Larvae from deep-sea hydrothermal vents disperse in surface waters

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Larval dispersal significantly contributes to the geographic distribution, population dynamics and evolutionary processes of animals endemic to deep-sea hydrothermal vents. Benthic invertebrates with a pelagic larval period can be categorized as lecithotrophic or planktotrophic species. Among vent-animals, the former lecithotrophs generally disperse near the ocean floor while the latter planktotrophs have been considered to disperse in mid-water, above the influence of a hydrothermal plume.
However, surprisingly little is known as to the extent that the planktotrophic larvae migrate vertically to shallower waters to take advantages of richer food supplies and strong currents. Here, we first provide converging evidence from the taxonomy, phylogeny, population genetics, physiology and behaviour of the species of Shinkailepadinae (Gastropoda: Neritimorpha) for their vertical migration as long-lived planktotrophic larvae from deep-sea hydrothermal vents to the surface water.
Sixteen species were identified from global hydrothermal vent fields and cold methane seeps as the extant members of the subfamily. They generally show wide distribution ranges with their panmictic population structure. The culture experiments of larvae of the vent-endemic *Shinkailepas myojinensis* strongly suggested that their larvae grow and disperse in the surface water for an extended period of time. The oxygen isotopic analyses of the larval and adult shells of three *Shinkailepas* species, which is the first attempt for vent-endemic taxa, perfectly supported the vertical migration of larvae as an obligatory part of the species' life cycles. All settled juveniles collected from hydrothermal vent fields were found to have experienced the warm surface water during their larval period. Lastly, the geographic distributions and genetic population structures of four planktotrophic species of the shrimp family Alvinocarididae suggested that the vertical larval migration of vent animals can well be a widespread phenomenon, at least for those with planktotrophic early development.
Based on the new evidence and exploration of previous literature, we propose that the sea surface temperature represents a critical factor in determining the geographic distribution of many deep-sea vent endemic species with a planktotrophic early development. This finding sheds new light on the connectivity between photosynthetic and hydrothermal-vent ecosystems and has direct implications for the biogeography and evolution of vent faunas.

Keywords: Biogeography, early-life history, larval dispersal, vertical migration, SST

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