FIRST RECORD OF SOME ECTOPARSITES OF *RAJA CLAVATA* Linnaeus, 1758 AND *MUSTELUS MUSTELUS* (Linnaeus, 1758) (ELASMOBRANCHS) FROM TUNISIAN WATERS

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ملخص

اول تسجيل لوجود بعض الطفيليات عند سمك *Raja clavata* Linnaeus,1758 و*Mustelus mustelus* (Linnaeus,1758) (صفحيات الخياشيم) في المياه التونسية : دراسة 480 سمكة *من* نوع *Raja clavata* Linnaeus, 1758 و 480 سمكة من نوع *Mustelus mustelus* (Linnaeus, 1758) من مختلف الخلجان التونسية مكننا من جمع العديد من أنواع الطفيليات من مجدافيات الأرجل و متساويات الأرجل و أحاديات النسل. حيث تمكنا من جمع نوعان من متساويات الأرجل و هي *Ceratothoa parallela* (Otto, 1828) و *Mothocya nana* (Schioedte et Meinert, 1884) و نوع من أحاديات النسل *Rajonchocotyle emarginata* (Olsson, 1876). كما نلاحظ لأول مرة في تونس وجود *Lernaeopoda galei* Kroyer, 1837 على هدا السمك المضيف.

و من ناحية أخرى نعلن لأول مرة على السواحل التونسية وجود *Anilocra physodes* (Linnaeus, 1758) على *Mustelus mustelus*. و بالإضافة إلى ذلك، تمكنا من إيجاد نوعين من مجدافيات الأرجل *Lernaeopoda galei* و *Kroyeria lineata* Van Beneden, 1853 على هدا السمك المضيف.

كشفت دراسة هده الأسماك المضيفة أن *Rajonchocotyle emarginata* هو الطفيلي الموجود بكثرة على *Raja clavata* و *Kroyera lineata* هو الطفيلي الموجود بكثرة على *Mustelus mustelus*. كما تقدم هده الدراسة تقارير *مفصلة عن كل طفيلي و عن* وجوده في مختلف بقاع العالم و تقدم أيضا كل أنواع الأسماك المضيفة لها.

كلمات مفاتيح : *Mustelus mustelus*, *Raja clavata*, متساويات الأرجل, مجدافيات الأرجل, أحاديات النسل, الخلجان التونسية.

RESUME

première mention de certains ectoparasites de *Raja clavata* linnaeus , 1758 et de *Mustelus mustelus* (Linnaeus, 1758) des eaux tunisiennes : L'étude de 480 poissons de *Raja clavata* Linnaeus, 1758 et de 480 spécimens de *Mustelus mustelus* (Linnaeus, 1758) en provenance des différentes côtes tunisiennes a permis de récolter plusieurs espèces de parasites Copépodes, Isopodes et Monogènes. En effet, sur *Raja clavata*, nous avons récolté deux espèces d'Isopodes (*Ceratothoa parallela* (Otto, 1828) et *Mothocya nana* (Schioedte et Meinert, 1884)) et une espèce de Monogène (*Rajonchocotyle emarginata* (Olsson, 1876)). Nous notons également pour la première fois en Tunisie, la présence de *Lernaeopoda galei* Kroyer, 1837 (Copépode) sur cette espèce hôte.

D'autre part, nous signalons pour la première fois sur les côtes tunisiennes la présence de *Anilocra physodes* (Linnaeus, 1758) sur *Mustelus mustelus*. En outre, nous avons pu récolter deux espèces de Copépodes *Lernaeopoda galei* et *Kroyeria lineata* Van Beneden, 1853 sur ce même hôte.

L'examen de ces deux poissons chondrichtyens a révélé que *Rajonchocotyle emarginata* est l'espèce parasitaire la plus abondante sur *Raja clavata* ainsi que *Kroyera lineata* sur *Mustelus mustelus*. Des rapports détaillés sur chaque parasite provenant de différentes régions géographiques et la diversité des espèces hôtes sont également fournis.

Mots clés : *Raja clavata*, *Mustelus mustelus*, Isopodes, Copépodes, Monogènes, côtes tunisiennes.

