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SPECIAL ISSUE: INVASIVE FISHES

Trends in research on invasive fishes

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Species range expansion, linked directly or indirectly to human activity, is a well-recognised phenomenon, which strongly intensified in the 19th Century with the mass migrations of people between continents. This trend continued in the 20th Century when international trade and the transport of people and goods greatly accelerated. Initially the negative effects of deliberate and accidental introductions of alien species were not fully recognised. One of the first insightful works on the subject was the book by the famous British ecologist, Charles Elton, "The Ecology of Invasions by Animals and Plants", published in 1958. In the 1980s the Scientific Committee on Problems of the Environment (SCOPE) focused on the causes, impacts, and management of invasions, but a breakthrough came after 1992 when, during the United Nations Conference on Environment and Development (UNCED), also known as the Rio de Janeiro Earth Summit, biological invasions were identified as one of five threats to biodiversity (Meyerson & Simberloff 2021). The Convention on Biological Diversity, Article 8, which was formulated at the Rio summit, committed signatory nations to prevent, control, and eradicate potentially harmful alien species. Following this event, the number of publications on biological invasions began to increase exponentially (Ricciardi & MacIsaac 2008, Richardson & Pyšek 2008). Understanding the causes of expansion, especially of an invasive nature, and the consequences for local biota stimulated a generation of researchers to undertake studies aimed at recognizing the principles and general patterns related to this problem (e.g. Lodge 1993, Moyle & Light 1996, Vitousek et al. 1996, Williamson & Griffiths 1996, Richardson & Pyšek 2008), and to develop a common, consistent nomenclature (Copp et al. 2005).

Among the vertebrates, fishes are a group that appear particularly prone to being invasive, while also extremely susceptible to the negative effects of introduced alien species. This group have consequently been the object of both theoretical and practical study on this subject (Casal 2006). Deliberate introductions of fish species have been justified both by a desire to improve (through biomanipulation) the quality of the environment (e.g. Asian herbivorous carps), or the enhancement or creation of commercial fisheries (brook trout, bullhead, gibel carp). In many cases, introductions were intended to lead to the economic improvement of local communities; e.g. Nile perch (Goldschmidt et al. 1993).

From an ecological and evolutionary perspective, introductions either intentional or unintentional, such as from accidental inclusion in stocking material and in ballast water, or migration through canals connecting previously isolated catchments, has provided an opportunity to study life-history traits that favour invasiveness and the establishment of self-sustaining populations in newly invaded areas (Erős 2005, Vila-Gispert et al. 2005, Olden et al. 2006, Garcia-Berthou 2007, Grabowska & Przybylski 2015). In analysing biological invasions by fishes, researchers have also recognised its far-reaching consequences for local environments (Casal 2006).

The time-line of research on fishes as invasive taxa started with studies documenting first occurrences

of alien species and subsequent records tracking the expansion of their invasive ranges. These studies led to the analysis of biological traits associated with invasion success and to research aimed at understanding the interactions of invasive and local species. The study of the impact on native ecosystems has been complemented by the development of methods and protocols for assessing the risk and potential for invasion of non-native species on native species (especially endangered species) and ecosystem services, including in the context of climate change (Copp et al. 2016).

Given the prevalence, scale and diversity of the ecology of fish invasions, this Special Issue of *Journal of Vertebrate Biology* was assembled to focus on features related to: a) ecological, behavioural and physiological traits associated with successful invasion of fishes; b) biogeographical patterns of invasion; c) advances in our understanding of evolutionary responses to invasion; d) impacts of environmental change on habitat susceptibility to invasion; and e) the biotic and economic impacts of invasion, as well as mitigation measures to limit its impacts.

This Special Issue comprises 11 papers, with contributions from eight European countries and the USA, with a focus on the temperate zone, but also addressing tropical islands in the Pacific. Pleasingly, these contributions cover the key issues we recognised as most topical, such as the history of invasion and current distribution of invaders (Slovák Švolíková et al. 2021, Rakauskas et al. 2021), as well as reproductive traits of alien species associated with newly invaded regions (Dashminov & Puzunova 2021, Fuad et al. 2021). We were also delighted to receive studies focused on the life-history traits associated with invasive success of alien fishes, both in subtropical regions (Lawson & Hill 2021) and tropical Pacific islands (Walsh et al. 2021). The question of parasitic fauna exchange when invaders occupy a new area (Ondračková et al. 2021), as well as resource partitioning as the main reason for invasion success (Top-Karakuş et al. 2021), are also tackled. Thought-provoking results using an experimental approach to understand how habitat modification promotes invasive species in riverine fish communities is included (Roche et al. 2021), as well as a study on socioeconomic perceptions and policy regulation of non-native fish in the Balkans; an important global hotspot of biodiversity (Piria et al. 2021). Finally, a substantial review addressing control technologies for invasive carp species is included, which offers a suite of approaches that have great practical value in informing management programs for invasive fishes (Cupp et al. 2021).

In conclusion, we believe that the papers in this Special Issue offer a valuable snapshot of the current state of knowledge and research trends of the influence of non-native fish on invaded ecosystems, along with current ideas to explain the effects of their presence and of the measures available for limiting their negative impacts. We hope these papers will contribute to a better understanding of this key ecological problem, for which humans are largely responsible.

We would like to express our deep gratitude to the authors of all the submitted papers and thank them for their valuable contributions to furthering research on invasive fishes.

