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Gastrointestinal helminth parasites of *Lithognathus mormyrus* (Linnaeus, 1758) (Perciformes Sparidae) in the Western Mediterranean Sea

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ABSTRACT Between December 2014 and April 2016, 235 specimens of striped seabream *Lithognathus mormyrus* (Linnaeus, 1758) (Perciformes Sparidae) caught along the western Algerian coast were examined for helminth parasites. This taxa includes 5 monogeneans (*Lamellodiscus flagellatus*, *L. ignoratus*, *L. mormyri*, *L. verberis* and *Pagellicotyle mormyri*), 13 digeneans (*Lepidauchen stenostoma*, *Derogenes latus*, *Magnibursatus bartolii*, *Proctoeces maculatus*, *Holorchis pycnoporus*, *Lepocreadium album*, *L. pegorchis*, *Macvicaria maamouriae*, *M. maillardi*, *M. mormyri*, *Pycnadenoides senegalensis*, *Diphterostomum brusinae* and *Zoogonus rubellus*), 3 nematodes (*Hysterothylacium rhacodes*, *Dichelyne tripapillatus* and *Ascarophis* sp.), 1 cestode (*Scolex pleuronectis*) and 2 Acanthocephala (*Acanthocephaloides propinquus* and *A. incrassatus*). All the species were recorded for the first time in the western Algerian coast in this host. Furthermore, *Lepidauchen stenostoma* and *Hysterothylacium rhacodes* are reported for the first time in the western Mediterranean. *Magnibursatus bartolii*, *Zoogonus rubellus*, *Dichelyne tripapillatus*, *Ascarophis* sp. and *Scolex pleuronectis* provide a new host record in *Lithognathus mormyrus* from the Mediterranean Sea. Epidemiological indexes (prevalence, abundance and mean intensity) were calculated for each helminth species identified in this fish. The Algerian west coast shows the highest value in the helminth species richness among all the Mediterranean coasts.

KEY WORDS Helminthfauna; *Lithognathus mormyrus*; Mediterranean Sea; Sparidae.

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INTRODUCTION

The Sparidae Rafinesque, 1810 (Pisces Perciformes) form a family of fish that include more than 100 species worldwide. They are demersal fish that live in coastal waters and occupy a variety of trophic niches (Bargelloni et al., 2005). One of the sparids found in Algeria is the striped sea bream *Lithognathus mormyrus* (Linnaeus, 1758), the only species of the genus *Lithognathus* Swainson, 1839, recognized to date in the area. It is a gregarious species that lives in groups on sandy and muddy bottoms, as well as on prairies and estuaries, up to 80 meters (Mediterranean Sea) and 150 meters (Atlantic Ocean) in depth (Bauchot & Hureau, 1986, 1990; Pajuelo et al., 2002). *Lithognathus mormyrus* is very mobile, but very dependent on the sea bottoms in which it gets its food (Hammami et al., 2013). It is carnivorous, looking for worms, molluscs, small crustaceans and debris (Russell et

al., 2014). Its excellent meat makes it a commercially important fish. *Lithognathus mormyrus* is widely distributed along the coasts of the Mediterranean and is present in the Atlantic Ocean from the bay of Bicay to the promontory of Good Hope, the Red Sea. This species is also found in the Western Indian Ocean and the Black Sea (Bauchot & Hureau, 1990; Kallianiotis et al., 2005).

