

Nematodes parasitizing *Trachurus trachurus* (L.) and *Boops boops* (L.) from Algeria

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Abstract A total of 455 *Boops boops* (Linnaeus, 1758) and 953 *Trachurus trachurus* Linnaeus, 1758 from the east coast of Algeria were examined for their parasitic Nematoda. Two hundred ninety-five specimens of larval stages L3 and L4 were collected from the peritoneal cavity of these two examined fishes. Photonic and scanning electronic microscopy (SEM) studies were performed on these larvae specimens in order to characterize their morphology. Two different species of Nematoda (Anisikidae) were identified: *Anisakis simplex* (Rudolphi, 1809) and *Hysterothylacium aduncum* (Rudolphi, 1802). These two parasitic species were reported for the first time on *T. trachurus* and *B. boops* from the eastern coast of Algeria. These parasites were attached on different organs in the abdominal cavity (particularly on ovaries and testes). The infestation rate changed according to the month and the host size. The parasitism did not show a significant negative impact on the condition of the examined fishes.

Keywords Anisikidae · *T. trachurus* · *B. boops* · Algerian coasts

Introduction

Nematodes are bilaterally symmetrical and generally take the form of an elongate cylinder, tapered at each extremity and varying from less than 1 mm to more than 1 m in length at maturity (Roberts and Janovy 2005). Nematodes of the family Anisakidae have a global distribution among a wide variety of marine fish species that serve as intermediate or paratenic hosts (Koie et al. 1995).

Many studies were conducted on Anisakidae parasitizing Mediterranean fishes with high commercial value: Greece (Papoutsoglou 1975; Chaligiannisa et al. 2012), Spain (Valero et al. 2000; Valero et al. 2006; Rello et al. 2008; Gutiérrez-Galindo et al. 2010), Italy (Larizza and Vovlas 1995), Egypt (Morsy et al. 2012), and North African central Mediterranean coasts (Farjallah et al. 2008).

Fisheries are often worried with health problems. Infestation with anisakids can affect the commercial value of fish (Angot and Brasseur 1995). For example, in 1996, the EU excluded imports of Mauritanian fish for food safety reasons (Khlifa et al. 2013). This has led to great losses to the Mauritanian economy. According to Larizza and Vovlas (1995), an extensive alarm for public health was raised by the occurrence of *Anisakis* sp. larvae in the peritoneal cavity of *Merluccius merluccius* (L.) and *Sardina pilchardus* (Walbaum, 1792), common fish species of the South Adriatic and Ionian seas.

Many international programs were conducted on the impact of Anisakidae on fish and especially on health consumers. European fisheries are usually controlled for their infestations by nematodes.

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Larval stages of Anisakid nematodes (superfamily: Ascaridoidea, family: Anisakidae) of some genera such as *Anisakis* Dujardin, 1845, *Contracaecum* Railliet and Henry, 1912, *Pseudoterranova* Mozgovoy, 1951 and *Hysterothylacium* Ward and Magath, 1917, are commonly found in the viscera and the musculature of many species of teleost fish (Costa et al. 2003; Mattiucci and Nascetti 2008), and can infest humans causing a significant clinical disease (anisakiasis) in several countries (Zhou et al. 2008). *Anisakis* and *Pseudoterranova* are the two genera most associated with anisakidosis (Bernardi et al. 2011).

Associated pathologies are pseudo-ulcerations, intestinal obstruction, allergic anisakiasis, and pseudo-allergies food (Martin et al. 2005; Petithory 2008).

Trachurus trachurus (Carangidae) and *Boops boops* (Sparidae) are economically important species of the Mediterranean Sea. In Algeria, *T. trachurus* and *B. boops* are caught by trawlers at around 205,807 and 5000 t per year, respectively. Despite the economic importance of these two fish species, no studies have been conducted on their anisakid infestation. Data on the epidemiological information of this family of parasites are very few for all commercial fishes, especially for these two common species. In the western coast of Algeria, Marzoug et al. (2012), reported the potential presence of the two species parasites, *Anisakis simplex* (Rudolphi, 1809) and *Hysterothylacium aduncum* (Rudolphi, 1802) when she studied the parasitofauna of *B. boops*. Algerian fisheries need a serious control of their epidemiological infections by nematodes, as all countries interested by the development of their fisheries in terms of food security and quality.

The aim of this study was to give information on the morphology of anisakid infesting Algerian *T. trachurus* and *B. boops* using light and scanning electron microscopy, to determine their epidemiological indexes and dynamic of infestation, and to get an insight into the effect of anisakid on biological performances of these two hosts.

Material and methods

Nine hundred fifty-three specimens of *T. trachurus* (L.) and 455 specimens of *B. boops* (L.) were sampled in the fishing port of the gulf of Bejaia (east coast of Algeria) from February 2013 to April 2014. After sampling, specimens of fish were transferred to the laboratory. For each specimen, lengths were measured to the nearest 0.1 cm. After dissection, the abdominal cavity of every specimen was examined and its sex was determined. The body eviscerated weights were measured to the nearest 0.1 g, and also liver and gonad weights to the nearest 0.001 g. Inspection of the internal organs and muscles was performed by visual and under stereoscope examination. The number of parasites and the attachment site were noted for

each fish. Collected specimens of Nematoda were photographed under a light microscope, measured using a graduated eyepiece, drawn with a camera Lucida and kept in an alcohol 70 % for detail examination and identification on the basis of their morphology and anatomy. The parasitological indexes were calculated according to Margolis et al. (1982) and Bush et al. (1997).

