Early life history traits of coastal pelagic fish species in the northern Benguela upwelling system – advantage for Cape Horse Mackerel

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INTRODUCTION

The recruitment process is a bottleneck for the development of fish stocks and survival rates of the planktonic larval stages are generally low.

Influencing factors are hydrodynamic processes such as advection from favorable onshore feeding grounds, trophic interactions such as predation and starvation, and physiological constraints to environmental conditions.

The northern Benguela Upwelling System (nBUS) has experienced a regime shift from a "sardine-dominated" state until the 1970s to the present state where horse mackerel is the only coastal pelagic of greater economic importance.

Environmental factors that may have an influence on present stock sizes are: a warming of the system during peak spawning season, the expansion of oxygen minimum zones, a shift in the copepod community towards microcopepods, and increased predation pressure by jellyfish.

Here we compare **larval traits** of three coastal pelagic species - cape horse mackerel (*Trachurus capensis, TR*), anchovy (*Engraulis encrasicolus, EN*) and sardine (*Sardinops sagax, SA*)- and discuss **ecological implications** in relation to environmental changes in the nBUS.

RESULTS

Spatio-temporal distribution (Fig. 1)

- *TR, EN, SA*: highest densities during summer
- *TR:* most abundant and equally distributed
- *TR, EN:* spatially wider distributed than *SA*
- *TR,EN:* higher upper temperature limit than *SA*

Vulnerability for locally poor conditions (e.g. jellyfish)

→ reduced for *TR, EN* by wider spatial distribution

Intrusion of warm water from north

→ *TR, EN* less affected

Feeding ecology

- *TR, EN, SA:* diet based on copepod taxa → trophic level around 3
- *TR:* high feeding success and microcopepods (e.g. *Oithona)* important dietary components

Potential for prey competition

→ under food scarcity *TR* likely favored

Variation in plankton composition and shift to microcopepods

→ *TR* able to exploit varying zooplankton compositions

Nutritional condition

TR, EN, SA: generally higher during summer

SA: at very high larval densities during summer condition lower than during spring