The parasitic fauna of *L. mormyrus* has been studied in several areas: the Western Mediterranean Sea (Euzet, 1984; Oliver, 1987; Bartoli et al., 1989; Bartoli et al., 1993; Bartoli & Bray, 1996; Jousson et al., 1999; Sasal et al., 1999; Jousson et al., 2000; Benmansour et al., 2001; Jovelin & Justine, 2001; Desdevises et al., 2002; Bartoli et al., 2005; Ramdane et al., 2007; Gargouri Ben Abdallah & Maamouri, 2008; Boudaya et al., 2009; Ramdane et al., 2009; Boualleg et al., 2010, 2011; Gargouri Ben Abdallah et al., 2011; Poisot et al. , 2011; Derbel et al., 2012; Samn et al., 2014; Antar et al., 2015; Gargouri Ben Abdallah et al., 2015); the Eastern Mediterranean Sea (Deardorff & Overstreet, 1978; Saad Fares & Maillard, 1990; Saad-Fares & Combes, 1992a, b; Bruce et al., 1994; Akmırza, 2010; Cafer et al., 2015; Demirkale et al., 2015); other undefined areas of the Mediterranean Sea (Bray & Cribb, 1997; Desdevises, 2001); Adriatic (Radujkovic & Raibaut, 1989a, b; Radujkovic & Euzet, 1989; Orecchia et al., 1988; Desdevises, 2001; Radujkovic et al., 1989; Bray & Bartoli, 1996); the North-Eastern Atlantic Ocean (Gijon-Botella & Lopez-Roman, 1989); the South-Eastern Atlantic Ocean (Gaevskaya & Aleshkina, 1988); the Aegean Sea (Akmirza, 2013; Çinar, 2014) and the Red Sea (Bray & Cribb, 1989).

To date, there are no detailed reports on the communities of helminth parasites along the Algerian coasts. The aim of this study is to describe and characterize the helminth fauna of *L. mormyrus* that inhabits the Oran Bay (North-Western Algeria), thus contributing to the knowledge of the biodiversity of the region.

MATERIAL AND METHODS

From December 2014 to April 2016, 235 specimens of *L. mormyrus* from the Oran bay (35° 43' N - 0° 37' W) (Fig. 1) were collected in order to determine the helminth fauna of this host. The caught fishes were transported as quickly as possible to the laboratory in an isotherm container. Each specimen was measured, weighed and dissected. All organs, including visceral parts were removed and carefully checked for parasites. Helminth parasites were examined and identified under a binocular microscope. The sites of each parasite species were noted. For the taxonomic studies, the nematodes were relaxed and cleaned in a petri dish, then fixed and stored in a mixed solution of glycerine (50 ml) and ethanol 70% (950 ml). Acanthocephala, Cestoda, Digenea and some Monogenea were fixed in 70% ethanol, stained with iron acetocarmine, dehydrated through a graded alcohol series, cleared in dimethyl phthalate and finally examined as permanent mounts in Canada balsam. Other Monogenea were transferred individually onto a slide in a drop of ammonium picrate-glycerine (APG) (Malmberg, 1957). Calculation of the infection parameters related to prevalence, mean intensity and abundance was based on the work of Bush et al. (1997).

RESULTS

In this set of 235 *L. mormyrus* analyzed specimens, 24 helminth parasite species were collected. Their list, life stage and infection site in the hosts are presented in the Table1. There are: 5 species of Monogenea of which 4 Monopisthocotylea (*Lamellodiscus flagellatus*, *Lamellodiscus ignoratus*, *Lamellodiscus mormyri* and *Lamellodiscus verberis*) and 1 Polyopisthocotylea (*Pagellicotyle mormyri*); 13 species of Digenea (*Lepidauchen stenostoma*, *Derogenes latus*, *Magnibursatus bartolii*, *Proctoeces maculatus*, *Holorchis pycnoporus*, *Lepocreadium album*, *L. pegorchis*, *Macvicaria maa mouriae*, *M. maillardi*, *M. mormyri*, *Pycnadenoides senegalensis*, *Diphterostomum brusinae* and *Zoogonus rubellus*); 3 species of Nematoda (*Hysterothylacium rhacodes*, L3, L4 stage larvae and adults, *Dichelyne tripapillatus*, adult stage and *Ascarophis* sp., adult stage); 1 species of Cestoda (*Scolex pleuronectis*, larval stage) and 2 species of Acanthocephala (*Acanthocephaloides propinquus* and *A. incrassatus*).

