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Digenetic trematodes of some teleost fish off the Mudanya Coast (Sea of Marmara, Turkey)

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Summary

A total of 200 fishes belonging to nine species were sampled from the Sea of Marmara. Thirteen trematode species were recorded in the intestine of these hosts: *Helicometra fasciata* and *Diphterostomum brusinae* in *Zosterisessor ophiocephalus*; *Monascus filiformis* in *Trachurus trachurus*; *Dicrogaster purpusilla*, *Schikhobalotrema sparisomae* and *Sacccocoelium obesum* in *Liza saliens*; *Macvicaria alacris*, *H. fasciata* and *Gaevskajatrema perezi* in *Symphodus tinca*; *Anisocladium fallax* and *A. capitellum* in *Uranoscopus scaber*; *Stephanostomum caducum* in *Merluccius merluccius; Bucephalus marinus*, *Stephanostomum gaidropsari* and *H. fasciata* in *Gaidopsarus mediterraneus; H. fasciata* in *Scorpaena scrofa* and *Gobius cobitis.*

Key words: helminths; Digenea; Mudanya; Sea of Marmara; Turkey

Introduction

In the recent checklist of parasites of Turkish marine waters, Öktener (2005) records 45 species of digeneans. He uses the checklist to bring to general attention reports from locally available theses, greatly increasing our sparse knowledge of this fauna. Among these theses is that of the senior author (Oguz, 1995) and this paper is an update of those observations, including several re-determinations. These constitute only the second report of Digenea from the Sea of Marmara, the first being Sezen-Akandere (1972) who reported *Lepidapedon sengunii* Sezen-Akandere, 1972 and *L. ricci* Sezen-Akandere, 1972 from *Trachurus trachurus.* Bray and Gibson (1990) synonymised both species with *Prodistomum polonii* (Molin, 1859), a common parasite of this host.

Material and Methods

The study area is in north-western Anatolia, 40° 22' N, 28° 52'E (Fig. 1). During the study period from November 1990 to May 1993, between 6 and 28 specimens of 9 fish species were collected. The fish were placed in plastic containers containing sea water and then transferred the research laboratory. They were kept in the tanks until examination within 24 hours of collection. Methods adapted and utilised for the helminthological necropsy, and later for the analysis, were routine techniques (Pritchard & Kruse, 1982). All possible sites of infection were examined for the occurrence of parasites with the aid of a stereo microscope with ×12 and ×50 magnifications. The parasites were fixed with AFA, and then stained with Mayer's carmalum. Data for the prevalence, intensity and abundance are given (see Margolis, *et al.* 1982). The specimens are deposited in the Biology Department, Faculty of Science and Art, Ataturk University.

Results

A total of 184 fishes from 9 species *Liza saliens* (Risso), *Gaidopsarus mediterraneus* (L.), *Gobius cobitis* Pallas, *Merluccius merluccius* (L.), *Symphodus tinca* (L.), *Scorpaena scrofa* L., *Uranoscopus scaber* L., *Trachurus tra-*

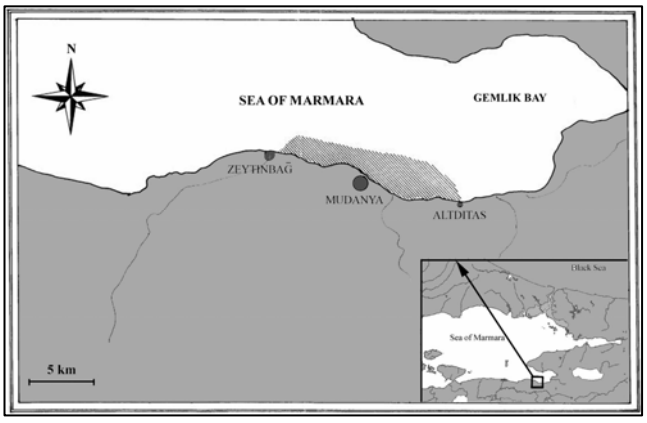

Fig. 1. The research area

churus (L.) and *Zosterisessor ophiocephalus* (Pallas) were investigated. 183 individuals of 13 trematode species were identified from the intestine of these species (Table 1). Basic measurements are given in Table 2.

