"This project is funded from Norway Grants in the Polish-Norwegian Research Programme operated by the National Centre for Research and Development"

Size-related response of zooplankton to various temperature regimes along latitudinal gradient from boreal to polar marine coastal ecosystems

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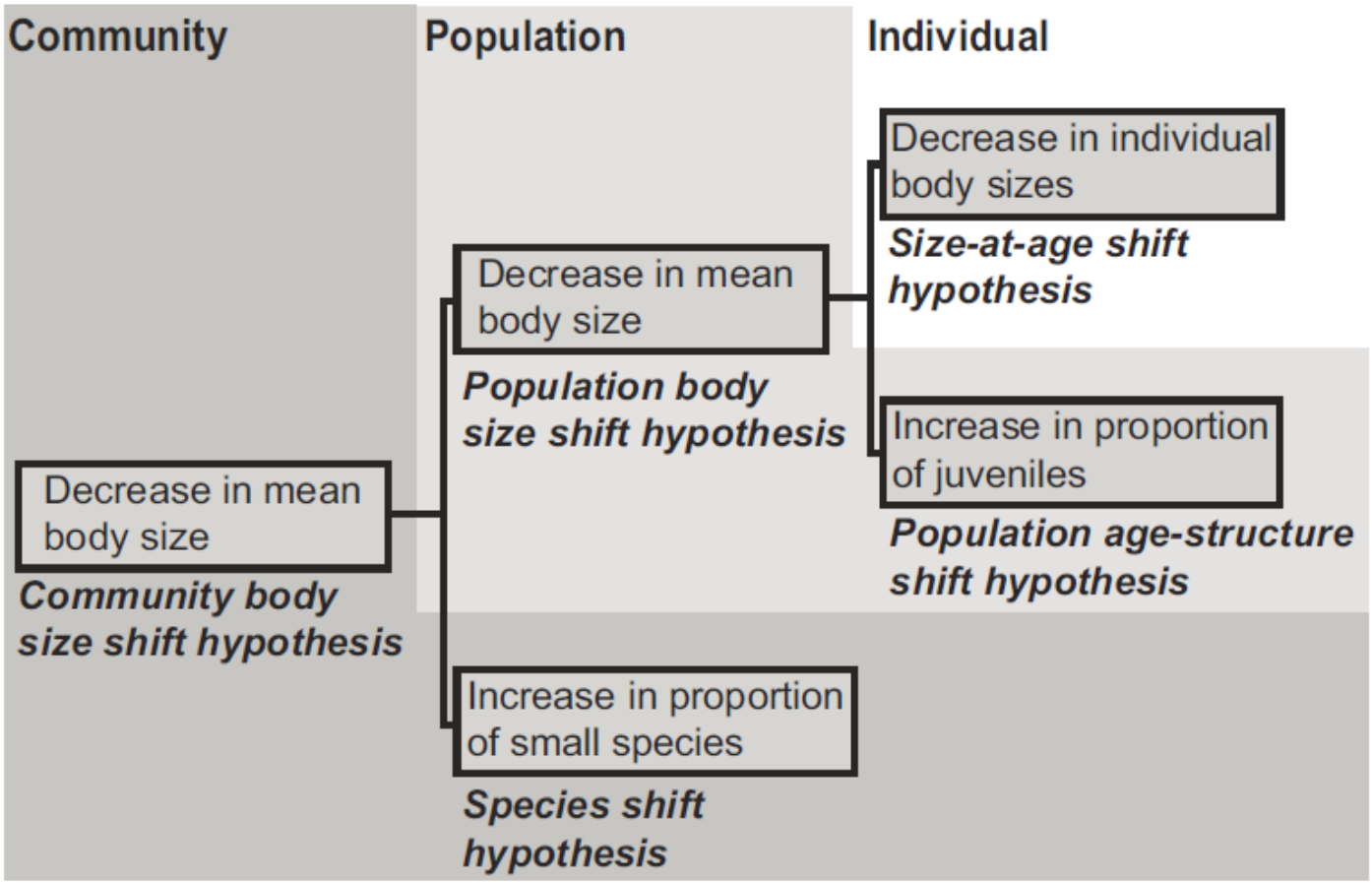
Study motivation and background

- The prime effect of contemporary global climate change is the temperature increase (Hansen et al., 2006; IPCC, 2013)
- Temperature is a key driver of ecological processes and patterns, it influences on life from genes to ecosystems, through an assortment of biological or coupled bio-physical mechanisms (Reuman et al., 2014)
- Rising of environmental temperatures results in reductions in body size of organisms (the third universal ecological response to „GW", besides the shift of species ranges and shifts in „phenologies" (Daufresne et al., 2009; Gardner et al. 2011; Forster et al., 2012)
- Causes and consequences of reduction in body size are intensively studied but remain unsolved: Bergmann's Rule (1847 - size variation with temperature or latitude in any taxon); Temperature-Size-Rule (slower growth at lower temperatures, larger as adults) (Atkinson, 1994; Angiletta et al., 2004; Stillwell, 2010; Forster et al., 2011)

Study motivation and background

- Body size affects biological properties (fecundity, growth rate, competitive interactions), it determines community structure, and in combination with abundance controls biomass partitioning (Daufresne et al., 2009 ; Yvon-Durocher et al., 2011)
- Reorganization of ecosystem toward dominance by smaller organisms may influence networks of carbon flows (Pershing et al., 2005; Beaugrand et al., 2010)
- Contemporary research issues: Is the tendency of organisms to be smaller at high temperatures (and vice versa, acc. Bergmann's rule) stronger in homeotherms than in poikilotherms, stronger at the intra-specific or inter-specific level, stronger at the assemblage level; is the pattern manifesting phenotypic plasticity or adaptive? (Meiri, 2011)

Study motivation and bacground



Set of hypotheses regarding the impact of warming on body size at different levels of biological organization (Daufresne et al., 2009)

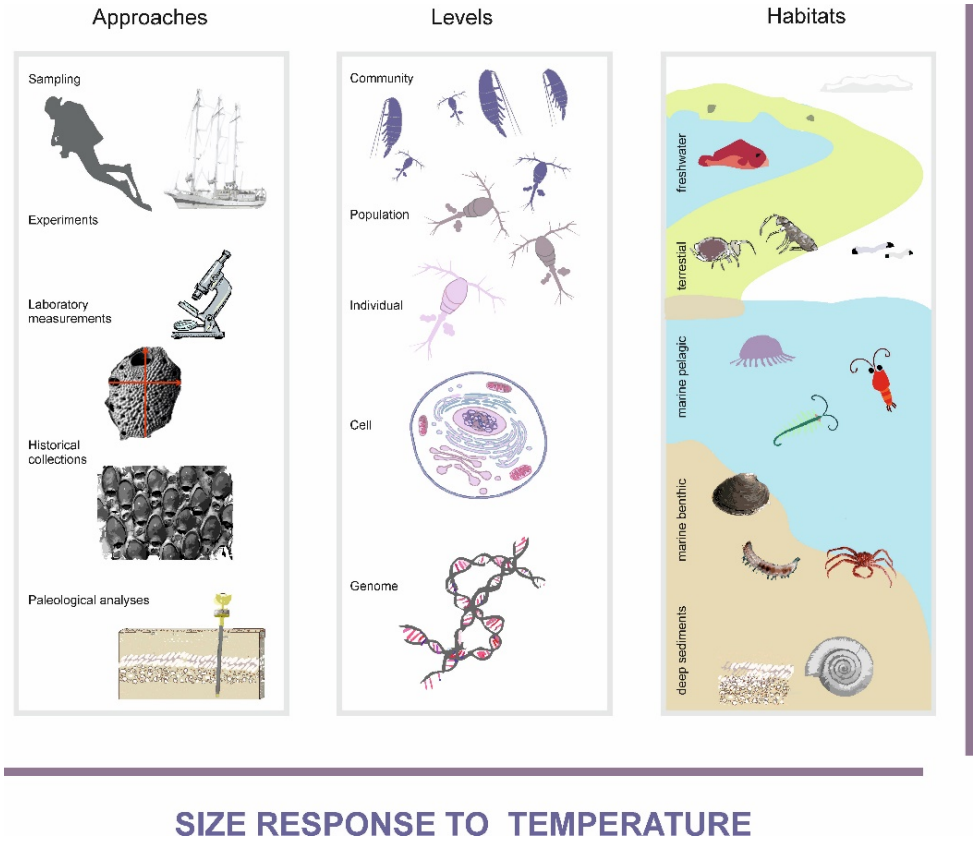
Study motivation and methods

- Project DWARF hypothesis:

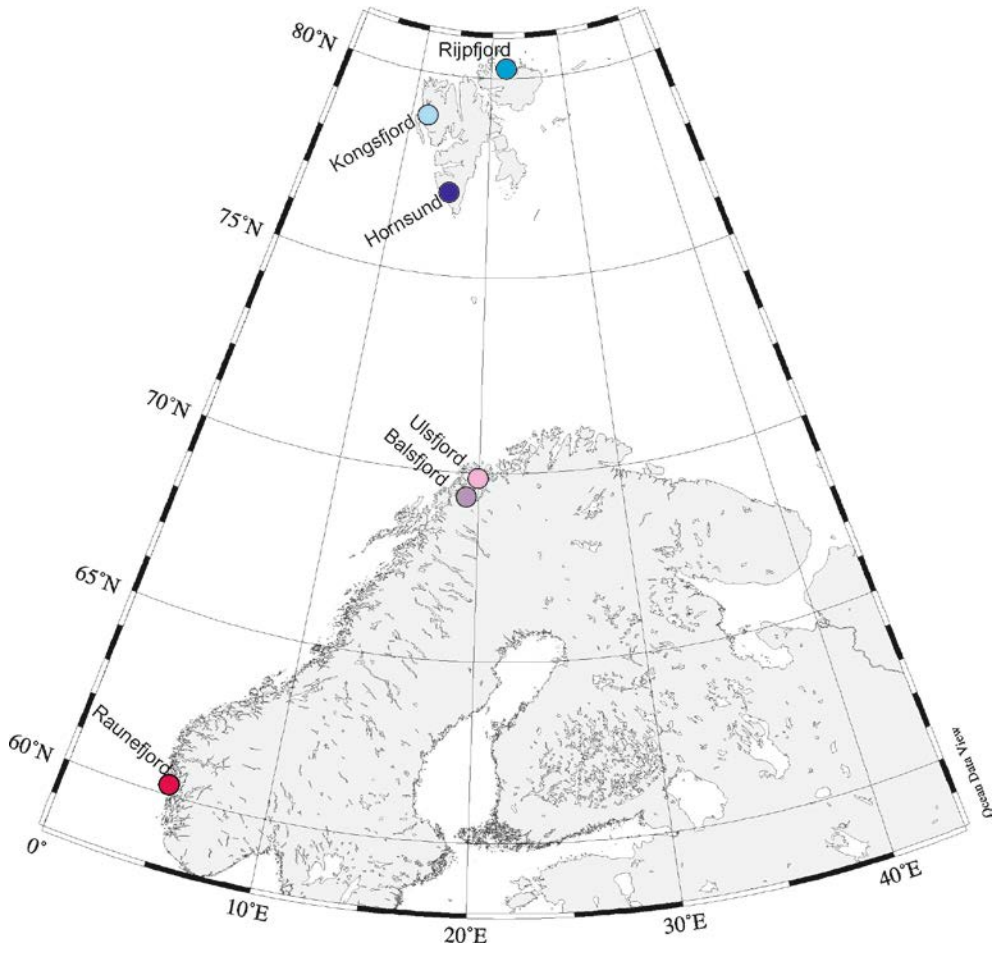
  elevated temperatures will induce size reductions in a large range of animals in the Arctic

- Study approach:

  to compare „similar" zooplankton communities among locations with differing temperatures, distributed along geographical span offering a range of environmental temperatures
  (Mackas et al., 2007)



Study location & sampling



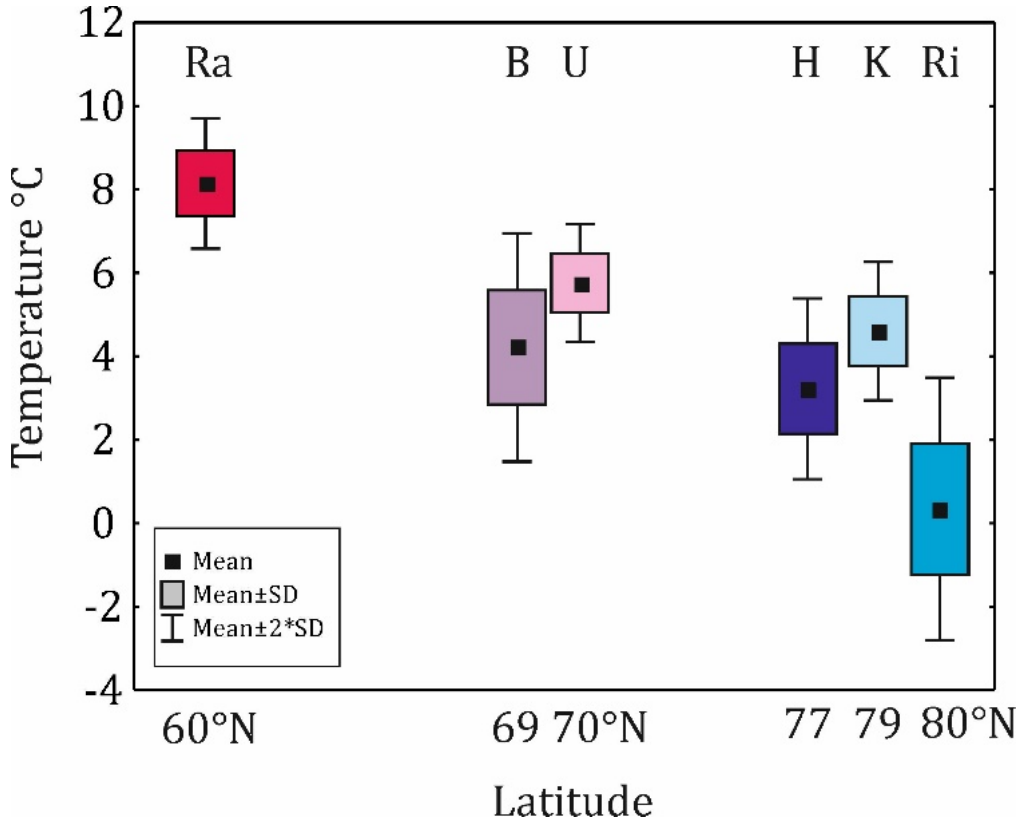
LOPC
Laser Optical Plankton Counter
100 – 3 500 µm