The Digenea are the dominant group of helminths and show a high species diversity. The study of these parasites distribution within the host di-

gestive tract showed that *Derogenes latus* occupies the gall blader, *Magnibursatus bartolii* is localized at the stomach level and *Proctoeces maculatus* in the rectum. The majority of the trematodes seems to show clear ecological preference and limits its distribution to only one niche, in this case the intestine. *Holorchis pycnoporus* has the highest prevalence, mean intensity and abundance (P%= 61.27, A= 2.99, MI= 4.88).

The 5 monogenean species were detected only in the gills of *L. mormyrus*, the highest infestation rate being found for *Lamellodiscus ignoratus* at 84.89%. The highest mean infestation intensity exceeds 4 parasites per fish as found for *Lamellodiscus mormyri*, whereas the highest abundance value is recorded for *L. mormyri* (2.28).

The 3 Nematoda taxa were found only in the intestine, except for *Hysterothylacium rhacodes,* which were also observed in the connective tissues of the visceral cavity with a high prevalence (29.78%) and abundance (0.56). *Dichelyne tripapillatus* presented the highest mean intensity of 2.34 and *Ascarophis* sp. the lowest prevalence.

Larvae of *Scolex pleuronectis* (Cestoda) occurred only in the intestine with the following infection values: P%= 3.40; A= 0.05 and MI= 1.62.

The 2 Acanthocephala, *Acanthocephaloides propinquus* and *A. incrassatus*, were detected only in the rectum with a prevalence of 5.10 and 1.27, respectively.

DISCUSSION

The diversity of Digenea in *L. mormyrus* is more important in the Oran bay than in any other localities of the Mediterranean Sea. The successful completion of the life cycles of these parasites in the Oran bay may be due to a confined environment that limits the dispersion of the larval stages. The biodiversity, environment, and stability of the site can also contribute to this richness of digeneans. Indeed, a high level of digenean diversity in the Scandola Nature Reserve (Corsica) has been related to the equilibrium stability of the ecosystem that is devoid of major pollutants and opens directly to the Western Mediterranean basin (Bartoli et al., 2005). Also, environmental factors are important in determining parasitic fauna (Holmes, 1990). They may be the living environment, pelagic or benthic living conditions, coastal life, temperature and physico-chemical conditions of water (Polyanski, 1961; Rohde, 1978; Campbell, 1983; Moller, 1997). It should be noted though that Gargouri Ben Abdallah et al. (2011) revealed the presence of *Allopodocotyle pedicellata* (Stossich, 1887) in *L. mormyrus* from the Bizerte lagoon, whereas this parasite was not collected in this investigation. Its absence might be attributed to the rarity of this parasite or the absence of different intermediate hosts.

Since the majority of Digenea (*Lepidauchen stenostoma*, *Holorchis pycnoporus*, *Lepocreadium album*, *L. pegorchis*, *Macvicaria maamouriae*, *M. maillardi*, *M. mormyri*, *Pycnadenoides senegalensis*, *Diphterostomum brusinae* and *Zoogonus rubellus*) was recorded in the intestine, it constitutes the preferred habitat probably in relation to the host diet. In fact, since it presents the greatest surface area in comparison to the other organs of the studied fish and the most nutrient-rich site, it influences the parasite specificity towards the host. Smith (1981) reported that most parasites inhabit the intestine because of their general feeding habits. As pointed out by Holmes (1990), the use of nutrients by pests constitutes one of the major regulating parameters for the competition among the intestine parasites. According to Sasal et al. (1999), it is the main factor affecting parasite community structure, especially for digenean trematodes that are transmitted to their final host through a predator-prey relationship. Indeed, according to Froese & Pauly (2014) and Fischer et al. (1987), *L. mormyrus* feeds on worms, mollusks and small crustaceans. However, some species are limited to the stomach (*Magnibursatus bartolii*), rectum (*Proctoeces maculatus*) or gall bladder (*Derogenes latus*). The movement of the stomach muscle and the hydrochloric acid it contains may lead to a reduced number of the parasites in it (Akinsanya et al., 2008). According to Ricklefs & Schluter (1993), as some parasites are limited to a microbiotope, it results in the presence of a physical or chemical barrier difficult to cross by other digeneans. Indeed, a key factor in niche restriction processes is intra- and inter-specific competition (Holmes, 1990; Sukhdeo & Sukhdeo, 1994; Dezfuli et al., 2002).

