Krill, an indicator: ecology, trophic position and adaptive capacity in three euphausiids of the Northern Benguela Ecosystem

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Introduction

Krill is a **pivotal component** of the Northern Benguela upwelling system and an important food source for top predators like fish, squid, birds and whales. Variation in krill biomass modifies the energy transport between lower and upper trophic levels and may have far-reaching effects on fish stock dynamics, e.g. of the horse-mackerel.

The short krill food chain facilitates the energy transport between lower and upper trophic levels. Despite the large biomass of euphausiids in Eastern Boundary Upwelling Ecosystems (EBUE), essential knowledge about their exact position in these ecosystems is still lacking. Euphausiids can play a **crucial role in OMZ** regions, such as the Northern Benguela Current, because some species tolerate very low oxygen concentrations. Within the GENUS sub-project 7 we investigate the **behaviour, abundance and eco-physiology** of dominant euphausiid species. **Growth and reproduction** of the most abundant species, *E. hanseni*, was related to seasonal upwelling events. In cooperation with GENUS co-workers Krill's trophic position is being identified.

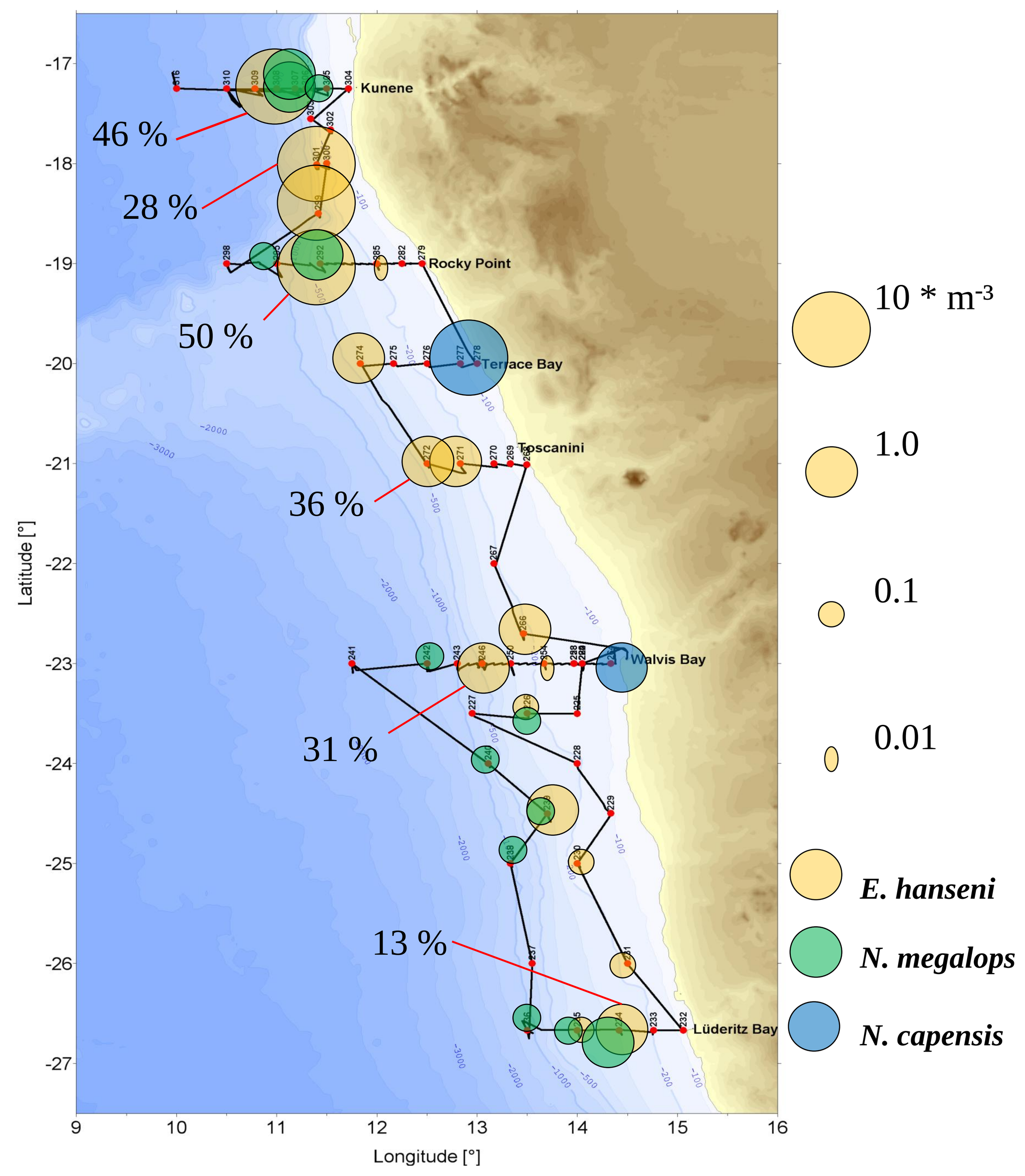

Fig. 1: Horizontal distribution of three euphausiid species and moult activity of *E. hanseni* during the MSM 17/3 cruise in February 2011.