ABSTRACT

The study of 480 fish of *Raja clavata* (Linnaeus, 1758) and 480 specimens of *Mustelus mustelus* (Linnaeus, 1758) from the Tunisian coast allowed us to harvest several species of Copepods, Isopods and Monogenea parasites. Indeed, on *Raja clavata* Linnaeus, 1758, we harvested two species of Isopods (*Ceratothoa parallela* (Otto, 1828) and *Mothocya nana* (Schioedte and Meinert, 1884)) and one species of Monogenea (*Rajonchocotyle emarginata* (Olsson, 1876)). On the other hand, we note for the first time in Tunisia, the presence of *Lernaeopoda galei* Kroyer, 1837 (Copepod) on this host species.

We also note the presence of *Anilocra physodes* (Linnaeus, 1758) on *Mustelus mustelus* for the first time in tunisian coasts. In addition, we were able to harvest two species of Copepods *Lernaeopoda galei* and *Kroyeria lineata* Van Beneden, 1853 on this same host.

The examination of these two chondrichthyan fish revealed that *Rajonchocotyle emarginata* is the most abundant parasite species on *Raja clavata* as well as *Kroyera lineata* on *Mustelus mustelus*. Detailed reports of each parasite from different geographical locations and diversity of the host species are also provided.
Keywords: *Raja clavata*, *Mustelus mustelus*, Isopods, Copepods, Monogenea, Tunisian coasts.

INTRODUCTION

The Elasmobranchs is an original group and they represent the oldest known vertebrates. With more than 62 species reported in Tunisian coast (Bradai *et al*, 2012) they are abundant. However, because of their low reproductive potential, bycatch fisheries and pollution, these species are in danger of extinction.

Mustelus mustelus and *Raja clavata* are widely spread in the Mediterranean Sea and on the tunisian coast (FAO, 2000). *Raja clavata* (Thornback ray) belongs to the family of Rajidae (Blainville, 1816). This species inhabits shelf and upper slope waters and it is common in coastal waters between 10-60 m depth (Wheeler, 1978). This nocturnal species feeds on all kinds of bottom animals, preferably crustaceans (Stehmann and Bürkel, 1984) and fishes (Last *et al*, 2016).

Mustelus mustelus (Smooth-hound) belongs to the family of Triakidae (Gray, 1851) (Bradai *et al.*, 2012). Among the 34 known species of this family, only 4 species are reported from the Tunisian coasts namely *Mustelus asterias* (Cloquet, 1821), *Mustelus mustelus* (Linnaeus, 1758), *Mustelus punctulatus* (Risso, 1826) and *Galeorhinus galeus* (Linnaeus, 1758) (Saidi *et* al., 2009 and Bradai *et al.*, 2012).

Mustelus mustelus is found on the continental shelves and uppermost slopes, from the intertidal region to at least 350 m depth (Compagno, 1984). This species feeds mainly on crustaceans, but also cephalopods and bony fishes (Compagno, 1984 ; Saidi *et al.*, 2009).

These two species possess an important commercial and gastronomic value in Tunisia. In fact, they are extensively fished despite their vulnerable and near threatened status according to the International Union for Conservation of Nature and Natural Resources (IUCN).

However, little is known about these species in Tunisia (Capapé, 1974; Saidi *et al*., 2009 and Bradai et al, 2012) and only few studies were carried on them and on their parasites (Essafi, 1975; Neifar, 2001; Youssef *et al*, 2016).

Elasmobranchs infected by ectoparasites suffer a variety of health issues which may include retarded development of reproductive organs (Yano and Musick, 2000), reduced respiratory efficiency and anemia (Benz and Adamson, 1990; Heupel and Bennett, 1998).

It is within this framework that our research problematic lies. Thus the aim of our work is to study the etoparasitofauna of two species of Elasmobranchs, *Raja clavata* Linnaeus, 1758 and *Mustelus mustelus* (Linnaeus, 1758), as well as to provide host–parasite associations and to see if those parasites cause any pathogenic effects on their hosts already vulnerable due to pollution and by-catch fishing.

MATERIALS AND METHODS

The present study was performed along the Tunisian coasts, comprising especially the Bay of Bizerte, the Gulf of Tunis, the Gulf of Hammamet and the Gulf of Gabès (Sfax and Zarzis) (Fig 1).

Two different species of Chondrichthyan fishes namely *Mustelus mustelus (*Linnaeus, 1758) (480 individuals) and *Raja clavata* Linnaeus, 1758 (480 individuals) were sampled and examined for their ectoparasites (Tab. I). The host species were identified using Fisher *et al* (1987) and Séret (2006). Name, size and weight of the fish as well as the sampling sites were specified.