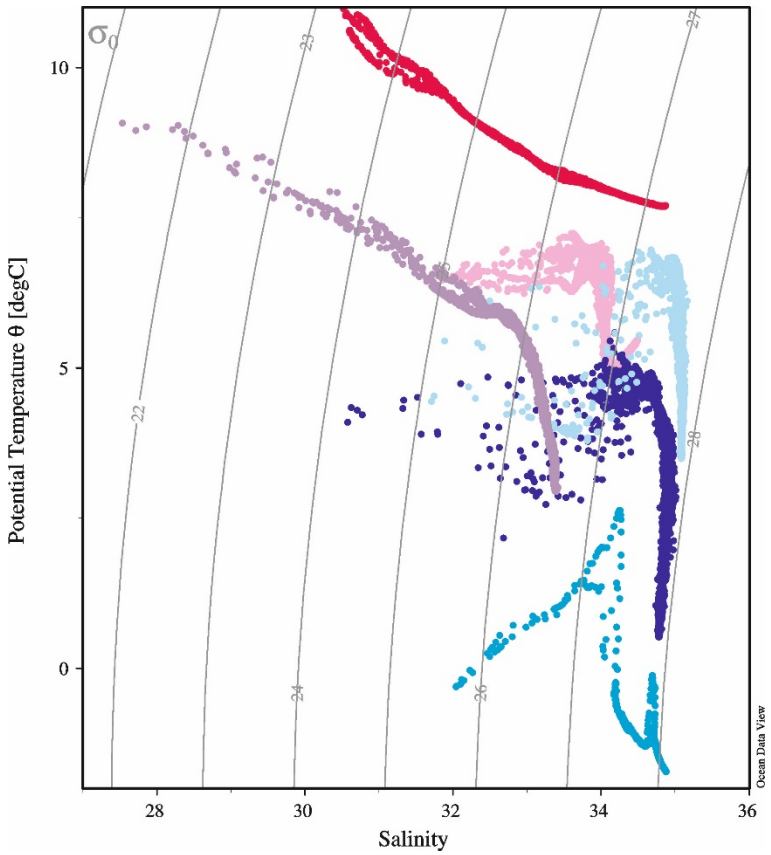
WP-2
60 µm

MPS
180 µm

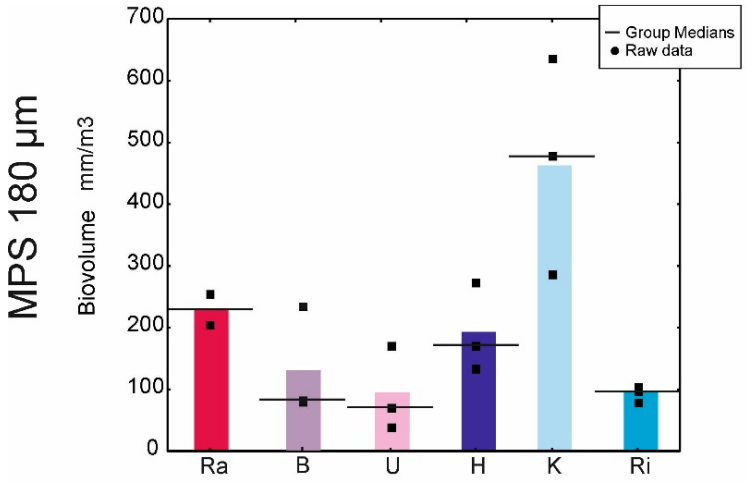
Study time: Summer 2014/2015
Sampling effort: 3 stations/fjord

