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Size response to global warming in high latitude and Arctic marine zooplankton – DWARF-ing is likely

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Motivation and background

- Global climate change causes increasing temperature (Hansen et al., 2006; IPCC, 2013) that is increasing of the key ecological driver, influencing processes and structures from genes to ecosystems through many 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 size ↓ with temperature ↑, though long studied remain unsolved, theories include 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; Angilletta et al., 2004; Stillwell, 2010; Forster et al., 2011)

Motivation and background

- Body size

  - affects individual's biological properties (growth, fecundity, competition)

  - determines population and community structure;

  - controls biomass partitioning;

  -reorganizes ecosystems and influences matter and energy fluxes.

  (Daufresne et al., 2009; Yvon-Durocher et al., 2011; Leinaas etal. 2016; Pershing et al., 2005; Beaugrand et al., 2010; Hebert et al., 2017)

- Contemporary research issues focus on questions:

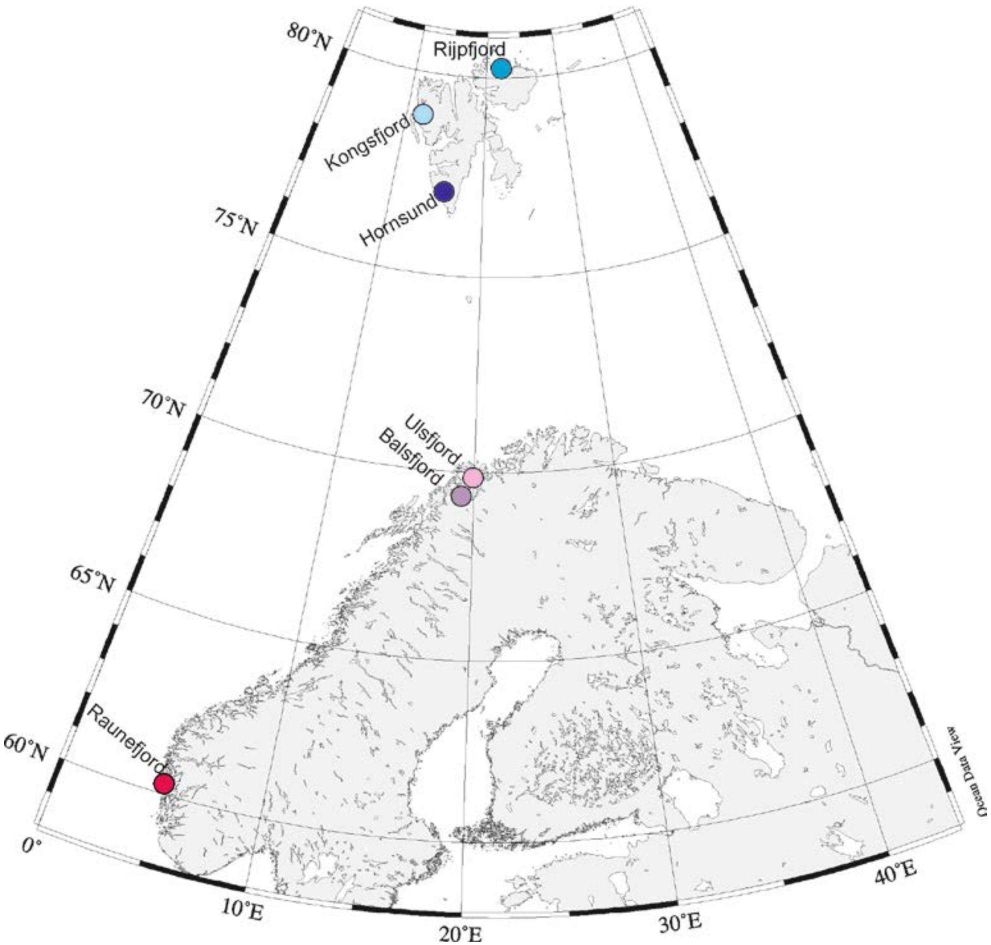
  -Do organisms tend to be smaller at high temperatures?

  -Is Bergmann's rule stronger in homeotherms than poikilotherms, stronger at the intra-, inter- or assemblage level?

  -Is the pattern manifesting phenotypic plasticity or adaptation?