The collected isopods were fixed and preserved in 70% alcohol. Before to be dissected, they were cleared and stained in lactic acid and the size was measured using on ocular micrometer. Isopods were studied using stereo and light microscopy. Examination of the collected isopods specimens consists to study the morphological features of the different appendices in order to identify the species. Sex, life stage and fixing site of the collected specimens were noted.

The identification of the collected species was performed according to Trilles and Raibaut (1971), Trilles (1979), Bruce (1986), Charfi-Cheikhrouha *et al* (2000) and Horton (2000).

Collected copepods were immediately removed from the hosts and preserved in 70% ethanol. Subsequently, specimens were cleared in lactic acid for 2 hours prior to examination using stereo and light microscopy. Specimens were dissected on glass-slides and mounted as temporary preparations in lactophenol under a dissecting microscope. Measurements were made using an ocular micrometer. Parasites species identification was based on morphological features according to Yamaguti (1963), Kabata (1979) and Ho and Kim (2004).

The gill arches removed after two incisions, a ventral and a dorsal, are placed in Petri dishes containing sea water. The Monogenea, marked under a binocular

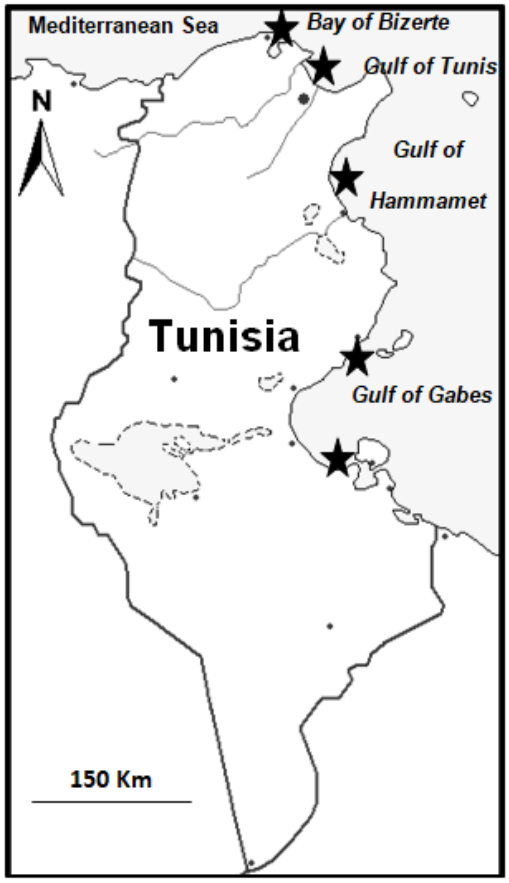

Figure 1: Sampling sites (black stars indicating sampling site)

Table I: Sampling details of *Mustelus mustelus* and *Raja clavata*

Host	**Sampling location**	**Period (2015-2016)**	**Number of examined fish**
Mustelus mustelus	Bay of Bizerte	Autumn	22
		Winter	32
		Spring	30
		Summer	36
	Gulf of Tunis	Autumn	30
		Winter	30
		Spring	30
		Summer	30
	Gulf of Hammamet	Autumn	30
		Winter	15
		Spring	47
		Summer	28
	Gulf of Gabes	Autumn	30
		Winter	25
		Spring	25
		Summer	40
Raja clavata	Bay of Bizerte	Autumn	16
		Winter	30
		Spring	45

		Summer	30
	Gulf of Tunis	Autumn	32
		Winter	30
		Spring	36
		Summer	30
	Gulf of Hammamet	Autumn	30
		Winter	19
		Spring	35
		Summer	30
	Gulf of Gabes	Autumn	20
		Winter	26
		Spring	41
		Summer	30

lens, are detached from the gill lamellae. Most individuals are examined on the live, slightly flattened, between blade and lamella. Others are fixed and stained with the Malmberg mixture (1957) and the lip balm of Canada. Individuals, fixed to aqueous Bouin or 70% ethanol, were washed in several baths of distilled water and then stained with carmine with alcoholic borax. After dehydration and passage into girofle gasoline, they are mounted between blade and balsam blade of Canada. A few individuals have been thinned and assembled in the chloral gum of Berlesse for better observation of the sclerified parts of the hapter and the genital apparatus. Parasites species identification was based on morphological features according to Radujković and Euzet (1990). The parasitological indexes (prevalence, mean intensity and abundance) were calculated according to Margolis *et al* (1982) and Bush *et al* (1997).

