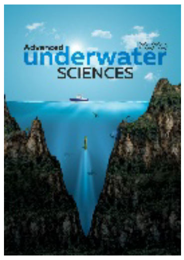
Volume: 2
Issue: 2
September, 2022

Advanced underwater SCIENCES

e-ISSN: 2791-8734

Advanced Underwater Sciences



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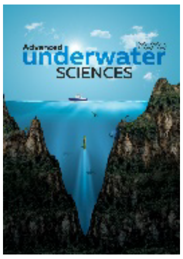

Advanced Underwater Sciences

Advanced Underwater Sciences

Volume 2

Issue 2 *September, 2022*

Contents

Research Articles;

Review Articles;

Advanced Underwater Sciences
http://publish.mersin.edu.tr/index.php/aus/index
e-ISSN: 2791-8734

The Determination of Ecto parasites in Two Lessepsian Fish Species Caught in the North East Mediterranean Shores (Mersin)

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Keywords
Nemipterus randalli,
Sphyraena chrysotaenia,
Lernanthropus sp,
Paragnathia sp.

ABSTRACT

This study was conducted between March 2019 and March 2020. Samples were taken monthly. As a result of this study, two types of ectoparasites were encountered in the gills of Randall's threadfin bream (Nemipterus randalli, Russell, 1986) fish, Lernanthropus sp. (Blainville 1822) and Yellowstripe barracuda (Sphyraena chrysotaenia, Klunzinger 1884) in the fins of fish Paragnathia sp.

1. INTRODUCTION

With the opening of the Suez Canal in 1869, the Mediterranean Sea has seen the biggest ecological changes in the world caused by human intervention. There has been a rapid rise in migratory activities of aquatic organisms between both environments with the removal of the geographical barrier between the Mediterranean and the Red Sea because of this intervention (Halim et al., 1995: 1-133). Especially in the eastern part of the Mediterranean, a great bio-ecological change has started leading to the migration of many vertebrate and invertebrate organisms showing high ecological adaptability to wide range of abiotic factos such as salinity and temperature, towards the Eastern Mediterranean and Aegean coasts (Basusta, 1996: 12).

Disease agents such as bacteria and parasites that the fish could bring with them through these migrations also threaten the fauna in the regions where they migrate. Disease agents could cause mass mortality by affecting the fish in the region in various ways and this might cause severe economic losses by minimizing the fishing activities in the region (Grabda, 1991: 1-304). Fish in natural populations and culture environments are constantly in danger of being infected by parasites.

It is very difficult to observe the damage caused by parasites in fish populations living in natural environments. On the other hand, parasites could cause serious infections in aquaculture as well. In particular, the presence of natural fish populations near to the farming site may cause an increase in the density of parasite species and infest fish in the farms. Parasites on body surface of fish, fins, gills filament, inner and outer surfaces of the gill cover (operculum) and the mucus of the host by adhering to the mouth, they feed on epithelial and/or blood tissue. Hold organelles and nutrition patterns mechanical damage to the tissue and They can cause the development of stress and secondary infections on the host, and indirectly the death of the host fish species due to the lesions that occur afterwards.

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Cite this article;

Koyuncu, C. E. (2022). The Determination of Ecto parasites in Two Lessepsian Fish Species Caught in The North East Mediterranean Shores (Mersin). *Advanced Underwater Sciences*, 2(2), 23-26

Research Article **Received: 31/01/2022; Accepted: 29/08/2022**

(Roberts, 2012:). Mersin province is an important fishing center due mainly to its long coastal line and fish species that are in high economic value. There are studies available on parasites found in fish in different geographical regions. However, no previous research has been found on ectoparasites living in Lessepsian fish species on the Erdemli-Anamur coastline that is considered one of the important fishing areas of the Eastern Mediterranean. In addition, as far as the number of existing and future fish farming projects are concerned, it is understood that extensive aquaculture activities will be conducted on the coastal lines of Mersin province in the coming years (Koyuncu, 2020: 1409-1420).

For all these reasons, it is vital to identify and investigate the damage that these ectoparasites create on fish considering ectoparasites are one of the biggest disease causing agents in natural fish species.

This study was able to identify the presence of ectoparasites in two commercially important Lessepsian fish species living on the coastline of Mersin province (Erdemli-Anamur). The findings of this investigation are also expected to help the efforts of determination of the ecto parasite fauna which has not yet been identified for the region and to assist future parasite studies.

2. MATERIAL and METHODS

The fish examined in this study were purchased from the fishermen operating in Erdemli-Anamur districts beginning from east towards west between March 2019 and March 2020.

The fish were immediately taken to the Fish Diseases Laboratory of Mersin University Faculty of Fisheries and kept at -20 °C until the parasitological examination. Before the dissection process, the fish were thawed and their live weights and total lengths were measured and recorded. Then, the oral cavity of the fish, fins, body surface and their macroscopic investigations and the dissected gills were carefully examined using a stereo-microscope. After these procedures were completed, the dissection process was started. Then in the dissection process; first of all, the operculum (gill covers) of the fish were cut. Following this procedure, the gill arch on both sides was cut and removed separately. The detected parasites were separated from the tissue with a forceps and then fixed in 70% ethanol solution for two days before the species identification. Parasites removed from gill filaments were kept in lactic acid for two hours for cleaning purposes before starting the identification process. The general appearance of the cleaned individuals was photographed using a Nikon (Eclipse 80 i) phase contrast microscope.

The species-specific structures of the parasites were identified according to the previously reported procedures (Kabata, 1979: 1-468; Davies et al., 1987: 134-147; Kırkım, 1999: 1-237; Diebakate, 1994: 1- 90; Bahri et al., 2002: 253-267, Ho et al., 2008: 251-280; 2011: 611-635) along with the utilization of morphological features of the species themselves.

3. RESULTS and DISCUSSION

This study involved the ecto-parasite screening of Nemipterus randalli and Sphyraena chrysotaenia individuals caught with an average length of 11.88 ± 0.64 cm (n=1230) and 28.94 ± 1.35 cm (n=200) respectively. The results of this study demonstrated that Lernanthropus sp. on the gills of Nemipterus randalli and Paragnathia sp. on the fins of Sphyraena chrysotaenia were existed (Fig. 1,2).

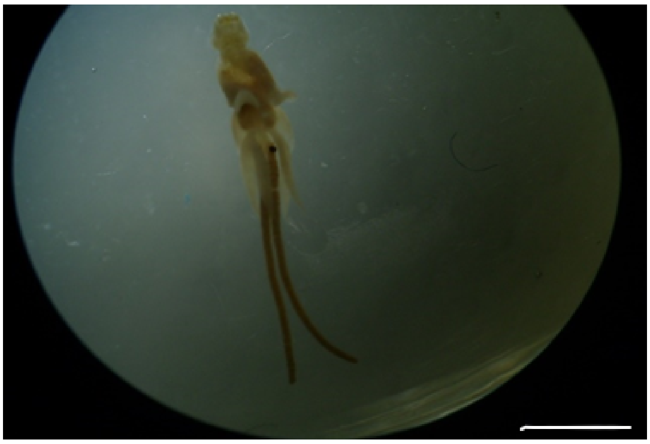

Figure 1. Lernanthropus sp.(female) (Blainville 1822) (Scale:1mm).

Parasite: Lernanthropus sp. (Blainville 1822) (Siphonostomatoida: Lernanthropidae)

Host Fish: The randall's threadfin bream (Nemipterus randalli, Russell, 1986)

Collection date: June 2019

Infestation Site in the Host: Gill arch and spines

Infestation Locality: Erdemli Beach

Number of fish examined: 1230

Number of parasitic fish: 7

Percentage of Infected Fish: 0.56%

Minimum-maximum number of parasites in a fish: 1-2

Total number of parasites: 7 female

Measurements (length in mm): The body length of female individuals was measured between 4-5 mm on average (Figure 2).

Figure 2. Paragnathia sp. (Praniza larva stage)(Scala: 1 mm).