Table 1. Digenetic trematodes of some fish species of Mudanya coast, Turkey

Host fish species	N	In & (%)	Identified parasites group	Mx (Mn) ∑
Gaidopsarus mediterraneus	14	3 (21 %)	*Helicometra fasciata*	4 (3.3) 10
Gaidopsarus mediterraneus	14	1 (7 %)	*Stephanostomum gaidropsari*	1 (1) 1
Gaidopsarus mediterraneus	14	1(7 %)	*Bucephalus marinus*	1(1) 1
Gobius cobitis	25	3 (12 %)	*Helicometra fasciata*	6 (5.3) 16
Liza saliens	18	3 (16 %)	*Dicrogaster perpusilla*	5 (3.3) 10
Liza saliens	18	5 (27 %)	*Saccocoelium obesum*	6 (2.4) 12
Liza saliens	18	5 (27 %)	*Schikhobalotrema sparisomae*	3 (2.0) 10
Merluccius merluccius	39	1 (2 %)	*Stephanostomum caducum*	1 (1) 1
Scorpaena scrofa	17	4 (23 %)	*Helicometra fasciata*	20 (10.0) 40
Symphodus tinca	14	4 (28 %)	*Helicometra fasciata*	6 (3.7) 15
Symphodus tinca	14	1 (7 %)	*Macvicaria alacris*	1 (1) 1
Symphodus tinca	14	10 (71 %)	*Gaevskajatrema perezi*	6 (1.2) 12
Trachurus trachurus	39	8 (20 %)	*Monascus filiformis*	5 (2.5) 20
Uranoscopus scaber	16	6 (37 %)	*Anisocladium fallax*	3 (1.6) 10
Uranoscopus scaber	16	7 (43 %)	*Anisocoelium capitellatum*	4 (1.7) 12
Zosterisessor ophiocephalus	18	6 (33 %)	*Helicometra fasciata*	3 (2.6) 16
Zosterisessor ophiocephalus	18	1 (5 %)	*Diphterostomum brusinae*	1 (1) 1

Number of examined fish (N); number of infected fish (In); percentage (%); maximum (Mx); mean (Mn) and total (∑) number of parasite

Table 2. Measurement (length x width) of the digenetic trematodes of the fish species caught in Mudanya coast, Turkey

Parasite Species	Bd	Ph	Os	Vs	Tt (A-P)	Ov	Egg
S. sparisomae	1854 x 739	84 x 110	156 x 167	233 x 250	507 x 900	100 x 147	87 x 55
B. marinus	1400 x 494	60 x 67	n/a	278 x 308*	207 x 203 – 141 x 230	140 x 106	29 x 14
H. fasciata	3007 x 1148	101 x 120	241 x 225	365 x 379	234 x 612 – 322 x 544	73 x 360	18 x 58
G. perezi	1146 x 652	66 x 101	100 x 160	259 x 292	166 x 226 – 196 x 257	140 x 152	58 x 89
M. alacris	932 x 352	54 x 70	108 x 118	200 x 220	130 x 140 – 140 x 150	60 x 80	24 x 70
D. perpusilla	936 x 356	59 x 83	91 x 120	127 x 127	168 x 222	87 x 121	19 x 41
S. obesum	1666 x 500	104 x 125	30 x 60	120 x 153	96 x 216	100 x 180	27 x 43
D. brusinae	1040 x 486	32 x 90	153 x 173	288 x 360	100 x 130 – 84 x 130	100 x 110	22 x 27
S. caducum	4804 x 508	80 x 164	170 x 200	46 x 95	320 x 520 – 280 x 480	168 x 264	40 x 63
S. gaidropsari	5783 x 548	110 x 90	114 x 140	180 x 220	480 x 600 – 470 x 700	126 x 256	No egg
M. filiformis	4633 x 487	153 x 244	212 x 223	194 x 212	199 x 210 – 202 x 214	178 x 212	28 x 21
A. fallax	2714 x 316	59 x 99	109 x 129	170 x 170	96 x 188 – 105 x 207	75 x 82	No egg
A. capitellatum	3006 x 344	55 x 76	168 x 224	55 x 60	168 x 224 – 151 x 204	106 x 120	19 x 8

