Oxygen-dependent asynchrony of embryonic development in embryo masses of brachyuran crabs

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Abstract

Among brooding species, passive and active means to provide oxygen to embryos can be observed. Among passive oxygen providers, lower oxygen availability in the center than at the periphery of embryo masses seems to delay development of inner embryos. We investigated the differences in patterns of oxygen supply to the periphery and the center of embryo masses in two active oxygen providers, the brachyuran crabs *Cancer setosus* and *Homalaspis plana*, and evaluated the consequences on: (1) the proportion of time that early- and late-stage embryos were exposed to low or high oxygen partial pressure (PO_2), (2) oxygen consumption of the embryos from the center (inner) and the periphery (outer) of the embryo mass at those PO_2levels that the embryos experience throughout development, and (3) development of inner and outer embryos. We found that oxygen availability in the embryo masses of brachyuran crabs exhibited dramatic contrasts between the periphery and the center during early development and that these differences decreased throughout embryonic development. These dissimilar patterns of oxygen availability produced differences in the proportion of the time that the embryos were exposed to high and low PO_2 levels throughout development. PO_2 affected oxygen consumption of the inner and outer embryos in the same fashion, but the oxygen demand of inner embryos was lower. Furthermore, development of inner embryos was delayed, in comparison to outer embryos of the same female. We suggest that the asynchrony in the development of inner embryos, in comparison to outer embryos, is due to oxygen limitation, since oxygen availability affects embryonic oxygen consumption. The differences between development of inner and outer embryos is relatively small, when compared to other marine invertebrates, probably because female crabs are able to adjust oxygen supply to the embryos according their needs, while passive oxygen providers are not. However, active oxygen provision may affect investment in reproduction. Our results could have important implications both on studies of larval development and survival and in understanding the life-history tradeoffs of aquatic invertebrates.