Parasite: Paragnathia sp. (Hesse, 1864)
(Isopoda:Gnathiidae)
Host Fish: The yellowstripe barracuda (Sphyraena chrysotaenia Klunzinger, 1884)
Collection date: June 2019
Infestation Site in the Host: On the Fins
Infestation Locality: Anamur Beach
Number of fish examined: 200
Number of parasitic fish: 17
Percentage of Infected Fish: 8.5%
Minimum-maximum number of parasites in a fish: 1-3
Total number of parasites: 38

Measurements (length in mm): The average length of parasites detected in the study was measured as 2.8-3.0 mm (n=38). (Fig. 2)

This study was able to identify the first record of one type of parasite copepoda belonging to Lernanthropidae family in Nemipterus randalli, (Russell, 1986) and one type of parasite from Gnathiidae family in Sphyraena chrysotaenia (Klunzinger, 1884) classified as Lessepsian fish species caught from the North East Mediterranean Coasts (Mersin Province).

Ho, et al., (2011) emphasized that the family Lernanthropidae includes about 150 species and is one of the largest families of siphonostomatoid copepods.

The parasite Lernanthropus nordmanni was first reported by Tareen (1982) in Dicentrarchus labrax (Linnaeus, 1758) caught in Turkish coast of the Aegean Sea. Later, studies by Altunel (1983), Akmirza (2000) and Özel et al. (2004) were all able to report the parasites Lernanthropus kroyeri in the gills of Liza aurata (Risso, 1810), Lernanthropsis mugilis and Lernanthropus brevis in Dicentrarchus labrax caught from the Aegean Sea respectively. In addition, Öktener et al. (2010) were also able to report Lernanthropus kroyeri in the gills of Dicentrarchus labrax caught in the Black Sea.

Lernanthropus indefinitus parasite was reported for the first time in Argyrosomus regius (Asso, 1801) caught from Mersin coast of Mediterranean by Koyuncu et al. (2012). Later, Özak et al. (2016) recorded Lernanthropus callionymicola parasite in the gill filaments of Umbrina cirrosa (Linnaeus 1758) and Lernanthropus callionymicola in Callionymus filamentosus (Valenciennes, 1837) in their investigation conducted in the Eastern Mediterranean. Furthermore, Romero et al. (2010) found Mitrapus oblongus in the gill arches of Sardinella aurita (Valenciennes, 1847) occuring in the Mediterranean. This study, on the other hand, was able to determine Lernanthropus sp., a copepod species in the gills of Nemipterus randalli, (Russell, 1986).

Kırkım ,1998) detected parasitic isopods in marine fish and decapods sampled from the Aegean Sea in their study. The authors were able to first report of Paragnathia sp. parasites on the body surface of Sphyraena chrysotaenia caught from Turkish waters.

Genç, (2007) reported that 128 out of 468 Grouper (Epinephelus marginatus, Lowe 1834) caught and investigated from the Eastern Mediterranean coast were found to be infested with Gnathia parasite in the Praniza larva stage Their research also concluded that Paragnathia sp. was found only in August .

It is known that there are studies available on the parasites of marine fish both in other parts of the world and in our seas. However, it appears that there are not enough studies on the lessepsian fish species in our country. In this respect, the parasite fauna of these species which are considered to be an important source of income in the future should be well known. It is also thought that further research generating new information regarding to parasite infestation of these fish will contribute economically to the fishing sector by understanding the control mechanisms of possible parasitic diseases.

ACKNOWLEDGEMENTS

This study was supported by Mersin University Scientific Research Projects Unit. (Project Number: 2019-1-TP3-3464).

Author contributions

All contributions belong to the author in this paper.

Conflicts of interest

The authors declare that they have no conflict of interest.

Statement of Research and Publication Ethics

For this type of study formal consent is not required.

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Advanced Underwater Sciences
http://publish.mersin.edu.tr/index.php/aus/index
e-ISSN: 2791-8734

Metal Pollution Status of Surface Sediments in the Two Coastal Regions of the Mersin Bay, Northeastern Mediterranean Sea

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Keywords
Metal pollution assessment,
Sediment,
River systems,
Mediterranean Sea,
Türkiye.

ABSTRACT
The objective of this study is to determine metal pollution status of surface sediments in the two coastal regions of Mersin Bay under the influence of Seyhan and Göksu River inflows for the 2005-2009 period. The average metal concentrations orders were found to be Al > Cr > Cu > Zn > Cd for the Station Mersin affected by Seyhan River inflows and Al > Zn > Cr > Cu > Cd for the Station Taşucu under the influence of Göksu River. According to classification of metal pollution of surface sediments, though there was no Cd pollution, the sediments are highly polluted by heavy metals Cr, Cu and Zn in the Seyhan River influenced coastal region due to agricultural and industrial wastewater discharges.

1. INTRODUCTION

It was well known that some metals are essential for living organisms while several heavy metals such as cadmium and lead are nonessential for life and can be highly toxic (Yim and Tam, 1999; Okay et al., 2008; Tan and Aslan, 2020). These toxic heavy metals have critical importance for the aquatic ecosystems since they are non-biodegradable and persistent (Diagomanolin et al., 2004; Buccolieri et al., 2006; El-Sorogy et al., 2016). Toxic metals entering the food chain via bio-accumulation are, therefore, hazardous for the ecosystem functioning (Yu et al., 2012).

The shelf region of Mersin Bay, located in the North-Eastern Mediterranean Sea, is 43 km wide in the east off the Seyhan River Delta and narrows down to 8.4 km near the Göksu River Delta in the west (Okyar et al., 2013). The coastal region the Mersin Bay has been affected by regional rivers that are Ceyhan, Seyhan, Berdan, Lamas and Göksu Rivers (Tugrul et al., 2009). In the Seyhan River basin, there are many rural and urban areas and in these areas agricultural and industrial activities are carried out intensively. The Seyhan River is highly affected by these socio-economic activities, and therefore, among the regional rivers flowing into Mersin Bay, Seyhan River has the maximum volume fluxes with the higher organic and inorganic matter inputs (Tugrul et al., 2009; Kocak et al., 2010). Therefore, the Seyhan River is the largest river flowing to the shelf region of the Mersin Bay. Based on the study performed by Kocak et al. (2010), annual discharge rate of Göksu River is almost 4-fold lower than annual volume fluxes of Seyhan River. The inorganic matter inputs (nutrients) from the Göksu River to the coastal site are also from 3 to 20 fold less than calculated for the Seyhan River (Akcay et al., 2021).

In the marine ecosystems, metals can be transported by natural and terrestrial inputs (Saher and Siddiqui, 2016). The sources of anthropogenic metal pollution in the coastal regions are generally rivers, estuaries, wastewater discharges, vehicle emissions, and

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Cite this article;

Akçay, İ. & Özbay, Ö. (2022). Metal Pollution Status of Surface Sediments in the Two Coastal Regions of the Mersin Bay, Northeastern Mediterranean Sea. *Advanced Underwater Sciences*, 2(2), 27-32

Research Article **Received: 29/06/2022; Accepted: 20/09/2022**

agricultural runoff (Ip et al., 2007; Saher and Siddiqui, 2016; Tan and Aslan, 2020). In the present study, metal pollution status of surface sediments was determined in the two coastal sites affected by Seyhan and Göksu Rivers flowing into the coastal region of the Mersin Bay. Four different pollution assessment tools were used for the four selected metals measured in the surface sediments by the study of Tugrul et al. (2009).

2. METHODOLOGY

In the present study, the sediment data were retrieved by Tugrul et al. (2009). In authors' study, the concentrations and spatial distributions of the Chromium (Cr), Cupper (Cu), Zinc (Zn), Cadmium (Cd) and Aluminum (Al) in surface sediments were reported (Tugrul et al., 2009). In this study, however, the ecological risk assessment of metal pollution in the surface sediments of two coastal regions were determined in the Mersin Bay affected by Seyhan and Göksu Rivers having different discharge rates. The sampling strategy and measurements methods were presented in the study of Tugrul et al. (2009). The stations were annually visited between 2005 and 2009. The total depths of visited stations were nearly 30 m for the Station Mersin and 20 m for the Station Taşucu affected by Seyhan and Göksu River inflows, respectively.

