Research Paper

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Prevalence and Morphological Characterisation of *Anisakis* spp. in Some Commercial Fish from the Libyan Coast: A Comparative Study of *Scomber scombrus* and *Scorpaena scrofa*

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ABSTRACT

This study presents the first parasitological investigation of two commercially important fish species: the Atlantic mackerel (*Scomber scombrus*) and the red scorpionfish (*Scorpaena scrofa*) from the Misurata local market in Libya. A total of 40 specimens, with 20 specimens per species, were examined for *Anisakis* spp. infections in their digestive tracts, gills, and livers. The prevalence of *Anisakis* spp. was found to be 80% in *S. scombrus* and 40% in *S. scrofa*, with a statistically significant difference ($P \leq 0.05$) in the infection rates between the 2 species. Additionally, *S. scombrus* showed a significantly higher infection intensity, with the heaviest burden of parasites concentrated in the digestive system. The distribution of *Anisakis* spp. across different organs varied by host species. These findings highlight distinct infection profiles that are likely influenced by differences in host ecology and feeding behaviour. The results of this study provide an important baseline for food safety and fisheries management in the region.

KEYWORDS: *Anisakis* spp; *Scomber scombrus*; *Scorpaena scrofa*; Prevalence; Infection intensity; Misurata; Food safety

INTRODUCTION

Libya, with an extensive coastline spanning approximately 1,770 kilometres along the southern Mediterranean Sea, hosts significant yet understudied marine fishery resources (Shakman, 2008). These resources constitute a vital pillar for both food security and the national economy, providing a crucial source of affordable animal protein, essential micronutrients, and livelihoods for coastal communities (Nanna Roos et al., 2007). The nutritional importance of fish is well-established; regular consumption is linked to reduced risks of cardiovascular disease and improved neurodevelopmental outcomes, benefits predominantly attributed to their high content of long-chain omega-3 polyunsaturated fatty acids, vitamins, and minerals (FAO, 2018). Consequently, promoting fish consumption is often a key component of public health strategies. However, the sustainable utilization of this resource is compromised by biotic constraints, particularly parasitic infections. Fish parasites, especially helminths, represent a pervasive challenge in global aquaculture and wild-caught fisheries (Shinn, 2015). Infections can lead to substantial economic losses through multiple pathways: they can cause direct mortality, reduce growth rates and flesh quality, and increase susceptibility to secondary infections. From a public health perspective, certain zoonotic helminths pose a direct risk to consumers, potentially causing allergic reactions or gastrointestinal disorders, thereby undermining consumer confidence and market value (Shinn, 2015).

Despite the clear economic and nutritional importance of fish in Libya, parasitological studies targeting commercially important species remain scarce. A significant knowledge gap exists regarding the prevalence, intensity, and diversity of helminth parasites in key species landed at local markets. Species such as the Atlantic mackerel (*Scomber scombrus*) and the red scorpionfish (*Scorpaena scrofa*) are ecologically distinct; mackerel are pelagic filter-feeders, while scorpionfish are benthic ambush predators. These differing ecological niches and feeding behaviours are known to influence parasite community composition and infection dynamics, yet this has not been investigated in the Libyan context (Swayi, 2023). The parasitic nematode genus *Anisakis* holds significant zoonotic and economic importance worldwide. Infections caused by *Anisakis* species, especially A. *simplex* sensu stricto, are commonly reported in marine fish. The prevalence and intensity of these infections can vary depending on the host species, geographical location, and ecological factors.

Parasitic infections in *Scomber scombrus* and *Scorpaena scrofa* have been documented across various regions, highlighting their vulnerability. The Mediterranean region is known to be a hotspot for anisakiasis, with significant infection rates found in commercially important fish species. Recent research conducted by Ben Ali et al. (2024) on Atlantic mackerel (*Scomber scombrus*) in Tunisian waters revealed a high infection prevalence of the parasite A. *simplex*, at 67.68%. This finding highlights the considerable parasitological pressure affecting this pelagic species. It is consistent with earlier research by Feki et al. (2016), which also reported a high abundance of nematodes in S. scombrus in the same region. Moreover, studies conducted outside the Mediterranean further confirm the susceptibility of this species. For example, Rego et al. (1985) observed that frozen specimens of Scomber spp. were rarely free from parasitic infections.