The examination of the ecological terms shows that *Holorchis pycnoporus* and to a lesser degree *L. pegorchis* and *M. mormyri* seem to be the most frequent parasites. The former was recorded in many different regions of the Mediterranean Sea

***Lithognathus mormyrus* (N=235) infected by:**	**Stage**	**Site**	**P(%)**	**A**	**MI**
MONOGENEA					
Pagellicotyle mormyri (Lorenz, 1878)	A	G	22.97	0.45	2
Lamellodiscus flagellatus Boudaya, Neifar et Euzet, 2009	A	G	31.06	0.78	2.53
Lamellodiscus ignoratus Palombi, 1943	A	G	54.89	1.86	3.40
Lamellodiscus mormyri Euzet et Oliver, 1967	A	G	51.91	2.28	4.40
Lamellodiscus verberis Euzet et Oliver, 1967	A	G	20.85	0.52	2.51
DIGENEA					
Lepidauchen stenostoma Nicoll, 1913	A	I	28.51	0.44	1.55
Derogenes latus Janiszewska, 1953	A	GB	3.40	0.07	2.12
Magnibursatus bartolii Kostadinova, Power, Fernandez, Balbuena, Raga et Gibson, 2003	A	S	7.23	0.22	3.05
Proctoeces maculatus (Looss, 1901)	A	R	4.68	0.06	1.36
Holorchis pycnoporus Stossich, 1901	A	I	61.27	2.99	4.88
Lepocreadium album (Stossich, 1890)	A	I	8.93	0.18	2.09
Lepocreadium pegorchis (Stossich, 1901)	A	I	49.97	1.31	3.05
Macvicaria maamouriae Antar, Georgieva, Gargouri et Kostadinova, 2015	A	I	2.55	0.03	1.5
Macvicaria maillardi Bartoli, Bray et Gibson, 1989	A	I	5.53	0.07	1.30
Macvicaria mormyri (Stossich, 1885)	A	I	44.25	0.94	2.13
Pycnadenoides senegalensis Fischthal et Thomas, 1972	A	I	2.97	0.02	1
Diphterostomum brusinae (Stossich, 1889)	A	I	18.29	0.54	2.95
Zoogonus rubellus (Olsson, 1868) Odhner, 1902	A	I	6.80	0.11	1.62
NEMATODA					
Hysterothylacium rhacodes (Deardorff et Overstreet, 1978)	AL	VCI	29.78	0.56	1.9
Dichelyne tripapillatus (Gendre, 1927)	A	I	23.40	0.54	2.34
Ascarophis sp.	A	I	2.55	0.02	1
CESTODA					
Scolex pleuronectis Müller, 1788	L	I	3.40	0.05	1.62
ACANTHOCEPHALA					
Acanthocephaloides propinquus (Dujardin, 1845)	A	R	5.10	0.07	1.5
Acanthocephaloides incrassatus (Molin, 1858)	A	R	1.27	0.02	1.66

Table 1. Infection parameters of striped seabream (*Lithognathus mormyrus*) from the Oran bay. Abbreviations: P% = prevalence; A= abundance; MI= mean intensity; A= adult; L= larva; G= gills; I= intestine; GB= gall blader; S= stomach; R= Rectum; VC= Visceral cavity.

(Orecchia et al.,1988; Radujkovic & Raibaut, 1989; Radujkovic et al., 1989; Bartoli & Bray, 1996; Bray & Cribb, 1997; Sasal et al., 1999; Akmirza, 2000).