The assessment of metal pollution was performed using the mean metal concentration of each parameter for the 2005-2009 period. Metal pollution status of surface sediments were assessed using four different classification tools that are presented in Table 1. Enrichment Factor (EF) (Sakan et al., 2009), Geoaccumulation index (Igeo) (Müller, 1981) and contamination factor (CF) (Hakanson, 1980) were used for the degree of metal pollution. Pollution Load Index (PLI) (Tomlinson et al., 1980) was used for the assessment of overall metal pollution in sediments of the two coastal regions of Mersin Bay.

Table 1. Assessment of metal pollution in sediments

Pollution Index	Classification	Formula
Enrichment factor (EF)	< 2 Depletion to mineral enrichment 2 ≤ EF < 5 Moderate enrichment 5 ≤ EF < 20 Significant enrichment 20 ≤ EF < 40 Very high enrichment EF > 40 Extremely high enrichment	$EF=\frac{\left(M_{xs}/M_{Al}\right)_{SAMPLE}}{\left(M_{xb}/M_{Al}\right)_{BACKGROUND}}$

Enrichment factor (EF) is used to determine heavy metal pollution that increases as a result of anthropogenic activities accumulated in the sediment (Rani et al., 2021):

where $(M_{xs}/M_{Al})_{Sample}$ is the ratio of trace elements and aluminum concentrations in the sediment sample, and $(M_{xb}/M_{Al})_{Background}$ is the ratio of trace elements and aluminum concentrations in the background sample.

Pollution Index	Classification	Formula
Geoaccumulation index (Igeo)	Igeo ≤ 0 Unpolluted 0 ≤ Igeo ≤ 1 Unpolluted to moderately polluted 1 ≤ Igeo ≤ 2 Moderately polluted 2 ≤ Igeo ≤ 3 Moderately to strongly polluted 3 ≤ Igeo ≤ 4 Strongly polluted 4 ≤ Igeo ≤ 5 Strongly to extremely polluted Igeo > 5 Extremely polluted	$Igeo=\log_2\left(\frac{M_{xs}}{1.5 \times M_{xb}}\right)$

It was developed to determine the level of toxic metal pollution in the metal sediment and shows the pre-industrial and current status of the metal level in the sediment (Martínez-Guijarro et al., 2019; Rani et al., 2021)

where M_{xs} is the measured concentration of the element x in the sediment, M_{xb} is the geochemical background concentration or reference value of the element x.

Pollution Index	Classification	Formula
Contamination factor (CF)	CF < 1 low 1 ≤ CF < 3 Moderately 3≤ CF <6 considerable contamination factors CF ≥ 6 very high contamination factor	$CF=\frac{M_{xs}}{M_{xb}}$

The CF index is used for metal pollution assessment in the sampling region (Martínez-Guijarro et al., 2019):

The CF index is the ratio between element concentration at the sampling site (M_{xs}) and the concentration of the same element at reference level (M_{xb}).

Pollution Index	Classification	Formula
Pollution load index (PLI)	≤ 1 Unpolluted > 1 Polluted	$PLI=(CF_1 x CF_2 x CF_3 \text{ x } \ldots \text{ x } CF_n)^{1/n}$

Pollution load index (PLI) is used for the overall quality of sediment (Rani et al., 2021):

Background/reference values were taken from Krauskopf (1979).

Figure 1. Mersin and Taşucu stations in the study of Tugrul et al. (2009).

3. RESULTS and DISCUSSION

The mean values of metal concentrations of the surface sediments for the 2005-2009 period were presented in Table 2. The spatial variability of surface sediment concentrations of Cr, Cu, Zn and Al was more pronounced between 2005 and 2009 with the maximum concentrations recorded in the Station Mersin. The average metal levels of the surface sediments are in the following order: Al > Cr > Cu > Zn > Cd for the Station Mersin affected by Seyhan River inflows and Al > Zn > Cr > Cu > Cd for the Station Taşucu under the influence of Göksu River.

Table 2. The mean values of metal concentrations for the 2005-2009 period (data were retrieved from Tugrul et al. (2009).

Station	Cr (mg/kg)	Cu (mg/kg)	Cd (mg/kg)	Zn (mg/kg)	Al (mg/kg)
Mersin	173	137	0.25	124	25251
Taşucu	66.3	33.8	0.25	94.0	19007

The sources of anthropogenic metal pollution in the coastal regions are generally rivers, estuaries, wastewater discharges, vehicle emissions, and agricultural runoff (Ip et al., 2007; Saher and Siddiqui, 2016; Tan and Aslan, 2020). Based on the calculated metal pollution assessment tools, the sediment in the Seyhan River influenced region was highly contaminated by metals (Figure 2-5). The surface sediments were highly enriched by Cr, Cu and Zn in the region affected by Seyhan River inflows having greater volume fluxes and suspended matter concentrations (Tuğrul et al., 2009; Koçak et al., 2010). On the other hand, level of metal contamination in surface sediments of the Göksu River-influenced region was low (Figure 2-5). However, the calculated metal pollution indices showed that surface sediments in the Göksu River influenced region is contaminated by Zn (Figure 2-5).

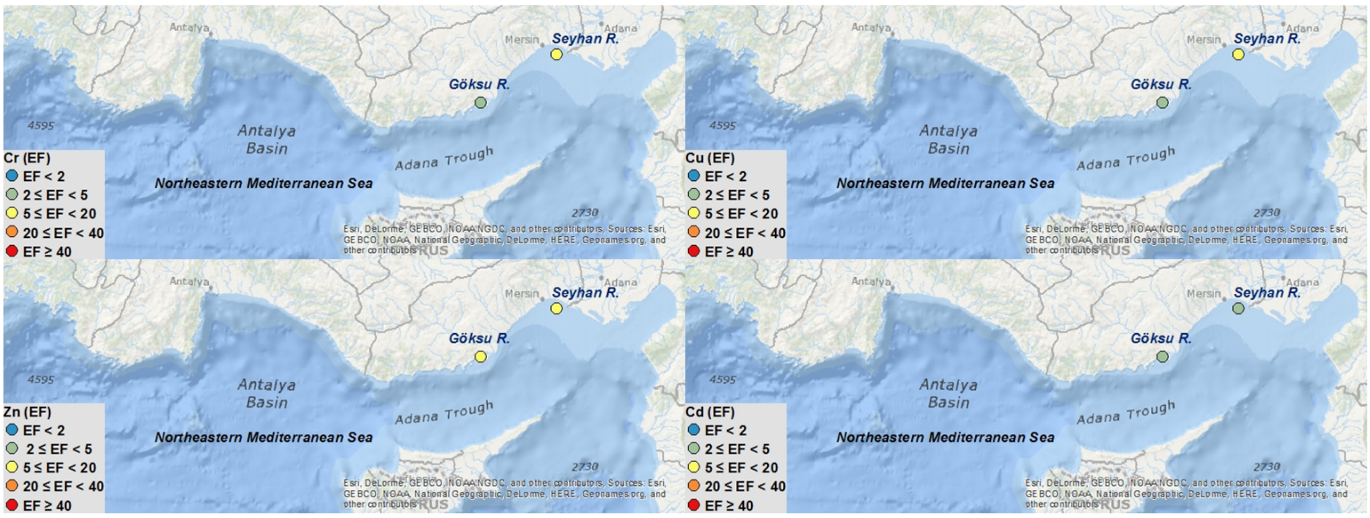

Figure 2. Assessment of metal pollution based on Enrichment Factor (Index values were calculated from the data obtained by Tugrul et al. (2009).

