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Of the large number of species that are introduced into novel habitats, few become successful as invaders. What allows some species to invade, when most cannot? We hypothesized that invasions into novel environments might involve the rapid and parallel evolution of genetically labile traits. Within the past century, the copepod *Eurytemora affinis* has invaded freshwater habitats multiple times independently from saline sources. To begin exploring genomic targets of selection during these independent habitat invasions, we integrated comparative gene expression analysis (using custom cDNA microarrays), quantitative genetic approaches, and physiological assays (ion efflux and uptake). We analyzed evolutionary shifts in transcription profiles and physiological function for (1) pairs of saline ancestral source and derived freshwater populations across four independent invasions from two genetically distinct clades, and (2) laboratory-selected lines, where saline populations from each clade were selected for freshwater tolerance in the laboratory. Our gene expression analysis revealed evolutionary shifts in the expression of genes spanning diverse functional categories, including osmoregulation, energy production, cell cycle regulation, protein synthesis, and stress response. In particular, shifts in gene expression and physiological function suggested mechanisms to reduce ionic loss rather than to increase ion uptake in the freshwater populations. In addition, a diverse array of genes showed parallel shifts in gene expression across multiple independent invasions, within and among genetically distinct clades and in the laboratory-selected lines. Greater parallelism occurred within each clade, with laboratory-selected lines following the pattern of wild freshwater populations within each clade. In some cases, differences between the clades were striking. This study revealed functional evolutionary shifts between ancestral saline and freshwater invading populations, and provided a pool of plausible candidate genes that might serve as the targets of selection. Some degree of evolutionary determinism was apparent across independent freshwater invasions, but particularly within clades. The evolutionary parallelism observed here might have relevance for taxonomically different but ecologically similar species that invade across similar habitat clines.