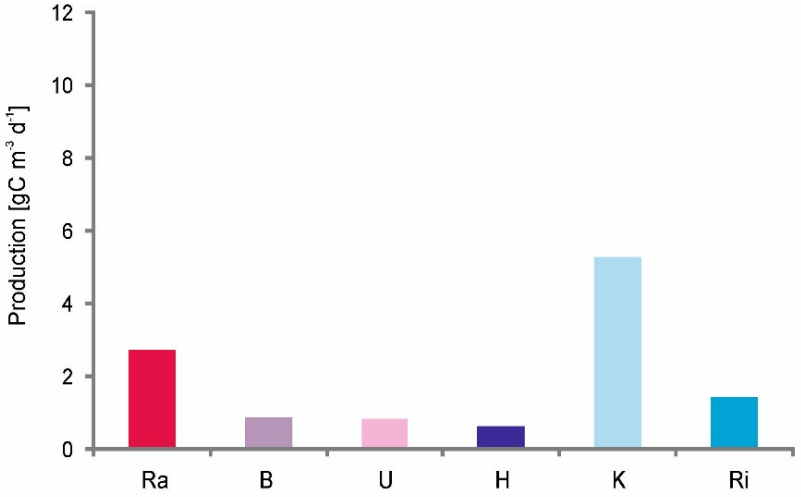
Instantaneous temperature gradient

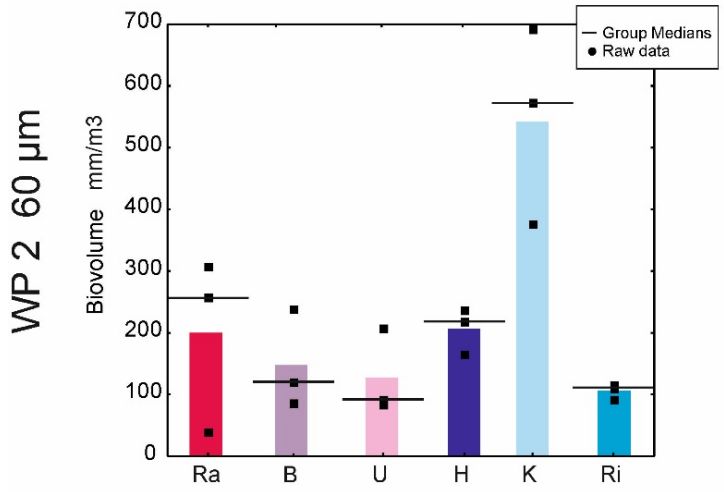


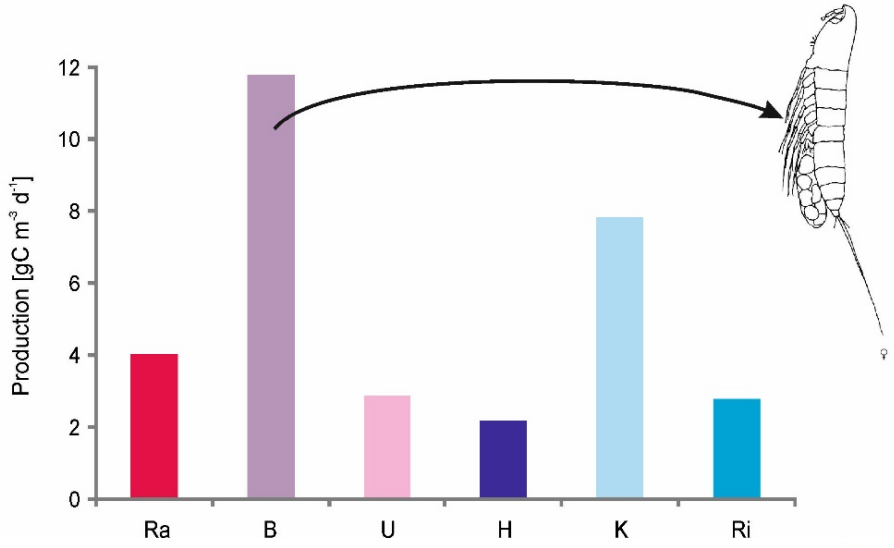


Zooplankton: Biovolume & Production - nets

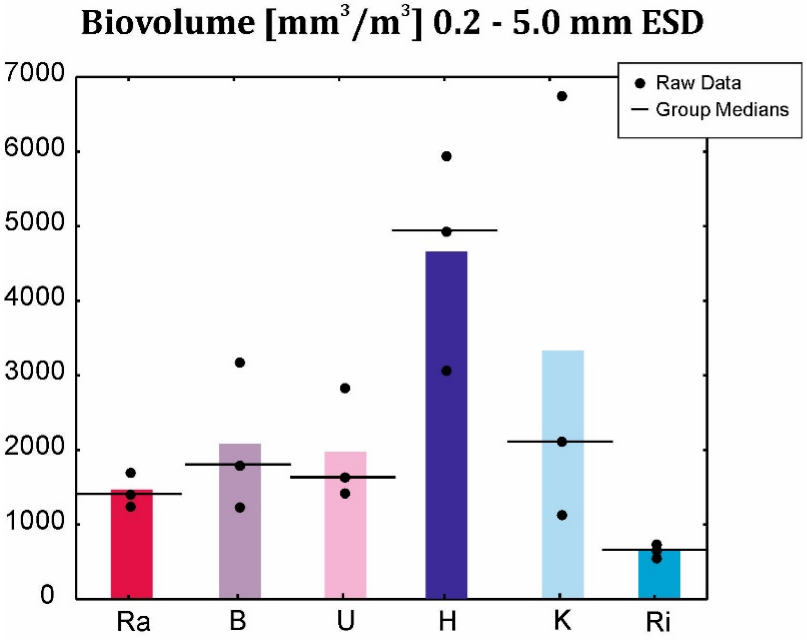


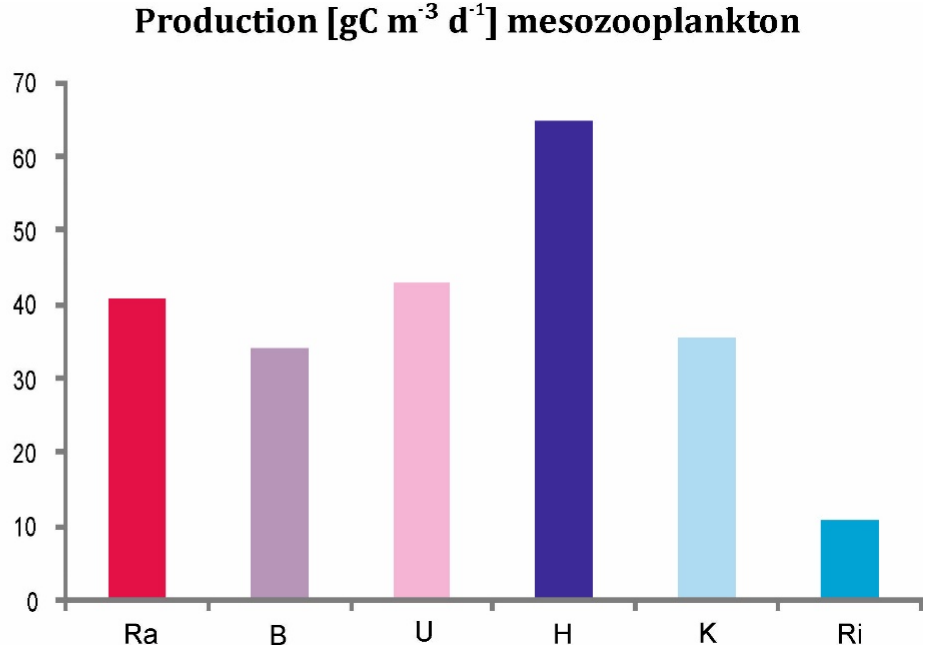