RESULTS

The examination of *Mustelus mustelus* and *Raja clavata* allowed us to collect 6 species of ectoparasites (3 species of Isopods, 2 species of Copepods and 1 species of Monogenea) (Tab II).
On *Mustelus mustelus*, we harvested 3 parasitic species: *Lernaeopoda galei* (Fig. 3a) and *Kroyeria lineata* (Fig. 3b) (Copepods) and *Anilocra physodes* (Isopod) (Fig. 3c).
The examination of *Raja clavata* allowed us to harvest one species of Monogenea (*Rajonchocotyle emarginata*) (Fig. 2a), 2 species of Isopod (*Ceratothoa parallela* (Fig. 2b) and *Mothocya nana* (Fig. 2c)) and one species of Copepod (*Lernaeopoda galei*) (Fig. 2d).

Parasitological indexes of the collected ectoparasites

The hosts, the number of examined fish, the number of the infected fish, the attachment sites, the parasitological indexes (Prevalence (P%), Mean intensity (MI) and Abundance (A)), of each parasite were calculated and specified in the table II with the attachment site .
Lernaeopoda galei presents the lowest prevalence on *Raja clavata* (P=0.83%). The prevalences of the isopodes species are slightly higher. Indeed, the prevalences of *Ceratothoa parallela* (P= 1.45%) and *Mothocya nana* (P=1.66%) do not exceed 2%.
On the other hand, *Rajonchocotyle emarginata* possesses the highest prevalence on this host (P=2.51%).
On *Mustelus mustelus*, the highest prevalences were recorded on copepods, *Kroyeria lineata* (P=2.87%) and *Lernaeopoda galei* (P=2.50%). The lowest prevalence was recorded on *Anilocra physodes* (P=0.41%).

Attachment sites of the collected parasites

Among the different species of parasites collected, three attachment sites were observed (Tab II). In fact, *Anilocra physodes* was fixed on the side of the body of *Mustelus mustelus*. *Ceratothoa parallela* was also found on the body side of *Raja clavata.*
Mothocya nana and *Rajonchocotyle emarginata* were collected from the gills of *Raja clavata.*
Kroyeria lineata found on *Mustelus mustelus* was fixed on the gills of this host. On the other hand, *Lernaeopoda galei* was fixed in the cloacal cavity of its two hosts.

DISCUSSION

During our study we were able to collect a species of Monogenea (*Rajonchocotyle emarginata*) on *Raja clavata* (Fig 2 a; Tab II).
Monogeneans are parasitic flatworms that are among the most host specific of all parasites. Most are ectoparasites with relatively low fecundity and direct