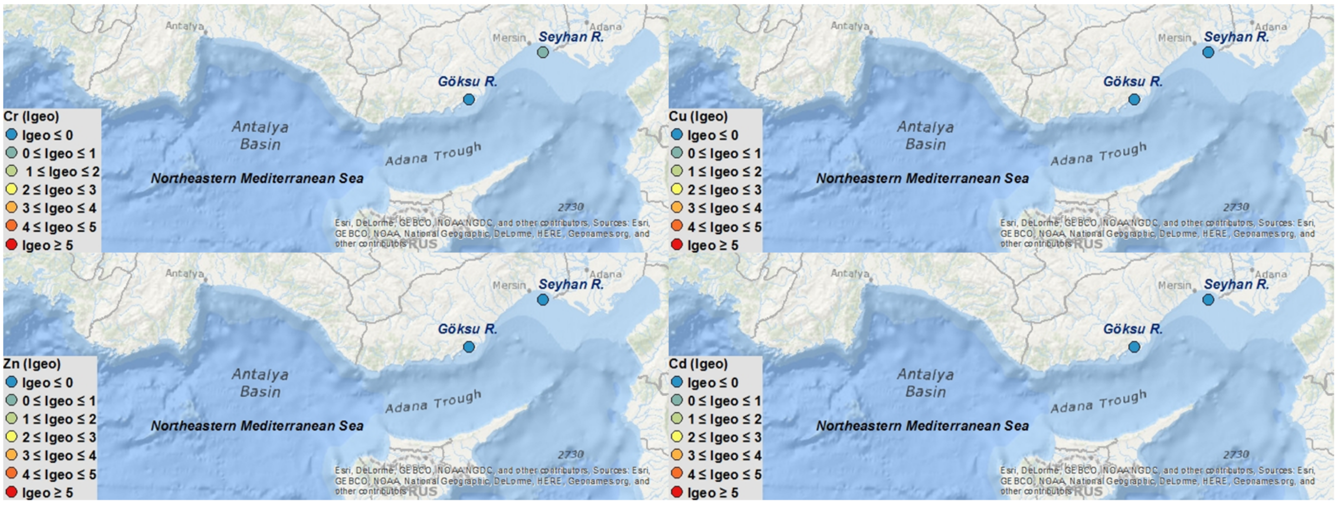

Figure 3. Assessment of metal pollution based on Geo-accumulation Index (Index values were calculated from the data obtained by Tugrul et al. (2009).

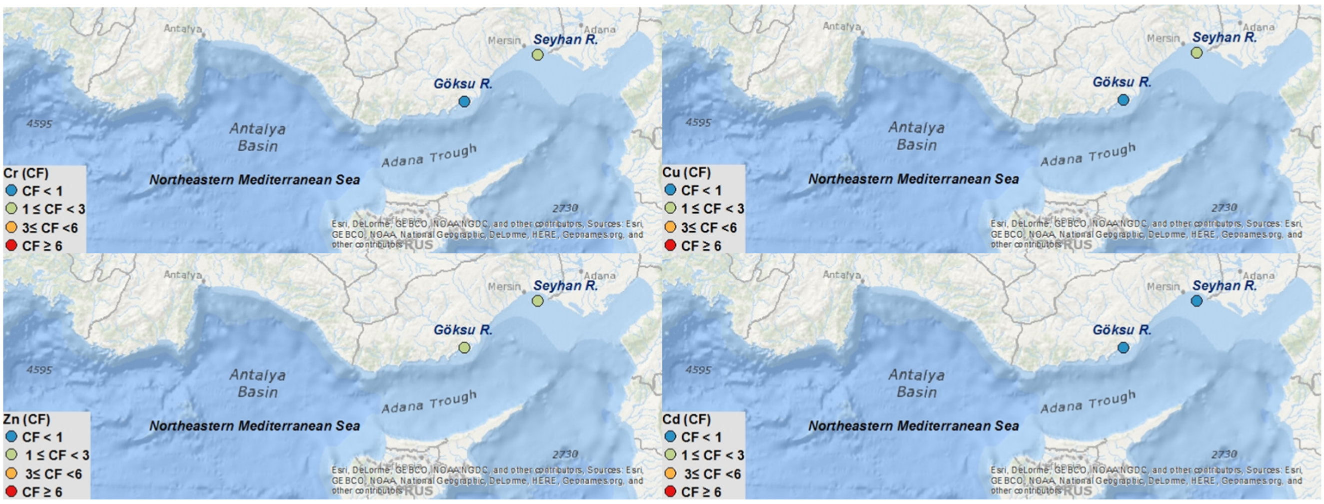

Figure 4. Assessment of metal pollution based on Contamination Factor (Index values were calculated from the data obtained by Tugrul et al. (2009).

Comparison of metal pollution status in sediments of different coastal regions of the Mediterranean Sea showed heavy metal pollution due to anthropogenic pressures (Table 3). Sediments of the coastal regions, affected by contaminated rivers and wastewaters, were polluted by different metals (Table 3). It was shown that there was an apparent sediment Cd pollution in the Southeastern Mediterranean Sea whilst surface sediments were not contaminated in the Mersin Bay, NE Mediterranean Sea. However, surface sediments were highly polluted by Zn in the study sites in the Mersin Bay compared to other regions in the Mediterranean Sea. According to the sediment Cr and Cu pollution assessment, this study showed that in the Seyhan River-influenced coastal regions, surface sediments were highly contaminated by Cr and Cu compared to the different regions of the NE Mediterranean, Western and Southeastern Mediterranean Sea (Table 3).

The PLI values, showing the overall metal pollution status of sediments, indicated Cr, Cu, Zn pollution in the coastal site influenced by Seyhan, Ceyhan and Berdan River inflows. In the Göksu River-influenced region, however, surface sediments were contaminated by only Zn (Fig. 5). Furthermore, the calculated PLI values showed that there was no apparent Cd pollution in the surface sediments of the studied sites.

The study findings indicated that organic and inorganic matter (metals) inputs from the Seyhan River have increased the enrichment of metals accumulated in the sediments of coastal region of the Mersin Bay. The study of Cevik et al. (2009) showed Cd and Cr pollution in the Seyhan Dam from the seasonally obtained sediment samples in 2004-2005 period. Though there was no Cd pollution in the studied sites, the Cr, Cu and Zn pollution was determined in surface sediments of the coastal region in the eastern Mersin Bay due probably to metal pollution of Seyhan and other rivers originated from agricultural activities and discharges of Chrome mines (Cevik et al., 2009; Ozbay et al., 2013).

Table 3. Comparison between metal pollution indices in sediments of the studied region and other regions in Mediterranean Sea (see Table 1 for the classification)

Station	EF				Lgeo				CF			
	Cr	Cu	Zn	Cd	Cr	Cu	Zn	Cd	Cr	Cu	Zn	Cd
Mersin[1],Turkey	6.3	9.9	5.0	3.1	0.2	-0.1	-0.2	-9.2	1.7	2.7	1.3	0.9
Taşucu[1],Turkey	3.2	3.3	5.1	4.1	-1.2	-2.2	-0.7	-9.2	0.7	0.7	1.0	0.8
Rosetta, Egypt[2]	0.001	0.26	0.79	51.57	-5.96	-1.61	0.72	4.84	0.002	0.52	1.84	96.27
Cyprus[3]	0.69	8.61	3.27	-	0.40	2.87	1.55	-	0.82	1.21	0.98	-
Sabratha,Libya[4]	-	12.80	8.56	81.48	-	1.01	-0.61	0.59	-	0.38	0.28	2.78
Muğla[5], Turkey	8.1	3.81	5.28	-	-	-	-	-	-	-	-	-
Thermaikos Gulf, Greece[6]	0.6	2.2	2.4	-	-2.1	0.0	0.3	-	0.5	1.8	1.9	-

[1] Pollution assessment indices were calculated from the data obtained by Tugrul et al. (2009)
[2] El-Sorogy et al. (2016)
[3] Abbasi et al. (2021)
[4] Nour and El-Sorogy (2017)
[5] Tuncel et al. (2007)
[6] Christophoridis et al. (2009)

