Microbial and parasitic threats to proteus

Mikrobna in parazitska ogroženost močerila

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Although proteus encounters various microorganisms and parasites in its natural environment, the records on them are scarce, while the only comprehensive work on the topic dates to over half a century ago (Vandel et al. 1965). The known data on specialized parasites comprise the protozoan *Chloromyxum protei* described in kidney channels (Joseph 1905) and the trematode *Plagioporus protei* (Prudhoe 1945) found in the small intestine of proteus, while the records on other parasites are less specific. These include an unidentified trematode found in the digestive tract (Matjašič 1956), monogenean flatworms and ciliate protozoans attached to its outer surface (Sket B., personal communication) and encysted nematodes in the pancreas (Schreiber 1933). The peritoneal cavity and gut lumen are commonly colonized by free-living nematodes (Fig. 1), while several other peculiar parasites in various developmental stages were observed in kidneys, liver and in the gut wall (Fig. 2). Despite frequent occurrence of parasites in their tissues, the parasitized proteus individuals remain in good shape, indicating the effectiveness of its defensive mechanisms and the ability to cope with naturally occurring parasites and pathogens.

On the other hand, animals kept in artificial or semi-natural environments for scientific, exhibition or recovery purposes (Aljančič et al. 2016) appear prone to opportunistic microbial infections. Among others, these include the infections of the outer surface with oomycoete water molds from the genus *Saprolegnia* sp. (Kogej 1999), black yeasts and amoebae (Gunde Cimerman, unpublished data). The most frequent bacterial etiological agent implicated with the opportunistic infections of proteus in captivity is *Aeromonas hydrophila*,

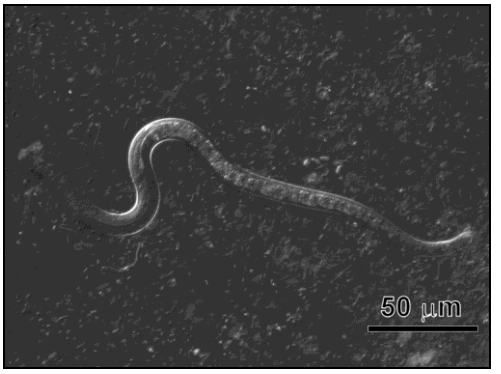

Figure 1. Nematode in the gut content of proteus from Stobe cave (photo: R. Kostanjšek).
Slika 1. Glista v črevesni vsebini močerila iz jame Stobe (foto: R. Kostanjšek).

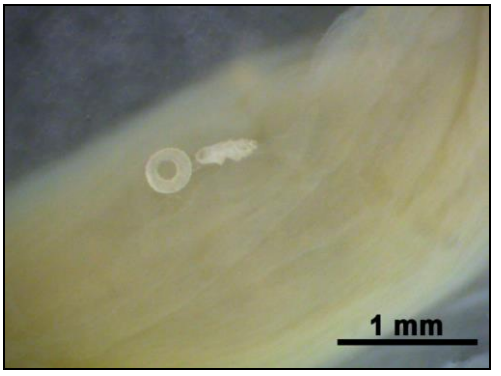

Figure 2. Unknown parasite with ring-shaped adhesion structure on the gut surface of proteus from Planinska jama (Photo: L. Bizjak Mali).
Slika 2. Nepoznani parazit z obročasto pritrjevalno strukturo na površini črevesa močerila iz Planinske jame (foto: L. Bizjak Mali).

causing dermatosepticemia or »red leg syndrome«, a generalized systemic bacterial disease associated with cutaneous erythema and hemorrhagic changes of the other tissues (Densmore & Green 2007). In addition, various fungi and oomycetes were identified in the outer jelly coat of proteus eggs laid in captivity (Zalar et al. 2016). The increased susceptibility of proteus to pathogens and parasites in controlled conditions simulating its natural environment indicates the sensitivity of its immune system even to moderate stressors. In that view, we can only speculate on proteus susceptibility to pathogens under constant

pressure of pollutants and other stressors in their natural environment (Bulog 2007).

Beside the factors compromising their defensive mechanisms, newly introduced pathogens pose yet another threat to native amphibians, including proteus. Among the wide array of etiological agents of amphibian diseases, the most severe threat to amphibian diversity on the global scale is currently posed by chitrydiomycosis, a lethal disease caused by chytrid fungi from the genus *Batrachochytrium*, and viral infections caused by ranaviruses from the family Iridioviridae (Densmore & Green 2007, Latney & Klaphake 2013). These two highly virulent pathogens are held responsible for the global decline and extinction of several hundred amphibian species (Latney & Klaphake 2013). Despite their severity and rapid spread throughout Europe, the fungal and viral threat to native amphibians in Slovenia, including proteus, is far from being appropriately monitored, although their possible introduction to the underground water systems of the Dinaric Karst could be devastating for entire proteus populations.

In conclusion, aside to newly emerged and highly virulent microbial pathogens, the most severe pathogenic threat to proteus is most probably related to pollution and other changes in the subterranean waters that potentially compromise the immune response of proteus and its innate ability to cope with the parasites and pathogens in its natural environment.

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