

Digenean Parasites of Labrid Fishes (Labridae: *Symphodus*) from Turkish Coasts of the Black Sea: New Records

Türkey Öztürk¹, Arzu Güven^{1,2}

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ABSTRACT

In the present study digenean parasite faunas of four labrid fishes, *Symphodus tinca*, *S. rossali*, *S. cinereus* and *S. ocellatus* were investigated and compared. A total of 52 fish specimens were caught on the Black Sea coast near Sinop, Turkey, over two years. Eight digenean species were found in the four labrid fishes. These are *Helicometra fasciata*, *Gaevskajatrema perezii*, *Proctoeces maculatus*, *Phyllodistomum crenilabri*, *Galactosomum lacteum*, *Condylocotyla pilodora*, *Metadana pauli* and *Opecoelidae* gen. sp. Each digenean species on their respective hosts were counted, their prevalence, mean intensity and abundance values were determined. While the maximum parasite diversity was found in *S. tinca*, *S. ocellatus* was infected with the fewest parasites. Total parasite abundance was significantly high in *S. roissali*, which was infected with four species. A close resemblance was observed in the digenean parasite faunas of *S. tinca* and *S. roissali*. The core, secondary, satellite, and rare species in the digenean parasite community of each host were determined. This study contains the first data on the digenean parasites of labrid fish on Turkish Black Sea coast. *Phyllodistomum crenilabri* and *Metadana pauli* are new parasite records in Turkish fish parasite fauna, while *Condylocotyla pilodora* is a new parasite record for the labrid fishes.

Keywords: Trematode, digenea, parasites, *Symphodus* spp., Black Sea

ORCID IDs of the author:
T.Ö. 0000-0001-5568-3214;
A.G. 0000-0002-8220-5282

¹Sinop University, Faculty of Fisheries and Aquatic Sciences, Sinop, Turkey

²Malatya Turgut Özal University, Vahap Küçük Vocational High School, Malatya, Turkey

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Correspondence:
Türkey Öztürk
E-mail:
turkay.ozturk@gmail.com

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INTRODUCTION

The family Labridae is one of the large taxons of fish, comprising approximately 580 species in 82 genera and they are widely dispersed in tropical and temperate marine waters around the world (Hanel, Westneat, & Sturmbauer, 2002). A total of 20 species of this family have been recorded from the Turkish Sea to date (Bilecenoğlu, Kaya, Cihangir, & Çiçek, 2014). A total of 5 out of 8 species of this family, which inhabit the Black Sea, are the species of the *Symphodus* genus. The native habitats of the genus *Symphodus* are the coastal zones of the East Atlantic Ocean, the Mediterranean and the Black Sea. They are found to a depth of 1–50 m near rocks and eel-grass beds. Labrid fish are not target species commercially. However, labrid fish are often caught by fishermen that focus on fishing for other species (Choat & Bellwood, 1998; Nelson, 2006).

Digenean parasites provide important information about the aquatic ecosystem since they have complex life cycles, during which several groups of marine animals are used as intermediate hosts. There are a lot of published data on digenean parasites of labrid fishes from the Mediterranean and Black Sea (Sey, 1970; Nikolaeva & Solonchenko, 1970; Parukhin, Naidenova, & Nikolaeva, 1971; Gaevskaya & Solonchenko, 1989; Campos, Carbonell, & Pellicer, 1990; Campos & Carbonell, 1994; Sasal, Niqil, & Bartoli, 1999; Korniychuk, 2001; Bartoli, Gibson, & Bray, 2005; Gargouri, Elbohli, & Maamouri, 2010; Radujkovic & Sundic, 2014; Munoz & Diaz, 2015).

To date, there have been many survey studies on digenean parasites in Turkey (Oğuz & Bray, 2006; Akmırza, 2013; Tepe, Oğuz, & Heckmann, 2014; Çınar, 2014; Öztürk & Özer, 2016; Öztürk & Güven,

2020). On the other hand, there are no previous studies on the digenean parasite fauna of labrid fish on the Black Sea coast of Turkey.

