Brattey, J., Uhazy, L. S., Hurley, P. C. F. 1983. Helminth parasites of swordfish (*Xiphias gladius* L.) from the Northwest Atlantic Ocean. *J Parasitol*, 69, 117–1179

Hogans, W. E., Brattey, J., Hurlbut, T. R. 1985. *Pennella filosa* and *Pennella instructa* (Copepoda: Pennellidae) on Swordfish (*Xiphias gladius* L.) from the Northwest Atlantic Ocean. *J Parasitol*, **71** (1), 111–112.

Hogans, W. E. 1986. Redescription of *Pennella instructa* Wilson, 19 17 (Copepoda: Pennellidae) from the swordfish (*Xiphias gladius* L.). *Can. J. Zool*, 64, 727–730.

Ichalal, K., Ramdane, Z., Ider, D., Kacher, M., Iguerouada, M., Trilles, J. P., Courcot, L., Amara, R. 2015. Nematodes parasitizing *Trachurus trachurus* (l.) and *Boops boops* (l.) from Algeria. *Parasitology Research*. doi 10.1007/s00436-015-4633-6.

Ichalal, K., Ramdane, Z., Iguer-Ouada, M., Kacher, M. 2016. First observation of intersex in *Trachurus trachurus* (Carangidae) from the Eastern Coast of Algeria: are nematodes the causative factor? *Cybium*, **40** (3), 225–233.

Ider, D., Ramdane, Z., Trilles, J. P., Amara, R. 2018. Metazoan parasites of *Boops boops* (Linnaeus, 1758) from the Algerian coast. *Cah. Biol. Mar*., 59.

Iles, C. 1971. *Fistulicola plicatus* (Cestoda) and *Tristoma* spp. (Trematoda) on swordfish from the northwest Atlantic. *J. Fish. Res. Board Can*., 28, 31–34.

Kayiş, S., Altinok, I., Balta, F., H. B. İmre, H. B. 2010. *First Report of Tristomella laevis (Monogenea, Capsalidae) from Aegean Sea in Turkey*. Kafkas Univ Vet Fak Derg 16 (Suppl-B): S373-S375, 2010.

Kouadri Krim, A., Selmani, R., Ferhani, K. 2017. Distribution des fréquences de taille et relation taille/poids de l'espadon de la côte Algérienne [Size frequency distribution and size/weight relationship of swordfish from the Algerian coast]. *Collect. Vol. Sci. Pap. ICCAT*, **73** (3), 1108–1114.

Kouadri Krim, A., Bouhadja A. 2019. Nouvelles données de distribution de fréquence de Taille de l'espadon *Xiphias gladius* obtenues le long de la cote Algérienne [New Size Frequency Distribution Data for Swordfish *Xiphias gladius* obtained along the Algerian Coast]. *Collect. Vol. Sci. Pap. ICCAT*, **76** (3), 79–84.

Llarena-Reino, M., Abollo, E., Pascuala, S. 2019. Morphological and genetic identification of *Pennella instructa* (Copepoda: Pennellidae) on Atlantic swordfish (*Xiphias gladius*, L. 1758). *Fisheries Research*, 209, 178–185.

Márquez, M. R. 1990. Sea turtles of the world. An annotated and illustrated catalogue of sea turtles species known to date. *FAO Fish Synop*, **125** (11), 1–81.

Massi, D., Titone, A., Bottari, A., Busalacchi, B., Gancitano, V., Giusto, G. B., Sinacori, G., Vitale, S. 2014. *Conchoderma virgatum virgatum* (Crustacea, Lepadidae) in association with *Pennella instructa* (Crustacea, Pennellidae) on a swordfish from the strait of Sicily. *Biologia Marina Mediterranea*; Genoa, **21** (1), 351–352.

Mattiucci, S., Farina, V., Garcia, A., Santos, M. N., Mariniello, L., Nascetti, G. 2005. Metazoan parasitic infections of swordfish (*Xiphias gladius* L., 1758) from the Mediterranean Sea and Atlantic Gibraltar waters: implications for stock assessment. *Col. Vol. Sci. Pap. ICCAT*, **58** (4), 1470–1482.