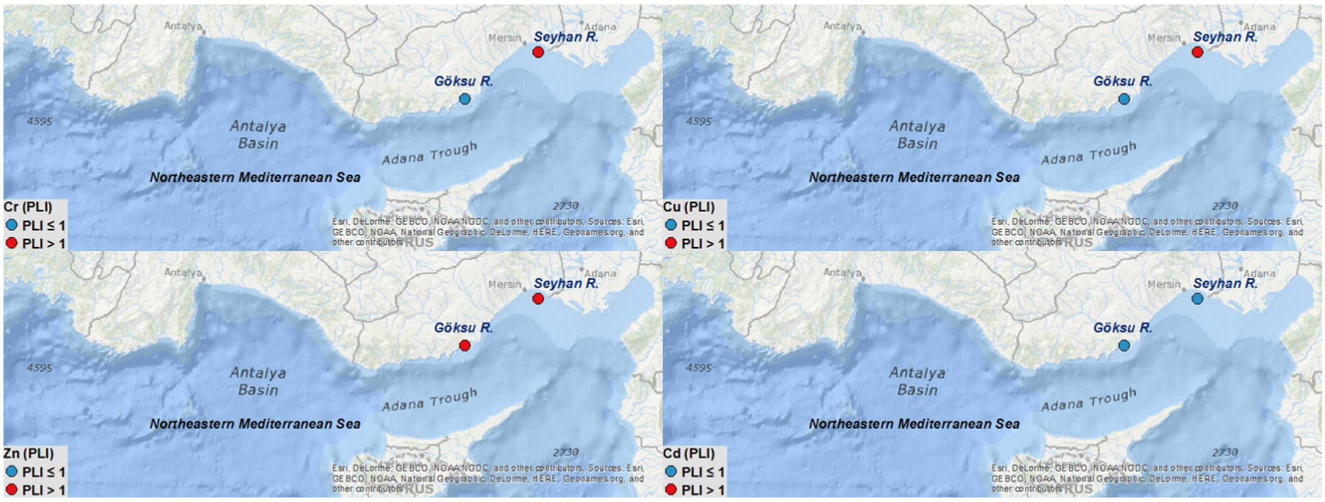

Figure 5. Assessment of metal pollution based on Pollution Load Index (Index values were calculated from the data obtained by Tugrul et al. (2009).

4. CONCLUSIONS

Metal pollution status of surface sediments in the two coastal regions of Mersin Bay (Northeastern Mediterranean Sea) was determined using four different assessment tools. The study findings showed that there was no Cd pollution in surface sediments of the Mersin Bay. However, the sediments are highly polluted by heavy metals Cr, Cu and Zn in the eastern Mersin inner bay due to metal pollution of Seyhan and other regional rivers flowing to coastal region of the bay originated from discharges by anthropogenic activities and Chrome mines. In order to prevent further metal pollution of Mersin inner bay, it is important to increase the efficiency of wastewater treatment plants.

Author contributions

The authors contributed equally.

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Statement of Research and Publication Ethics

For this type of study formal consent is not required.

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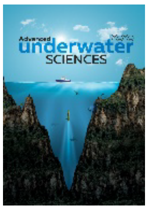
Advanced Underwater Sciences

http://publish.mersin.edu.tr/index.php/aus/index

e-ISSN: 2791-8734



A Rare Occurrence of Tripterygion Tripteronotum (Risso, 1810) from the North-Eastern Mediterranean

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Keywords
Red-Black Triplefin,
Triypterygiidae,
Endemic fish,
Iskenderun Bay,
Türkiye.

ABSTRACT

One male specimen the Red-black triplefin Tripterygion *tripteronotum* (Risso, 1810) was recorded by a SCUBA diving expedition at a depth of 3 m on 13 May 2017 in Iskenderun Bay, Turkey. T. *tripteronotum* is endemic to the Mediterranean and Black Sea. It is extremely rare in the eastern part of the Mediterranean Sea. This paper reporting an endemic fish confirms the occurrence of the species in Iskenderun Bay (North-Eastern Mediterranean, Turkey) in addition to the present report is the first observation for this location in the Mediterranean coast of Turkey. The previous studies have neither given any specific location nor any detailed information about this endemic fish species. Besides the historical captured record of the species in the Mediterranean Sea was well documented in this study.

1. INTRODUCTION

The genus Tripterygion includes well-known representatives of the family Triypterygiidae and consists of 4 valid species worldwide (Zander; 1986; Carreras-Carbonell et al., 2007; Froese and Pauly, 2022). The genus Tripterygion Risso, 1827 is represented four species in the Mediterranean, namely; Black-faced blenny Tripterygion delaisi Cadenat & Blache, 1970, Small triplefin blenny T. melanurus Guichenot, 1850, Triplefin blenny, T. tartessicum Carreras-Carbonell, Pascual & Macpherson, 2007 and Red-black triplefin T. *tripteronotum* (Risso, 1810). Of these species T. *tripteronotum* is also known as Three fin blenny, Risso's triplefin (Golani et al., 2006), or Moma Nariguda (IUCN, 2022).

The Red-black triplefin T. *tripteronotum* is widespread in the Eastern Adriatic Sea, Mediterranean Sea, Sea of Marmara, and Black Sea (Erazi, 1942; Tunesi and Molinari 2005; Carreras-Carbonell et al., 2007; Sefc et al., 2020; Froese and Pauly, 2022). In the Black Sea, T. *tripteronotum* commonly occurs off the Crimea and Ukraine coasts (Movchan, 2009).

Although the occurrence of T. *tripteronotum* has been reported in a checklist of fishes from Turkish marine waters in the Mediterranean Sea in previous years (Bilecenoğlu et al., 2014). Previous studies have neither given any specific location nor any detailed information about this endemic fish species.

The present paper reports the first occurrence and is the confirmation of the Red-Black triplefin T. *tripteronotum* from the Northeastern Mediterranean Sea, Turkey. This species could be considered as exceptionally rare in the easternmost area of the Mediterranean Sea, Turkey. Besides the present report is the first observation for this species in the Mediterranean coast of Turkey.

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Cite this article;

Ergüden, D., Ergüden, S. A., Şereflişan, M. & Uyğur, N. (2022). A rare occurrence of Tripterygion tripteronotum (Risso, 1810) from the North-Eastern Mediterranean. *Advanced Underwater Sciences*, 2(2), 33-36

Research Article **Received: 08/03/2022; Accepted: 20/09/2022**

2. METHOD

A single male specimen of T. *tripteronotum* was photographed at a depth of 3 m during a SCUBA diving expedition in Madenli coast (Coordinate: 36°28′N, 35°59′E), Iskenderun Bay on 13 May 2017 (Fig. 1). This specimen was caught on rocky bottoms, partially covered with algae (Fig. 2a,b).

Species identification follows Fricke (2002) and Zander (1986), and taxonomic nomenclature follows Eschenmeyer et al. (2022). The specimen was identified as a male of T. *tripteronotum* according to Sefc et al. (2022).

All morphological descriptions and colors agree with the descriptions given by Carreras-Carbonell (2007).

Figure 1. Map showing capture site (●) of T. *tripteronotum* in Iskenderun Bay

Figure 2a. Underwater observation of T. *tripteronotum* from Madenli coast, Iskenderun Bay (Frontal view)

Figure 2b. Underwater observation of T. *tripteronotum* in Madenli coast, Iskenderun Bay (Dorsal view)

3. RESULTS

The body is elongate and compressed, Scales ctenoid, Head broad, scaleless, profile acute, lips prominent. Eyes moderately large, head length more than 2.5 times orbit diameter. The first ray of the second dorsal fin of the mature males has the distal half not united by a membrane with the following ray. The blotch on the caudal peduncle not reaching its base. Caudal fin is truncate.

Color (male specimen): The body is reddish. The head is black. The caudal fin usually has four reddish or brownish bars.

4. DISCUSSION

The Red-black triplefin T. *tripteronotum* is a demersal, non-migratory species and also it is non-commercial fish species with lives in rocky coastal areas and inhabits cold, temperate, subtropical, and tropical areas (Fricke, 2002). Adult specimens are highly territorial, with a relatively sedentary lifestyle (Schunter et al., 2014). Besides Tripterygiids species are known a resident intertidal species with homing behavior (Gibson, 1999) found in shallow rocky shores. Their larvae are planktonic and occur in shallow waters (Watson, 2009).