The aim of this research study is to investigate digenean parasites of four labrid fishes collected from the Sinop coast of the Black Sea. This study is the first survey on digenean parasites of the labrid fishes on the Turkish Black Sea coast.

MATERIALS AND METHODS

The present study was carried out between May 2015 and April 2017. The fish specimens were sampled with gill nets by fishermen from the Sinop coast of the Black Sea (42°01' 55' N, 35°16' 36' E). The caught fish were transported to the parasitology laboratory of the Faculty of Fisheries and Aquatic Sciences at Sinop University. A total of 52 specimens of the four labrid species, *Symphodus tinca* (27), *S. cinereus* (16), *S. roissali* (7) and *S. ocellatus* (2) were investigated for the digenean parasites. The fish were examined within 24 h of capture. At necropsy, the fishes were measured and weighed. Skin, fins, gills, eyes, brain, liver, stomach, intestine, kidney, urinary and gall bladder were examined under the dissecting microscope. The number of parasites was counted individually and the site of infection was recorded. Parasite specimens were studied in both alive and permanent preparations. For identification, the parasites were fixed in Bouin's fluid between slide and coverglass without pressure, stained with acetic carmine and mounted in Canada balsam. Permanent preparations were examined using a light microscope (Olympus microscope BX53) at magnification X10 and X100. The prevalence (P, %), mean intensity (MI), and abundance (A) values of each digenean parasites were calculated following the definitions of Bush, Lafferty, Lotz, & Shostak, (1997). The standard deviation (SD) of the mean intensity was calculated. The Kruskal-Wallis test (Nonparametric ANOVA) was performed to compare the mean intensity values of digenean parasites in each fish host. The analyses were carried out using the computer programmes GraphPad InStat 3.0. P-values less than 0.05 were considered to be significant. The significance of the digenean parasite fauna

was determined by using an abundance (A) index according to the scale presented in Zander, Reimer, Barz, Dietel, & Strohbach, (2000), as follows; A>2: core species, A=0.6-2: secondary species, A=0.2-0.6: satellite species, A<0.2: rare species. The Czekanowski-Sørensen Index (ICS, %) was used to compare the digenean faunas of four *Symphodus* spp. (Sørensen, 1948).

RESULTS AND DISCUSSION

In the present study, a total of eight digenean parasite species including adults of *Helicometra fasciata*, *Gaevskajatrema perezii*, *Proctoeces maculatus*, *Phyllodistomum crenilabri* and metacercariae of *Galactosomum lacteum*, *Condylcotyle pilodora*, *Metadana pauli* and Opecoelidae gen. sp. were determined in four labrid fish (Table 1 and Figure 1).

Table 2 summarises the digenean parasite list with indications of prevalence (%), mean intensity (MI), and abundance (A) values of identified digenean parasites in their respective fish hosts. Our results showed that *S. tinca* has the richest digenean fauna with 7 digenean species, but *S. ocellatus* was infected with only 2 digenean species (Table 2). In other words, the most diverse digenean fauna was found in *S. tinca*; *S. ocellatus* showed a low diversity with 2 species (Table 2). In this study, the parasite species richness observed in labrid fish may be related to sampling effort. Many more specimens of *S. tinca* (27 individuals) were examined, compared to *S. ocellatus* (2 individuals).

The overall mean intensity values of digenean parasite species varied significantly among the four labrid fish ($P<0.05$). Overall, the highest prevalence and mean intensity values (100% and 73.86) were found in *S. roissali*, which was infected with 4 digenean species. *Galactosomum lacteum* occurred only in *S. tinca* and *Condylcotyle pilodora* occurred only in *S. cinereus* (Table 2).