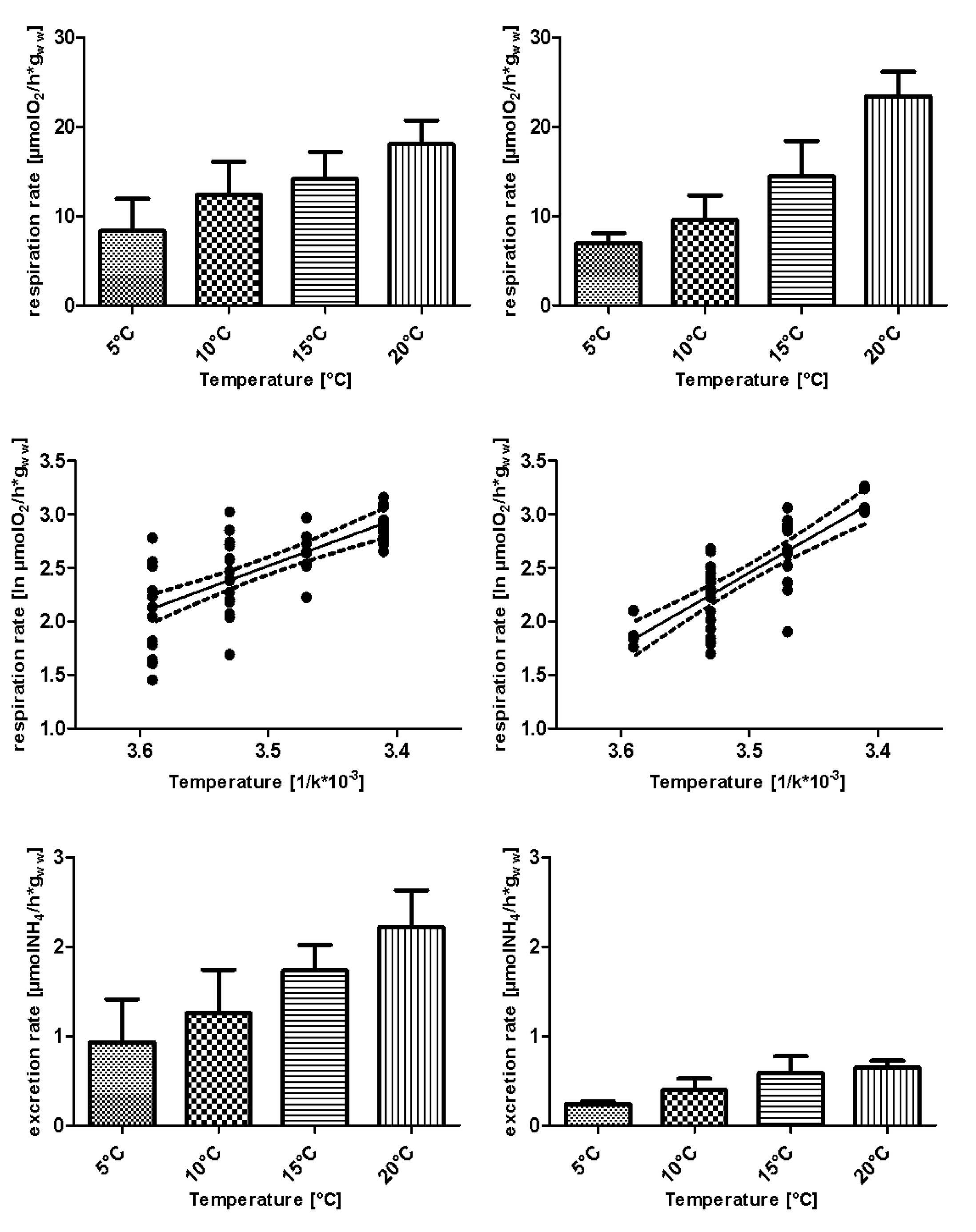

Fig. 2: Respiration rates [µmol O_2*h^{-1}*g_{ww}^{-1}], Arrhenius plot and excretion rates [µmol NH_4 *h^{-1}*g_{ww}^{-1}] of *E. hanseni* (left) and *N. megalops* (right) at 5, 10, 15 and 20°C