Furthermore, *Holorchis pycnoporus* is the most prevalent and abundant and has the highest mean intensity of trematode species. This result agrees with studies carried out on the *L. mormyrus* in other parts of the Mediterranean Sea (Bartoli et al., 2005; Gargouri Ben Abdallah & Maamouri, 2008; Gargouri Ben Abdallah et al., 2011; Derbel et al., 2012).

The 9 species of Trematodes (*Derogenes latus*, *Proctoeces maculatus*, *Lepocreadium album*, *L. pegorchis*, *Macvicaria maamouriae*, *M. maillardi*, *M. mormyri*, *Pycnadenoides senegalensis* and *Diphte-*

rostomum brusinae) recorded in the present study were already detected in different Mediterranean areas (Orecchia et al., 1988; Bartoli et al., 1989; Radujkovic & Raibaut, 1989a; Radujkovic et al., 1989; Saad Fares & Maillard, 1990; Saad-Fares & Combes, 1992a, b; Bartoli et al., 1993; Sasal et al., 1999; Jousson et al., 1999; Jousson et al., 2000; Bartoli et al. 2005; Gargouri Ben Abdallah & Maamouri, 2008; Gargouri Ben Abdallah et al., 2011; Derbel et al., 2012; Antar et al., 2015). In contrast, *Lepidauchen stenostoma*, *Magnibursatus bartolii* and *Zoogonus rubellus* were observed only among *L. mormyrus* from the Oran bay, although the first one was already described as a parasite of *L. mormyrus* in the Adriatic Sea off the coast of Montenegro (Bray & Bartoli, 1996). *Magnibursatus bartolii* was already encountered in: *Boops boops* (Linnaeus, 1758), another sparid species from the North-east Atlantic coast, Spain (Kostadinova et al., 2003); *Oblada melanura* (Linnaeus, 1758) from the Gulf of Tunis (Gargouri Ben Abdallah & Maamouri, 2008); *Sparus aurata* (Linnaeus, 1758) from the Bizerte Lagoon (Gargouri Ben Abdallah et al., 2011); *Diplodus sargus* (Linnaeus, 1758) off the coast of Buriana, Spain (Kostadinova & Gibson, 2009) and *D. sargus* from the Oran bay (Bellal et al., 2016).

Similary, *Zoogonus rubellus* has been reported in several fish species belonging to the Sparidae family in: the Southeast Atlantic (Parukhin, 1966); Corsica (Jousson et al., 1999; Sasal et al., 1999; Bartoli et al., 2005); the Gulf of Tunis (Gargouri Ben Abdallah & Maamouri, 2008); the Bizerte Lagoon (Antar & Gargouri Ben Abdallah, 2013.) and also the Oran bay (Bellal et al., 2016). Hence, we report them here for the first time in *L. mormyrus* from the western Mediterranean.

The evaluation of the parasite indices as seen on the table reveals that it is the Monopisthocotylea that records the highest values. The difference observed between the two subclasses may be due to the large size of the Polyopisthocotylea which increases the spatial competition in the gills of the infested fish. According to Combes (1995), high parasite loads may indicate that the host provides better habitat, and it means that parasite/host encounters are easier and compatibility is possible.