Research on benthic fish, such as the red scorpionfish (*Scorpaena scrofa*), shows the presence of *Anisakis*, although the prevalence rates can vary. In the Aegean Sea, Coskun and Gokmen (2023) reported a prevalence of *Anisakis* larvae at 9.6% in S. scrofa. Other studies on parasites in scorpion fish have revealed a diverse community of helminths. Additionally, Arculeo et al. (2014) documented seasonal fluctuations in nematode infections among benthic fish, including S. scrofa, with prevalence reaching up to 23% during the summer months in Italian waters.

Recent studies confirm that S. scombrus and S. scrofa are competent hosts for *Anisakis* spp., with infection dynamics significantly influenced by the host's ecology, specifically, whether they exhibit pelagic filter feeding or benthic ambush predation. Despite extensive research on *Anisakis* in other regions of the Mediterranean, there has not been a dedicated parasitological survey of *Anisakis* in these commercially important species along the Libyan coast. This study aims to fill this critical geographical gap by providing the first comparative assessment of *Anisakis* prevalence, intensity, and organ distribution in S. scombrus and S. scrofa from Libyan waters. This research contributes essential baseline data for regional food safety and fisheries management.

This study was conducted to fill a significant knowledge gap regarding nematode *Anisakis* infections in two commercially important fish species in Libyan waters. The specific aims were: To estimate and compare the prevalence and infection severity of *Anisakis* parasites in Atlantic mackerel (*Scomber scombrus*) and red scorpionfish (*Scorpaena scrofa*) from the Misurata fish market. To identify the *Anisakis* species morphologically from infected fish and record their organ-specific distribution within the digestive tract, gills, and liver.

MATERIALS AND METHODS

Sample Collection and Preparation

A total of 40 fresh fish specimens were purchased from vendors at the Misurata local fish market. This collection included 20 Atlantic mackerel (*Scomber scombrus*) and 20 red scorpionfish (*Scorpaena scrofa*). To ensure the integrity of the tissues and the viability of parasites, the samples were immediately placed on ice in an insulated cooler and transported to the Parasitology Laboratory at the Faculty of Science, Misurata University.

In the laboratory, each specimen was processed individually under sterile conditions to avoid cross-contamination. Each fish was assigned a unique serial number, placed in separate labelled polyethene bags, and subjected to standard morphometric analysis. The following measurements were recorded for each fish: Total weight (g), measured using a calibrated digital balance. Total length (TL, cm), measured from the tip of the snout to the distal end of the longest caudal fin ray. Standard length (SL, cm), measured from the tip of the snout to the posterior end of the last vertebra (caudal peduncle).

Dissection and Preliminary Examination

After conducting a morphometric analysis, each specimen underwent a standard necropsy. A ventral incision was made, extending from the operculum to the vent, to fully expose the visceral cavity. The gastrointestinal tract, which includes the stomach and intestines, liver, and gills, was carefully excised and separated. Each organ complex was placed in an individual Petri dish containing sterile physiological saline (0.9% NaCl) to maintain osmotic balance and preserve the integrity of any parasites. All organs were systematically examined under a stereomicroscope (Leica M80; magnification 10–40×) for the presence of nematode larvae of the genus *Anisakis*.

Parasite Procedures

All identified *Anisakis* larvae were carefully collected using fine dissecting needles and soft camel-hair brushes. For initial fixation and long-term morphological preservation, the specimens were placed in vials containing 4% phosphate-buffered formalin. The fixative solution was replaced daily for three consecutive days to ensure optimal tissue penetration and preservation, following the protocol established by Rasheed (1989).

For detailed morphological identification, a subset of the preserved *Anisakis* nematodes was cleared in lactophenol for 24 to 48 hours to make internal anatomical structures transparent. The cleared specimens were then mounted on glass slides using DPX, a synthetic resin mounting medium, and covered with coverslips, as described by Rasheed (1989), to create permanent reference slides.

Parasite Identification

All permanent and temporary mounts were examined under a compound light microscope (Olympus CX23) equipped with an ocular micrometre for morphometric analysis. *Anisakis* larvae were identified to the species level based on diagnostic morphological characteristics established by Stock and Blair (2012) and validated against regional keys. Identification was confirmed by examining key anatomical features, including the presence and shape of the boring tooth at the anterior end. The morphology and dimensions of the ventriculus. The structure and position of the excretory pore. The shape of the tail, including the presence of a distinct mucron. The overall body size and cuticular morphology.

Data analysis

Statistical analyses were performed using IBM SPSS Statistics (v.26). Data were assessed with independent two-tailed t-tests ($\alpha = 0.05$) to compare (1) the overall prevalence of *Anisakis* spp. between fish species, (2) mean infection intensity between species, and (3) infection intensity across host size categories.