Mattiucci, S., Abaunza, P., Damiano, S., Garcia, A., Santos, M. N., Nascetti, G. 2007. Distribution of Anisakis larvae, identified by genetic markers, and their use for stock characterization of demersal and pelagic fish from European waters: an update. *Journal of Helminthology*, 81, 117–127.

Mattiucci, S., Garcia, A., Cipriani, P., Santos, M. N., Nascetti, G., Cimmaruta, R. 2014. Metazoan parasite infection in the swordfish, *Xiphias gladius*, from the Mediterranean Sea and comparison with Atlantic populations: implications for its stock characterization. *Parasite*, 21, 35.

Mehouel, F., Bouayad, L., Berber, A., Van Hauteghem, I., Van De Wiele, M. 2019. Risk assessment of mercury and methyl mercury intake via sardine and swordfish consumption in Algeria. *Journal of the Hellenic Veterinary Medical Society*, **70** (3), 1679–1686.

Merella, P., Zucca, D., Garippa, G. 2003. Contribution to the knowledge of the ectoparasites of swordfish *Xiphias gladius* Linnaeus, 1758 from the western Mediterranean. *Revista Ibérica de Parasitología*, **63** (3–4), 117–120.

Merella, P., Scala, A., Marrosu, R., Garippa, G. 2005. Occurrence of the pedunculate barnacle *Conchoderma virgatum virgatum* in the western Mediterranean. vie et milieu, **55** (1), 41–44.

Moravec, F., Garibaldi, F. 2000. *Huffmanela paronai* sp. n. (Nematoda: Trichosomoididae), a new parasite from the skin of swordfish *Xiphias gladius* in the Ligurian Sea (Western Mediterranean). *Folia Parasitologia*, 47, 309–313.

Muñoz, G., Garcíaand, N., Valdebenito, V. 2012. Gastric helminths in the swordfish *Xiphias gladius* collected off the coast of central-south Chile. *XI European Multicolloquium of Parasitology- EMOP 11* (*July 25-29, 2012, Cluj-Napoca, Romania*).

Muscolino, D., Giarratana, F., Giuffrida, A., Panebianco, A. 2012. Inspective investigation on Swordfish (*Xiphias gladius*) frozen slices of commerce: anatomical-histopathological findings. *Czech Journal of Food Sciences*, 30, 206–210.

Nakamura, I. 1985. FAO species catalogue. Vol. 5. Billfishes of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes and swordfishes known to date. *FAO Fish. Synop*, **125** (5), 65.

Nigrelli, R. F. 1938. *Parasites of the swordfish, Xiphias gladius Linnaeus. American Museum Novitates*. The American Museum of Natural History, New York City. Number 996.

Öktener, A., Trilles, J. P., Leonardos, I. 2007. Five Ectoparasites from Turkish fishes. T he Turkish *Journal of Parasitology,* **31** (2), 154–157.

Öktener, A., Koç, H. T., Erdoğan, Z. 2010. Three Ectoparasites on swordfish from Aegean Coasts of Turkey. *Bulletin of the European Association Fish Pathologists*, **30** (5), 185–188.

Palko, B. J., Beardsley, G. L., Richards, W. J. 1981. Synopsis of the Biology of the Swordfish, *Xiphias gladius* Linnaeus. NOAA Technical Report NMFS Circular 441. *FAO Fisheries Synopsis*, 127.

Paggi, L., Mariniello, L., Ortis, M., Mattiucci, S., D'Amelio, S., Di Cave, D., Orecchia, P. 1998. Parasitological survey on fish of economic value from Italian waters. *Biologia Marina Mediterranea*, 5, 1483–1492.

Palombi, A. 1949. Trematodi d'Italia. Parte I. Trematodi Monogenetici. *Archivio Zoologico Italiano*, 34, 203–408.

Parnell, P. E. 2001. The distribution of estuarine and oceanic water masses on the southern shore of O'ahu, Hawai'i: Ecological and coastal management implications, and novel methodology. *Limnol Oceanogr*, **46** (6), 1468–1485.