* Rhynchus; Bd – body; Ph – pharynx; Os – oral sucker; Vs – ventral sucker; Tt – testes (A – anterior; P – posterior); Ov – ovary

Discussion

Systematic observations on parasites found:

Family Haplosplanchnidae

Genus *Schikhobalotrema* Skrjabin & Gushanskaya, 1955

Schikhobalotrema sparisomae (Manter, 1937) Skrjabin & Gushanskaya, 1955

This species appears to be that known by the above name and reported in mullets in the Mediterranean basin by various authors. The only description available from this region is that of Saad-Fares (1985), who reported the worm from several mullet species, including *Liza saliens*, from off the coast of Libya. Other records from this region include Solonchenko and Tkachuk (1985) from *L. auratus* in the Sea of Azov, and Dmitrieva and Gaevskaya (2001) from *Mugil cephalus* in the Black Sea. Unnamed *Schick-hobalotrema* species are reported in Mediterranean basin mullet, but not *L. saliens*, by various authors, including the report from three species of mullet off the Aegean coast of Turkey by Altunel (1982). This species is most frequently reported in scarid fishes in the north-western Atlantic (Nahhas *et al.*, 1997), having been initially found in *Spari-soma* spp. off Florida (Manter, 1937).

The record of *Piriforma* sp. from *Zosterisessor ophiocephalus* by Oguz (1995) relates to a single specimen which we have re-examined. Our further observation is that it is a heavily-flattened haplosplanchnid which is not identifiable further in this condition.

Family Bucephalidae Poche, 1907
Genus *Bucephalus* Baer, 1827

Bucephalus marinus Vlasenko, 1931
This material was not mentioned in Öktener (2005). This species is commonly reported from *Gaidropsarus mediterraneus* (syn. *Onos tricirratus*), having been originally described from this host in the Black Sea (Vlasenko, 1931). Since then it has been reported from the Black Sea by Osmanov (1940), Dolgikh and Naidenova (1968), Nikolaeva and Solonchenko (1970), Lushchina (1985), Naidenova *et al.* (2002) and Gaevskaya and Korniychuk (2003), the Mediterranean off Greece by Papoutsoglou (1976). The record of this species in the Western Mediterranean by Bartoli *et al.* (2005) is now thought to refer to *Rhipidocotyle genovi* Dimitrov, Kostadinova & Gibson, 1996 (see Bartoli *et al.*, in press).

Family Opecoelidae Ozaki, 1925
Genus *Helicometra* Odhner, 1902

Helicometra fasciata (Rudolphi,1819) Odhner,1902
This record includes that of *H. insolata* [*sic*] (Polyansky, 1955) by Oguz (1995) and Öktener (2005). Enzyme electrophoresis indicated to Reversat *et al.* (1989) and Reversat *et al.* (1991) that morphologically indistinguishable *Helicometra* forms constituted a complex of three species. The species they reported in *Scorpaena scrofa*, *Symphodus tinca* and *Zosterisessor ophiocephalus* in the Western Mediterranean was, however, considered to be *H. fasciata*. Korniychuk (1999, 2000a), in studies of the morphological variation within *H. fasciata*, also reported it from *S. tinca*, We are, therefore, identifying these forms as *H. fasciata*, well aware of the fact that many workers consider this a species complex whose constituent species are not distinguishable by morphology alone (Aken'Ova *et al.,* 2005). Several other authors have reported *H. fasciata* in the five host species reported here from localities in the Mediterranean basin (see the Natural History Museum Host-parasite database on: http://www.nhm.ac.uk/research-curation/projects/host-parasites/database). Bartoli *et al.* (2005) reported forms of *Helicometra* from three of these hosts in the Western Mediterranean, those from *S. scrofa* they called 'form 2', those from *G. mediterraneus* they called 'form 3' and both 'forms' were reported from *S. tinca*.

