Taxonomy and genetics

Last of its kind: Danubian lacustrine brown trout (*Salmo trutta*)

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Brown trout (*Salmo trutta*), native to Europe, North Africa and parts of Asia, has been introduced to various regions worldwide due to human-mediated translocations. This has resulted in the establishment of populations across all continents, except Antarctica, demonstrating the species' extraordinary adaptability and phenotypic plasticity. This ability to adapt to diverse aquatic environments and colonize new habitats is mirrored in the plethora of life histories a brown trout can adopt. Within lakes, brown trout gradually develop distinct characteristics over generations, adapting to lacustrine conditions and forming what is known as a lacustrine ecotype. The Danubian phylogenetic lineage of brown trout, native to Europe's largest river system, is renowned for producing large lacustrine individuals that historically thrived in Alpine lakes and supported local food needs. Regrettably, unfavourable management practices, introductions of non-native strains, and anthropogenic habitat degradation over the past century have likely led to the extinction of these iconic lake dwellers in their pure form.

To investigate the genetic composition and origins of potentially remnant Danubian lacustrine brown trout, we focused on populations inhabiting lakes Bled and Bohinj in Slovenia. Using microsatellite and mitochondrial DNA analysis on 365 specimens, we evaluated their genetic diversity and structure, comparing them to potential source populations. Additionally, low-coverage whole-genome sequencing was conducted to pinpoint genomic regions differentiating lacustrine and riverine populations and revealing signs of adaptation. Our findings revealed distinct genetic profiles between the two lake populations. Bohinj trout closely aligned with the native Danubian lineage, making it the last known population of non-hybridized Danubian lacustrine brown trout. In contrast, Bled trout displayed a hybrid composition with extensive influence from introduced Atlantic strains. The origin of the alien trouts was traced to Denmark and the most likely scenario for the formation of the hybrid swarm is discussed. These results highlight the complex genetic consequences of human-mediated introductions and emphasize the challenges in conserving natural populations amidst such pressures. It is imperative to implement urgent, ecotype-specific conservation measures to safeguard the native genetic pool of the Bohinj trout. Strategies should prioritize preserving the genetic integrity of this locally adapted population by restricting non-native introductions, mitigating habitat disturbances, and recognizing ecotypes as distinct conservation units. This approach is essential to prevent further genetic dilution and ensure the long-term survival of these unique populations, which hold significant ecological and cultural value.