For the scanning electron microscopy (SEM), nematodes specimens (stored in 70 % ethanol) were dehydrated in a graded ethanol (Carlo Erba, Absolute, PA) series 80 % (1/2 h), 90 % (1/2 h), and 100 % (1/2 h). The specimens were immersed in hexamethyldisilazane (HMDS), Molekula for 1/2 h (twice). After removing the excess of HMDS, the specimen was allowed to evaporate overnight under a fume hood. Finally, samples were mounted on aluminum stubs (Agar Scientific) with double sticky carbon tabs (Agar Scientific) and sputter-coated under argon flow with Au/Pd Polaron SC 7620 for 90 s. Afterward, the specimens were examined with a SEM LEO 438 VP. Statistical study was performed using a statistical software XLS TAT 2012 version.

Results

Morphology of the collected Nematoda specimens

Two species of nematoda were collected in the peritoneal cavity of *T. trachurus* and *B. boops* (Fig. 1). The distribution and localization of parasitic nematodes along the body of the examined fishes revealed that the majority of these parasites are encapsulated or free form larvae fixed on the organs of the abdominal cavity (Fig. 1a). The most infested organs are male or female gonads (Fig. 1b, c).

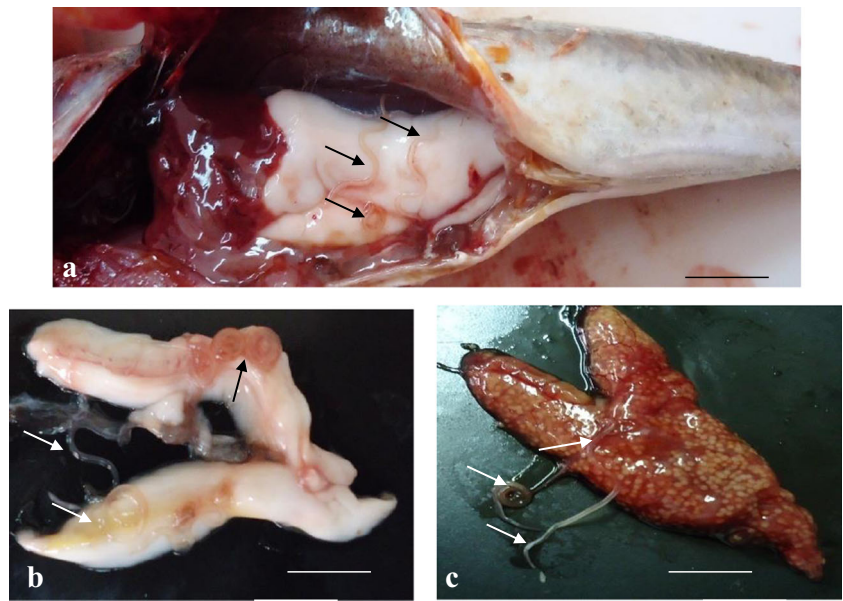
We collected many larvae belonging to the two nominal species: *A. simplex* ($n=230$) and *Hysterothylacium aduncum* ($n=65$).

The collected larvae (L3) of *A. simplex* (Rudolphi, 1809) obtained from the two examined fish species are morphologically and morphometrically identical. No differences have been noted compared to those collected in other regions especially in total length (Table 1). According to geographical areas (Table 1), differences were observed in the remaining measurements of *A. simplex*.

The collected larvae of *A. simplex* were elongate, cylindrical with tapering head and tail ends (Fig. 2a, g, j, k). They measured 19.37 ± 3.88 mm in length and 0.13 ± 0.02 mm in width. The internal structure of these larvae is typical: after the mouth opening, a long esophagus and a short ventriculus located 1/3 of the anterior part (Fig. 2a, e, j) were visible. A horizontal junction was clearly observed between the ventriculus and the esophagus (Fig. 2e, j).

Specimens of *A. simplex* was studied at the anterior, middle, and posterior parts using a SEM. Cuticle is striated

Fig. 1 Photographs showing the heavy infestation by Nematoda (Viscera, particularly gonads) of *T. trachurus*. **a** In the body cavity, **b** in the testes, and **c** in the ovaries, nematodes are shown by arrows. Scale bar, **a–c** 1 cm



transversely principally at the anterior and posterior body extremities and irregularly wrinkled near the tail (Figs. 2g, j, k and 3a, h). The middle region had longitudinal striations (Fig. 3a). The anterior part of the body includes the following: a globular head triangular oral opening clearly visible between trilobed lateral lips; a prominent V-shaped projecting boring tooth (length $5.7 \pm 1.94 \mu\text{m}$) located ventrally in the mouth, this structure allows probably the likely penetration of the parasites in the tissues of examined fish; an excretory opening (an oval lateral slit) located below the boring tooth on the ventral side (Fig. 3–e). Papillae could be seen on each of the

latero-ventral lips. Posterior part of collected L3 larvae includes the following: an anal opening and long tail ends (Table 1) with a distinct mucron ($9.3 \pm 1.56 \mu\text{m}$) (Fig. 3f–j).