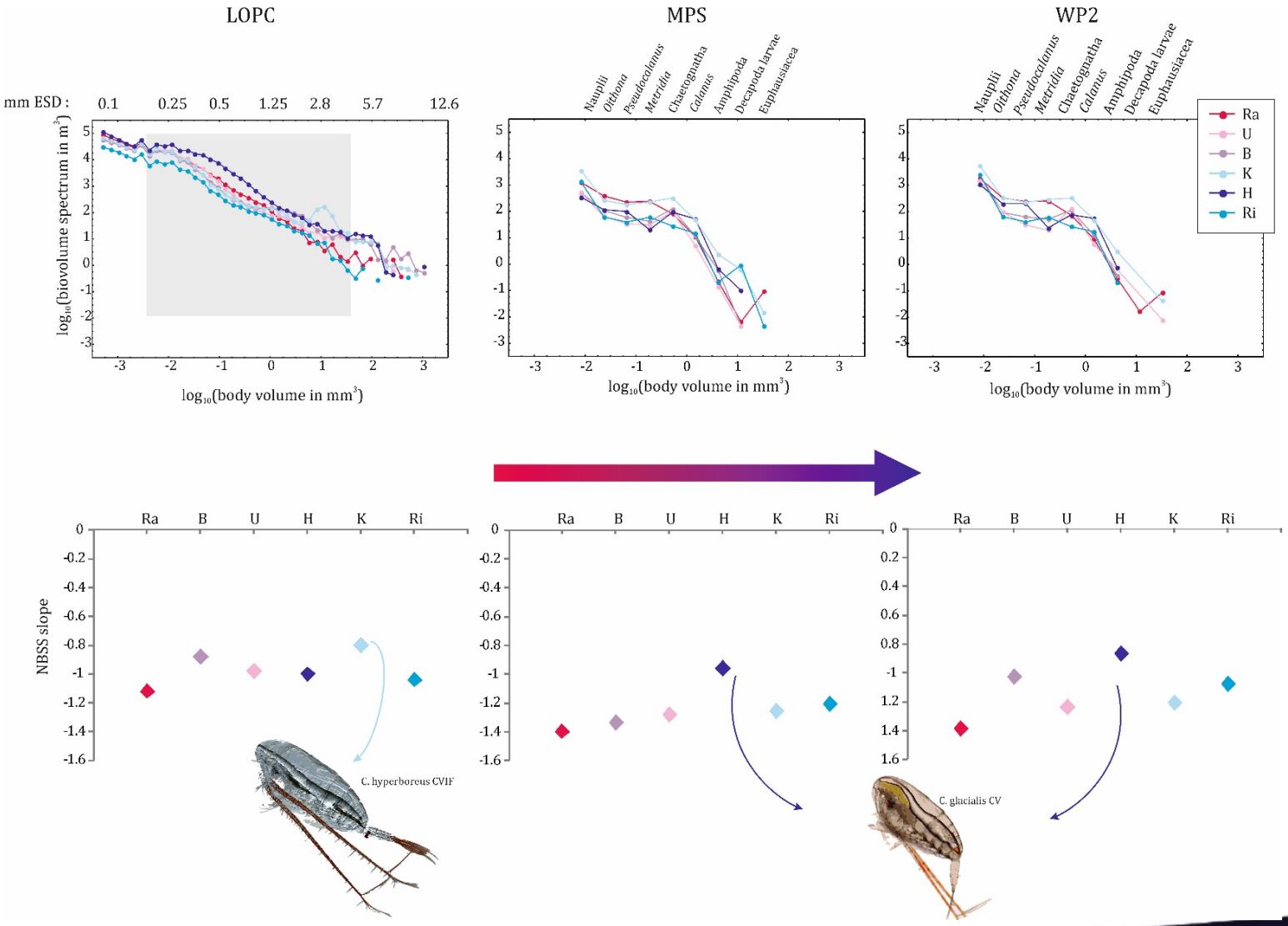


Zooplankton: Biovolume & Production - LOPC

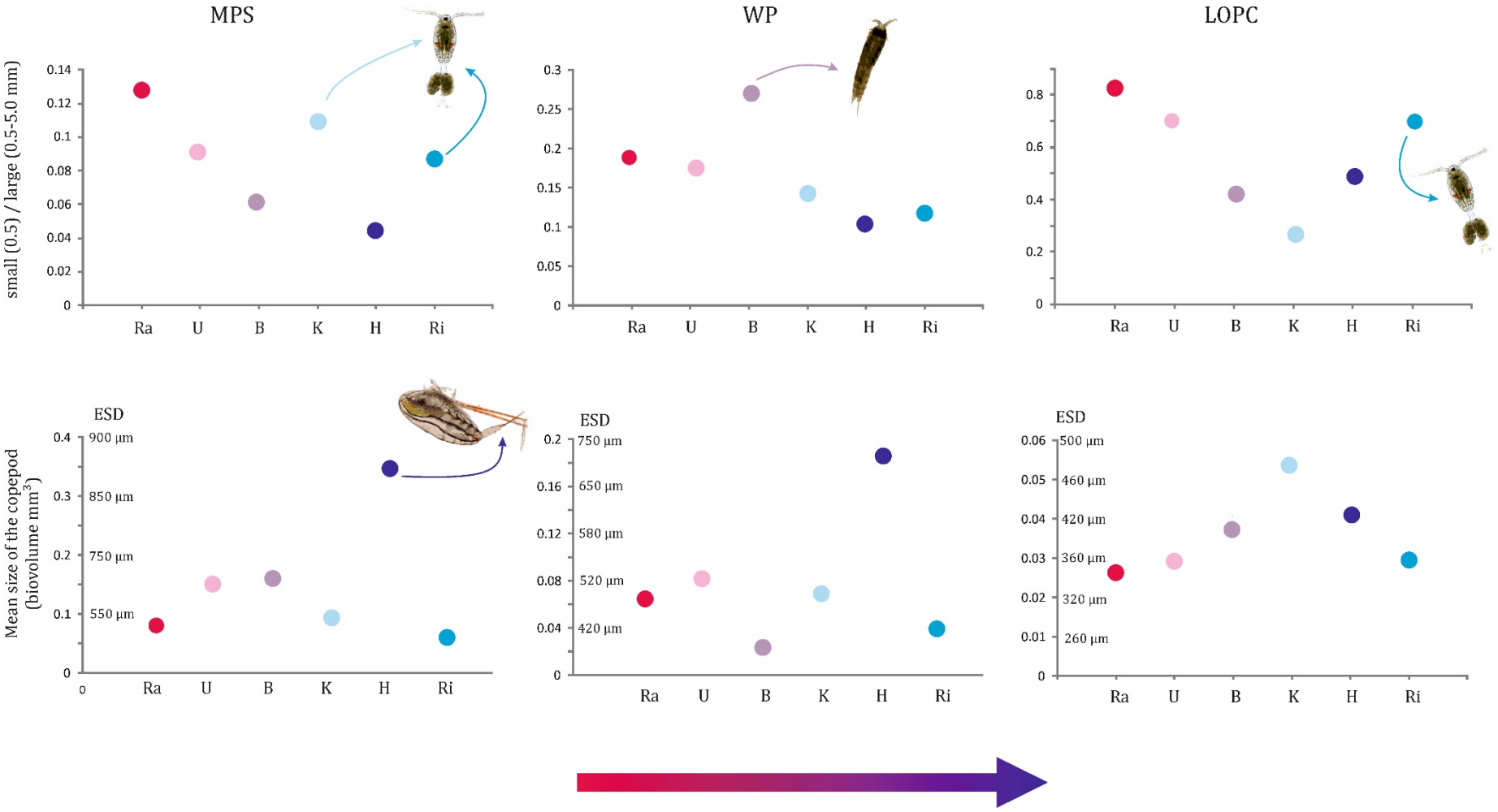




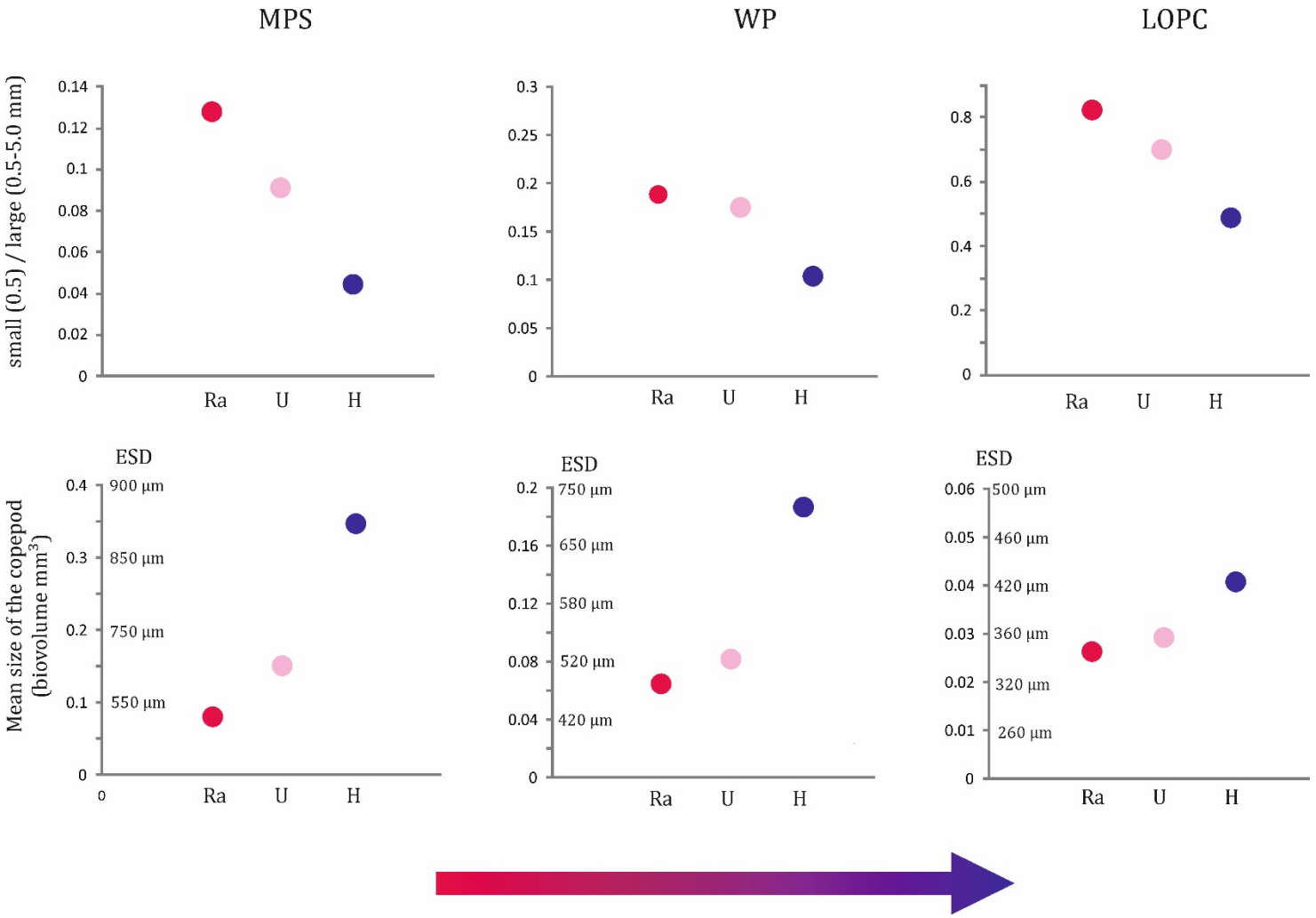
Zooplankton: size spectra (NBSS) - LOPC



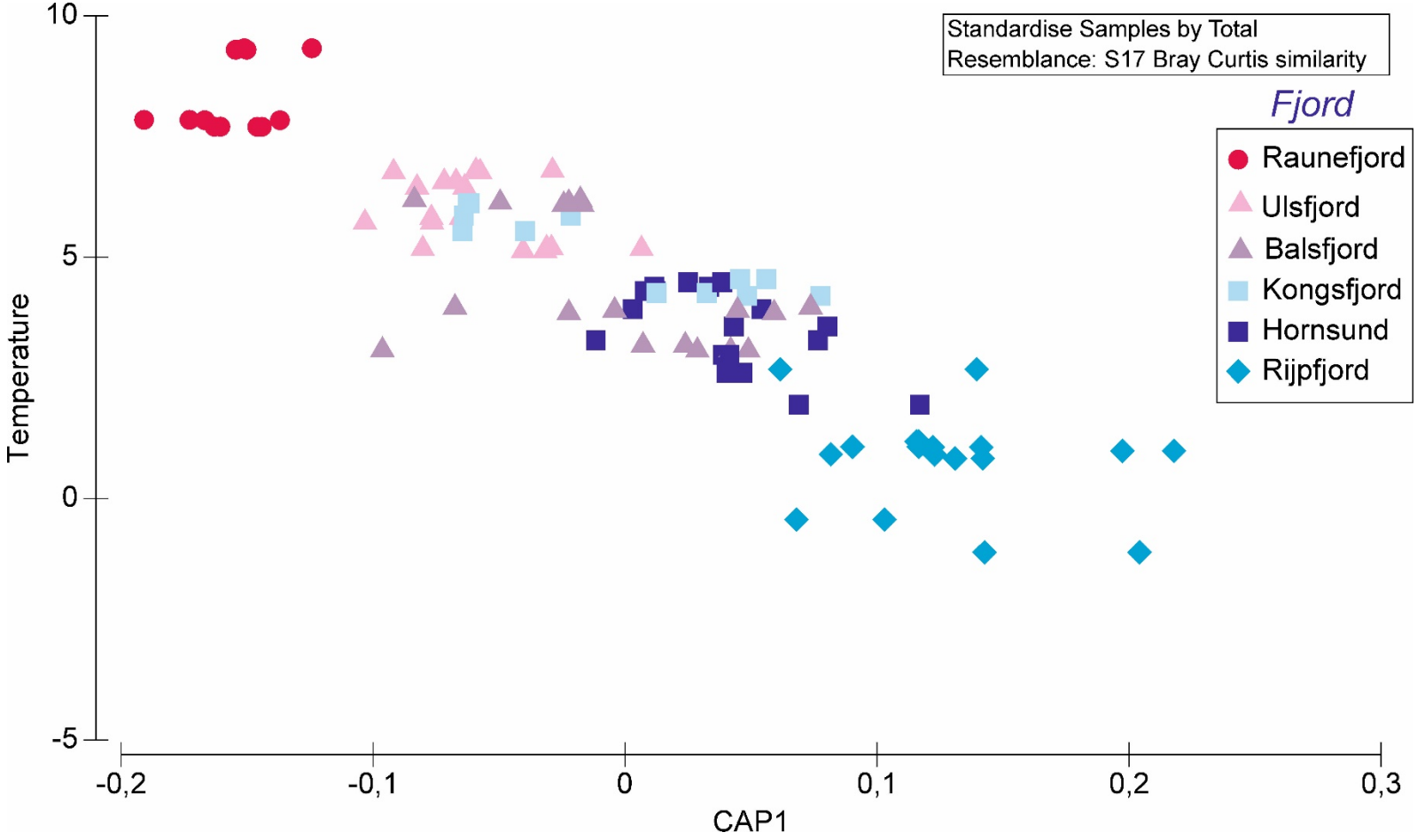