Genus *Gaevskajatrema* Gibson & Bray, 1982
Gaevskajatrema perezi (Mathias, 1926) Gibson and Bray, 1982
(syns. *Plagioporus pontica* Koval, 1966, *Gaevskajatrema pontica* (Koval, 1966) Machkevsky, 1990)
Plagiporus pontica was described from several labrids, including *Symphodus* (= *Crenilabrus*) *tinca* in the Black Sea (Koval, 1966). Gibson and Bray (1982) considered it to be conspecific with *Gaevskajatrema perezi* from various labrids in the north-eastern Atlantic Ocean (Mathias, 1926; Gibson & Bray, 1982). Gaevskaya and Solonchenko (1989) also adopted this synonymy, reporting *G. perezi* from *S. tinca* in the Black Sea. Further records of this parasite from this host in the Black Sea include Machkevsky (1990), who used the combination *Gaevskajatrema pontica* for the first time as far as we are aware, and Korniychuk (2000b, 2001).

Genus *Macvicaria* Gibson & Bray, 1982
Macvicaria alacris (Looss, 1901) Gibson and Bray, 1982
This material, listed as *Plagioporus dogieli* (Pogorelt'seva, 1975) by Oguz (1995) and Öktener (2005), is re-identified here. *M. alacris* was described originally by Looss (1901a) from labrids off Trieste in the Adriatic Sea, has been reported several times from *Symphodus tinca*; from the Black Sea (Pogorelt'seva, 1952; Gaevskaya & Korniychuk, 2003), the Adriatic Sea (Sey, 1970) and the western Mediterranean (Sasal *et al.*, 1999; Bartoli *et al.*, 2005). Gibson and Bray (1982) figured the worm from several hosts in the northeastern Atlantic and erected the new genus *Macvicaria*, with this species as its type-host.

Family Haploporidae Nicoll, 1914
Genus *Dicrogaster* Looss, 1902

Dicrogaster perpusilla Looss, 1902
(syn. Dicrogaster contracta Looss, 1902)

A recent study by Sarabeev and Balbuena (2003) has demonstrated the synonymy of *D. perpusilla* (the type-species of the genus) and *D. contracta*, based on morphological variability. The species has been known almost exclusively as *D. contracta* and, as such, has been reported in *Liza saliens* by Solonchenko (1976, 1982) and Solonchenko and Tkachuk (1985) from the Sea of Azov, by Ibragimov (1988) from the Caspian Sea and by Fares and Maillard (1974) and Merella and Garippa (2001) from the western Mediterranean Sea.

Genus *Saccocoelium* Looss, 1902
Saccocoelium obesum Looss, 1902
Overstreet and Curran (2005) pointed out that Dawes (1956) and Fischthal and Kuntz (1963) [to which they could have added others, e.g. Markevich (1951)] considered *S. tensum* Looss, 1902 a synonym of *S. obesum*, but they also pointed out that Fares and Maillard (1974) showed that life-history stages in addition to morphological differences indicated the validity of both species. The distinctness of these forms have generally been recognised by later studies, including the redescriptions by Radujkovic *et al.* (1989) and the review by Gaevskaya and Dmitrieva (1993). The species has been reported from *Liza saliens* by Mikailov (1958) and Ibragimov (1988) in the Caspian Sea, Gaevskaya and Dmitrieva (1993) from the Black Sea and

Fares and Maillard (1974) and Merella and Garippa (1998) from the western Mediterranean. Both *S. obesum* and *S. tensum* have been reported from the Aegean Sea coast by Altunel (1982), but not in *L. saliens*.

