ID: W2511535371

TITLE: Hypoxia Tolerance and Metabolic Suppression in Oxygen Minimum Zone Euphausiids: Implications for Ocean Deoxygenation and Biogeochemical Cycles

AUTHOR: ['Brad A. Seibel', 'Jillian L. Schneider', 'Stein Kaartvedt', 'Karen F. Wishner', 'Kendra L. Daly']

ABSTRACT:

The effects of regional variations in oxygen and temperature levels with depth were assessed for the metabolism and hypoxia tolerance of dominant euphausiid species. The physiological strategies employed by these species facilitate prediction of changing vertical distributions with expanding oxygen minimum zones and inform estimates of the contribution of vertically migrating species to biogeochemical cycles. The migrating species from the Eastern Tropical Pacific (ETP), Euphausia eximia and Nematoscelis gracilis, tolerate a Partial Pressure (PO2) of 0.8 kPa at 10 °C (?15 µM O2) for at least 12 h without mortality, while the California Current species, Nematoscelis difficilis, is incapable of surviving even 2.4 kPa PO2 (?32 µM O2) for more than 3 h at that temperature. Euphausia diomedeae from the Red Sea migrates into an intermediate oxygen minimum zone, but one in which the temperature at depth remains near 22 °C. Euphausia diomedeae survived 1.6 kPa PO2 (?22 µM O2) at 22 °C for the duration of six hour respiration experiments. Critical oxygen partial pressures were estimated for each species, and, for E. eximia, measured via oxygen consumption (2.1 kPa, 10 °C, n = 2) and lactate accumulation (1.1 kPa, 10 °C). A primary mechanism facilitating low oxygen tolerance is an ability to dramatically reduce energy expenditure during daytime forays into low oxygen waters. The ETP and Red Sea species reduced aerobic metabolism by more than 50% during exposure to hypoxia. Anaerobic glycolytic energy production, as indicated by whole-animal lactate accumulation, contributed only modestly to the energy deficit. Thus, the total metabolic rate was suppressed by ?49-64%. Metabolic suppression during diel migrations to depth reduces the metabolic contribution of these species to vertical carbon and nitrogen flux (i.e., the biological pump) by an equivalent amount. Growing evidence suggests that metabolic suppression is a widespread strategy among migrating zooplankton in oxygen minimum zones and may have important implications for the economy and ecology of the oceans. The interacting effects of oxygen and temperature on the metabolism of oceanic species facilitate predictions of changing vertical distribution with climate change.

SOURCE: Integrative and comparative biology

PDF URL: https://academic.oup.com/icb/article-pdf/56/4/510/6758239/icw091.pdf

PUBLICATION YEAR: 2016

TYPE: article

CONCEPTS: ['Euphausia', 'Oxygen minimum zone', 'Oxygen', 'Hypoxia (environmental)', 'Biology', 'Biogeochemical cycle', 'Respiration', 'Oceanography', 'Animal science', 'Ecology', 'Botany', 'Chemistry', 'Crustacean', 'Geology', 'Organic chemistry']