Zooplankton: Size structure metrics



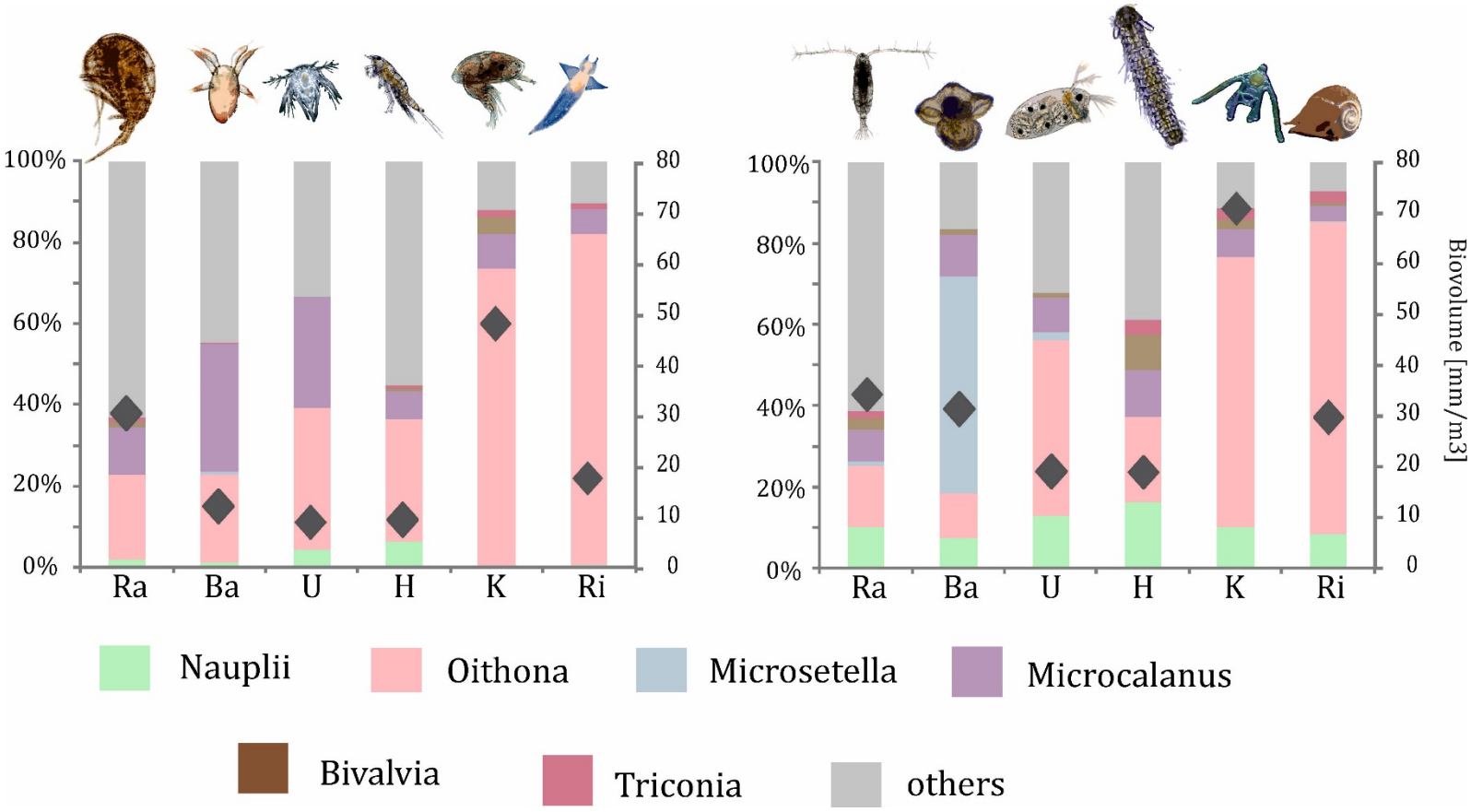
Zooplankton: Size structure metrics



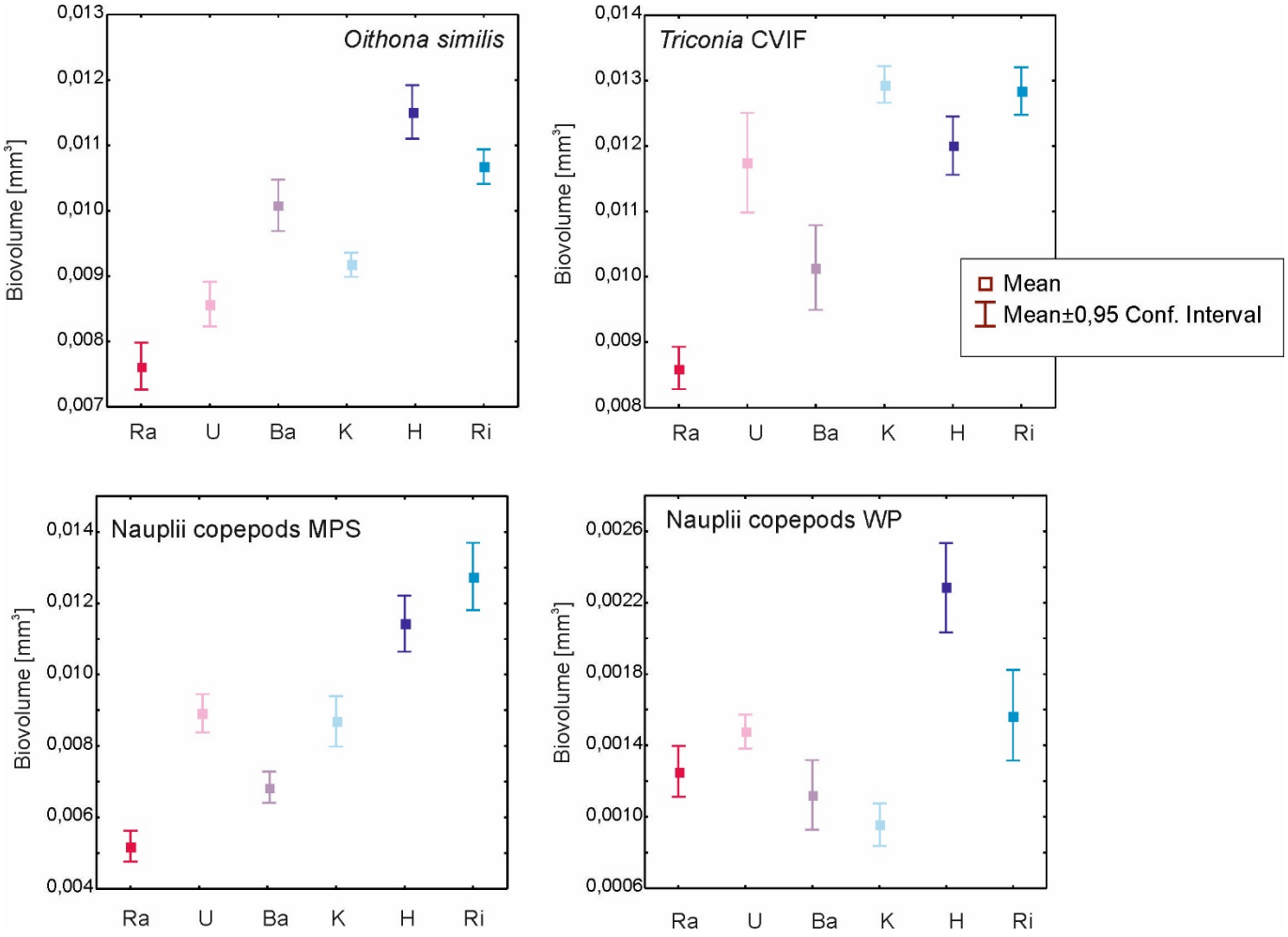
Zooplankton: Taxonomic structure (temperature)



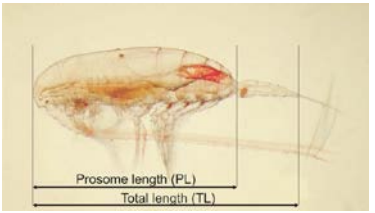
Zooplankton: Taxonomic structure (latitude)

