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First report of some parasites from Mediterranean mussel, *Mytilus galloprovincialis* Lamarck, 1819, collected from the Black Sea coast at Sinop

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Abstract: This is the first study on parasite fauna of *Mytilus galloprovincialis* Lamarck, 1819 in Turkish waters. Mussel samples were collected monthly at 3 sampling stations on the coast of Sinop on the Black Sea in the period between August 2012 and July 2013. A total of 1740 mussels were examined for parasites using standard parasitological investigation procedures. The parasites identified included the following: 2 protozoans, *Nematopsis legeri* (32.12%) and *Peniculistoma mytili* (6.72%); 1 turbellarian, *Urastoma cyprinae* (6.32%); 1 trematode, *Parvatrema duboisi* (4.54%); and 1 polychaeta, *Polydora ciliata* (2.24%). All identified species are illustrated in figures and constitute new records of Turkish parasite fauna.

Key words: *Mytilus galloprovincialis*, parasite fauna, Black Sea, Turkey

1. Introduction

The Mediterranean mussel, *Mytilus galloprovincialis L., 1819,* is native to the Mediterranean Sea, Black Sea, and Adriatic Sea (http://www.issg.org/database/species/ecology.asp?si=102&fr=1&sts=), but has spread mostly via ballast water and ship hull fouling to many other regions worldwide (Branch and Steffani, 2004). Due to its widespread distribution, *M. galloprovincialis* has been listed as one of the "World's Worst 100 Invasive Alien Species" (http://www.issg.org/database/species/ecology.asp?si=102&fr=1&sts=sss&lang=EN). On the other hand, it is a major component of the littoral fauna in the Black Sea and is an aquatic product that has economic importance. Many parasite species can affect marine mussels and cause decreases in both natural and cultivated mussel populations (Sindermann, 1970; Figueras and Villalba, 1988; Bower and Figueras, 1989). The development of shellfish industries and the concomitant increase in demand also contribute to the introduction and transfer of different shellfish species, thereby increasing the risks of spreading their parasites and diseases around the world (Bower and McGladdery, 1994). Parasitic infections have been recognized as one of several stress factors that may lower the resistance of the host and its ability to adapt to changing environmental conditions (Williams and Jones, 1994). *Mytilus galloprovincialis* has been accepted as an aggressive invasive species and has a rapid growth rate under a wide range of environmental conditions, as well as a high level of tolerance to physiological limiting factors, which allows it to colonize in marginal areas (Calvo-Ugarteburu and McQuaid, 1998). Several diseases caused by parasites in the economically important mytilid mussel, *M. galloprovincialis*, have been documented (Murina and Solonchenko, 1991; Robledo et al., 1994; Villalba et al., 1997; Zaitsev and Alexandrov, 1998; Holodkovskaya, 2002; Rayyan et al., 2004; Gaevskaya, 2006; Machevsky et al., 2011). Several pathological occurrences threatening the health status of mussels have been reported: disorganization of the gill filaments reducing the feeding capacity of heavily infected mussels, weakness in juveniles and loss of harvest due to heavy infections of some protozoans, invasions of reproductive tissues causing parasitic castrations, and erosion and metaplasia in the intestinal epithelium (Lasiak, 1992; Cousteau et al., 1993; Robledo et al., 1994; Sprague and Orr, 1995; Villalba et al., 1997). Despite several studies conducted on the parasites of *M. galloprovincialis* where it is distributed, there is no parasitological report in Turkey. The aim of the present study was to conduct a parasite survey during the course of 1 year on *M. galloprovincialis* mussel populations of natural beds in Sinop on the coast of the Black Sea in Turkey, and this is the first study identifying its parasite fauna.