Family Zoogonidae Odhner, 1902
Genus *Diphterostomum* Stossich, 1903

Diphterostomum brusinae (Stossich, 1888) Stossich, 1903
As Bray and Gibson (1986) pointed out, this species is reported mostly from the Mediterranean and Black Seas, but is also recorded in a wide variety of sites in the Atlantic, Indian and Pacific Oceans. There must be considerable doubt as to whether all the records refer to this species, but we have no reason to doubt that this is the species we report here. It is found mainly in fishes of the family Sparidae, but has been reported in *Zosterisessor ophiocephalus* from the Black Sea by Nikolaeva (1975) and Gaevskaya and Korniychuk (2003).

Family Acanthocolpidae Lühe, 1906
Genus *Stephanostomum* Looss, 1899

Stephanostomum gaidropsari Bartoli & Bray, 2001
This was reported as *S. baccatum* (Nicoll, 1910) by Oguz (1995) and Öktener (2005). This species was described by Bartoli and Bray (2001) from *Gaidropsarus mediterraneus* from the Gulf of Marseilles. This specimen is similar to the original description, with about 36 hooks (counts are not easy on flattened specimens) and a relatively short ejaculatory duct with prominent sclerotised 'cupolas'. The related *S. pristis* (Deslongchamps, 1824), also a parasite of gadiforms, was differentiated in two tables by Bartoli and Bray (2001) and this specimen fits *S. gaidropsari* in most characteristics, but it has a smaller sucker-ratio and the vitellarium is interrupted at the level of the gonads on both sides (cf unilateral in the description of *S. gaidropsari*). *S. pristis* is reported from eleven gadiform species (see Bartoli & Bray, 2001; Gaevskaya, 2001) including *G. vulgaris* (see Looss, 1901b; Papoutsoglou, 1976), but not from *G. mediterraneus*.

Stephanostomum caducum (Looss, 1901) Manter, 1934
This was reported as *Stephanostomum* sp. by Oguz (1995) and Öktener (2005). There seems little doubt that the specimen of *Stephanostomum* (with 48 circum-oral spines) from *Merluccius merluccius* belongs to this species as it is morphologically indistinguishable from the forms described under this name by Looss (1901b), Lebour (1908), Nicoll (1914), Srivastava, Køie (1984) and Karlsbakk (1993). Later, Køie (1984) considered this species a synonym of another common parasite of gadiforms, *S. pristis*. This conclusion was not supported by Karlsbakk (1993) and Bartoli and Bray (2001), and this is followed here. *S. caducum* has been reported from eight species of gadid, but never from *M. merluccius*. In fact, we cannot trace any previous convincing records of adult *Stephanostomum* in this host. As pointed out by Bartoli and Bray (2001), the apparent record of *S. cesticillum* (Molin, 1858) from this host by Hristovski and Jardas (1991) is a result of a misalignment in the table. The host of *S. solontschenki* Parukhin, 1968 recorded as *M. merluccius* by Parukhin (1968) is corrected to *M. capensis* in later works (e.g. Parukhin, 1980). *S. caducum* is reported mainly in the north-eastern Atlantic, but was apparently originally found in the Adriatic off Trieste (Looss, 1901b).

Family Fellodistomidae Nicoll, 1909

Genus *Monascus* Looss, 1907
Monascus filiformis (Rudolphi, 1819) Looss, 1907
This species is a common parasite of carangid fishes and has frequently been reported in *Trachurus trachurus* in the Mediterranean and Black Seas and in the northern Atlantic (see Koie, 1979; Bray & Gibson, 1980; Bartoli *et al*., 2005 and the Natural History Museum Host-parasite database on: http://www.nhm.ac.uk/research-curation/projects/host-parasites/database). The life-cycle was investigated by Koie (1979), who found that the cercariae were eaten by small fish, in which the worm matured, and was passed to piscivorous fishes by consumption. Later work has shown that the worm can also utilize medusae and chaetognaths as second intermediate hosts (Girola *et al.*, 1992; Martorelli & Cremonte, 1998).