Literature

Casal C.M.V. 2006: Global documentation of fish introductions: the growing crisis and recommendations for action. *Biol. Invasions 8: 3–11.*

Copp G.H., Bianco P.G., Bogutskaya N. et al. 2005: To be, or not to be, a non-native freshwater fish? *J. Appl. Ichthyol. 21: 242–262.*

Copp G.H., Vilizzi L., Tidbury H., Stebbing P.D. et al. 2016: Development of a generic decision-support tool for identifying potentially invasive aquatic taxa: AS-ISK. *Manag. Biol. Invasions 7: 343–350.*

Cupp A.R., Brey M.K., Calfee R.D. et al. 2021: Emerging control strategies for integrated pest management of invasive carps. *J. Vertebr. Biol. 70: 21057. https://doi.org/10.25225/jvb.21057.*

Dashminov D.D. & Puzunova E.P. 2021: Reproductive biology of pioneer round gobies (*Neogobius melanostomus* Pallas, 1814) at the edge of their invasion front in three small rivers (Lower Danube Basin, Bulgaria). *J. Vertebr. Biol. 70: 21026. https://doi.org/10.25225/jvb.21026.*

Elton C.S. 1958: The ecology of invasions by animals and plants. *Methuen, London, UK.*

Erős T. 2005: Life-history diversification in the Middle Danubian fish fauna—a conservation perspective. *Arch. Hydrobiol. 16 (Suppl. 158, Large Rivers): 289–304.*

Fuad M.M.H., Vetešník L. & Šimková A. 2021: Is gynogenetic reproduction in gibel carp (*Carassius gibelio*) a major trait responsible for invasiveness? *J. Vertebr. Biol. 70: 21049. https://doi.org/10.25225/jvb.21049.*

Garcia-Berthou E. 2007: The characteristics of invasive fishes: what has been learned so far? *J. Fish Biol. 71 (Suppl. D): 33–35.*

Goldschmidt T., Witte F. & Wanink J. 1993: Cascading effects of the introduced Nile perch on the detritivorous/phytoplanktivorous species in the sublittoral areas of Lake Victoria. *Conserv. Biol. 7: 686–700.*

Grabowska J. & Przybylski M. 2015: Life-history traits of non-native freshwater fish invaders differentiate them from natives in the Central European bioregion. *Rev. Fish. Biol. Fish. 25: 165–178.*

Lawson K.M. & Hill E. 2021: Predicting successful reproduction and establishment of non-native freshwater fish in peninsular Florida using life history traits. *J. Vertebr. Biol. 70: 21041. https://doi.org/10.25225/jvb.21041.*

Lodge D.M. 1993: Biological invasions: lessons for ecology. *Trends Ecol. Evol. 8: 133–137.*

Meyerson L. A. & Simberloff D. 2021: The journal Biological Invasions evolves. *Biol. Invasions: https://doi.org/10.1007/s10530-021-02663-9.*

Moyle P.B. & Light T. 1996: Biological invasions of freshwater: empirical rules and assembly theory. *Biol. Conserv. 78: 149–161.*

Olden J.D., LeRoy Poff N. & Bestgen K.R. 2006: Life-history strategies predict fish invasions and extirpations in the Colorado River Basin. *Ecol. Monogr. 76: 25–40.*

Ondračková M., Janáč M., Borcherding J. et al. 2021: Non-native gobies share predominantly immature parasites with local fish hosts. *J. Vertebr. Biol. 70: 21050. https://doi.org/10.25225/jvb.21050.*

Piria M., Kalamujić Stroil B., Giannetto D. et al. 2021: An assessment of regulation, education practices and socio-economic perceptions of non-native aquatic species in the Balkans. *J. Vertebr. Biol. 70: 21047. https://doi.org/10.25225/jvb.21047.*

Rakauskas V., Virbickas T. & Steponėenas A. 2021: Several decades of two invasive fish species (*Perccottus glenii*, *Pseudorasbora parva*) of European concern in Lithuanian inland waters; from first appearance to current state. *J. Vertebr. Biol. 70: 21048. https://doi.org/10.25225/jvb.21048.*

Ricciardi A. & MacIsaac H.J. 2008: The book that began invasion ecology. *Nature 452: 34.*

Richardson D.M. & Pyšek P. 2008: Fifty years of invasion ecology – the legacy of Charles Elton. *Divers. Distrib. 14: 161–168.*

Roche K., Šlapanský L., Trávník M. et al. 2021: The importance of rip-rap for round goby invasion success – a field habitat manipulation experiment. *J. Vertebr. Biol. 70: 21052. https://doi.org/10.25225/jvb.21052.*

Slovák Švolíková K., Ševove B., Križek P. et al. 2021: Tubenose goby – a discreet invader from the past goes higher. *J. Vertebr. Biol. 70: 21042. https://doi.org/10.25225/jvb.21042.*

Top-Karakuş N., Karakuş U. & Tarkan A.S. 2021: Niche segregation of a newly introduced invasive and co-occurring native fish species in a productive shallow lake (Manyas, NW Anatolia). *J. Vertebr. Biol. 70: 21043. https://doi.org/10.25225/jvb.21043.*

Vila-Gispert A., Alcaraz C. & Garcia-Berthou E. 2005: Life-history traits of invasive fish in small Mediterranean streams. *Biol. Invasions 7: 107–116.*

Vitousek P.M., D'Antonio C.M., Loope L.L. & Westbrooks R. 1996. Biological invasions as global environmental change. *Am. Sci. 84: 468–478.*

Walsh S.J., Nico L.G. & Miller M.W. 2021: Evaluating establishment success of non-native fishes introduced to inland aquatic habitats of tropical Pacific islands. *J. Vertebr. Biol. 70: 21064 https://doi.org/10.25225/jvb.21064.*

Williamson M. & Griffiths B. 1996: Biological invasions. *Springer Science & Business Media, Germany.*