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2. Materials and methods

Mussel sampling was carried out between August 2012 and July 2013 at 3 sampling stations representing 3 ecologically different environments in Sinop on the coast of the Black Sea (Figure 1). Sampling site I: İskele is located at 42°00′58″N, 35°10′37″E on the inner harbor. Mussel samples were collected from a dock leg of the landing stage at depths of between 3 m and 13 m, maximum depth being 14 m. This area is polluted mainly by fishing boats during their landing activities. Sampling site II: Ada Başı is located at 42°01′05″N, 5°12′42″E. It has a rocky floor and mussel samples were collected at depths of between 3 m and 13 m, maximum depth being 20 m. This area is a natural ecosystem that is not affected by any kind of human activity. Sampling site III: Sarı Ada is located at 42°02′51″N, 35°02′56″E at the outer harbor. It has a rocky floor with a maximum depth of 3 m. This area is affected from time to time by small-scale fishing boats, human waste discharges, and a small stream pouring into this area. A total of 1740 mussels were collected by scuba divers, transported in local water to the parasitology laboratory, and kept alive until necropsy. The mussels were then opened and the internal organs were macroscopically and microscopically examined. Parasite morphology was observed using light microscopy. Infection prevalence (%) was determined in accordance with Bush et al. (1997). Authorities for parasite identification included Raabe (1971), Gaevskaya et al. (1990), and Gaevskaya (2006) for *Nematopsis legeri* and *Peniculistoma mytili*; Gaevskaya et al. (1990) and Chung et al. (2010) for *Parvatrema duboisi*; Gaevskaya et al. (1990), Crespo-Gonzalez et al. (2005), and Francisco et al. (2010) for *Urastoma cyprinae*; and Dorsett (1961) and Gaevskaya et al. (1990) for *Polydora ciliata*.

3. Results

During the investigation period, a total of 5 parasite species were identified: 2 protozoans, *Nematopsis legeri* de Beauchamp, 1910 (Figure 2A), detected in labial pulps, gills, hepatopancreas, mantle, and feet, and *Peniculistoma mytili* (Morgan, 1925) Jankowski, 1964 (Figure 2B), between gill filaments; 1 turbellarian, *Urastoma cyprinae* (Graff, 1882) (Figure 2C), between gill filaments; 1 trematode, *Parvatrema duboisi* (Dollfus, 1923) (Figure 2D), in gonads, hepatopancreas, and gill filaments; and 1 polychaeta, *Polydora ciliata* (Johnston, 1838) (Figure 2E), in the burrows on the inner side of the shell (Figure 2F). The most prevalent parasite was *N. legeri* (32.12%), followed by *P. mytili* (6.72%), *U. cyprinae* (6.32%), *P. duboisi* (4.54%), and *P. ciliata* (2.24%).

4. Discussion

The Mediterranean mussel *M. galloprovincialis* is native to all seas surrounding Turkey. Despite its economic value, there is no study on its parasites and their infection indices in Turkey. Here in this present study, we provided the first detailed data on its parasite and infection indices in nature on the Turkish Black Sea coast.

The protozoans *Nematopsis legeri* and *Peniculistoma mytili* were reported in *M. galloprovincialis* from the Black Sea coast (Belofastova, 1997; Holodkovskaya, 2002;

Figure 1. Map of the sampling areas.

