Salvaging the washed-out *Proteus*

Reševanje izplavljenih človeških ribic

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As a stygobiont, the olm, *Proteus anguinus*, is restricted to its subterranean aquatic habitat. Occasionally, during the night, it may appear in springs close to cave entrances (Bressi et al. 1999). However, during seasonal flooding, some individuals get washed-out onto the surface, far from their subterranean environment. The earliest description of this phenomenon was presented already by Janez V. Valvasor in the 17th century (Valvasor 1689). In one of the classic books on Slovene karst written by Franc A. Steinberg, another such case was attributed to fisherman Primož Ziherle, who caught five white animals from the flooded Planinsko polje in 1751 (Steinberg 1758); these animals were subsequently recognised as *Proteus*. Until the early 19th century, collecting washed-out *Proteus* was the only way to obtain fresh specimens for studies, and has later revealed many new localities (Aljančič & Năpăruş 2012).

While being flushed downstream during floods may in fact be part of natural history of *Proteus* as a rare chance to disperse into new habitats (Franci Kljun, pers. comm.), the fate of stranded individuals is quite predictable as the odds to re-enter the underground and thus to survive are minimal. The washed-out animals are often deposited in temporarily flooded fields: when exposed to sunlight, being without pigment, their skin suffers severe sunburns and desiccation. In winter, they may be exposed to low temperatures, hence serious chilblains were documented. In extreme cases they may survive for up to several months, as long as high waters persist; some *Proteus* already developed dark brown skin pigment (Freyer 1846). However, after the high groundwater retreats, many *Proteus* fail to find their way back into the karst underground and eventually die. Others may be carried further into surface streams where they are effectively preyed upon by fish, birds or other predators (Aljančič et al. 2014).

Figure 1. Washed-out *Proteus* exposed to freezing air (Kljunov ribnik, Pivka, Slovenia, 28. 12. 2008; photo: Gregor Aljančič).
Slika 1. Izplavljena človeška ribica izpostavljena ledeno hladnemu zraku (Kljunov ribnik pri Pivki, Slovenija, 28. 12. 2008; foto: Gregor Aljančič).

Seasonal flooding has probably been an important selective force in the evolution of *Proteus* behaviour. We presume that *Proteus* has evolved several responses to reduce the danger of being washed out of its subterranean habitat as well as adapted its feeding and reproduction strategies (Aljančič & Prelovšek 2010). Due to the extreme lifespan of *Proteus* (estimated to around 100 years in captivity) on the one hand and long reproduction cycles (approx. every 7 years in captivity; Aljančič, pers. comm.) on the other, loss of every individual may considerably reduce the size of its population. A concern is raised on how this species might respond to unpredictable effects of climate change, which may include changes in timing, frequency and magnitude of flood events (Aljančič & Năpăruş 2011).

From 1964 onwards, the Tular Cave Laboratory has served as occasional sanctuary for the washed-out or injured *Proteus,* and until 1993 all such animals were permanently kept in asylum. Researchers at the Tular Cave Laboratory have been closely studying this phenomenon since 2008, and documented nearly thirty cases in Slovenia and Bosnia and Herzegovina. All animals were found by chance after reported by local people. Through this research we unexpectedly

became involved in a rescue mission: seventeen of these animals were salvaged and returned to their source population. Veterinary inspection and animal care is conducted in partnership with the sanctuary for protected wildlife animals Golob d.o.o. Since 2013, Tular Cave Laboratory has again served as a sanctuary for injured *Proteus* and is now involved in the national network of sanctuaries for protected wildlife animals in Slovenia, under auspices of the Slovenian Environment Agency.

It is important for a sanctuary to have a precise action plan for rescuing the animals, providing first aid and treatment in controlled semi-natural conditions of the Tular Cave Laboratory in which animals are subjected to minimum stress and provided with optimal care. In case of the most rare and threatened black *Proteus* (*Proteus anguinus parkelj*), such service is particularly needed.

After being informed about a washed-out *Proteus*, we carefully examine and document (e.g., photograph and measure, skin-swab, etc.) the animal and then prepare it for transport in a container. The circumstances of the find and its location are also documented. The animal is kept in a quarantine tank at Tular Cave Laboratory, where it is clinically examined and treated if necessary. Quarantine is an essential part of the procedure, preventing uncontrolled transmission of disease to healthy populations. Handling of each specimen is documented; three months is the maximum period allowed by the Slovenian Environmental Agency to treat an animal in the sanctuary. After successful rehabilitation the animal is returned into the wild.

When a washed-out individual is ready to be returned to nature, its source population must be accurately identified. Screening for DNA markers powerful enough to detect ongoing gene flow, such as micro-satellites and single-nucleotide polymorphisms (SNPs), should minimize the danger of genetic mixing (Aljančič et al. 2014; compare Trontelj & Zakšek 2016). An accurate GIS distribution model (integrated georeferenced information on known *Proteus* localities, directions of groundwater flow, patterns of genetic variability of *Proteus* within the complex karst landscape, etc.) should guide the return of washed-out individuals to their source population. Researchers at the Tular Cave Laboratory have developed a method of detection of traces of *Proteus* environmental DNA in groundwater (see Stanković et al. 2016, Gorički et al. 2016) in order to efficiently survey *Proteus* distribution. However, this method can also be applied to identify which *Proteus* population is harbouring a potential release site (water cave or karst spring in the area where the washed-out *Proteus* was found).

If the washed-out individuals cannot be returned directly to their source population due to local inaccessibility of its subterranean habitat (e.g., no caves accessible to man, dry intermittent karst springs, etc.), these animals should be kept permanently for research, education or *ex situ* breeding program.

Researchers of the Tular Cave Laboratory put considerable effort into education and constant public promotion of *Proteus*, emphasizing its vulnerability and karst groundwater conservation issues. Besides addressing the general public, the Laboratory particularly focuses on nature conservation education in schools and local communities where *Proteus* is present. Through a program of regular lectures and education campaigns, designing local natural heritage information facilities, publishing leaflets and documentary films (Aljančič et al. 2015), the phenomenon of washed-out *Proteus*, instructions if finding washed-out *Proteus*, and the mission of the sanctuary are explained.

A case of good practice is the protected Texas blind salamander (*Eurycea rathbuni*), a species found in a few springs or artesian wells in San Marcos, Texas. There, washed-out individuals are collected for the purpose of a successful captive breeding program at the San Marcos National Fish Hatchery and Technology Center. To date, however, no individuals have been returned back to the wild (Andy Gluesenkamp, pers. comm.).

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