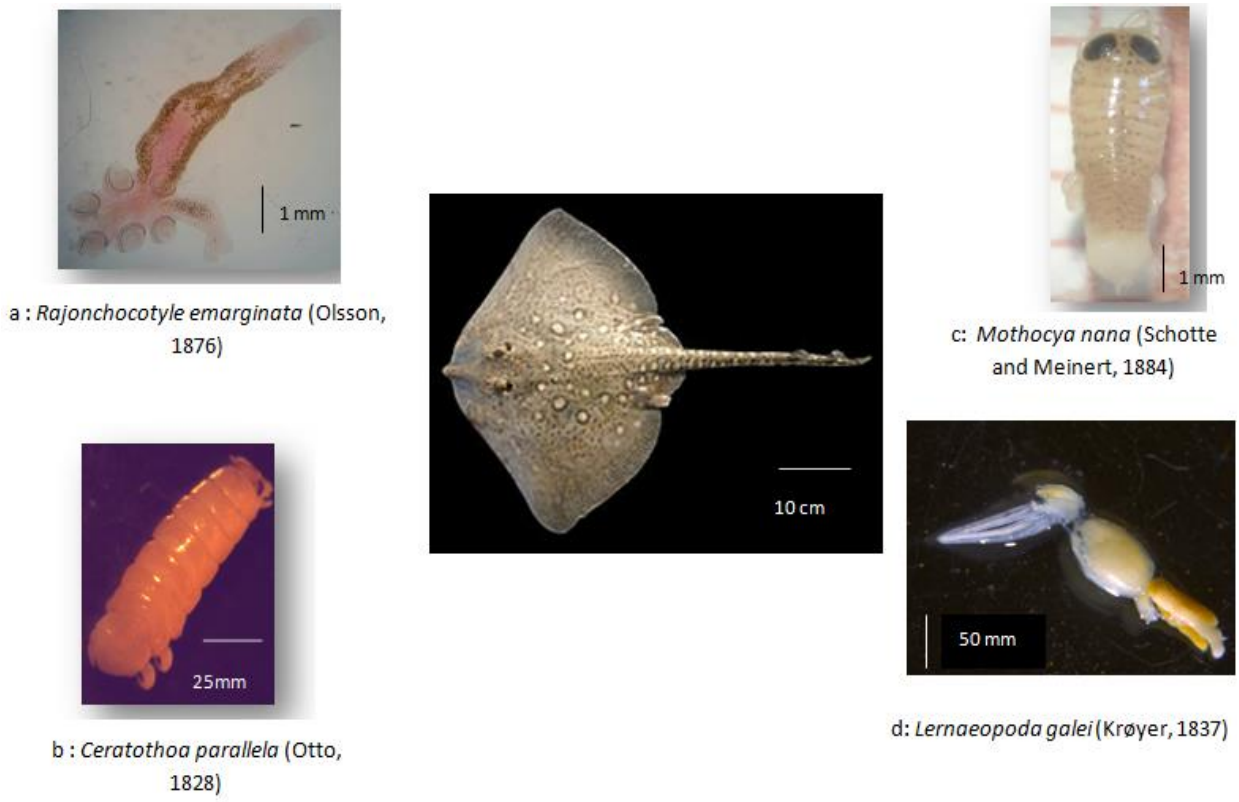

Figure 2: *Raja clavata* Linnaeus, 1758 and its ectoparasites

Table II: Parasitological indexes and attachment sites
NEF: Number of Examined Fish; NIF: Number of Infested Fish; P (%): Prevalence;
MI: Mean Intensity; A: Abundance

Host	NEF	NIF	Ectoparasites	P (%)	MI	A	Attachment site
Raja clavata Linnaeus, 1758	480	7	*Ceratothoa parallela*	1.45	1.42	0.014	Body
		8	*Mothocya nana*	1.66	2	0.016	Gills
		4	*Lernaeopoda galei*	0.83	1	0.037	Cloacal cavity
		12	*Rajonchocotyle emarginata*	2.51	1	0.025	Gills
Mustelus mustelus (Linnaeus, 1758)	480	2	*Anilocra physodes*	0.41	1	0.004	Body side
		12	*Lernaeopoda galei*	2.50	1	0.017	Cloacal cavity
		13	*Kroyeria lineata*	2.70	1	0.028	Gills

life cycles tied to water. They infect a single host species, usually a fish (Whittington and Kearn, 2011). *Rajonchocotyle emarginata* belong to the Polyopisthocotylean monogeneans of the hexabothriid genus *Rajonchocotyle* Cerfontain, 1899. Species of this genus are parasitic on the gills of elasmobranchs, mainly members of the family Rajidae (rays). *Rajonchocotyle emarginata* (Olsson, 1876) is a parasite of a variety of rays in Atlantic waters (Whittington and Kearn, 2011). In the Mediterranean Sea this parasite was reported on *Raja asterias* (Ulmer and James, 1981), on *Raja clavata* (Orecchia and Paggi, 1978; Ulmer and James, 1981; Di Cave *et al*, 2003) and on *Raja miraletus* (Ulmer and James, 1981) (Tab III).

In this work, we were able to collect 3 different species of Isopods (Cymothoidae). *Anilocra physodes* on *Mustelus mustelus* (Fig 3 c), *Ceratothoa parallela* and *Mothocya nana* on *Raja clavata* (Fig 2 b and 2 c). Cymothoid are ectoparasites infecting particularly the buccal-cavity, the gill chamber and burrow inside the fish to develop in a pouch (Horton, 2000). They feed

Table III: Records of Parasites showing geographic localities and diversity of host species
*****: First citation of this parasite on this fish