Metadana pauli was observed as a core species, but *G. lacteum* and *C. pilodora* were found as rare species (Table 2). *Helicometra fasciata* and *G. perezii* played the role of core in *S. tinca* and *S. roissali*. *Proctoeces maculatus* played the role of core, satellite or

Table 1. List of digenean parasite species identified in four labrid fish in the present study and their infection site (microhabitat)

Family	Digenean parasite species	hosts	Infection site (microhabitat)
Opecoelidae	<i>Helicometra fasciata</i> Rudolphi, 1819	<i>S. tinca</i> , <i>S. roissali</i>	intestine
	Opecoelidae gen. sp. (met.)	<i>S. tinca</i> , <i>S. roissali</i>	gills
	<i>Gaevskajatrema perezii</i> (Mathias, 1926)	<i>S. tinca</i> , <i>S. roissali</i> , <i>S. cinereus</i>	intestine
Fellodistomidae	<i>Proctoeces maculatus</i> (Looss, 1901), Odhner, 1911	<i>S. tinca</i> , <i>S. roissali</i> , <i>S. cinereus</i>	intestine
Gorgoderidae	<i>Phyllodistomum crenilabri</i> Dolgikh & Naidenova, 1968	<i>S. tinca</i> , <i>S. ocellatus</i>	urinary bladder
Heterophyidae	<i>Galactosomum lacteum</i> Jägerskiöld, 1896, (met.)	<i>S. tinca</i>	gills
	<i>Condylcotyle pilodora</i> Pearson & Prevot, 1805 (met.)	<i>S. cinereus</i>	brain
Cryptogonimidae	<i>Metadana pauli</i> (Vlasenko, 1931) Yamaguti, 1958 (met.)	<i>S. tinca</i> , <i>S. roissali</i> , <i>S. ocellatus</i>	gills, eyes

(met.: metacercariae)