Rajan, D. K., Ravichandran, S., Venmathi Maran. B. A. 2018. First record of the *Gloiopotes huttoni* (Thomson, 1890) (Copepoda: Caligidae) parasitic on the swordfish *Xiphias gladius* along the southeast coast of India. *J Parasit Dis* (July–Sept 2018), **42** (3), 458–461.

Ramdane, Z., Bensouilah, M. A., Trilles, J. P. 2009. Étude comparative des crustacés isopodes et copépodes de poissons marins algériens et marocains [Comparative study of isopod and copepod crustaceans from Algerian and Moroccan marine fish]. *Cybium,* 2009, **33** (2), 123–131.

Ramdani, S., Trilles, J. P., Ramdane, Z. 2020. Parasitic fauna of *Sardinella aurita* Valenciennes, 1847 from Algerian coast. *Zoology and Ecology*, **30** (1).

Relini, G. 1980. *Cirripedi Toracici*. (AQ/1/91). CNR, Roma, 1–122.

Saadi, N., Trilles, J. P., Amara, R., Ramdane, Z. 2019. Impact of parasitism by nematodes on gonadal anatomy of *Pagellus erythrinus* (L.). *Cybium*, **43** (3), 255–263.

Saadi, N., Trilles, J. P., Amara, R. & Ramdane, Z. 2020. Parasitic nematodes infecting commercial fishes off the coast of Algeria. *Zoology and Ecology*, **30** (1).

Silas, E. G. 1967. Parasites of scombroid fishes. Part 1. Monogenetic trematodes, digenetic trernatodes, and cestodes. *Proc. Symp. Scombroid Fishes,* Part 3. *Mar. Bio. Assoc. India*, Symp. Ser., 1, 799–875.

Silas, E. G., Ummerkutty, A. N. P. 1967. Parasites of scornbroid fishes. Part II. Parasitic Copepoda. Proc. Symp. Scombroid Fishes, Part 3. *Mar. Biol. Assoc. India*, Symp. Ser., 1, 876–993.

Smith, P. J., Diggles, B., Kim, S. 2007. Evaluation of parasite markers to access swordfish stock structure. *Scientific committee third regular session 13–24 August 2007*, *Honolulu, United States of America*. WCPFC-SC3-BI SWG/ IP – 1.

Sun, C. L., Wang, S. P., Yeh, S. Z. 2002. Age and growth of the swordfish (*Xiphias gladius* L.) in the waters around Taiwan determined from anal-fin rays. *Fishery Bulletin*, 100, 822–835.

Tanrikul, T. T., Akyo, O. 2011. First record of the parasitic Copepoda, *Pennella filosa* (L., 1758), on swordfish from the Turkish Aegean Sea. *J. Appl. Ichthyol*., **27** (6), 1392–1393.

Tserpes, G., Tsimenides, G. 1995. Determination of age and growth of swordfish, *Xiphias gladius* L., 1758, in the eastern Mediterranean using anal-fin spines. *Fishery Bulletin*, 93, 594–692.

Varghese, S. P., Unnikrishnan, N. 2015. Notes on metazoan parasites of *Alepisaurus ferox* and *Xiphias gladius* of the eastern *Arabian Sea. Mar Biodiv*. DOI 10.1007/s12526-015-0346-4.

Wierzbicka, J., Sobecka, E. 2003. *Hysterothylacium incurvum* (Rudolphi, 1819) (Nematoda: Anisakidae) a parasite of swordfish (*Xiphias gladius* L.). *Bulletin of the sea fisheries institute*, **1** (158).

Williams, E. H. Jr., Bunkley-Williams, L. 1996. *Parasites of offshore big game fishes of Puerto Rico and the western Atlantic*. Sportfish Disease Project Department of Marine Sciences and Department of Biology University of Puerto Rico P.O. Box 5000 Mayagüez, PR 00681-5000.

Wunderlich, A. C., Sant'Anna, B. S. 2014. Another record of *Pennella instructa* (Copepoda, pennellidae) parasitizing swordfish *Xiphias gladius* in the south Atlantic, after 20 years ago. *Bol. Inst. Pesca*, São Paulo, **40** (1), 105–109.

Received 5 August 2021
Accepted 3 November 2021