Larvae of *Hysterothylacium aduncum* (L4) collected from *T. trachurus* (prevalence=1.68 %) and *B. boops* (prevalence=7.03 %) are morphologically identical.

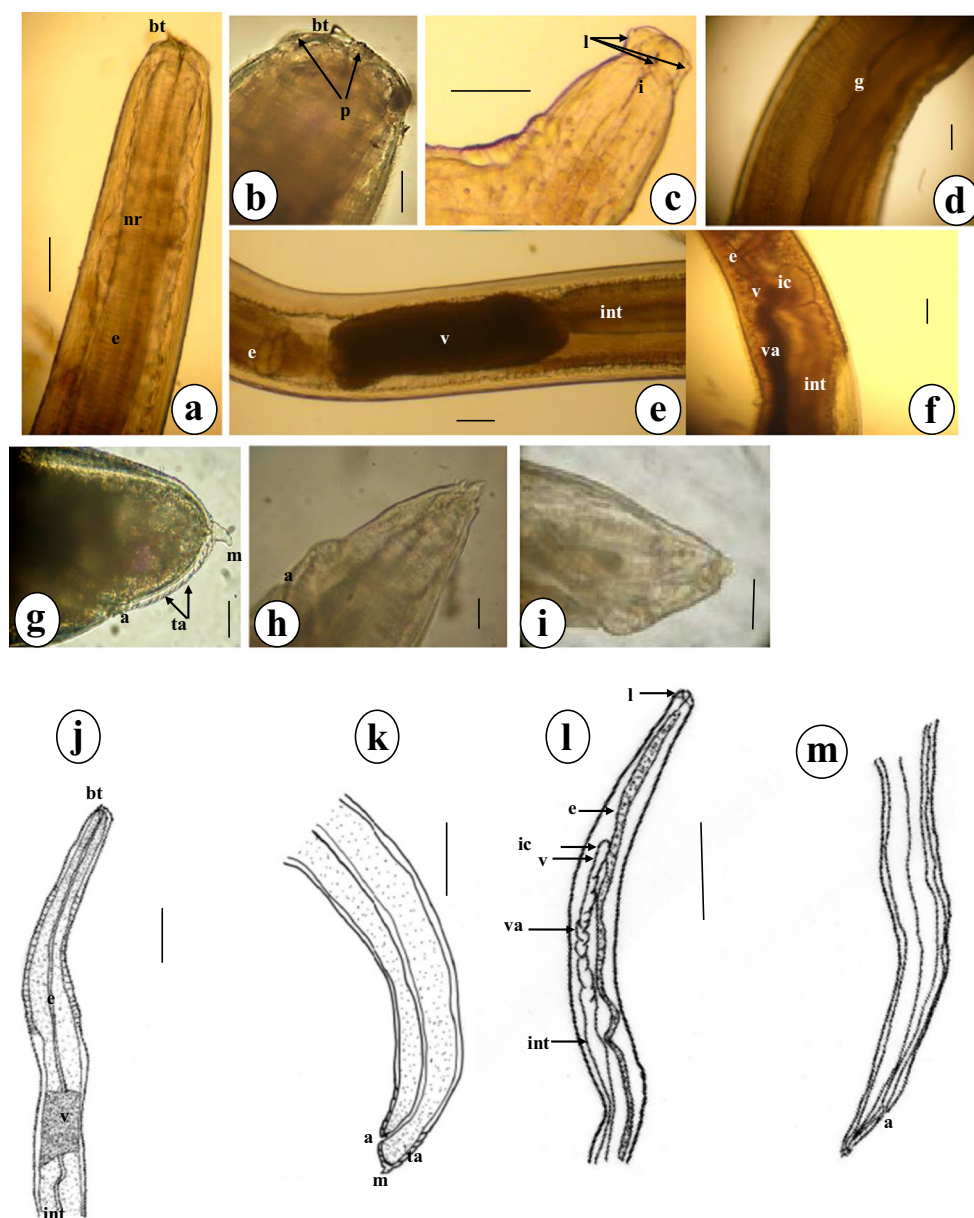
The body of the collected specimens, showing a transversely striated cuticle (Fig. 4a, g–j), averaged $16.46 \pm 2.35 \text{ mm}$ in length and $0.15 \pm 0.02 \text{ mm}$ in total width. The esophagus is muscular and measured $2.15 \pm 0.23 \text{ mm}$ in length, followed by the intestinal coecum which run interiorly at nearly half or