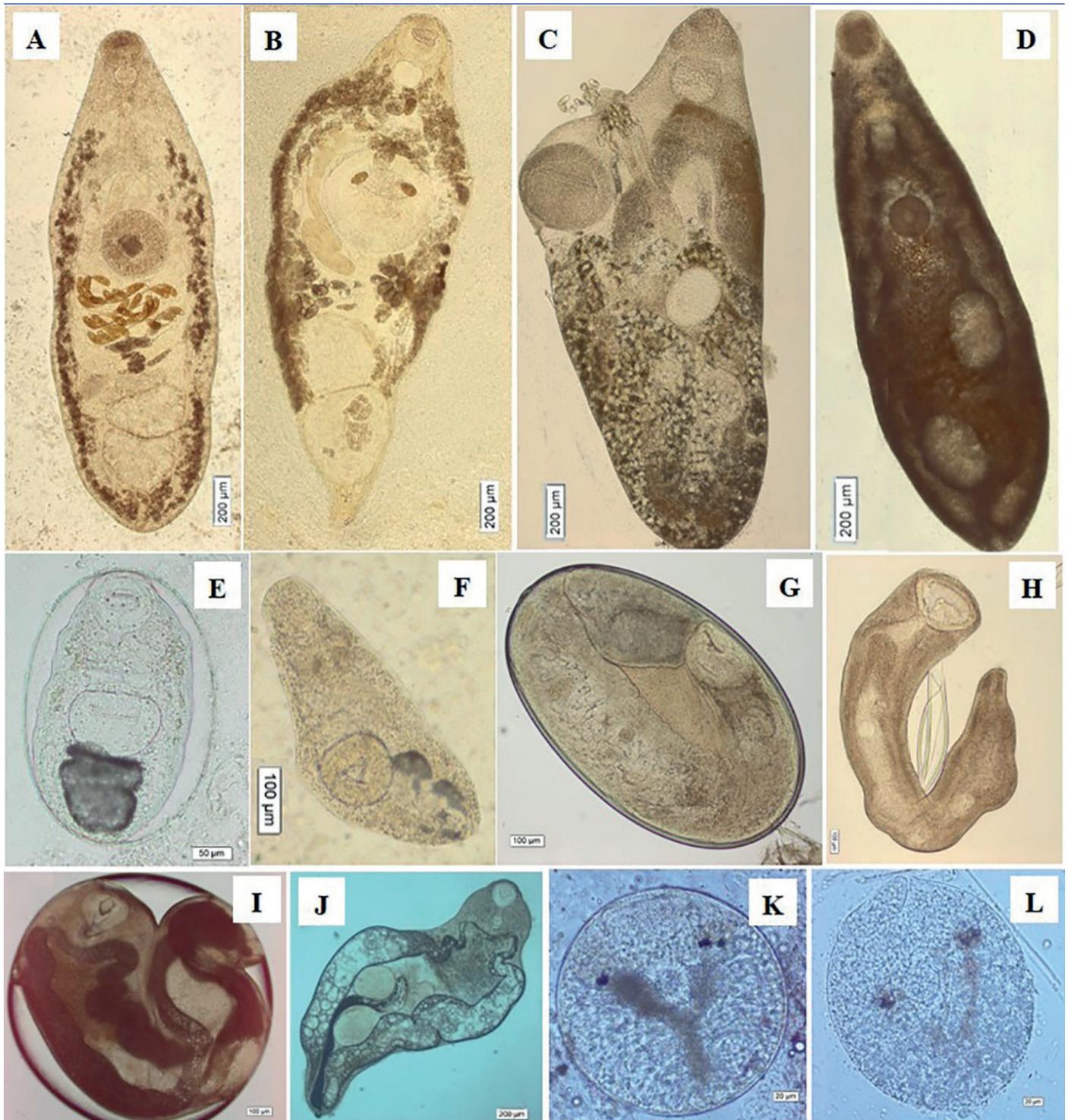


Figure 1. Digenean parasites identified in four labrid fish in this study (original), **A)** *Helicometra fasciata*, **B)** *Gaevskajatrema perezii*, **C)** *Proctoeces maculatus*, **D)** *Phyllodistomum crenilabris*, **E)** encysted metacercariae of Opcoelidae gen. sp., **F)** excysted metacercariae of Opcoelidae gen. sp. **G)** encysted metacercariae of *Condocotyla pilodora*, **H)** excysted metacercariae of *C. pilodora*, **I)** encysted metacercariae of *Galactosomum lacteum*, **J)** excysted metacercariae of *G. lacteum*, **K)** encysted metacercariae of *Metadena pauli*, **L)** excysted metacercariae of *M. pauli*.

Table 2. Overall infection prevalence (%), mean intensity (MI), and abundance (A) values of digenean parasite species from four labrid fishes in the present study

Digenean species	Symphodus tinca (n=27)			Symphodus roissali (n=7)			Symphodus cinereus (n=16)			Symphodus ocellatus (n=2)*		
	P	MI±SD	A	P	MI±SD	A	P	MI±SD	A	P	MI±SD	A
<i>Helicometra fasciata</i>	37.5	9.22±6.78	2.07	85.7	5.60±7.55	4.86						
Opcoelidae gen. sp. met.	37.5	2.30±1.00	1.02	85.7	3.00±0.00	0.43						
<i>Gaevskajatrema perezii</i>	22.2	34.00±15.2	7.55	14.3	105.00±0.00	15.0	18.8	11.5±9.85	1.43			
<i>Proctoeces maculatus</i>	11.1	3.67±2.51	0.41	42.8	90.67±15.36	38.9	6.25	1.00±0.00	0.06			
<i>Phyllodistomum crenilabri</i>	44.4	10.75±14.5	4.78					2.00±0.00		50.0	2.00±0.00	1.00
<i>Metadena pauli</i> met.	33.3	8.67±6.34	2.89	14.3	115.00±9.89	32.9				100	12.5±2.12	12.5
<i>Galactosomum lacteum</i> met.	3.7	1.00±0.00	0.04				6.25	1.00±0.00	0.06			
<i>Condylocotyle pilodora</i> met.												
Total	81.5	21.27±17.6 ^a	17.33	100	73.86±59.82 ^b	73.9	18.8	8.33±7.95 ^a	1.56	100	13.5±0.71	13.5

Means followed by the same superscript letter are not significantly different (P < 0.05). * too few values for statistical analysis; (n: number of examined fish, S.D.: standard deviation, met.: metacercariae)

rare parasite depending on the host species. *Phyllodistomum crenilabri* was core in *S. tinca*, but secondary in *S. ocellatus* (Table 2). Moreover, all digenean species found in *S. roissali* were determined as core species (Table 2).