RESULTS AND DISCUSSION

The examination confirmed parasitic *Anisakis* infections in both species. Overall prevalence was 80% in *Scomber scombrus* and 40% in *Scorpaena scrofa*. A statistically significant difference ($P \leq 0.05$) was observed in the overall prevalence between *Scomber scombrus* and *Scorpaena scrofa*. The prevalence recorded for S. scombrus (80%) was higher than the 67.7% reported in Tunisian waters by Ben Ali et al. (2024) and 62.5% recorded in Spain by Martin-Carrillo et al. (2022), a difference potentially attributable to local environmental conditions or sampling methods. Similarly, the prevalence in S. scrofa (40%) exceeded that documented for congeneric species in Mexico by Vidal-Martínez et al. (2014), suggesting geographical or ecological influences. Microscopic examination of internal organs confirmed the presence of both single and mixed helminth infections in both host species. (Table 1).

Table 1. shows the prevalence of *Anisakis* infection in *Scomber scombrus* and *Scorpaena scrofa*.

Type of fish	NO. of examined fish	NO. of infected fish	P. value
Scomber scombrus	20	16 (80%)	0.000
Scorpaena scrofa	20	08 (40%)	
Total	40	24 (60%)	

The mean weight of *Scomber scombrus* was 179.9g (range: 87–250 g). Within this sample, one individual (6%) weighed <100 g, 10 individuals (63%) weighed 100–200g, and 5 individuals (31%) weighed >200 g. For S. scrofa, the mean weight was higher at 332.35g (range: 198–678 g). The weight distribution was as follows: one fish (12.5%) weighed <200 g, 5 fish (62.5%) weighed 200–400 g, and 2 fish (25%) weighed >400 g (Table 2). Statistical analysis found no significant relationship ($P > 0.05$) between host body weight and parasite infection intensity for either species. This result corresponds with the study reported by Santos et al. (2017) in Portugal. This suggests that, within the sampled weight ranges, infection occurrence was not size-dependent and may be influenced by other ecological or behavioural factors.

A detailed parasitological analysis revealed significant infection patterns of *Anisakis* spp. in the examined fish. In *Scomber scombrus*, the overall prevalence of *Anisakis* infection was found to be 80%. Morphological examination identified a total of 130 larvae belonging to two species: *Anisakis simplex* (Fig. 1, 2) and *Anisakis typica* (Fig. 3, 4). The spatial distribution of the larvae was notably specific to certain organs. The vast majority of the larvae (n=126, 97.0%) were recovered from the abdominal cavity, where they were found encapsulated on the mesenteries and the serosal surfaces of the visceral organs. The remaining larvae were located in the gills (n=3, 2.3%) and the liver (n=1, 0.8%).

Table 2. Relationship between host weight and *Anisakis* infection rate in *Scomber scombrus* and *Scorpaena scrofa*.

	Scomber scombrus			*Scorpaena scrofa*		
Weights of fish	Less than 200g	200-400g	More than 400g	Less than 200g	200-400g	More than 400g
No of infected fish	1	10	5	1	5	2
Prevalence rate	6%	63%	31%	12.5%	62.5%	25%
P. value	0.06					

In contrast, *Scorpaena scrofa* exhibited a lower overall burden of *Anisakis simplex*, with a total of 35 larvae recovered. The distribution was similarly localised, with the majority of larvae (n=31, 88.6%) found encysted in the abdominal cavity, while the remainder (n=4, 11.4%) were located within the hepatic tissue. No A. *simplex* larvae were recorded in the gills of S. scrofa.

These findings confirm a high prevalence of *Anisakis* species, primarily A. *simplex*, in commercially significant fish along Libya's Mediterranean coast. This pattern is consistent with the established parasitological profile of the region. Similar prevalence rates have been documented in nearby waters: 51.3% in S. scombrus from Tunisia (Ben Ali et al., 2024) and 68.8% in other pelagic fish from Italy (Costa et al., 2018), 73% in Portugal by Santo et al. (2017), 100% in Spain by Martin-Carrillo et al. (2022). The consistently high infection rates reported across these studies highlight the endemic presence of this zoonotic nematode and the significant ecological pressure it exerts within the broader Mediterranean marine ecosystem.