Results

The dominant krill species in the Northern Benguela ecosystem are *E. hanseni*, typical for the continental slope, *N. megalops* typically oceanic and *N. capensis* in the neritic zone. The horizontal distribution and productivity in terms of moult activity characterizing growth are highly variable and indicate a `**hot spot**` between 17,5 and 19°S during all cruises. Two cruises in austral summer 2009 and 2011 and one cruise during austral winter 2010 illustrate favourable trophic conditions throughout the year (Fig.1). In *E. hanseni* good food conditions – e.g. as an effect of an upwelling event - **kick-start** a synchronized moult (Fig. 1a) with coupled reproductive activity

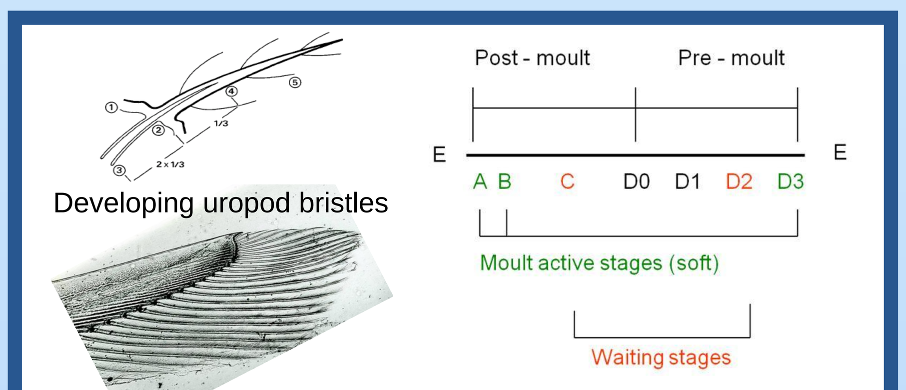

Fig. 1a: Stages of the moult cycle

Temperature strongly controls respiration and excretion rates in *E. hanseni* and *N. megalops*. The latter is more strongly influenced by increasing water temperatures with a concomitant lower overall excretion rate (Fig. 3). Q_{10} values of 1,8 for *E. hanseni* and 2,2 for *N. megalops* reveal **thermal adaptation** of both species to their *in situ* temperature range. For *E. hanseni* an average O/N ratio of 20 and for *N. megalops* of 57 was calculated, indicating different substrates metabolized. Estimated **carbon requirements**, as an index of minimum food consumption, indicate a lower demand in *N. megalops* compared with *E. hanseni* in relation to ambient temperatures (Fig. 3).

E. hanseni is the most pronounced vertical migrator (Fig. 4). In contrast, *N. megalops* does not cross the upper oxy- and thermoclines. In winter, during upwelling conditions, a different behavioural pattern emerges in *N. megalops* showing reverse DVM. This behaviour appears to be triggered by upwelling events, i.e. food availability while seasonal effects may be superimposed. A **model of energy transports** through DVM is being developed with SP 2.