The digenean species composition and the digenean species richness of the four labrid fishes were found to be different in the present study. A close similarity was observed in the digenean fauna of *S. tinca* and *S. roissali* (ICS = 80.0%) (Table 3). In this study, it was observed that the similarity among the digenean parasite fauna of the *Symphodus* species was low in general. Moreover, a similarity was not detected in digenean parasite fauna of two of the labrid fish, *S. cinereus* and *S. ocellatus* (Table 3).

Table 3. Czekanowski-Sorensen Index (%) in digenean fauna of four labrid fish in the study area

	<i>S. tinca</i>	<i>S. roissali</i>	<i>S. cinereus</i>	<i>S. ocellatus</i>
<i>S. tinca</i>	100			
<i>S. roissali</i>	80.0	100		
<i>S. cinereus</i>	44.4	57.1	100	
<i>S. ocellatus</i>	40.0	33.3	0.0	100

A high Czekanowski–Sorensen index, indicating a close similarity, was observed in the digenean parasite fauna of the *S. tinca* and *S. roissali* (80%). But the digenean fauna of *S. cinereus* and *S. ocellatus* were not similar in the present study (Table 3). This may be related to the diet of the labrid hosts. The composition of the parasite fauna depends on many factors. The type of diet is one of them. This may be related with the diet of the labrid hosts. *S. cinereus* is carnivorous with a slight tendency toward omnivory, mostly consuming polychaetes, foraminiferans and decapod non-crustaceans (Fernandez, Freire, & Gonzalez-Gurriaran, 1995). Whereas *S. ocellatus* is omnivorous, tending toward herbivory, mostly consume algae, and to a lesser extent bryozoans and hydroids (Kabasakal, 2001).

According to previous studies, it should be considered that the majority of the listed digenean species have been reported from *S. tinca* (Table 4).

Labridae is one of the most important families of marine fish with its biological diversity and ecological importance, and labrid fishes have distribution worldwide (Nelson, 2006). To date, a total of 134 records of digenean parasites have been enlisted from 127 labrid fish (Munoz & Diaz, 2015). So far, 35 nominal digenean species have been reported in the four labrid fishes in the Mediterranean basin and Black Sea according to data of various authors (Table 4). Four species, *H. fasciata*, *P. maculatus*, *P. acceptum* and *G. perezii*, are typical digenean parasites of the labrid fishes and have also been reported in both basins (Table 4). Considering the number of digenean species reported in the four labrid fishes, except for the digenean species reported in both basins, it is noteworthy that the species diversity in the Mediterranean basin (19 species) is higher than from the Black Sea (9 species) (Table 4). The difference in di-

Table 4. List of the digenean parasites reported by various authors in four labrid fish. [Reports in the Black Sea are shown with square brackets]