Among Monogenea, there were five most frequent species detected of which four *Lamellodiscus* Johnston et Tiegs, 1922, *L. ignoratus* being the dominant species with a prevalence of 54.89%. The latter was already reported in *L. mormyrus* by: Radujkovic & Raibaut (1989a) in Southern Adriatic Sea; Desdevises (2001) off the French coast of the Mediterranean Sea and Boudaya et al. (2009) off Sète (France) and Sfax (Tunisia). It has also been found in other sparid species (Oliver, 1987; Radujkovic & Euzet, 1989; Desdevises et al., 2002; Amin & Euzet, 2005; Amine et al., 2006, 2007a, b; Poisot et al., 2011; Kouachi et al., 2012). *Lamellodiscus mormyri* and *L. verberis* were found in *L. mormyrus* by Euzet (1984), Oliver (1987), Radujkovic & Euzet (1989), Desdevises (2001) and Boudaya et al. (2009). The *Lamellodiscus flagellatus* presence on the gills of *L. mormyrus* was detected off Sète (France) and Sfax (Tunisia) by Boudaya et al. (2009). With regards to *Pagellicotyle mormyri*, it was observed in the same host in Italy (Lorenz, 1878; Monticelli, 1888; Parona & Perugia, 1889, 1890), France (Marc, 1963), Tunisia (Ktari, 1971; Neifar, 1995) and the Gulf of Annaba, Algeria (Kaouachi, 2010). It should be noted that these five species were recorded in *L. mormyrus* for the first time in the Oran bay.

This is the first report of the occurrence of *Hysterothylacium rhacodes* (Nematoda) in larvae L3, L4 as well as adult stages in *L. mormyrus* from the Western Mediterranean Sea. However, they have been previously reported in the same host from the Eastern Mediterranean Sea (Deardorff & Overstreet, 1978; Bruce et al., 1994).

Dichelyne tripapillatus was encountered in another sparid species, *Diplodus sargus* from the Adriatic Sea (Radujkovic & Raibaut, 1989a; Petter & Radujkovic, 1989). The present work provides a new host (*L. mormyrus*) record for it, as well as for *Ascarophis* sp. in the Mediterranean Sea. This last species has a low prevalence and could be accidentally present on this host.

Scolex pleuronectis (Tetraphyllidean) larvae constitute the first report in Mediterranean *L. mormyrus* from the Oran bay. It is nevertheless reported in various sparid species in many other areas (Joyeux & Baer, 1936; Euzet, 1956; Parukhin, 1976; Renaud et al., 1980; Anato et al., 1991; Khalil et al., 1994; Naidenova & Mordvinova, 1997; Akmirza, 1998, 2000; Paraguassu et al., 2002; Luque & Poulin, 2004; D'Amico et al., 2006; Pérez-del-Olmo et al., 2007a, b, 2008; Marzoug, 2012).

Concerning the Acanthocephalan species, *Acanthocephaloides propinquus* and *A. incrassatus* were detected for the first time in the Oran bay. Gargouri

Ben Abdallah et al. (2015) reported in the studied host from the Bizerte lagoon the presence of three acanthocephalan species, *Acanthocephaloides propinquus*, *A. incrassatus* and *Neoechinorhynchus* (*Neoechinorhynchus*) *rutili*. *Acanthocephaloides incrassatus* has already been reported in *Pagellus erythrinus* (Linnaeus, 1758) from Corsica (Ternengo et al., 2005) and *A. propinquus* in *Diplodus annularis* from the Gulf of Cagliari (D'Amico et al., 2006).

The data gathered in this study show that all the parasite species recognized in *L. mormyrus* from the Oran bay were already reported in this fish specimen from different areas of the Mediterranean Sea, except for *Lepidauchen stenostoma*, *Magnibursatus bartolii*, *Zoogonus rubellus*, *Dichelyne tripapillatus*, *Ascarophis* sp. and *Scolex pleuronectis* for which new records for this Mediterranean striped seabream population are established. Hence, the greatest helminth parasitic richness is found in the Oran bay.

Some ecological studies on fish parasites have suggested that many parameters influence parasite species diversity such as: body size, habitat, distributional range as well as feeding and schooling habits (Morand et al., 1999; Rodhe, 2010; Timi et al., 2010). Experimentation conditions (Walther et al., 1995) pointed out that many elements may affect directly or indirectly specific richness including the efforts of individuals examining hosts and variables related to the phylogeny of hosts and parasites (Bush et al., 1997; Poulin, 1995; Guegan & Morand, 1996; Sasal et al., 1997). All these factors increase the likelihood to encounter more parasite species.

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