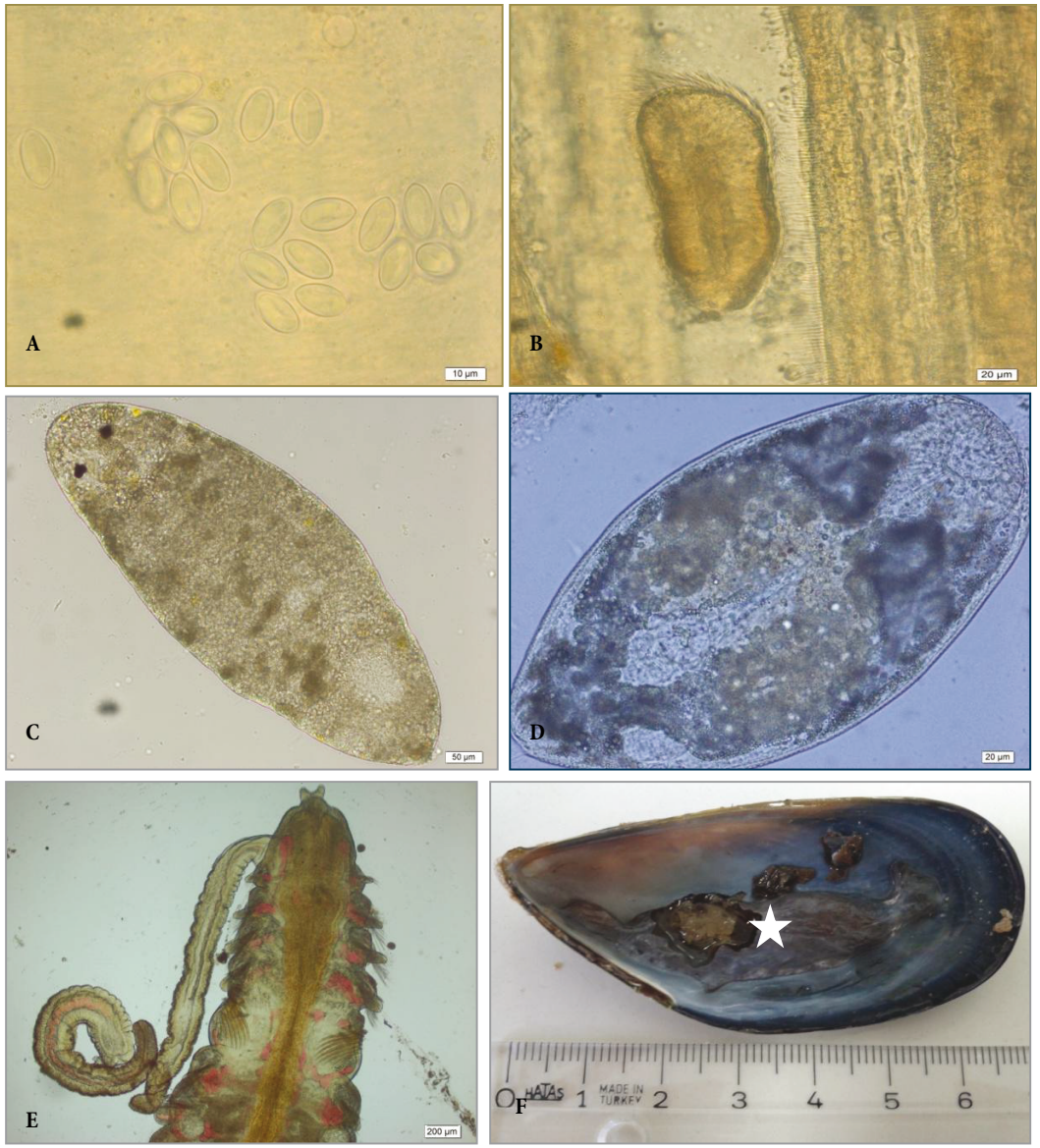

Figure 2. Parasites of *M. galloprovincialis*: **A.** *Nematopsis legeri*, **B.** *Peniculistoma mytili*, **C.** *Urastoma cyprinae*, **D.** *Parvatrema duboisi*, **E.** *Polydora ciliata*, **F.** burrow (☆) on the inner side of mussel shell.

Gaevskaya, 2006). The prevalence of the *Nematopsis* species varies among bivalve hosts in different geographic areas (Azevedo and Matos, 1999). *Nematopsis legeri* was the most prevalent parasite in our study and the highest recorded prevalence corresponded to this parasite species with an annual value of 32.12%. Belofastova (1997) reported an overall prevalence of 39%, ranging between 10% and 100%, and Gaevskaya (2006) reported a prevalence of values ranging between 30% and 100% in *M. galloprovincialis* in different sampling areas and periods on the Ukrainian coast of the Black Sea. For *Nematopsis* sp., Soto et al. (1996) and Francisco et al. (2010) reported prevalence values of 100% and 70% in *M. galloprovincialis* on the Mediterranean coasts of Spain and Portugal, respectively. The *Nematopsis* species show host alternation, with gametogony and sporogony occurring in bivalves (Prytherch, 1940) and the vegetative stage (schizogony) occurring in crabs, the definitive host (Théodoridès, 1962; Sprague, 1970). According to observations during sampling, crabs were more abundant in sampling site III where monthly prevalence values were between 50% and 100%, clearly indicating the possibility of higher prevalence values in *M. galloprovincialis* in different geographical areas. Thus, it can be said that the prevalence data previously reported in the literature regarding *N. legeri* are similar to those found in the