In the Mediterranean, the Red-black triplefin T. *tripteronotum* is found common on rocky bottoms on the continental shelf, usually between 6 m and 12 m depth ranges (Kovačić and Golani, 2007). Adult specimens are found on shallow rocky habitats up to 6 m. Their common size can reach 6.5 cm in TL and up to 8 cm in TL (Zander, 1986). T. *tripteronotum* feeds on benthic invertebrates (Gibson, 1999; Golani et al., 2006).

Although IUCN (2022) claimed that the species is usually found at 0-30 m depth ranges. The male specimen reported in this study was observed at about 3 m depth in its natural habitat in the Madenli coast on a rocky area, during a SCUBA diving expedition (Fig. 2a,b). This depth range is in accordance with the literature (IUCN, 2022). The present record for this specimen was found adult male specimen and similar to the previous record for Mediterranean samples report (Carreras-Carbonell et al., 2007; Sefc et al., 2020). The historical captured record of the species in the Mediterranean Sea was documented in Table 2.

Table 2. Records of Tripterygion *tripteronotum* in the Mediterranean Sea in 1959-2017.

Author(s)	Location/Country	Year (s)	Depth (m)	Sampling
Carreras-Carbonell et al. (2007)	Girne, Cyprus	1997-2002	0-5.5	Free-diving-Hand Net
	Aegean Sea, Marmara Sea, Turkey	1988-1969	-	Hand Net
	Greece	1969-2004	0-2	Hand Net
	Montenegro	1969-1977	-	Hand Net
	Croatia	1959-1990	0-1	Hand Net
	Italy	2004-2006	0-2	Hand Net
	France	2004-2005	0-2	Hand Net
	Spain	2002-2005	0-2	Hand Net
	Malta	1974-2005	0-1.5	Hand Net
	Morocco	1985	-	Hand Net
	Tunusia	1998	0-1.8	Hand Net
Sefc et al. (2020)	Eastern Mediterranean Sea	2006-2017	0-2	Free-diving-Hand Net
This study	Iskenderun Bay, N.E. Mediterranean, Turkey	2017	3	Scuba diving-Underwater observation

To date, *T. tripteronotum* has not been reported with certainty from the Iskenderun Bay (North-Eastern Mediterranean coast of Turkey). This report, hence, is very important information since it is the first confirmed occurrence of *T. tripteronotum* and with the first detailed information about its presence from, North-Eastern Mediterranean Turkey (Iskenderun Bay).

5. CONCLUSIONS

T. tripteronotum is endemic to the Mediterranean and the Black Sea. It is not targeted commercially and there are no known major threats to its survival. Thus, this species is considered as “Least Concern” in the Global Red List Categories and Criteria, (Holleman, 2014; IUCN, 2022; Malak et al., 2011). However, It is rare in the eastern part of the Mediterranean Sea. Thus, we propose that further studies are needed in this region to monitor for this endemic Mediterranean fish species.

Author contributions

The authors contributed equally to the article.

Conflicts of interest

The authors declare that they have no conflict of interest.

Statement of Research and Publication Ethics

For this type of study formal consent is not required.

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Advanced Underwater Sciences
http://publish.mersin.edu.tr/index.php/aus/index
e-ISSN: 2791-8734

Ichthyophthirius Multifiliis (Fouget, 1878) Infection in Koi (Cyprinus carpio, Linnaeus, 1758) Culture

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Keywords
Koi,
Ichthyophthirius multifiliis,
Symptoms,
Mortality.

ABSTRACT

This study was carried out to determine the cause of unexpected deaths in Koi fish (Cyprinus carpio) cultivated in a private aquarium farm in Mersin, Turkey between June and July 2021. In the samples taken from the skin and fin tissues of fish, it was determined that the cause of these sudden deaths was the parasite Ichthyophthirius multifiliis (Ciliophora: Ichthyophthiriidae). In addition, the morphological features of the parasite and its symptoms in fish were determined.

1. INTRODUCTION

Mersin province is one of the leading places in our country in aquarium fish production. In particular, there has been a rapid increase in the number of aquarium fish farms established in recent years, and aquaculture has become a sector that is gradually advancing towards being organized. The development of aquaculture and aquarium fishery also causes some problems. One of the most important factors in carp farming is diseases caused by parasites. It increases the transportation of fish to various geographical areas. Among the parasitic diseases of aquarium fish, one of the important parasites is also known as 'White spot disease' or 'Ich disease', it is also called scabies. It is seen in cultured fish, aquarium fish and wild fish. Ich infection can occur at any growth stage of fish, from fry, finger, table size to hatchling fish. (Nigrelli,et al. 1976:607 -613) The causative agent of the disease is Ichthyophthirius multifilis, a parasite with protozoan cilia. Ichthyophthiriasis is seen in all continents of the world in the water temperature range of 10-27 °C. Ich is spherical and the eyelashes are evenly distributed over the entire surface. The characteristic feature of the parasite is its horseshoe-shaped nucleus andp rotational motion. It is an obligate pathogen and has a unique direct life cycle that allows the infection to intensify rapidly. Its life cycle consists of an infective theront, a parasitic trophont, and a reproductive tomont. Infective theronts actively swim in the water host. After entering the fish epithelium, theronts become trophy and feed on host tissue until maturation. (Bauer, 1959:3-215).

The parasite invades the epithelial tissue of the gills, skin, or fins, resulting in a small sore and visible white spot or nodule where each parasite joins. Infected fish are extremely lethargic and covered with visible white spots. Mortality can be rapid and catastrophic. Severe infection by Ich damages fish skin and gills, causes loss of

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Cite this article;

Koyuncu, C. E. (2022). Ichthyophthirius Multifiliis (Fouget, 1878) Infection in Koi (Cyprinus carpio, Linnaeus, 1758) Culture, 1758) Culture. *Advanced Underwater Sciences*, 2(2), 37-39

Research Article **Received: 14/09/2022; Accepted: 22/09/2022**

respiratory, excretory and osmoregulation functions, and can serve as an entryway for secondary invaders and eventually lead to fish death. (Matthews l994: l7-42)

This study was carried out to determine the cause of death in Koi fish (Cyprinus carpio). It has been determined that the main factor is Ichthyophthirius multifiliis parasite. Also parasite the symptoms caused by infestation are discussed..

2. METHOD

There are 10 pools in total at the facility. Oxygen content (mg/L), temperature (°C) and pH values of pool waters meter was made with. Then, a total of 100 Koi fish, 10 from each of the 10 ponds in the enterprise, were taken into the tanks. Then the fish and their size were measured. The samples determined by scraping from the skin and fin tissues of the fish were examined under the microscope and permanent preparations were made. Afterwards, the permanent preparations brought to the Mersin University Faculty of Fisheries Department of Diseases were examined under the phase contrast microscope measurements and photographs were made. Diagnostic key and publications were used in the detection of parasites.

3. RESULTS

It has been determined that the dissolved oxygen amount of the water measured in the pools of the enterprise varies between 4.5-4.9 mg/L, the water temperature varies between 25-27.5 °C and the pH varies between 7-7.9 during the months when the disease is most intense in fish.

In the clinical examination of the sick fish, it was observed that the fish move slowly in the corners of the pond and especially rub against the sides of the pond.

In addition, it was observed that redness and hemorrhagic areas were formed in the skin area of the fish and accordingly wounds were formed. It has been determined that the fish do not regularly eat the feed given every day in the enterprise and deaths occur especially in juvenile and weak fish. In the morphological examination of the fins and body surface of the sick fish brought to the laboratory from the farm alive to determine the disease, white and gray spots and an increase in the number of mucus were observed, especially on the skin of the fish. Horseshoe-shaped macronucleated trophont and oval pear-shaped tomites were seen under the microscope in smear preparations prepared from the white-spotted areas of the skin of the fish, and it was determined that the cause of the disease was white-spotted ICH. In addition, in the measurements made under the microscope, the average of adult individuals was 0.8- 1 mm.

