Variability of responses to multiple chemical stressors in the invasive mosquitofish and ecological consequences

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Résumé

Rapid adaptation to pollution in wildlife is still debated. In addition, the ecological impact of potential pollution-induced phenotypic divergence is still unknown. Recent studies document fish adaptation to dioxin like pollutants, but few empirical studies have been conducted in realistic multistress conditions. Indeed, chemical pollution in anthropized freshwater streams is characterized by a cocktail of chemicals including historical and emerging compounds at sub-lethal concentrations. In this study, we studied the phenotypic divergence of wild populations of the invasive mosquitofish (*Gambusia holbrooki*) exposed to multiple chemicals and their ecological consequences on ecosystems functioning, using a combination of field and laboratory approaches. First, we performed an extensive field study in 11 natural populations having evolved in contrasted pollution conditions in French rivers. We compared the phenotype and health of F0 fish living along gradients of chronic pollution to characterize pollution-induced phenotypic divergence. Second (2) we experimentally tested the survival of their F1 offspring exposed to a cocktail of pollutants mimicking natural pollution to compare their resistance in microcosms. Third (3) we studied the impacts of pollution-induced phenotypic divergence on ecosystems functioning, by comparing the ecosystem functioning among mesocosms containing fish of different origins. We hypothesized that increased tolerance to pollutants in fish living in polluted streams would be associated with: (1) no or moderate detrimental effects of chemical stressors on fish health, due to increased defense capacities (detoxication metabolism, antioxidant defenses), and (2) a higher resistance of F1 from polluted streams to an experimental exposure to a realistic cocktail of pollutants and (3) a differential impact on ecosystems functions depending on fish origin. Results from the field study show that (1) F0 fish from polluted sites had an increased biotransformation activity and a decreased non-enzymatic antioxidant capacity. In addition (2) their F1 offspring had a higher survival when experimentally exposed to a cocktail of pollutants, showing increased resistance to pollution. Third (3) the origin effects of these populations in mesocosm

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affected primary production (macrophyte growth). This study thus shows that environmentally realistic pollution can induce significant phenotypic divergence in natural populations, with cascading consequences for the functioning of aquatic ecosystems. Further studies are now necessary to investigate the underlying genetic and epigenetic mechanisms explaining this phenotypic divergence and their impacts on evolutionary trajectories in heterogeneous populations.

Mots-Clés: mosquitofish, pollution, tolerance, phenotype, mescocosms