present study. On the other hand, *Peniculistoma mytili*, the second most prevalent parasite in this study, had an annual prevalence of 6.72%, similar to that of 7.7% reported by Holodkovskaya (1989) but different from the prevalence values of up to 100% reported by Gaevskaya (2006) on the shores of Crimea and the Caucasus. Considering *P. mytili* to be a direct parasite, differences in prevalence values in different areas could be the result of the differences in sampling areas both geographically and ecologically.

The turbellarian *Urastoma cyprinae* has a wide distribution area, having been recorded in several bivalve species (http://www.pac.dfo-mpo.gc.ca/science/species-especes/shellfish-coquillages/diseases-aladies/pages/mgtmu-eng.htm; http://www.pac.dfo-mpo.gc.ca/science/species-especes/shellfish-coquillages/diseases-maladies/pages/ogtoy-eng.htm). It has also been recorded from the cultured and natural beds of *M. galloprovincialis* from the Black Sea (Holodkovskaya, 1989, 2002; Murina and Solochenko, 1991). In our study, this parasite presented an annual prevalence of 6.32%. Holodkovskaya (1989) reported an annual presence of 12.4% in the northwestern part of the Black Sea, whereas Santos and Coimbra (1995) reported 32%–70% in *M. edulis* and Francisco et al. (2010) reported 39% in *M. galloprovincialis* at the same locality in Portugal, contrasting with the results of our study and that of Holodkovskaya (1989), where a low prevalence value was considered a possible result of a sampling area with lower salinity.

The trematode *Parvatrema duboisi* has been reported in *M. galloprovincialis* from the coast of the Black Sea (Holodkovskaya, 1989, 2002, 2003; Gaevskaya and Machevsky, 1995; Popov et al., 2010). In our study, this parasite presented an annual prevalence of 4.54% at all sampling sites, whereas Holodkovskaya (1989) reported an annual presence of 0.1% in the northwest of the Black Sea. Holodkovskaya (2003) also reported in her review that infection prevalence values ranged between 0% and 100% on different Black Sea shores of several countries with different ecological conditions. It has been shown that in an inshore zone polluted by sewage the prevalence and metacercariae of *Parvatrema duboisi* in mussels increase sharply (Machevsky and Trinitko, 1985). The reasons for this involve not only an increase in the concentration of sea birds, the definitive hosts of *P. duboisi*, in the vicinity due to an abundance of food, but also the weakened physiological condition and concomitant decrease in the resistance of the mussels themselves (Gaevskaya and Machevsky, 1995). *Parvatrema duboisi* was found throughout a 1-year period in the mussels collected from 1 of our 3 sampling stations located near a human settlement with a large aquatic bird population and our results clearly reflect the effects of ecological and biological factors on *P. duboisi* infections in *M. galloprovincialis*.

Polydora ciliata is a spionid polychaeta that excavates a U-shaped burrow that it lines with a tube composed of protein and sand grains (Dorsett, 1961) and infects bivalves. *Polydora ciliata* has been reported in *M. galloprovincialis* from the Black Sea coast (Holodkovskaya, 1989, 2002, 2003). In our study, this parasite had an annual prevalence of 4.54%, whereas Holodkovskaya (1989) reported an annual presence of 0.8% in the northwest of the Black Sea and Buck et al. (2005) reported very low infection prevalence values ranging between 0.8% and 1.9% in *M. edulis* on the German Bight in the North Sea. It has been shown to reduce shell strength and to increase crab predation pressure (Kent, 1981; Buschbaum et al., 2007). Despite the low overall infection value determined in this study, we can speculate that *P. ciliata* could be one of the reasons for the decrease observed in the local mussel harvest in recent years.

In conclusion, this research on the parasite fauna of *M. galloprovincialis* is the first conducted on Turkish coasts of the Black Sea. It yielded 5 species and all are new records for the Turkish parasite fauna. The authors think that the results obtained here will provide the basis for further scientific studies on mussels.

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