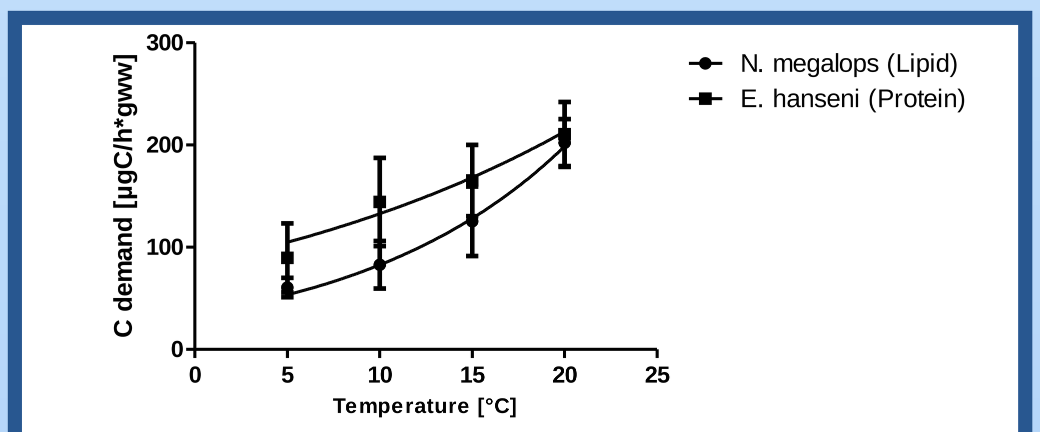

Fig. 3: Carbon demand of *E. hanseni* and *N. megalops*

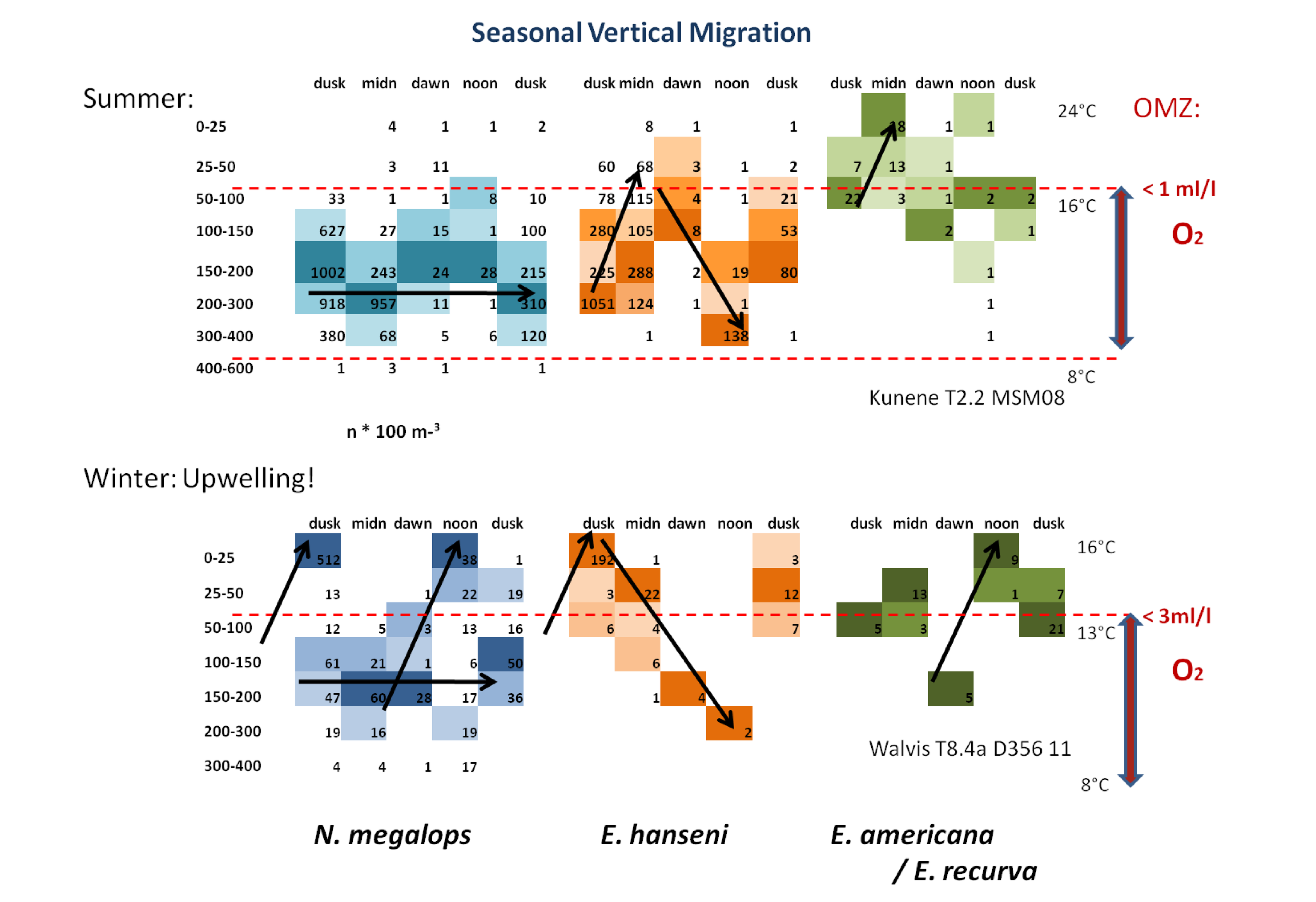

Fig.4: Vertical migration behaviour of 4 different krill species during austral summer and winter

Conclusions

→ **Primarily upwelling events rather than seasonality strongly influence the highly variable horizontal distribution of krill species within the Northern Benguela upwelling system.**

→ **Although their horizontal distributions largely overlap, the two dominant krill species are separated by their vertical migration behaviour and trophic position.**

→ **Favourable food conditions appear to modify the migration behaviour of euphausiid species. They use the OMZ as a refuge from predators during day-time.**

→ **The physiological performance of both species is closely adapted to their specific *in situ* temperature regime.**

→ **Krill species are indicators of different water masses**.