ID: W2801643971

TITLE: Effects of hypoxia on metabolic functions in marine organisms: Observed patterns and modelling assumptions within the context of Dynamic Energy Budget (DEB) theory

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ABSTRACT:

Hypoxia is a decrease in dissolved oxygen that causes physiological disturbances in marine fishes and invertebrates, including reduced mobility, growth rate and reproductive success, altered phenology and increased vulnerability to diseases. Under pressure from global changes such as warming or eutrophication, ocean and coastal ecosystems worldwide are becoming less oxygenated. In order to better understand the consequences of hypoxia on marine systems, there is a need for predicting hypoxia-induced changes from individual organisms to populations. By combining the effect of several stressors on species metabolic performances and life-history traits across their full life-cycle, the Dynamic Energy Budget (DEB) theory offers a suitable framework for studying the consequences of hypoxia on marine organisms and to envision an upscaling of these effects at population level through individual-based modelling approaches. Here, we propose a set of stylized biological facts which give a broad generalization of the effects of hypoxia on metabolic functions based on empirical findings. We used these stylized facts to derive assumptions on how to incorporate the effects of hypoxia on marine organisms in the framework of the DEB theory. We then validate some of these assumptions on marine species for which experimental datasets under hypoxic conditions and DEB parameters were available. We discuss the main issues that need to be dealt with, such as the various time-scales, ontogenic responses and multi-stressor effects which appear now as important targets of investigation for studying the effect of hypoxia on marine organisms.

SOURCE: Journal of sea research

PDF URL: None

CITED BY COUNT: 34

PUBLICATION YEAR: 2019

TYPE: preprint

CONCEPTS: ['Hypoxia (environmental)', 'Biology', 'Marine ecosystem', 'Ecology', 'Marine invertebrates', 'Eutrophication', 'Population', 'Ecosystem', 'Ocean acidification', 'Stylized fact', 'Context (archaeology)', 'Climate change', 'Environmental science', 'Oxygen', 'Chemistry', 'Paleontology', 'Demography', 'Macroeconomics', 'Organic chemistry', 'Sociology', 'Nutrient', 'Economics']