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Bathymetric and interspecific variability in maternal reproductive investment and diet of eurybathic echinoderms ☆

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ABSTRACT

While conditions in shallow-water and deep-sea environments differ markedly, it remains unclear how eurybathic species adapt their life histories to cope with these changes. The present study compared indicators of maternal reproductive investment of three common echinoderms collected shallower than 20 m and deeper than 850 m: *Cucumaria frondosa* (Holothuroidea), *Solaster endeca* and *Henricia sanguinolenta* (Asteroidea). Depth-specific and species-specific differences were found in gonad indices (GI), potential fecundity, oocyte size frequency, as well as lipid classes and fatty acids measured in gonad tissue and oocytes. The asteroids, *S. endeca* and *H. sanguinolenta*, exemplified the interspecific trade-off between size and number of oocytes: the former had fewer larger oocytes than the latter, with higher total lipid proportions in them. However, intraspecifically, larger oocytes found in deep specimens of *S. endeca* did not translate into lower fecundity but rather into a seemingly higher GI, indicating greater investment per oocyte without reducing fecundity. Oocytes were absent in specimens of *C. frondosa* sampled in deep water, suggesting delayed or impaired maturation at the limit of their depth tolerance. Analysis of *S. endeca* sterol proportions in gonads and oocytes across depths showed higher sterol input into oocytes in females from the deep. Gonads of *S. endeca* and *H. sanguinolenta* contained similar essential fatty acids, but showed significant differences in major fatty acids and some of the less dominant ones, indicating diet specificities. Analyses within *S. endeca* showed evidence of similar feeding mode (carnivory) at both depths, but suggested shifts in the diet or synthesis of fatty acids, presumably reflecting differences in available food sources and/or adaptations to their respective environments.

1. Introduction

A relatively large number of marine macrobenthic species are known to occur across a wide range of depths (Gage and Tyler, 1992), yet, only a few studies have been made on the adaptations that underlie this ability (e.g. Féral et al., 1990). Compared with surface waters, the deep sea below 200 m is generally colder and more saline; receives little or no sunlight and is characterized by a gradient of increasing hydrostatic pressure (Stein, 2007; Townsend et al., 2006). Differences in environmental conditions between the shallow sub-littoral and bathyal depths are likely to influence the life histories of eurybathic taxa, including various aspects of their reproduction. The ability of a species to colonize different environments, including the deep sea, follows a gradient from (1) areas where fully functional reproductive populations are maintained, to (2) the establishment of adult, but sterile, populations to (3) areas where larvae may occur but are unable to recruit (Bhaud, 2000). Food supply and temperature are among the key variables susceptible to modulate these reproductive processes (Giese et al., 1991; Mercier and Hamel, 2009).

A commonly studied effect of temperature on life-history traits is the inverse relationship between temperature and oocyte size (Moran and McAlister, 2009) initially documented by Thorson (1950) and Rass (1986). Thorson attributed the increased oocyte size to decreasing food availability with increasing latitude and depth, while Rass attributed the increased oocyte size to physiological changes in development due to temperature. Laptikhovsky (2006) hypothesized that colder temperatures induce a non-proportional deceleration of different oogenesis stages, leading to a larger species-specific oocyte size. At colder temperatures yolk accumulates in greater amounts, in excess of what is needed by the embryo/larva, and may continue to feed the juvenile after metamorphosis (Lawrence and McClintock, 1994). Colder temperatures also lower metabolic demands of poikilothermic organisms, allowing deep-sea taxa to allocate more energy

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Abbreviations: RPF, relative potential fecundity; OPF, overall potential fecundity

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