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CO_2-threats to metamorphosing larvae: a proteomics perspective

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Oysters, barnacles and tube-building polycheates are commercially important coastal species and have a complex life cycle, during which the swimming (pelagic) larvae must select a suitable substrate, attach to it, and then metamorphose into benthic adults. Natural environmental change and anthropogenic activities, i.e. rising CO_2, have resulted in a fluctuating and variable carbonate chemistry or ocean acidification (OA), which has the potential to greatly influence the success of this key metamorphic transition by potentially affecting both appropriate shell biomineralization events and physiology. Calcifying larval species may suffer more in this century as carbonate ions continue to decrease and the critical question of how this rising CO_2 might affect their key developmental, physiological, biomineralization and molecular processes remains largely unaddressed. Recently, a few larval biologists, in collaboration with molecular biologists and material scientists, have begun to address this question. In this talk, I will briefly review those literatures and unpublished results from our group. According to ours and others recent results, OA appears to disturb fast-growing larvae thereby poses a threat to their survival by affecting their timing and choice of attachment and accelerated growth afterwards. In such scenarios, stressed larvae tend to uptake more $CaCO_3$, which may impose significant costs. Using a proteomic (the large-scale study of proteins expressed by a genome) approach, we have tested the hypothesis that elevated CO_2 could alter the expression of calcification-related proteins. Using this modern tool and approach, we examined, for the first time, the larval proteome response to high-CO_2 stress. The larval proteome is plastic and capable of change in response to CO_2 stress. Our ongoing interdisciplinary (larval biology, environmental proteomics and biomineralogy) collaboration have started helping us to examine the mechanism(s) whereby changing estuarine carbonate chemistry will enable us to study, for the first time, larval metamorphosis and biomineralization in the biofouling and aquaculture species in natural as well as conditions projected to be imposed on them by global upcoming environmental changes and CO_2 emissions. In the end, I also show that some of the challenging OA questions could be answered if we integrate the rapidly advancing molecular, crystallographic and, OA perturbation technologies with traditional larval biology assays in this era of multidisciplinary collaboration.