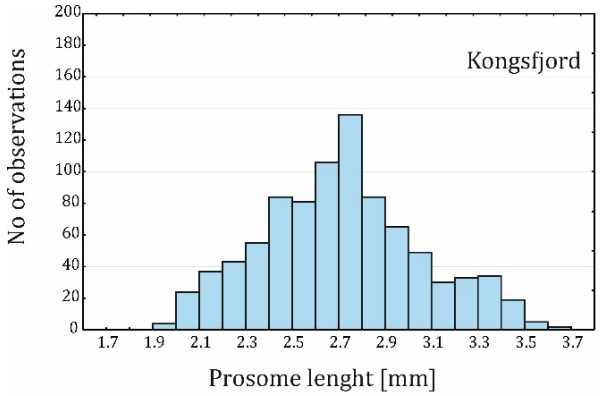


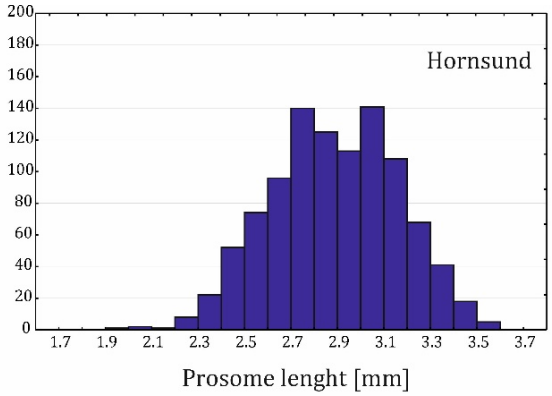
Population: mean individual biovolume

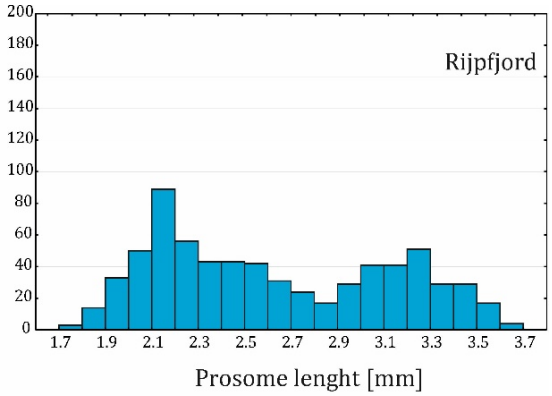


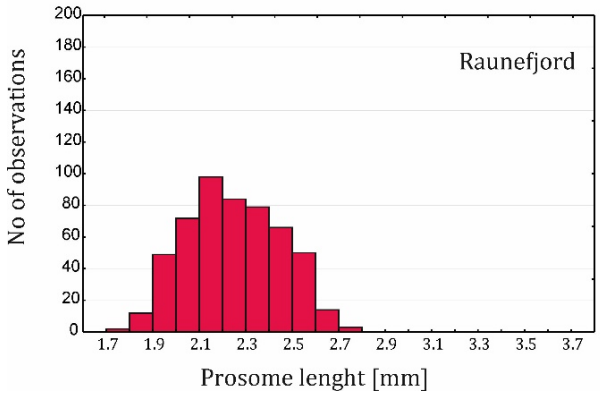
Individual: Calanus CV PL distribution

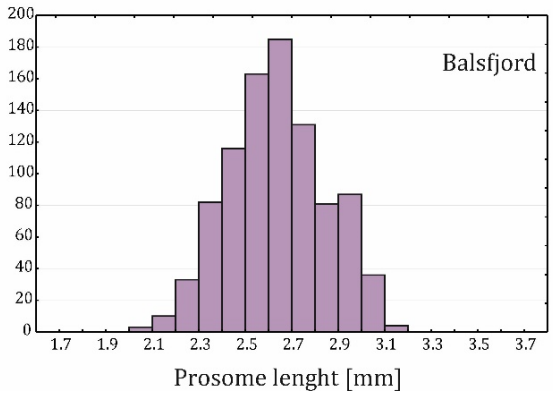


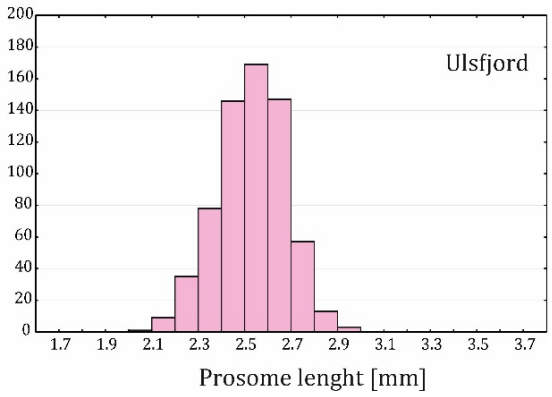




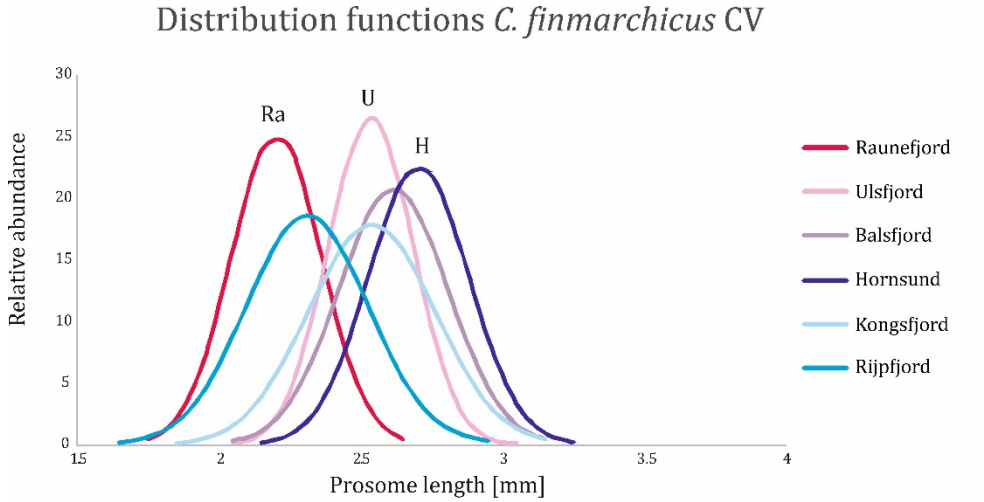


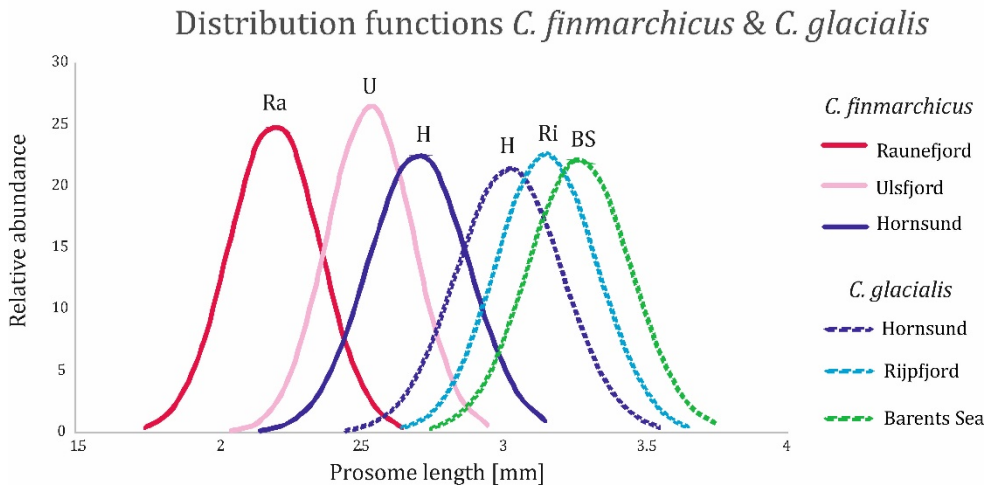


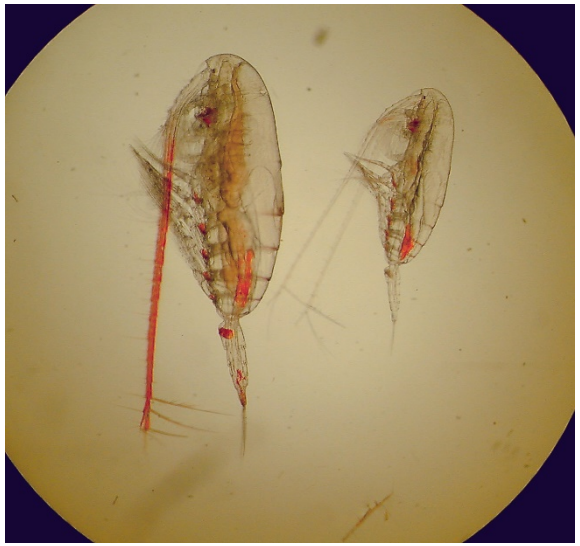




Individual: Calanus CV PL distribution

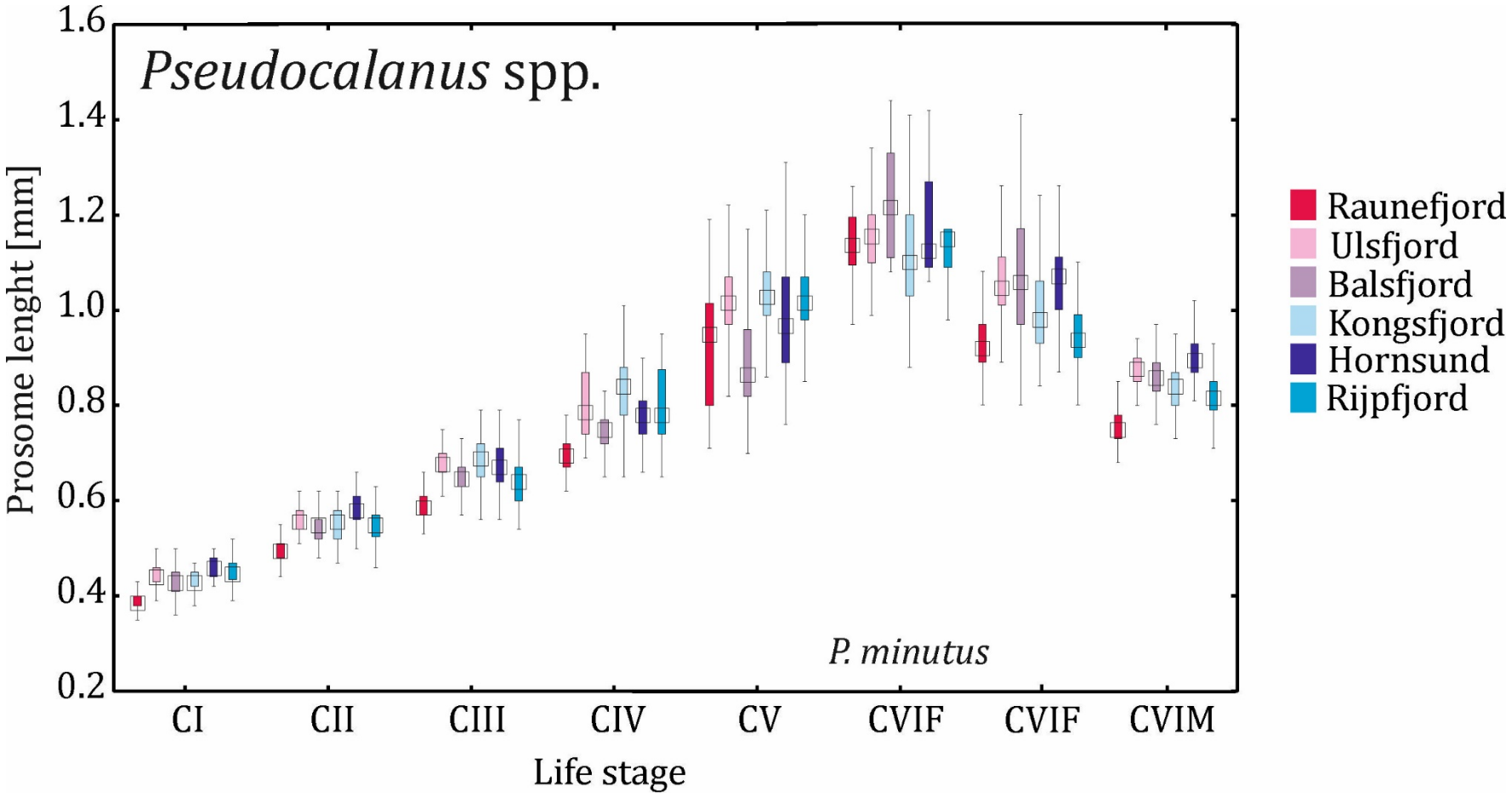




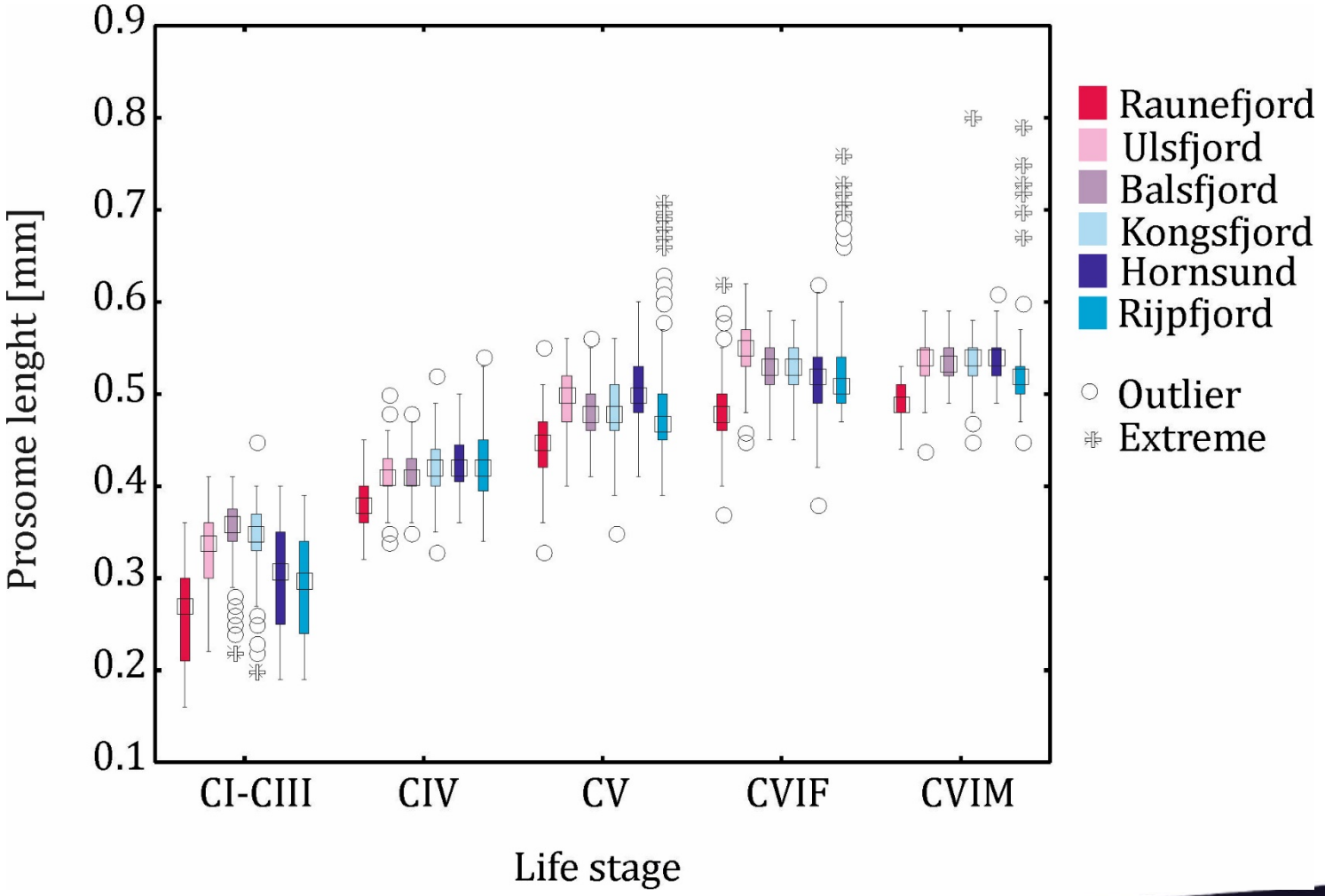


	Cf Raunefjord	Cf Ulsfjord	Cf Hornsund	Cg Hornsund	Cg Rijpfjord	Cg Barents
mean PL =	**2,20**	**2,54**	**2,71**	**3,03**	**3,15**	**3,27**
s=	0,16	0,15	0,18	0,19	0,18	0,18

Individual/Population: Psudocalanus



Individual/Population: Microcalanus



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Summary & Conclusions

- The zooplankton size spectra did not differ substantially among the studied locations This suggest the communities were functioning at relatively similar states
- The taxonomic composition of zooplankton was changing gradually, the diversity and complexity was decreasing with latitude
- Several of the investigated body size related characteristics of zooplankton showed an increase with decreasing temperature over the 20° latitude and 8 °C ecological gradients. This backs up the study hypothesis and can be interpreted as supportive to the Bergmann's Rule

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Summary & Conclusions cont.

With the temperature decrease:

- At the level of community, the contribution of small copepods decreases and the mean biovolume of copepods increases
- At the level of population, the mean biovolume of *Oithona similis* and „large" copepod nauplii increases
- At the level of individual, the mean PL of e.g. *Calanus finmarchicus* and *C. glacialis* CV increases
- There were departures from the expected pattern, some of which can be interpreted with regard to the local events. Explanations of the departures may involve: influence of „phenology", „disturbance" (advection, food shortage), individual variation, inverse relation or lack of response

Thank you for your attention

http://**www.iopan.gda.pl/projects/Dwarf/**

Population: age structure/stage index