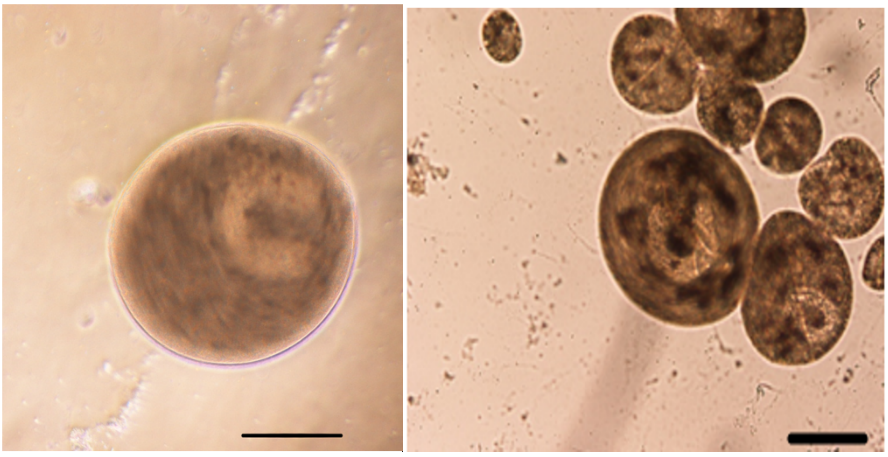

Figure 1. Wet mount of the koi skin during infection with Ichthyophthirius multifiliis (Note the C-shape nucleus)(original)(Scale bar=0,5mm).

4. DISCUSSION

The ICH ectoparasite, which is found in freshwater and aquarium fish, has been reported by various researchers from different geographical regions. In the current study, it was reported for the first time as ICH (Ichthyophthirius multifiliis) isolated from koi fish grown in Mersin.

It is known that ICH infestations cause significant damage in fish farming areas (Bauer, 1959, Ogut vd..2005: 23-27, Öztürk vd.2010: 209-215). The parasite feeds on the fish's mucus and skin tissue. Among the symptoms of infestation, melting of the fins, skin hyperemia, petechial hemorrhages and wounds draw attention.

It can cause significant losses in aquaculture as it is a porter for secondary bacterial and fungal infestations. In the current study, anorexia, swimming disorders, pale color of the fins, melting, skin redness and hemorrhage were recorded as clinical symptoms. With extensive infestation, death has been reported in the later stages of the disease. In many studies, it has been reported that many ectoparasites such as skin and gills of fish were found together with ICH infestations. (Ogut vd..2005: 23-27).The presence of another parasitic agent was not found in the parasitic examination performed in the current study. It is known that water temperature is a limiting factor in ICH infestation, especially in the transition from spring to summer, infestation rates increase. In the current study, it was determined that the parasite causes mortality during high temperature periods. Under adverse environmental conditions Ich infections grown in intensity and weak fish in fish appear to be rising too much (Kabata 1985: 1-318). I. multifiliis is endemic in the region. Many factors may be responsible for this endemism. These are improper water circulation,insufficient water supply, insufficient tank cleaning and disinfection regimes or, in some cases, reuse water without purification. Controlling water quality, optimum feeding, maintaining ponds and removing waste reduce the risk of ICH infestation. (Woo, 1995: 200-202).

In this study, ICH type ectoparasite was identified as the main factor causing sudden death in koi fish in a commercial aquarium fish farm in Mersin.It is thought that the current study findings will be useful in terms of taking the necessary precautions against ICH infestations of the aquarium fish farming sector and preventing economic losses.

Author contributions

The authors contributed equally to the article.

Conflicts of interest

The authors declare that they have no conflict of interest.

Statement of Research and Publication Ethics

For this type of study formal consent is not required.

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Advanced Underwater Sciences
http://publish.mersin.edu.tr/index.php/aus/index

The New Venomous Fish in The Mediterranean: the Lionfish

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Keywords
Pterois sp.,
Lionfish,
Venom,
Marine toxins.

ABSTRACT

In recent years, more alien fish species have been encountered in the Mediterranean. One of the alien species that have entered the Mediterranean in recent years is the lionfish. Lionfish attract attention with their appearance but should be carefully monitored due to their rapid and successful invasions on the West Atlantic coasts, and they are venomous. They contain a neurotoxin in protein structure. The lionfish, which spread rapidly in the Mediterranean in a short time, also cause poisoning due to the venom they include in their spines. For this reason, it has become even more important to have information about the properties and possible effects of the venom they contain, as well as the rapid invasion skills of lionfish. This study compiled some information on venom content, poisoning mechanism, and poisoning cases of lionfish (*Pterois sp*.).

1. INTRODUCTION

An intense migration of non-native marine species enters through the Suez Canal in the Mediterranean Sea. Toxic fish are among many non-native species that came and settled in the Mediterranean through this migration, called the Lessepsian migration due to its proximity to the Suez Canal and intensive maritime traffic. After the poisonous pufferfish, which is very popular throughout the Mediterranean, a new toxic fish species, the lionfish, started to appear and spread rapidly (Bariche et al., 2013; Aktaş and Mirasoglu, 2017; Ulman et al., 2020). The effective invasion success of the lionfish previously observed in the Caribbean is a frightening warning to the Mediterranean. Because lionfish pose a risk to natural resources, fisheries, and public health due to them contain venom and physical tolerance abilities such as high fecundity rates, low parasite load, being ability to starve for a long time, being successful hunters at the top of the food chain (Albins and Hixon, 2015; Cote and Smith 2018).

The lionfish, which spread rapidly in the seas of our country and in the Mediterranean, is a fish in the Scorpaenidae family, native to the Indo-Pacific regions. The Scorpaenidae family is divided into three major subfamilies, the lionfish, the scorpionfish, and the stonefish subclass, by the morphology of the fish's venomous spines (Elston, 2006). These fish have spines on their dorsal, pelvic, and anal fins. These spines are encapsulated by integumentary sheaths that produce glandular venom. When integumentary sheaths are mechanically disrupted by contact with a victim, it releases venom (Rensch and Murphy-Lavoie, 2021). Although the venom contains, lionfish are popular species that have been preferred in aquariums for many years due to their attractive appearance (Aldred et al., 1996; Elston et al., 2006; Morris et al., 2008; Haddad et al., 2009; Badillo et al., 2012). In addition to these features, successful invasion skills have recently attracted more attention to lionfish. (Albins and Hixon, 2015; Galanidi et al., 2018; Galloway and Porter, 2019). Lionfish have been able to settle on the eastern coast of the United States, the western Atlantic, the Gulf of

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Cite this article;

Koşker, A. R. & Ayas, D. (2022). The new venomous fish in the Mediterranean: the lionfish. *Advanced Underwater Sciences*, 2(2), 40-43

Reiview Article

Received: 03/10/2021; Accepted: 30/09/2022

Mexico, and the Caribbean within twenty years and are considered one of the most dangerous invasive fish due to these characteristics (Morris et al., 2008; Badillo et al., 2012; Albins and Hixon, 2015; Rensch and Murphy-Lavoie, 2021). In the first instance imported to the US as a popular fish, the lionfish is now one of the most abundant top predators in much of this region's marine ecosystem (Galloway and Porter, 2019).

The lionfish invasion in the northwest Atlantic and Caribbean represents one of the fastest marine fish invasions in history (Morris et al., 2008). The early period of the lionfish invasion on the coasts of the West Atlantic is similar to the invasion that is taking place in the Mediterranean today. Similar invasion potential of lionfish exists for the Mediterranean and Turkish coasts. The first record of the lionfish in the Mediterranean was given in Israel in 1992 (Golani and Sonin, 1992). However, lionfish, which were not reported in any region throughout the Mediterranean in the following years, was reported again about twenty years later with two specimens caught in Lebanese waters (Bariche et al., 2013). After this process, the lionfish that spread quite rapidly were reported in the Gulf of Iskenderun, on the coasts of Turkey (Turan et al., 2014), in Cyprus (Oray et al., 2015; Iglésias and Frotté, 2015; Jimenez et al., 2016) in Rhodes Island (Crocetta et al. 2015). Also, the first record for the Central Mediterranean in Tunisian waters was reported by Amor and Ghanem (2016). Subsequently, lionfish records were reported from Sicily in southern Italy (Azzurro et al., 2017) and the Libyan coast (Mabruk and Rizgalla, 2019). The first record of lionfish found in the southern coasts of Turkey was reported by Turan et al. (2014), and then they spread rapidly westwards to Fethiye Bay and Dalyan (Ozbek et al., 2017).