	Parasites	Geographic location	Host	References
Isopoda	*Anilocra physodes* (Linnaeus, 1758)	Brazil	*Raja clavata* Linnaeus, 1758	Moreira and Sadowsky (1978)
		Mediterranean Sea Tunisian coasts		Trilles and Raibaut (1971) Present work*
		Brazil	*Squatina squatina* (Linnaeus, 1758)	Moreira and Sadowsky (1978)
		Tunisian coasts	*Raja clavata* (Linnaeus, 1758)	Capapé and Pantoustier (1976)
		Tunisian coasts	*Diplodus annularis*, *Dentex vulgaris*, *Pagrus auriga*, *Pomatomus saltator*, *Lithognathus mormyrus*, *Spondyliosoma cantharus*, *Diplodus annularis*, *Boops boops*, *Sciaena umbra* and *Uranoscopus scaber*	Trilles and Raibaut (1971) Charfi-Cheikhrouha *et al*. (2000)
		Tunisian coasts	*Mustelus mustelus* (Linnaeus, 1758)	Present work*
	Ceratothoa parallela (Otto, 1828)	Mediterranean Sea	*Raja asterias* Delaroche, 1809	Capapé and Pantoustier (1976) Trilles (1994)
		Mediterranean Sea	*Raja clavata* Linnaeus 1758	Capapé and Pantoustier (1976) Trilles (1994)
		Tunisian coasts	*Boops boops*, *Diplodus annularis*	Charfi-Cheikhrouha *et al*., (2000)
		Tunisian coasts	*Raja clavata* Linnaeus, 1758	Present work
	Mothocya nana (Schotte and Meinert, 1884)	Tunisian coasts	*Belone belone* *Dicentrarchus labrax*	Trilles and Raibaut (1971) Charfi-Cheikhrouha *et al*. (2000)
		Tunisian coasts	*Raja clavata* Linnaeus, 1758	Present work
	Lernaeopoda galei Krøyer, 1837	Atlantic ocean (Ireland western coast)	*Galeorhinus galeus* (Linnaeus, 1758)	Henderson *et al*. (2003)
		New Zealand coasts	*Mustelus antarcticus* Günther, 1870	Hewitt and Hine (1972)
		Mediterranean Sea	*Mustelus asterias* (Cloquet, 1821)	Raibaut *et al*. (1998)
		Pacific Ocean (San Francisco Bay)	*Mustelus henlei* Gill, 1863	Russo (2013)

Copepoda		Mediterranean Sea	*Mustelus mustelus* (Linnaeus, 1758)	Raibaut *et al*. (1998)
		South Africa coasts		Dippenaar (2004)
		Turkish coasts		Karaytug *et al*. (2004)
		Mediterranean Sea	*Mustelus punctulatus* Risso, 1827	Raibaut *et al*. (1998)
		Atlantic Ocean (Argentina coasts)	*Mustelus schmitti* Springer, 1939	Etchegoin and Ivanov (1999)
		Mediterranean Sea	*Myliobatis aquila* Linnaeus, 1758	Raibaut *et al*. (1998)
		Irish coasts (Galway Bay)	*Scyliorhinus canicula* (Linnaeus, 1758)	Henderson and Dunne (1998)
		Mediterranean Sea		Raibaut *et al*. (1998)
		British coasts		Moore (2001)
		Mediterranean Sea	*Scyliorhinus stellaris* (Linnaeus, 1758)	Raibaut *et al*. (1998)
		The Black Sea	*Squalus acanthias* Linnaeus, 1758	Gaevskaya (2012)
		Pacific Ocean (San Francisco Bay)	*Squalus suckleyi* (Girard, 1855)	Russo (2013)
		Pacific Ocean (San Francisco Bay)	*Triakis semifasciata* Girard, 1855	Russo (2013)
		Tunisian coasts	*Mustelus mustelus* (Linnaeus, 1758) *Raja clavata* Linnaeus, 1758	Present work
	Kroyeria lineata Van Beneden, 1853	Pacific Ocean	*Galeorhinus galeus* (Linnaeus, 1758)	Deets (1994)
		Mediterranean Sea		Raibaut *et al*. (1998)
		Mediterranean Sea	*Mustelus asterias* (Cloquet, 1821)	Raibaut *et al*. (1998)
		Atlantic ocean (Ireland western coast)		Henderson *et al*. (2003)
		Japanese coasts	*Mustelus griseus* Pietschmann, 1908	Izawa (2008)
		Japanese coasts	*Mustelus manazo* Bleeker, 1854	Yamaguti and Tamasu (1959)
		Mediterranean Sea	*Mustelus mustelus* (Linnaeus, 1758)	Raibaut *et al.* (1998)
		Tunisian coasts	*Mustelus mustelus* (Linnaeus, 1758)	Present work
		Mediterranean Sea	*Mustelus punctulatus* Risso, 1827	Raibaut *et al*. (1998)
		South African waters	*Mustelus palumbes* Smith, 1957	Mokumo and Dippenaar (2015)
		Mediterranean Sea North-East Atlantic Ocean	*Prionace glauca* (Linnaeus, 1758)	Raibaut *et al*. (1998) Henderson *et al*. (2002)