Family Cryptogonimidae Ward, 1917
Genus *Anisocladium* Looss, 1902
Anisocladium fallax (Rudolphi, 1819) Looss, 1902
For comments see below.

Genus Anisocoelium *Lühe, 1900*
Anisocoelium capitellatum (Rudolphi, 1819) Lühe, 1900

Bartoli and Gibson (2000) redescribed and reviewed the cryp-togonimid parasites of *Uranscopus scaber* and came to the conclusion that *Anisocladium fallax* and *Anisocoelium capitellatum* are specific to this host, and that records from other fish species are either probably erroneous or represent accidental infections. They list earlier records of these species, and show that the worms have been widely reported in the Mediterranean and Black Seas. In the light of this study, some recent reports of these species need confirmation. Lozano *et al.* (2001) reported both species in the batrachoidid batrachoidiform *Halobatrachus didactylus* (Bloch & Schneider) and in trachinid perciform *Echiichthys vipera* (Cuvier) from the southern Iberian Peninsula. Al-Bassel (2002) reported *Anisocladium fallax* in the mullid perciform *Mullus surmuletus* L. from the Mediterranean off Egypt.

Discussion

The Sea of Marmara is connected with the Black Sea to the northeast via the Bosporus and with the Aegean Sea via the Dardanelles to the southwest. Its area is small (about 280 x

80 km, 11 350 square km), but it is relatively deep (average depth is about 494 m, maximum 1 355 m). Salinity averages 22 ‰ and is, therefore, not much greater than that found in the Black Sea (17 – 18 ‰ in the upper layers – Briggs, 1974) and is greatest near the Dardanelles. It is believed that the sea formed about 2.5 million years ago (late Pliocene Epoch). The fauna of this sea is, therefore, likely to be intermediate between that of the Black and Mediterranean Seas. The Black Sea is considered to have a depauperate fauna relative to the Mediterranean with only 20 to 29 % as many species (according to Briggs, 1974). Ekman (1953) quoted figures on the mollusc fauna, showing that the Sea of Marmara harbours 59 % as many species as the nearby Aegean Sea, whereas the relative figure for the Black Sea is 22 %. Similarly, Can and Belecenoğlu (2005) listed the fish fauna, with the Sea of Marmara harboring 64 % (249) of the number of species found in the Aegean and wider Mediterranean (389), whereas the Black Sea has only 39 % (151). The digenean fauna of the Sea of Marmara is not well enough studied for us to produce comparable figures, but it is noteworthy that nearly all species reported here are found in both the Black Sea and the Mediterranean Sea. None are found only in the Black Sea, and only two (*Stephanostomum gaidropsari* and *S. caducum*) have not been reported in the Black Sea. One species, *Bucephalus marinus* may be of Black Sea origin as, so far, its only Mediterranean report is from the Saronic Gulf off Greece.

Bartoli *et al.* (2005) studied the occurrence of fish digeneans throughout the Mediterranean Sea and Black Seas, based on the diversity index M = N/N' (N number of digenean species/N' number of fish species examined). The highest figure they discovered was M = 3.8 for the region off Corsica in the western Mediterranean. The figure we calculate from the present, admittedly small, sample is M = 1.4. This is lower than was found in the Black Sea (M = 2.2 and 2.7) or any of the eastern Mediterranean sites (M = 2.1 to 2.6), and closer to those found in the Adriatic Sea (M=0.6 to 2.0). Bartoli *et al.* (2005) thought that the relatively high figures in the eastern Mediterranean may reflect Lessepsian migration. According to Fischthal (1980) some Lessepsian fishes have brought their parasites with them and some have acquired local parasites. This can be expected to continue as more fish species establish themselves in the Mediterranean (Belecenoğlu *et al.*, 2002). Bartoli *et al.* (2005) also thought that the diversity index might reflect the stability of the site and the pollution levels.

This study is the first of its kind in the Sea of Marmara and leaves many questions to be answered by further collection.

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