Awareness of the venom content of lionfish, which attracts attention with its rapid invasion ability, its ability to find a place in the market, and its visuality, is important for public health. This paper compiled venom content, poisoning cases, and poisoning symptoms of lionfish.

2. Toxicity of Lionfish

The lionfish are venomous, with its spines containing apocrine-type venom glands. Each spine of the lionfish (except tail spines) is venomous (Fig 1), including 13 dorsal spines, three anal spines, and two pelvic spines (Galloway and Porter, 2019).

The venomous spines of lionfish contain acetylcholine as well as venom. Similar to the species of Soldierfish (*Gymnapistes marmoratus*) and stonefish (*Synanceia trachynis*), lionfish venom induces marked neuromuscular activity. The venom of the toxic Scorpaenidae species usually provides a 2-3-fold increase in intracellular calcium. (Elston, 2006).

The spines are covered with an integumentary sheath or skin and contain two glandular epithelial grooves containing venom-producing tissue. Spinal glandular tissue extends for approximately three-quarters of the distance from the base of the spine to the tip (Halstead et al. 1955). Lionfish venom is a proteinaceous neurotoxin, and heat quickly denatures the venom.

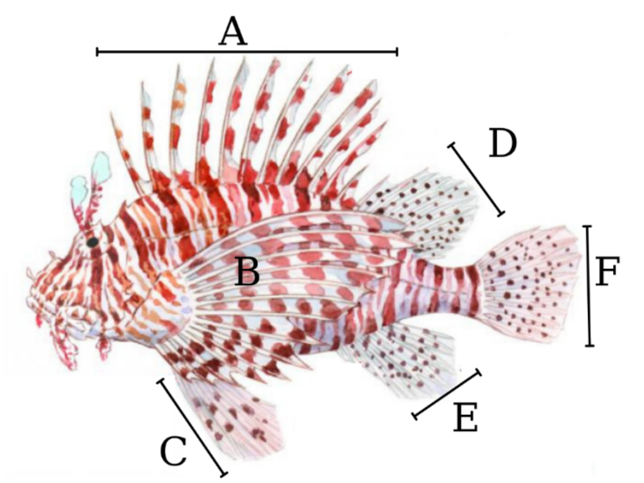

Figure 1. External anatomy of lionfish (A: Dorsal spines, 13 spines are venomous; B: Pectoral fin, non-venomous; C: Pelvic fin, the first spine of each pelvic fin is venomous; D: Secondary dorsal fin, non-venomous; E: Anal fin, the first three spines are venomous; F: Caudal fin, non-venomous)

Priyadharsini et al. (2015) reported that lionfish venom could be a neuroprotective agent. On the other hand, Sommeng et al. (2019) investigated the use of antioxidant compounds isolated from *P. volitans* venom as a drug or food component.

3. Lionfish's envenomation

Envenomations of lionfish native to Indo-Pacific coastal waters have been seen in these regions for many years. However, over the last few decades, there have also been records of envenomation on the West Atlantic coast, mostly for divers, tourists, and aquarists. Particularly in the United States, it is more common for aquatic workers to attempt to hand-feed, transfer, or catch these fish without containment equipment (Aldred et al., 1996; Haddad et al., 2009; Schaper et al., 2009; Rensch and Murphy-Lavoie, 2021). In the USA, poisoning cases can occur in interior areas due to aquariums. Lionfish pose an additional epidemiological threat as valuable aquarium fish. Of the 45 cases of lionfish (*P. volitans*) reported to the San Francisco Bay Area Regional Poison Control Center from 1979 to 1983, 82% occurred in homes with saltwater aquariums and 18% in tropical fish stores. Injuries occurred while transferring, catching, or hand-feeding fish (Rensch and Murphy-Lavoie, 2021). Similarly, 188 cases of lionfish envenomation were reported to the Texas poison control center between 1998 and 2006, some of whom were employees of commercial aquatic aquariums, while others that were poisoned were also patients who had a hobby aquarium at home (Forrester, 2008). In patients, mostly adult males, 94% of poisonings occurred by contact with lionfish from the hands and fingers (Forrester, 2008). In addition, divers are exposed to poisoning by lionfish in their natural habitats. Many divers hunt lionfish to serve the health of the reef, but this must be done very carefully, wearing gloves and other protective gear to avoid being pierced by the spines. (Rensch and Murphy-Lavoie,2021).

The fact that lionfish are attractive aquarium fish causes poisoning from lionfish fed in aquariums in Europe and the USA. Between 1996 and 2006, many poisonings from exotic domestic animals were observed in Europe, mainly from lionfish (*Pterois sp.*) (Schaper et al., 2009). Although there is news of poisoning in the media or social media in Turkey, there is one case report (Ayaz et al., 2020).

Lionfish envenomation occurs when the integumentary sheath of the spine is compressed as it burrows into the victim. This process ruptures the glandular tissue, allowing the venom to diffuse into the puncture wound (Saunders and Taylor, 1959). The lionfish venom contains acetylcholine and a neurotoxin that affects neuromuscular transmission (Cohen and Olek, 1989). Lionfish venom has been found to cause cardiovascular, neuromuscular, and cytolytic effects, from mild reactions such as swelling, extreme pain, and paralysis in the upper and lower extremities (Kizer et al., 1985). The antidote of related stonefish (Synanceia spp.) is highly effective in neutralizing lionfish venom activity (Shiomi et al., 1989, Aldred et al., 1996; Church and Hodgson, 2002).

Immediately after envenomation, local symptoms such as extreme pain, redness, and swelling are triggered in victims; In severe cases, deaths may occur (Kiriake et al., 2013). The severity of sting reactions in humans depends on factors such as the amount of venom administered, the victim's immune system, and the site of the sting. Records of home aquarists stung by lionfish provide a comprehensive assessment of how lionfish stings affect humans (Kizer et al., 1985, Vetrano et al., 2002; Morris et al., 2008). Because venomous glandular tissue is closer to the end of the spine, envenomation is more likely in contact with smaller-sized and short-spined lionfish (Halstead et al., 1955).

First aid for envenomation in the case of a lionfish sting involves immersing the affected area in hot water (45°C) until the pain subsides. The affected area should be immersed in hot water for at least 30 minutes, preferably 60-90 minutes, and repeated when pain persists (Aldred et al., 1996; Vetrano et al., 2002; Haddad et al., 2015). The primary clinical effect of lionfish envenomation is local pain, systemic symptoms include headache, malaise, nausea, hypotension, chest pain, hypertension, cardiac arrhythmias, and pulmonary edema (Aldred et al., 1996; Elston, 2006; Badillo et al. 2012; Wilcox and Hixon, 2015; Hornbeak and Auerbach, 2017). Secondary medical treatment is usually recommended, as symptoms and complications vary depending on the severity of the sting, whether part of the spine remains in the wound, and individual reactions to lionfish venom (Aldred et al., 1996; Galloway and Porter, 2019). Appropriate comprehensive wound care is the basis of treatment and is extremely important. Therefore, it is important to investigate foreign bodies through examination and possibly radiographs. Tetanus prophylaxis is important, and booster immunization may be required (Aldred et al., 1996). As most of these envenomations present as puncture wounds on the hands and feet, prophylactic antibiotics are often recommended (Aldred et al., 1996).

4. CONCLUSION

Lionfish are fish that should be monitored carefully and regularly, given their invasive abilities in the Western Atlantic and the potential public health risks of the venom they contain. There is no scientific research conducted in the Mediterranean regarding lionfish venoms yet. In order to take correct and timely measures by public health and public authorities, it is important to know the venom levels of lionfish in our coasts and whether these venom levels have regional differences. In addition to the scientific studies to be carried out, it will be beneficial to raise awareness of the community and health sector workers, especially those living in coastal areas, in order to prevent envenomation.

Author contributions

The authors contributed equally to the article.

Conflicts of interest

The authors declare that they have no conflict of interest.

Statement of Research and Publication Ethics

For this type of study formal consent is not required.

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