Table 1 Nematoda measurements according to hosts species and geographical areas

<i>Anisakis simplex</i> (Rudolphi, 1809)				
Measured characters	Present study Min–max (M $\pm$ SD) <i>T. trachurus</i> (NP=99)	Present study Min–max (M $\pm$ SD) <i>B. boops</i> (NP=1)	Larizza And Vovlas (1995) Area 1: Mediterranean Sea	Hurst (1984) Area 2: New Zealand waters
Body length (mm)	19.37 ± 3.88	17	21.60 ± 3.47	20.3 ± 3.00
Maximum Body width (mm)	0.13 ± 0.02	0.18	0.41 ± 0.05	0.43 ± 0.06
Ventriculus length (mm)	0.28 ± 0.04	0.2	0.70 ± 0.08	0.69 ± 0.09
Tail (mm)	0.41 ± 0.12	0.5	0.11 ± 0.01	0.12 ± 0.01
Tail's mucron (μm)	9.3 ± 1.56	10	25.69 ± 4.15	–
Boring tooth (μm)	5.7 ± 1.94	4	9.35 ± 2.41	–
<i>Hysterothylacium aduncum</i> (Rudolphi, 1802)				
Measured characters	Present study Min–max (M $\pm$ SD) <i>T. trachurus</i> (NP=15)	Present study Min–max (M $\pm$ SD) <i>B. boops</i> (NP=5)	Morsy et al. (2013) Area 1: Red Sea, Egypt	Shih HH and Jeng MS (2002) Area 2: Taiwanese coast of the Northwest Pacific
Total length (mm)	16.46 ± 2.35	8.61 ± 2.33	11.4 ± 2.0	15.42
Total width (mm)	0.15 ± 0.02	0.05 ± 0.02	0.2 ± 0.02	0.22
Lips (μm)	11.66 ± 2.06	10 ± 0.81	–	–
Esophagus length (mm)	2.15 ± 0.23	2.87 ± 1.03	1.55 ± 0.2	1.37

M mean, SD standard deviation, NP number of parasite specimens

Fig. 2 Photomicrographs of the *Anisakis simplex* and *Hysterothylacium aduncum* larvae showing the typical nematode structure: **a–c** the anterior end with the boring tooth (*bt*), papillae (*p*), nerve ring (*nr*), interlocked lips (*l*), and interlabium (*i*); **d–f** the middle region showing esophagus (*e*), ventriculus (*v*), intestine (*int*), intestinal cecum (*ic*), ventricular appendix (*va*), and groove (*g*); **g–i** the posterior end with mucron (*m*), cuticle (*c*) with its transverse annulations (*ta*) and anus (*a*). Scale bar=0.1 mm (**a, d, e, f**); 0.05 mm (**b, c, g–i**). Drawings of *A. simplex* larvae and *H. aduncum*, using a camera lucida: **j** cephalic end and ventricular part of *A. simplex*; **k** caudal end of *A. simplex*; **l** Cephalic end and region of ventriculus (showing intestinal cecum and ventricular appendix) of *H. aduncum*; **m** caudal end of *H. aduncum*. Scale bar=0.1 mm



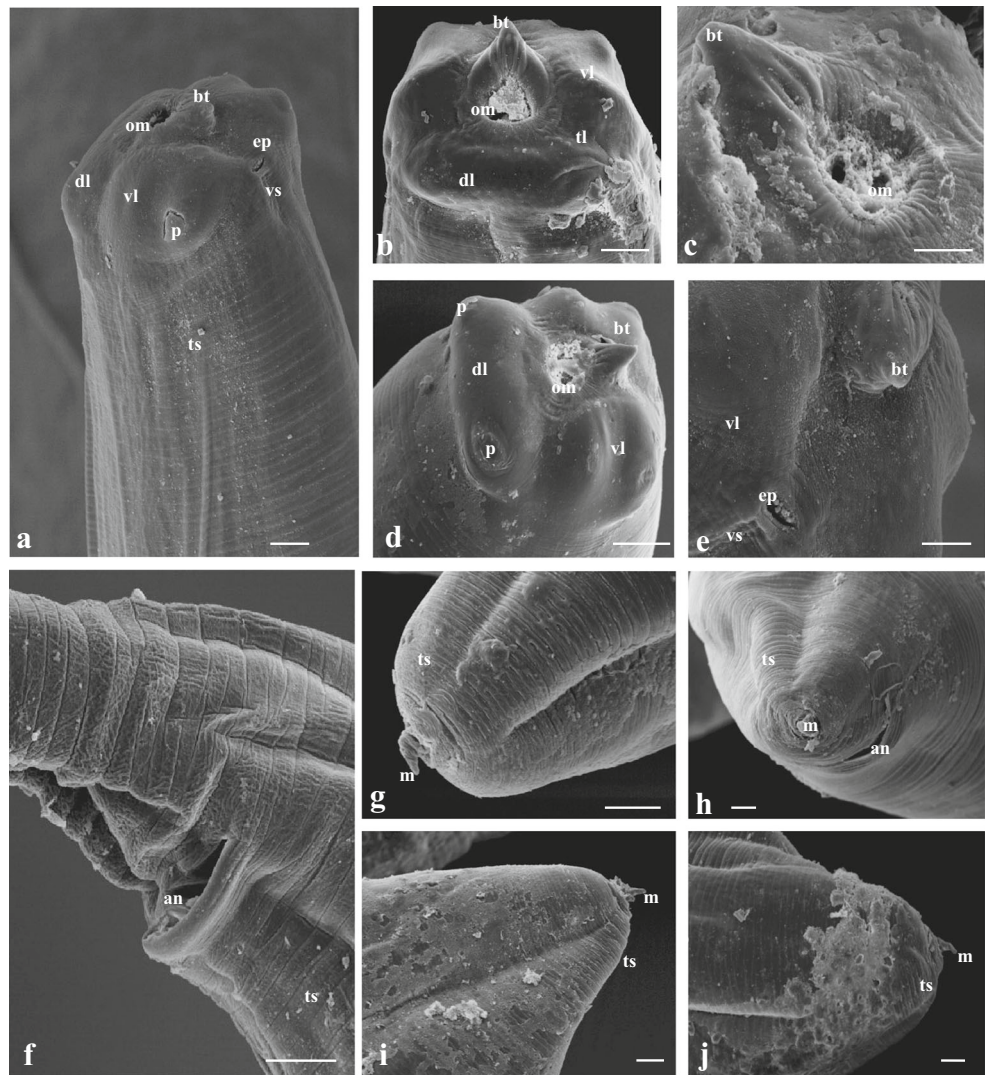
more of the esophagus (Fig. 2f, l). Ventricular appendix runs posteriorly. These larvae were characterized by the presence of a head region (Fig. 4a–f) carrying three distinct and large lips measuring $11.66 \pm 2.06 \mu\text{m}$, with relatively broad bases and two subdorsal double papillae (Fig. 4c, d); the space between the two adjacent lips is occupied by a short interlabia (Fig. 4a–c). The posterior end is conical, armed with numerous spines situated at different levels, and appeared as a cactus-tail. The anal opening is subterminal (Figs. 2m and 4g–j).