Monogenea *Rajonchocotyle emarginata* (Olsson, 1876)	Brazilian coasts Norwegian Sea	*Amblyraja radiata* (Donovan, 1808)	Cohen *et al*. (2013) Poddubnaya *et al*. (2015) Poddubnaya *et al*. (2016)
	Brazilian coasts	*Bathyraja brachyurops* (Fowler, 1910)	Cohen *et al*. (2013)
	Brazilian coasts	*Bathyraja magellanica* (Philippi , 1902)	Cohen *et al*. (2013)
	England (Plymouth coast)	*Leucoraja naevus* (Müller and Henle, 1841)	Llewellyn *et al*. (1984) Whittington and Kearn (1986)
	Brazilian coasts	*Psammobatis scobina* (Philippi, 1857)	Cohen *et al*. (2013)
	Mediterranean Sea	*Raja asterias* Delaroche, 1809	Ulmer and James (1981)
	England (Plymouth coast) Spain (Northwest coast)	*Raja brachyura* (Lafont, 1871)	Llewellyn *et al*. (1984) Whittington and Kearn (1986) Alvarez *et al*. (2006)
	England (Plymouth coast) Ireland Mediterranean Sea Brazilian coasts	*Raja clavata* Linnaeus, 1758	Llewellyn *et al*. (1984) Whittington and Kearn (1986) Henderson *et al*. (1999) Orecchia and Paggi (1978) Ulmer and James (1981) Di Cave *et al*., 2003 Cohen *et al*., (2013)
	England (Plymouth coast) Spain (Northwest coast)	*Raja microocellata* Montagu, 1818	Llewellyn *et al*. (1984) Whittington and Kearn (1986) Alvarez *et al*., (2006)
	Mediterranean Sea	*Raja miraletus* Linnaeus, 1758	Ulmer and James (1981)
	England (Plymouth coast)	*Raja montagui* Fowler, 1910	Llewellyn *et al*. (1984) Whittington and Kearn (1986)
	Spain (Northwest coast)	*Raja undulata* Lacepède, 1802	Alvarez *et al*. (2006)
	Southwestern Atlantic (Brazil)	*Sympterygia bonapartii* Müller and Henle, 1841	Irigoitia *et al*. (2017)
	Tunisian coasts	*Raja clavata* Linnaeus, 1758	Present work

on blood and tissues of a suitable host (Horton and Okamura, 2003) (Tab III).

Anilocra physodes is widely spread in the Mediterranean Sea. In Tunisia, this parasite was reported on a variety of hosts (*Diplodus annularis*, *Dentex vulgaris*, *Pagrus auriga*, *Pomatomus saltator*, *Lithognathus mormyrus*, *Spondyliosoma cantharus*, *Diplodus annularis*, *Boops boops*, *Sciaena umbra* and *Uranoscopus scaber*) (Trilles and Raibaut, 1971; Charfi-Cheikhrouha *et al*, 2000) (Tab III). However, this is the first time in the world to report the presence of this Isopod on *Mustelus mustelus* from Tunisian coasts (Fig 3 c).