Digenean Species	<i>Symphodus tinca</i>	<i>Symphodus roissali</i>	<i>Symphodus cinereus</i>	<i>Symphodus ocellatus</i>
<i>Skrjabiniella aculeata</i>	6, 12			
<i>Proserhynchus crucibulum</i>	12			
<i>Metadena depressa</i>	12			
<i>Metadena pauli</i>	[18], [PS]	[18], [PS]	[18]	[18], [PS]
<i>Proctoeces maculatus</i>	10, 12, 16, [18], 19, 21, 22, [PS]	[5], [18], [PS]	[18], 22, [PS]	[5], 14, [18]
<i>Stringotrema pagelli</i>	22		22	
<i>Tergestia laticollis</i>	22		[3], 22	
<i>Theledera skrjabini</i>	[1]		[18]	
<i>Phyllodistomum acceptum</i>	[4], 12, [18]	[18]	[18], 22	[18]
<i>Phyllodistomum crenilabri</i>	[2], [18], [PS]		[18]	[18], [PS]
<i>Lecithochirium musculus</i>	22		19, 22	
<i>Lecithochirium rufoviride</i>	12	6		
<i>Synaptobothrium caudiporum</i>	6	6		
<i>Lecithaster gibbosus</i>			3, 22	14, 16, 17, 19
<i>Lecithaster stellatus</i>		16		
<i>Holorchis micracanthum</i>		13, 19		14
<i>Holorchis pycnopus</i>				
<i>Lepidauchen stenostoma</i>	8, 10, 12			
<i>Centroderma spinosissimum</i>	3			
<i>Monorchis monorchis</i>	[4]			
<i>Genitocotyle mediterranea</i>				
<i>Gaevskajatrema perezii</i>	[9], [18], 12, [PS]	16, [18], 19, [PS]	16, [18], 19 [PS]	14, 16, 17, 19
<i>Helicometra fasciata</i>	10, 12, [15], 16, [18], 21, [PS]	3, 16, [18], [PS]	3, 11, [18]	14, 16, [18]
<i>Helicometra pulchella</i>	21		11, [18]	[18]
<i>Macvicaria alacris</i>	16, 19, 20, 21		16, 19, 22	14, 16, 17, 19
<i>Peracreadium idoneum</i>	22		3, 22	
<i>Peracreadium sp.</i>	[4]	[4]		
<i>Gaevskajatrema pontica</i>	[4]	[4]		
<i>Caudotestis skrjabini</i>	[4]			
<i>Caudotestis trachuri</i>	[4]	[4]		
<i>Deretrema scorpaenicola</i>				19
<i>Diphtherostomum brusinae</i>	8, 10, 12, 22	7	7	
<i>Zoogonus rubellus</i>	10, 12, 19, 21, 22			
<i>Galactosomum lacteum</i>	[18], [PS]	[18]	[18]	[18]
<i>Cardiocephalooides longicollis</i>				[18]
<i>Condocotyla pilodora</i>			[PS]	[18]
Number of species	28	14	16	14

[1]. Koval & Tsarychkova (1964), [2]. Dolgikh & Naidenova (1968), 3. Sey (1970), [4]. Nikolaeva & Solonchenko (1970), [5]. Parukhin, Naidenova, & Nikolaeva, (1971), 6. Papoutsoglou (1976), 7. Bray & Gibson (1986), 8. Orecchia, Paggi, & Radujkovic, (1988), [9]. Gaevskaya & Solonchenko (1989), 10. Campos, Carbonell, & Pellicer, (1990), 11. Reversat & Silan (1993), 12. Campos & Carbonell (1994), 13. Bartoli & Bray (1996), 14. Bartoli & Boudouresque (1997), [15]. Korniychuk & Gaevskaya (1999), 6. Sasal, Niquil, & Bartoli, (1999), 17. Bartoli, Morand, Riutort, & Combes, (2000), [18]. Korniychuk (2001), 19. Bartoli, Gibson, & Bray, (2005), 20. Oğuz & Bray (2006), 21. Gargouri, Elbohli, & Maamouri, (2010), 22. Radujković & Sundic (2014), [PS], Present Study.

versity of digenean parasites reported from the Mediterranean basin and Black Sea may be related to the number of the intermediate hosts and the variation in physical and chemical parameters of the environment that can influence the host. So far, *Condylocotyle pilodora* has not been previously recorded in labrid fishes. It is remarkable that this digenean parasite is reported for the first time in labrid fish in the present investigation (Table 4). Thus, the number of digenean parasite species in the four labrid fishes reported in both basins has increased to 36 with the addition of *C. pilodora*.

CONCLUSIONS

This study revealed the first data on the digenean fauna of four fish species belonging to *Symphodus* genera in Turkish waters, and the data recovered in this paper contribute to the digenean parasites list of labrid fish inhabiting the Black Sea. In addition, these results contain some valuable knowledge, which can be used in future digenean parasite research.

Conflict of interest: The authors declare that they have no conflicts of interest.

Ethics Committee Approval: All applicable international, national and institutional guidelines for the care and use of animals were followed. The study protocol no. 19 of 13/07/2015 was approved by the Republic of Turkey, Sinop University Experimental Animals Local Ethics committee.

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