Parasite identification was performed based on standard morphological characteristics. The nematode specimens exhibited a cylindrical, unsegmented body, which is consistent with the genus *Anisakis*. Sexual dimorphism was apparent; adult females had one or two ovaries, while males possessed one or two testes along with a pair of posterior spicules. These morphological diagnoses were confirmed using the taxonomic keys from Stock and Blair (2012).

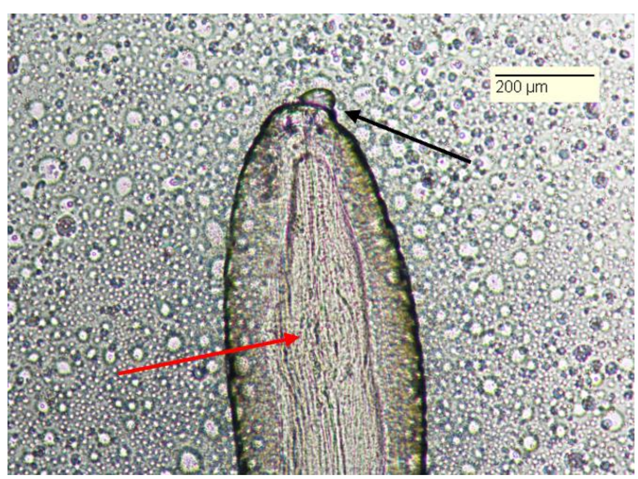

Fig. 1. Anterior end of an *Anisakis simplex* third-stage larva (L3), showing the boring tooth (black) and nerve ring (red arrow).

Phylum: Nematode
Class: Chromadorea
Order: Rhabditida
Family: Anisakidae
Genus: *Anisakis*
Anisakis simplex Rudolphi, (1809) Dujardin, 1845
Anisakis typica (Diesing, 1860) Baylis, 1920 (Gibson, 2001).

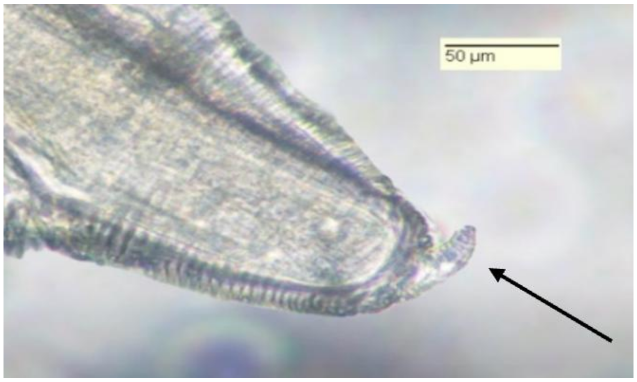

Fig. 2. Posterior end of an *Anisakis simplex* third-stage larva (L3), showing the tail with a terminal mucron (arrow).

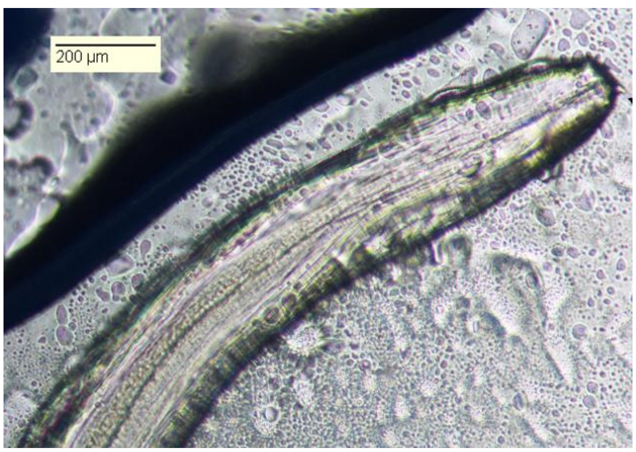

Fig. 3. Anterior end of an *Anisakis typica* third-stage larva (L3) showing the small dentigerous tooth.

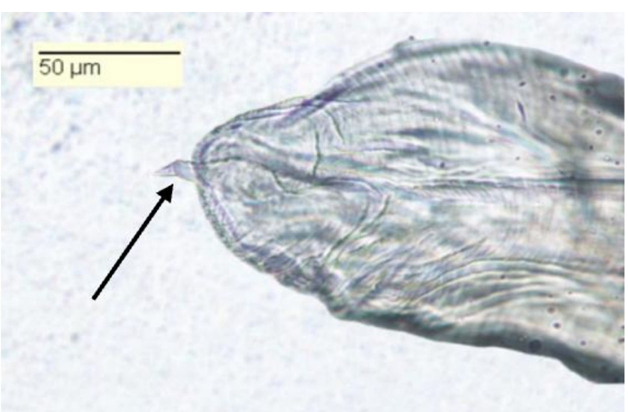

Fig. 4. Posterior end of an *Anisakis typica* third-stage larva (L3), showing the tail with a terminal, straight mucron (arrow).