The parasitological indexes (Table 2) show that *T. trachurus* is more parasitized by nematodes ($P=12.60\%$) than *B. boops* ($P=7.25\%$) with a high mean intensity (2.60 parasites/infested fish). *T. trachurus* is more infested by *Anisakis simplex* ($P=9.44\%$) than by *Hysterothylacium aduncum* ($P=1.68\%$). However, *B. boops* seems to be more

infested by *H. aduncum* ($P=7.01\%$). Females of *T. trachurus* are slightly more infested ($P=26.84\%$) than males ($P=24.81\%$). The mean intensity of males ($\text{Im}=1$ parasite/infested fish) is slightly higher than that of females ($\text{Im}=0.84$ parasite/infested fish) (Table 2). In general, a low rate of infestation by Nematoda was observed in the two studied fish species.

The infestation rates of *T. trachurus* are higher between October and February 2013 ($P=30\text{--}35\%$; $\text{Im}=1\text{--}2$ parasite/infested fish) with high mean intensities (five parasites/infested fish) in April. For *B. boops*, the highest infestation was observed in spring: March, April, and May ($P=10\text{--}20\%$; $\text{Im}=1\text{--}2$ parasites/infested fish) (Fig. 5a, b). Both sexes have practically the same rate of infestation for each fish species (Fig. 5c, d). Specimens of *T. trachurus* which sizes vary from

Fig. 3 Scanning electron micrographs of *Anisakis simplex* (L3). **a–e** Anterior part details; *Om* opening mouth, *bt* boring tooth, *p* papillae, *tl* three lobed lips, *ep* excretory pore, *vs* ventral line, *ts* transversal striations, *vl* ventrolateral lip, *dl* dorsal lip. **f–j** Posterior extremity showing *m* mucron, *an* anus. Scale bars, **a, b, d, f–j** 20 μ m; **c, e** 10 μ m



17 to 25 cm have the highest infestation by parasitic nematodes ($P=40\%$). The highest mean intensity ($I_m=7$ parasites/infested fish) was observed in largest specimens, from 25 to 28 cm in length. For *B. boops*, the highest infestation ($P=25\text{--}30\%$) was observed in large specimens, over 19 cm in length (Fig. 5e, f).

The Fulton's K (Table 3) showed statistically only one significant difference between the males and the females of *T. trachurus* ($P=0.033$). No significant difference was observed in any fish specimens categories of *B. boops*.