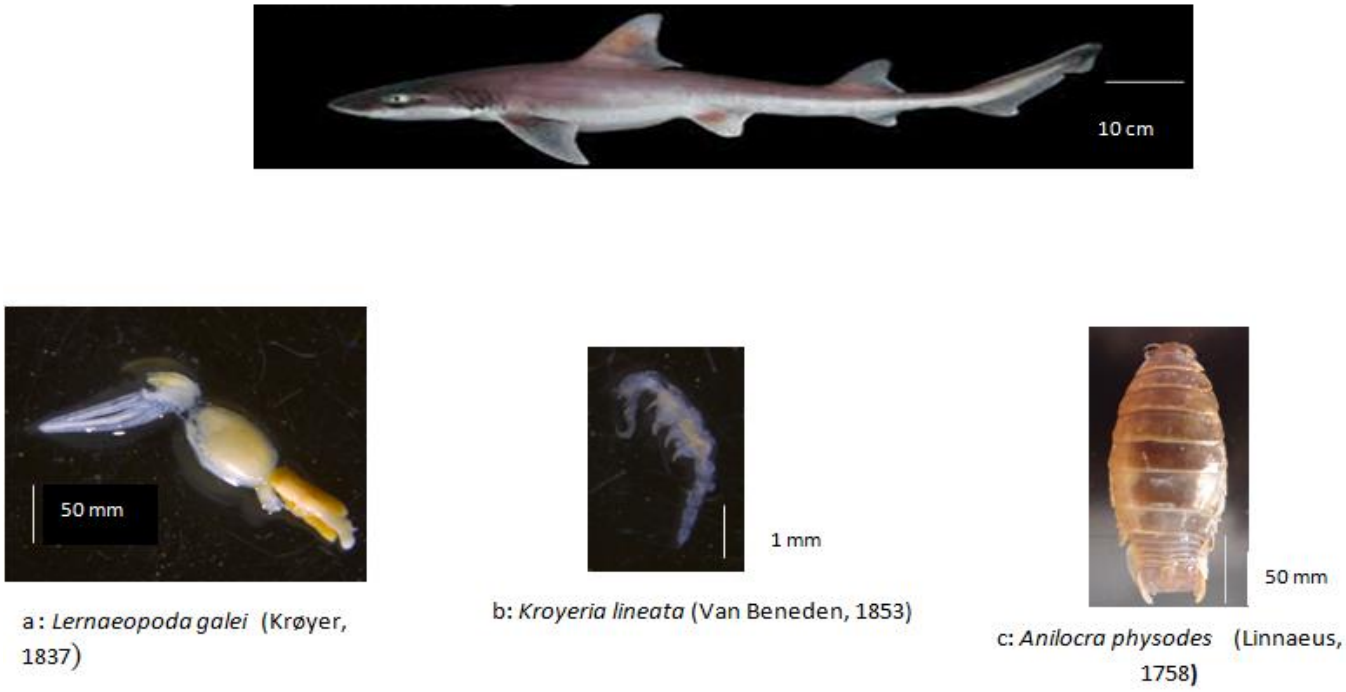

Figure 3: *Mustelus mustelus* (Linnaeus, 1758) and its ectoparasites

Ceratothoa parallela was found on *Raja clavata* (Fig 2 b). According to Trilles (1994) this parasite was already found in Tunisian waters on chondrichtyan fish (*Raja asterias* and *Raja clavata*) in the female and male sexual stages. We collected the male sexual stage of *Mothocya nana* on *Raja clavata* (Fig 2 c). This is the first mention of this parasite on a Chondrichtyan fishes both in Tunisian coasts and worldwide. Indeed this Isopod is well known in the Tunisian waters to parasite some teleost fish species namely *Belone belone* and *Dicentrarchus labrax* (Trilles and Raibaut, 1971; Charfi-Cheikhrouha *et al*, 2000) (Tab III).

Our results reveal that the prevalence rates of all collected Cymothoids parasites are relatively low and do not exceed 1.66% (Tab II).

Parasitic copepods are common on marine fish (Kabata, 1979; Benmansour and Ben Hassine, 1998; Benmansour, 2001). During our study we were able to collect 3 different species of Copepods. *Lernaeopoda galei* was found in the cloacal cavity of *Raja clavata* and *Mustelus mustelus* (Fig 2 d, Fig 3 a). This copepod was found on several species of Elasmobranchs (*Mustelus mustelus* and *Mustelus punctulatus*) in the Mediterranean Sea (Raibaut *et al*, 1998; Dippenaar 2004; Karaytug *et al*, 2004) (Tab III).

However, this is the first time we report this Lernaopodidae on *Raja clavata* worldwide. *Lernaeopoda galei* presents the lowest prevalence on *Raja clavata* (P= 0.83%). On the other hand this parasite presents a high prevalence on *Mustelus mustelus* (P= 2.50%) (Tab II).

On *Mustelus mustelus* we were able to find a second species of Copepod *Kroyeria lineata* (Fig 3 b). This copepod was first recorded on *Mustelus mustelus* by Deets (1994). Most *Kroyeria* species are relatively host specific on carcharhiniform sharks of the families Carcharhinidae and Triakidae with a few species having been reported from the family of Sphyrinidae (Benz, 1994; Deets, 1994). In our work, this copepod species presents the highest prevalence (P=2.87%). According to Deets (1994), *Kroyeria* species are considered to have a high parasite load on their hosts which is consistent with our results.

CONCLUSION

We note that the encountered parasites on *R. clavata* and *M. mustelus* on the Tunisian coasts do not induce any pathogenic effects. Indeed, the parasitological

index values of the different species of parasites are not high and do not exceed 2.8% for prevalence, 2 for mean intensity and 0.037 for abundance. This suggests that there is no parasite proliferation that may induce health problems for these fish.

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