In the case of *Scorpaena scrofa*, all recovered specimens of A. physeteris were found in the larval stage (L3) (Fig. 5, 6). They were located either encapsulated in the mesenteries and on the visceral surfaces of the abdominal cavity, or in the gastrointestinal tract.

(Kingdom): Animalia
(Phylum): Nematoda
(Class): Chromadorea
(Subclass): Chromadoria
(Order) : Rhabditida
(Suborder): Spirurina
(Infraorder): Ascaridomorpha
(Superfamily): Ascaridoidea
(Family): Anisakidae
(Subfamily): Anisakinae
(Genus): *Anisakis*
(Species): *Anisakis pegreffii* Campana-Rouget & Biocca, 1955
Gibson. (2001)

Fig. 5. Anterior end of an *A. physeteris* third-stage larva (L3) showing the small dentigerous tooth (indicated by the arrow).

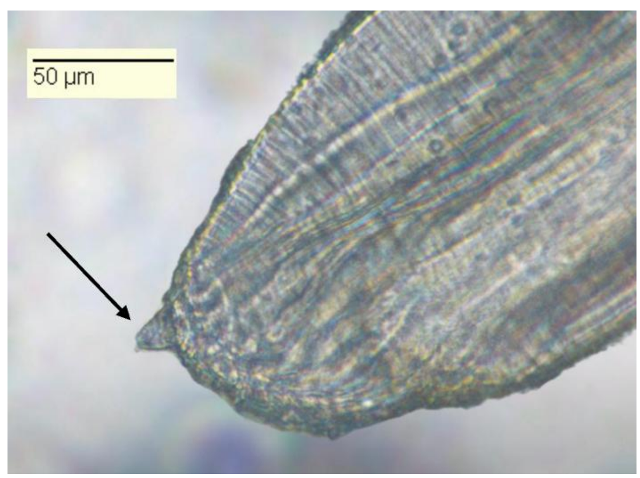

Fig. 6. Posterior end of an A. physeteris third-stage larva (L3), displaying the tail with a terminal mucron (arrow).

The high prevalence of *Anisakis* infection noted in this study aligns with findings from other regions of the Mediterranean. A prevalence rate of 100% for *Anisakis* larvae has been reported in certain host species in Atlantic waters (Abollo et al., 2001). Additionally, morphological identification of larvae from the Ionian Sea has identified a similar high prevalence (50%) of A. *pegreffii* (Costa et al., 2018). In this study, we found that the overall prevalence of *Anisakis* infection in S. scrofa was 40%, significantly higher than previously reported rates for this species in other regions of the Mediterranean Sea. For example, the prevalence in the Western Mediterranean was 27% (Ferrantelli et al., 2015), while a rate of 13.7% was observed in the Aegean Sea (Coskun and Gokmen, 2023). This variation in prevalence across different geographical areas may be due to differences in local environmental conditions, the availability of intermediate hosts, and the methodologies used for sampling.

Consistent with established patterns in the Mediterranean basin, where A. *pegreffii* is recognised as the dominant sibling species (Mattiucci et al., 2013, 2017, 2018 and Costa et al., 2018). Genetic analysis in this study confirmed that 100% of the larvae recovered from S. *scrofa* were A. *pegreffii*. This finding provides the first molecular confirmation of A. *pegreffii* in this host species along the Libyan coast, thus addressing a notable geographical gap in the documented distribution of the species.

CONCLUSION

This study presents the first parasitological assessment of *Anisakis* spp. infections in two economically important fish species: *Scomber scombrus* and *Scorpaena scrofa*, from the Libyan coast. It provides new data on the prevalence of these infections, particularly highlighting significant findings for S. scrofa from Misurata. The results indicate a high overall prevalence of *Anisakis* infections, especially in S. scombrus, and reveal notable interspecific differences in both infection intensity and organ distribution. The observed pattern shows a predominance of larvae located in the abdominal cavity, with the identification of *Anisakis simplex* and A. *pegreffii* . This aligns with the established parasitological profile of the Mediterranean region and reflects the distinct ecological niches and feeding behaviours of pelagic and benthic hosts.

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