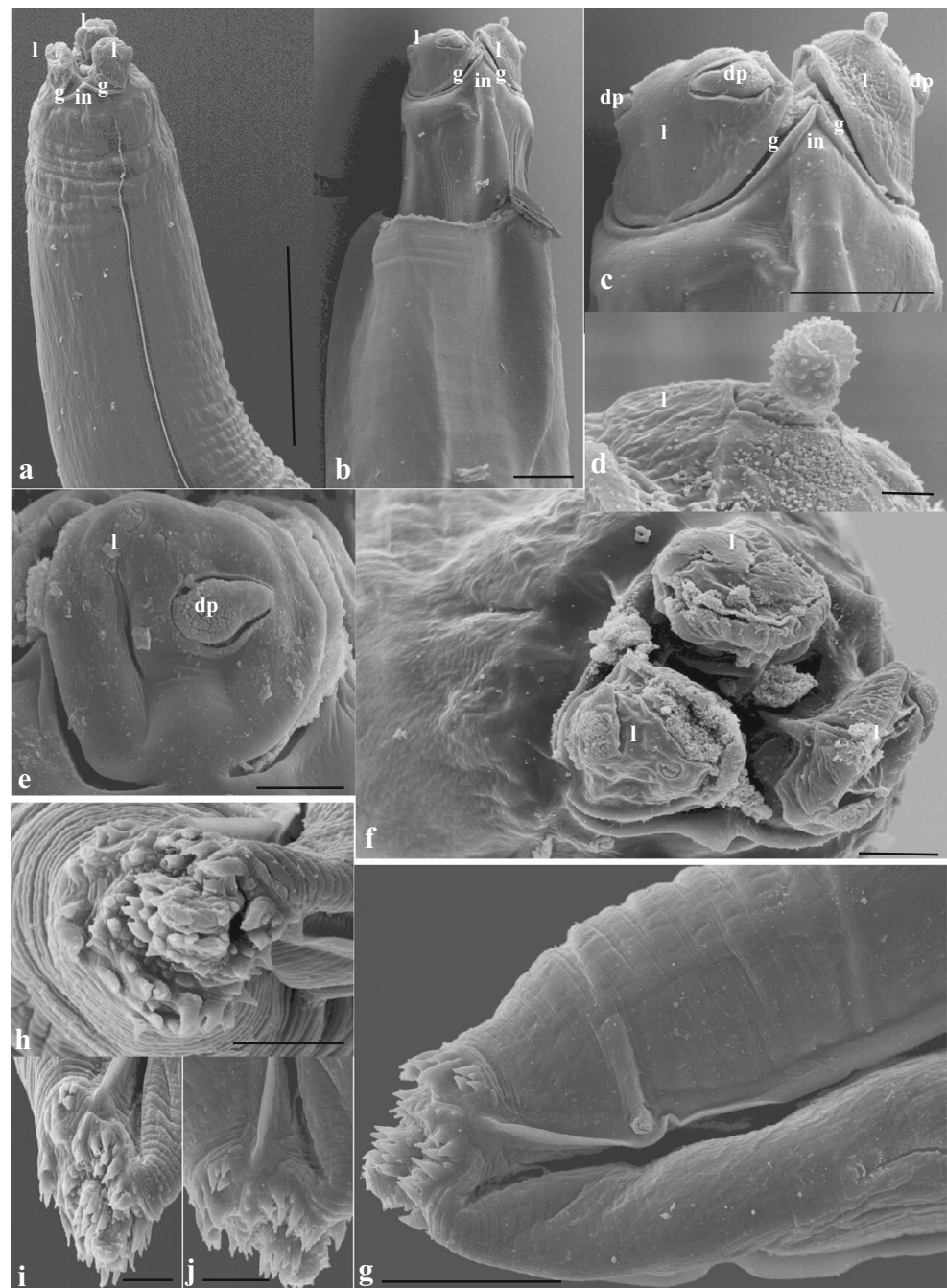
Remarks

In the present study, the nematodes infesting two teleost species (*B. boops* and *T. trachurus*) from the eastern coast of Algeria are morphologically characterized. These fish, the most abundant in the Algerian fisheries, are economically very interesting. Anisakidae larvae (L3 and L4) commonly

parasitize these two species in the eastern coast of Algeria. The same results were reported during several previous surveys carried out in most areas of the Mediterranean Sea along the European and African coasts where a wide variety of fish were examined (Papoutsoglou 1975; Kosuth et al. 2001; Abollo et al. 2003; Costa et al. 2004; Farjallah et al. 2008; Rello et al. 2009).

The collected larvae of nematodes belong to the species *A. simplex* (L3) and *Hysterothylacium aduncum* (L4). They infest the both sexes of the examined fishes. The highest presence of these parasites was observed in the peritoneal cavity of the hosts. The other parts of the body were not infested. According to a macroscopic and a microscopic study, no mechanical effects of these worms were observed on the internal organs (wall of the peritoneal cavity, gonads, intestine, liver, etc.) of the two fish species. In addition, the Fulton's K showed no impact of infestation on the condition of the infested fishes.

Fig. 4 Scanning electron micrographs of *Hysterothylacium aduncum*. **a–c** The anterior region showing lips, grooves, and interlabium; **d, e** detail of lips papillae; **f** cephalic end, apical view; **g** the posterior end showing the tail and the conical nodulose apex; **h** detail of the conical nodulose apex, ventral view; **i, j** detail of the conical nodulose apex, lateral view. Scale bars **a** 50 μ m, **b** 20 μ m, **c, e–j** 10 μ m, **d** 2 μ m



The morphological features of these parasites recorded in the present study are almost the same of those reported in the Mediterranean Sea, especially for the length and width, by Larizza and Vovlas (1995). Recently, Marzoug et al. (2012) reported the presence of these two parasite species on *B. boops* from the western of Algeria, without providing data on morphological and morphometrical details.

The present study confirms the existence of a remarkable similarity among parasite specimens of the same species and regardless to examined host species *B. boops* or *T. trachurus*. However, morphometric details of the collected parasites

(boring tooth, mucron, oesophagus, ventriculus, etc.) show differences from those reported in other regions of the world. The same results have been reported by Larizza and Vovlas (1995) for the Mediterranean population of *A. simplex* when they compared them to those reported from Australia, the North Sea, New Zealand, and Japan (Brunsdon 1956; Koyama et al. 1969; Pippy and Van Banning 1975; Smith 1983; Hurst 1984). According to Larizza and Vovlas (1995), the L3 *Anisakis* larvae from the Adriatic and Ionian seas are very similar (with considerable overlaps) to the type I larvae found by Brunsdon (1956) in 54 New Zealand fishes and