food supply during low upwelling season

→ generally sufficiently high

→ food limitation possible at very high larval densities

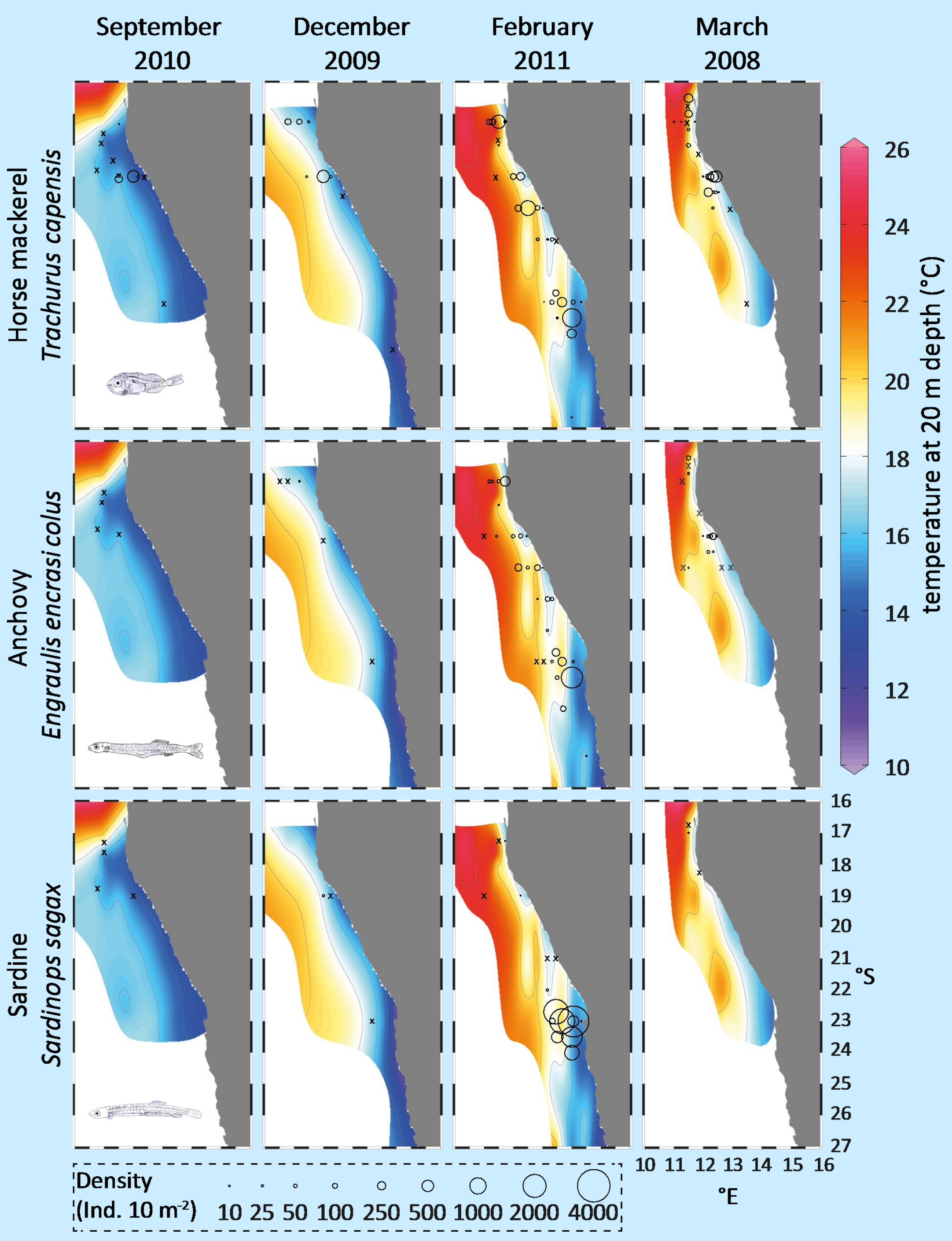

Figure 1 Larval densities (Ind. 10 m^{-2}) in Multinet hauls and water temperatures at 20 m depth (°C, colourbar index) during GENUS-cruises. Crosses indicate presence at stations without quantitative Multinet hauls

Energy demand

- *TR:* ontogenetic development of routine metabolic rate in larvae and juveniles from 0.001 - 20.8 g wet mass or 0.4 - 13.2 cm = $RMR_{18°C} = 0.418\ (\text{g wet mass})^{0.774}$

→ *TR* can fuel energy demand to a significant amount by microcopepods during the entire larval phase

Metabolic response to low O_2

- *TR:* juveniles: pO_2crit = 11% (at 20°C); larvae: no response in *RMR* until 30% $O_{2\ sat}$; anaerobic enzyme activity higher in *TR* than in *EN, SA* (Lactate dehydrogenase)

Hypoxia tolerance

→ *TR* tolerates short term hypoxia exposure

→ Maintenance potential of retention mechanisms changed under hypoxia? (Fig. 2)

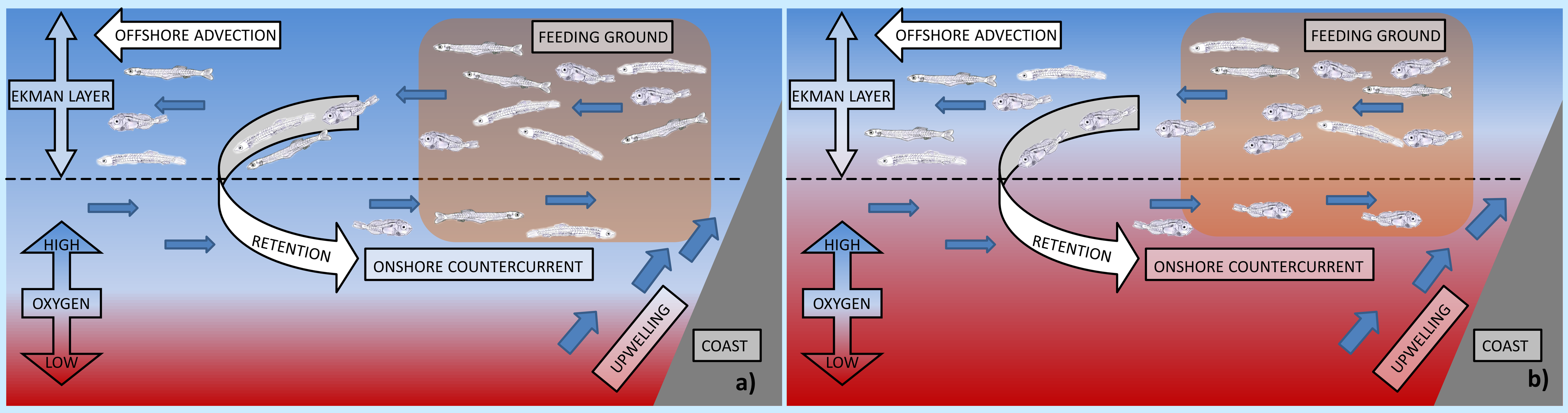

Figure 2 Hypothetical influence of hypoxia on larval retention potential a) normal situation: larvae of all species are able to enter onshore currents b) extended hypoxic zone: only hypoxia tolerant species (e.g. *TR*) are able to maintain this mechanism (based on vertical migration models of Sundby, Stenevik, Kjesbu - IMR Bergen)

CONCLUSIONS

TR larvae are more robust than *SA* and *EN* larvae and thus favoured by present environmental conditions.

Differences in larval traits influence recruitment success and by this can explain present stock size of the three species.

RELATED PUBLICATIONS

Ekau et al. 2010, BIOGEOSCIENCES 7: 1669-1699;

Geist et al. 2013, MAR BIOL 160: 3221-3232

Geist 2013, University Bremen, PhD thesis;

Geist et al. 2014, ICES JMS: in press

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