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# Phenotypic and genetic variability of an invasive species within a meta-ecosystem: patterns and drivers

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## Abstract

The functional importance of intraspecific variability in modulating the ecological impacts of invaders on recipient ecosystems has been recently demonstrated. During the biological invasion process, environmental filters and selective forces act synergistically to shape intraspecific variability. Yet, our understanding of the historical and environmental drivers promoting this variability within and between invasive populations remains extremely limited. Here, we used a meta-ecosystem formed by a dynamic mosaic of heterogeneous freshwater ecosystems (artificial gravel pit lakes) colonized by a highly invasive species (red-swamp crayfish *Procambarus clarkii*) to i) first quantify phenotypic and genetic variability and ii) assess its potential drivers. Functional phenotypic variability was measured using body shape (geometric morphometric analyses) and trophic niche (stable isotope analyses:  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$ ), while genetic diversity was quantified using neutral markers (14 microsatellites). The role of environmental conditions (e.g. hydromorphology, predation, competition) and invasion history (e.g. ecosystem age, dispersion patterns) in shaping patterns of both phenotypic and genetic variability within and between populations was then tested. We first demonstrated that intraspecific variability was high, both within and between populations, and strongly influenced by the environmental and historical contexts. For example, we observed significant phenotypic variability within some invasive populations without any significant genetic differentiation between individuals inhabiting the littoral and pelagic habitats. We also demonstrated the existence of a genetic structuration ('isolation by distance') of invasive populations in the studied meta-ecosystem associated with the colonization history of the species. Finally, we found some associations between morphological and trophic traits related to resource exploitation that varied among populations, indicating a strong context-dependency of intraspecific variability among invasive individuals and their ecological impacts.

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