Table 2 Parasitological indexes according to host sex and parasites species

Host/parasite		Range of size classes [min–max]	Mean size [M±SD]	P %	MI	AS
<i>T. trachurus</i>	Both sexes infested by the two parasites	[5.2–26.5]	[14.75±4.10]	12.60	2.60	In, Go
	Male infested by the two parasites	[11.3–26.5]	[18.65±4.16]	44.20	2.57	In, Go
	Female infested by the two parasites	[12.5–26.2]	[17.90±4.16]	43.50	2.28	In, Go
	Both sexes infested by <i>A. simplex</i>	[11.2–25]	[19.31±4.27]	9.44	2.6	In, Go
	Male infested by <i>A. simplex</i>	[16.4–23.9]	[20.04±4.33]	23.91	2.54	In, Go
	Female infested by <i>A. simplex</i>	[16.7–26.2]	[19.97±4.32]	20.12	2.32	In, Go
	Both sexes infested by <i>H. aduncum</i>	[12.5–21.6]	[17.38±4.59]	1.68	1.31	In, Go
	Male infested by <i>H. aduncum</i>	[17.5–20.2]	[19.12±4.82]	3.62	1.2	In, Go
	Female infested by <i>H. aduncum</i>	[17.9–20.5]	[19.2±3.08]	1.29	3	In, Go
<i>B. boops</i>	Both sexes infested by the two parasites	[10.4–24.2]	[15.06±1.98]	7.25	1.36	In
	Male infested by the two parasites	[11.1–23.2]	[15.06±1.98]	72.72	9.71	In
	Female infested by the two parasites	[12.2–24.2]	[15.13±1.97]	71.82	10.18	In
<i>B. Boops</i>	Both sexes infested by <i>A. simplex</i>	16.2	–	0.21	1	In
	Male infested by <i>A. simplex</i>	16.2	–	0.69	1	
	Female infested by <i>A. simplex</i>	–	–	–	–	In
	Both sexes infested by <i>H. aduncum</i>	[13.8–22.6]	[16.62±1.96]	7.03	1.37	In
	Male infested by <i>H. aduncum</i>	[11.6–19.1]	[12.34±1.71]	9.79	1.21	In
	Female infested by <i>H. aduncum</i>	[13.8–19.7]	[15.00±1.92]	7.73	1.57	

M mean, SD standard deviation, P% prevalence, MI mean intensity, AS attachment site, Go gonads, In intestine

agree very well with all the previous descriptions (Berland 1961; Koyama et al. 1969) of this larval stage.

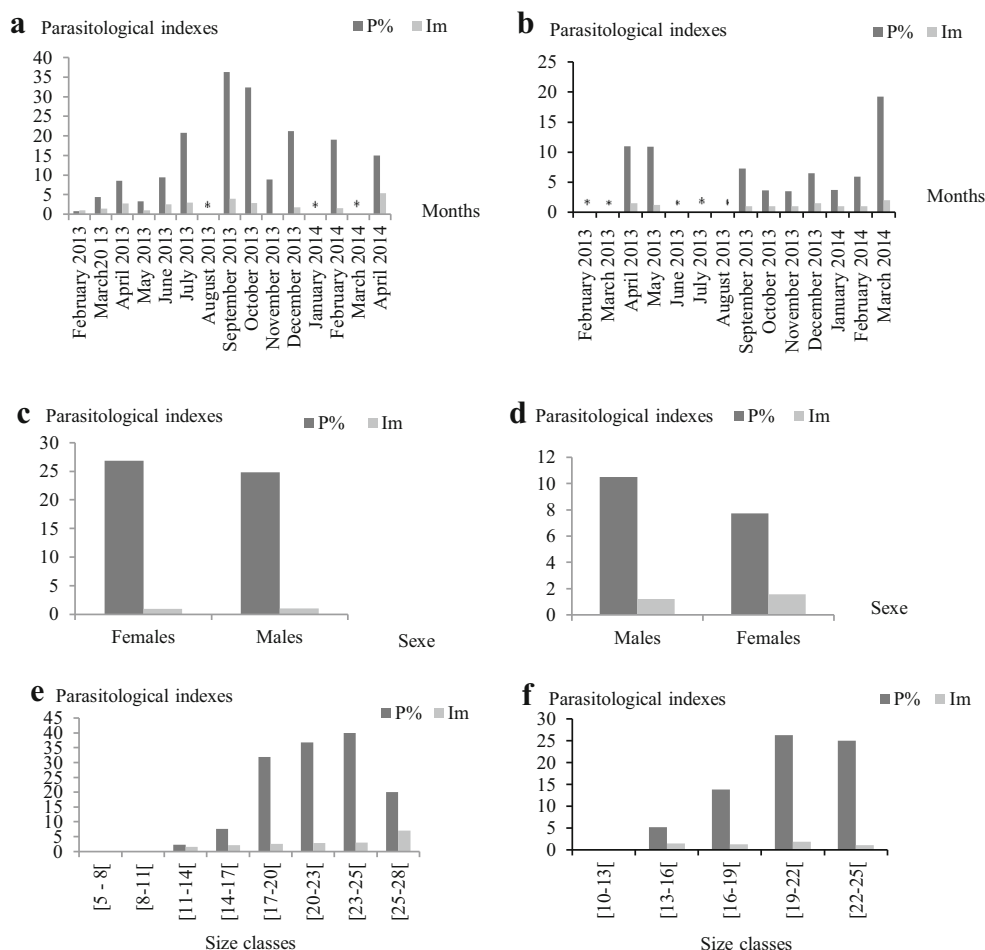
The third-stage larval (L3) nematode *Anisakis* population from Mediterranean waters was identified as *A. simplex* (type I larvae Berland 1961), taking into account the ventriculus dimensions and the presence of the tail spin (mucron) and according to the key suggested by Pippy and Van Banning (1975). The measurements of some details of the parasites that we collected show a slight importance compared to the specimens from other areas of the Mediterranean Sea (Larizza and Vovlas 1995). For example, our specimens are characterized by a short mucron. Such morphometric differences could be associated with some geographical factors of the environment.

