

THE TRANSFER OF ENERGY FROM PROTOZOOPANKTON TO LARVAL FISH IN A WARMING OCEAN

Protozooplankton (PZP) are small-sized (<200 µm), single-celled grazers (e.g. ciliates and heterotrophic dinoflagellates) that function as a trophic link between microbial and traditional food webs. PZP serves as an **abundant and high quality food** source for larger zooplankton and larval fish thus providing energy for higher trophic levels. The first days of external feeding of larval fish are considered as the critical days *sensu* Hjorts' (Hjort (1914)) **critical period hypothesis**, highlighting the pivotal role of PZP as food for larval fish (Montagnes, Dower et al. 2010).

With regard to global warming, a **potential mismatch** (Cushing 1975) between the availability of optimal prey items at sufficient quantities and the timing of consumers (e.g. larval fish) needs further consideration. In this context, enhanced growth of PZP and reduced time-lags between PZP and its algal food sources under elevated temperature conditions are expected to alter trophic pathways through PZP (Calbet and Saiz 2005, Irigoien, Flynn et al. 2005). Whether PZP in a warming ocean will act as a **trophic link** rather than a **trophic sink** with regard to energy transfer to larval fish highly depends on the **functional ecology of PZP** species. While e.g. ciliates serve as an optimal prey item for larval fish, toxic or inedible heterotrophic dinoflagellates (HABs) are likely to reduce **energy transfer efficiency** and subsequently fish larvae survival. Recent studies point at a reduced temporal occurrence of ciliates in the plankton at elevated temperature conditions while heterotrophic dinoflagellates seem to benefit from warming (Aberle, Bauer et al. 2012, Aberle, Malzahn et al. 2015). Such an enhanced occurrence of heterotrophic dinoflagellates is likely to cause 'trophic sink' situation in the plankton thus resulting in reduced larval fish condition and energy transfer efficiency in a warming ocean.

This project will focus on the link between PZP and larval fish under present and future ocean conditions. The aim is to relate **temperature-induced changes in PZP** (e.g. growth, biomass, timing, community composition and diversity) to **physiological and behavioural traits of larval fish** (e.g. growth, survival, fitness, respiration, metabolisms and behaviour). Especially the functioning of PZP as a 'trophic sink/link' and alterations in energy transfer within planktonic food webs will be considered in detail.

The following approaches will be addressed:

- (I) Routine field sampling campaigns (both land and research vessel based) in the Trondheim Fjord: Investigations on trophodynamic interactions between PZP and larval fish in the field and on potential match-/mismatch situations between predator and prey in relation to changes in abiotic conditions (e.g. temperature, nutrients).
- (II) Experimental set-ups (e.g. micro- and mesocosm experiments) simulating future warming conditions: Analyses on feeding preferences and consumption rates of post-hatched larval fish and on the impact of PZP quality and quantity (ciliates vs. dinoflagellates) on the growth, fitness, behaviour and survival of larval fish under different thermal conditions.