Metabolism and Physiological Adaptations of Pelagic Copepods in the Northern Benguela Current Ecosystem

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Introduction

• Copepods play a key role in the marine ecosystem as a linkage between primary producers and higher trophic levels. Through vertical migration they contribute to the biological carbon pump by enhancing the vertical flux of organic matter from the euphotic zone to deeper layers.

• Respiration rates give an estimate of the copepods' metabolic demand and energy expenditure which helps to understand nutrient and carbon fluxes in marine ecosystems.

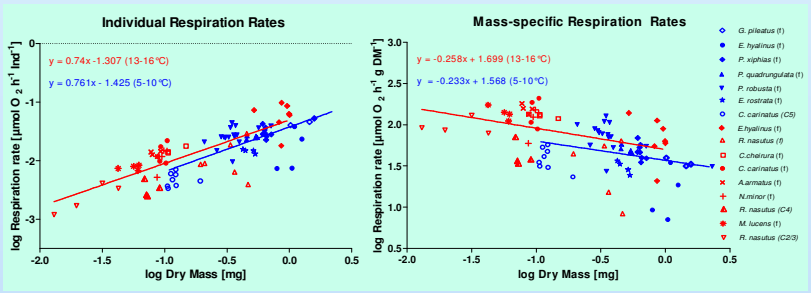
• Direct measurements of respiration rates of copepods in a controlled system provide information on their minimal energetic requirements. The respiratory electron transport system (ETS) assay was introduced as a biochemical measure of the potential metabolic rate to estimate plankton respiration. Data were collected during the GENUS cruise MSM 17/3 in February 2011.

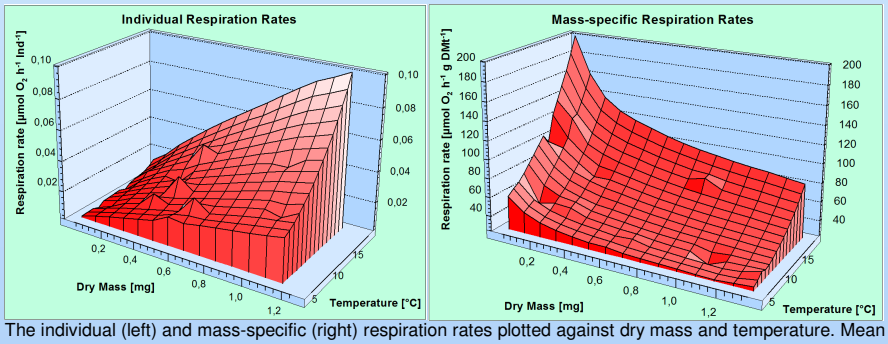
Results

• Individual respiration rates varied from 0.003 to 0.061 µmol O_2 h^{-1} Ind^{-1}, while mass-specific respiration rates were in the range of 17 to 157 µmol O_2 h^{-1} g DM^{-1}.

• Individual respiration rates increased significantly while mass-specific rates decreased with increasing body mass (p-values < 0.05).

• Temperature had a significantly positive effect on copepods' respiration. Q_{10} values varied from 2.0 to 6.8. Non-migrating, rather lethargic species as *Eucalanus hyalinus* and *Rhincalanus nasutus* showed the highest Q_{10} while the active vertical migrator *Pleuromamma quadrungulata* had the lowest.



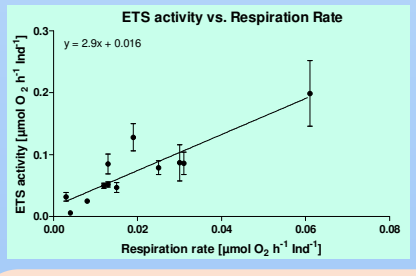


The individual (left) and mass-specific (right) respiration rates plotted against dry mass and temperature. Mean measured values at habitat temperatures were added to the model to see their deviation from calculated values.

• Combining the effect of temperature and body mass, a mathematical model was developed to predict copepods' respiration rates from these parameters.

• 67% of the variance of the individual respiration rates and 51% of the variance of the mass-specific respiration rates could be explained by differences in dry mass and habitat temperature.

• Using the allometric function of $R = a\ W^b$, where R is respiration and W is body mass, the scaling coefficient b was 0.728 and -0.272 for individual and mass-specific respiration rates, respectively.



• ETS activities ranged from 0.006 to 0.199 µmol O_2 h^{-1} Ind^{-1} and 14 to 125 µmol O_2 h^{-1} g WM^{-1} and were positively correlated with respiration rates (p-value < 0.0001).

• The ratios of respiration rates to ETS activities (R:ETS) varied between 0.1 and 0.6. Surface *R. nasutus* and deeper-living *E. hyalinus* exploited merely 10 and 16% of their potential metabolic rates for respiration. Diapausing copepodids C5 of *Calanoides carinatus* had severely reduced ETS activities.

Conclusions

• By means of R:ETS ratios, respiration rates may be estimated from ETS activities, although species- and depth-related differences need to be considered.

• Besides body mass and temperature, environmental conditions such as oxygen concentrations and vertical distribution as well as physiological and behavioural patterns like diel vertical migration, reproductive maturity and general activity play an essential role in influencing copepods' metabolism.

• The model represents considerable progress towards the goal of the GENUS project to parameterize consumption and energy requirements of copepods which helps to understand nutrient and carbon fluxes within the Benguela Current ecosystem. Collecting more metabolic data and including further independent variables such as oxygen or depth may increase its predictive accuracy.

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