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Elemental fingerprints of mollusk larval shells can help estimate population connectivity in deep-sea hydrothermal vent systems

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As natural deposits of metals and rare earth elements, deep-sea hydrothermal-vent sites have been identified by mining companies as potential sources for exploitation ventures. Hydrothermal-vent fields are ephemeral and patchy environments, which means that their endemic communities depend critically on larval dispersal for resilience and colonization of new sites. The impact of deep-sea mining on these ecosystems has yet to be determined, in particular on population connectivity, which is a major knowledge gap in deep-sea environments.

We explore for the first time the potential of elemental fingerprinting of larval shells for connectivity assessment in the deep-sea. This first requires to find enough geographic heterogeneity in the chemical measurement of individual minute-size larval shells, in order to determine reference compositions that would be specific to each potential natal site over a wide area. In a second step, the elemental fingerprint of the preserved larval shell of a juvenile after dispersal could be compared with these references to determine the geographic origin of individuals.

Here, we present results from the first step of this approach, based on 600 shells of encapsulated larvae of the gastropod *Shinkailepas tollmanni* collected from 14 hydrothermal sites in the Southwest Pacific, spanning over 3,500 km. Our data indicate that the larval shells exhibit an elemental composition sufficiently contrasted to discriminate their geographic origin. Using classification methods, we obtain a 70% accuracy in the assignment of the larvae to their true origin between all sites. By integrating results from other indirect methods (larval transport modelling and population genetics) that restrict dispersal to smaller regions, we obtain a higher classification success within these regions (77.1-86.5%).

The next step is now to collect juvenile specimens, in order to determine the elemental fingerprint of their pre-dispersal larval shell and assess their natal site with the aim to estimate the proportion of self-recruitment and potential of recovery of the targeted sites.

Our study indicates that elemental fingerprinting is a promising method to assess connectivity in deep-sea hydrothermal-vent settings, and therefore the impact of habitat destruction by mining on the resilience of their associated faunas.