The occurrence of L3 and L4 larvae of *H. aduncum* was possible because teleost fishes are potential intermediate hosts of these larvae. However, in the present study, we collected only L4 larvae and never L3 of this parasite. According to Navone et al. (1998), morphological criteria observed on *H. aduncum* specimens corresponds to L4. According to these authors, L4 differ from L3 by the presence of three distinct lips and interlabia, lips about as long as wide slightly constricted at anterior end, interlabia length about half of lip length, two lateral papillae present on the dorsal lip, on each subventral lip, one double and one simple papilla and the presence of a characteristic “cactus-tail.” Fourth-stage larvae (L4) were previously identified in the abdominal cavity of *T. trachurus* as *H. aduncum* (Pekmezci et al. 2012) and as *Hysterothylacium* sp. (Adroher et al. 1996). Specimens of *H. aduncum* identified

in this study from the two fish species *T. trachurus* and *B. boops* show the same morphological criteria as those observed by Shih and Jeng (2002) in Taiwanese coast of the Northwest Pacific and Morsy et al. (2013) in the Red Sea. However, the morphometric criteria of our specimens show a slight difference compared to those reported by the same authors. Differences in measurements were observed between the specimens collected from *T. trachurus* and those infesting *B. boops*.

The rate of infestation by these nematodes does not vary according to the sex of the host fish. However, the dynamics of the infestation changes according to the month and the fish size. The increasing rate of infestation according to the size of examined fish may be explained by the fact that the host species accumulate parasites with increasing in size. Also, large host feed large quantities of intermediate prey thereby strengthening infestation by these parasites (trophic factor favors infestation by these parasites). So, we could easily understand why specimens of *T. Trachurus* are more infested than those of *B. boops*. *T. trachurus* is a pelagic species with planktonic food habit, feeding particularly crustaceans (copepods) (Muus and Dahlström 1966), which are abundant in the water column and which are potential intermediate hosts for these parasitic nematodes, enhancing parasitism (and development cycle). The horse mackerel may therefore be infested with *A. simplex* and *H. aduncum* larvae by consumption of euphausiids, which are intermediate hosts of these nematodes (Smith 1983). However, food habit specimens of *B. boops* does not

Fig. 5 Variation of parasitological indexes according to month, sexes, and size classes of *T. trachurus* (a, c, e) and *B. boops* (b, d, f)



seem to favor nematode infestation because the diet of this fish does not include many crustaceans (omnivorous diet trend and

Table 3 Variation in Fulton's K of the two fish species according to specimens categories

Species	Examined specimens categories	N	K±SD	P
<i>T. trachurus</i>	Males	133	0.703±0.063	0.033
	Females	149	0.687±0.058	
	Unparasitized specimens	105	0.690±0.057	0.991
	Parasitized specimens	120	0.691±0.064	
	Unparasitized male	12	0.694±0.050	0.909
	Parasitized male	45	0.692±0.067	
	Unparasitized female	21	0.668±0.048	0.284
	Parasitized female	40	0.684±0.064	
<i>B. boops</i>	Males	249	0.817±0.073	0.101
	Females	245	0.841±0.078	
	Unparasitized specimens	612	0.835±0.072	0.715
	Parasitized specimens	33	0.827±0.078	
	Unparasitized male	234	0.835±0.072	0.504
	Parasitized male	15	0.851±0.054	
	Unparasitized female	231	0.792±0.068	0.332
	Parasitized female	14	0.812±0.062	

K Fulton's condition factor, SD standard deviation, P probability, N examined specimens

feeds on benthic prey) (Derbal and Kara 2008). The temporal dynamics of infestation differs from one fish species to another. This variation may be associated with several parameters specially related to the environment, to the host and to the parasite: temperature, feeding behavior of these two fish species, the development cycle of these parasites, the availability of potential intermediate hosts (infested with parasites) and probably the behavior of the intermediate host (pelagic or benthic).

Epidemiological indexes reveal that both species of examined fishes have low infestation by these parasites and less health risk (anisakidose, allergens, etc.) on consumers of these two fish species. According to the present study, it may be desirable to eat the bogue rather than the horse mackerel and also little specimens because they are less infested with nematodes. In perspective, it will be very wise to regularly review the parasitofauna of all fish species caught from the east coasts of Algeria and especially for their parasitic nematodes. Studies on the molecular biology are also recommended.

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