  (Meiri, 2011)

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

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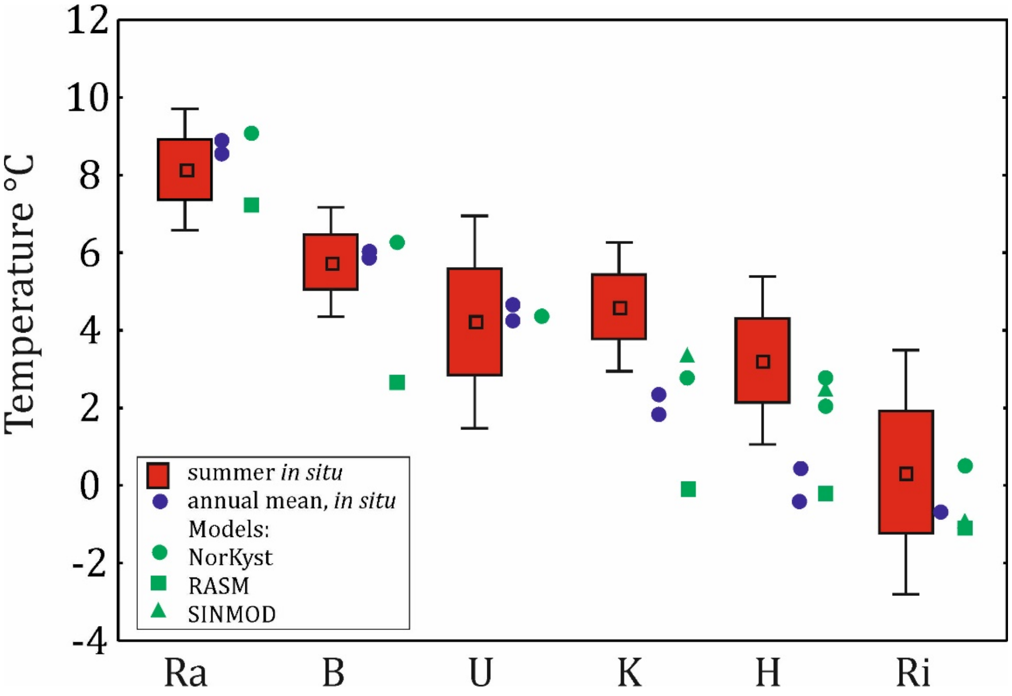
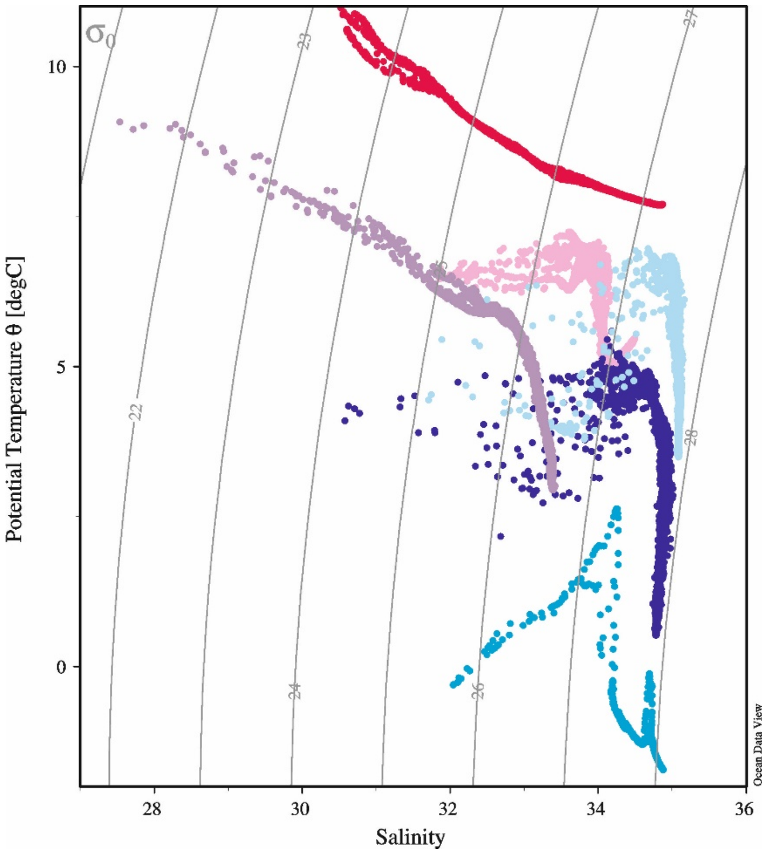
Temperature gradient





T data:

in situ: (J.A. IMR, H.Ch.E. UiT, A.P. IO PAN, F.C. SAMS)

models: NorKyst - J.A. IMR, RASM - R.O. IO PAN, SINMOD - I.E. SINTEF)

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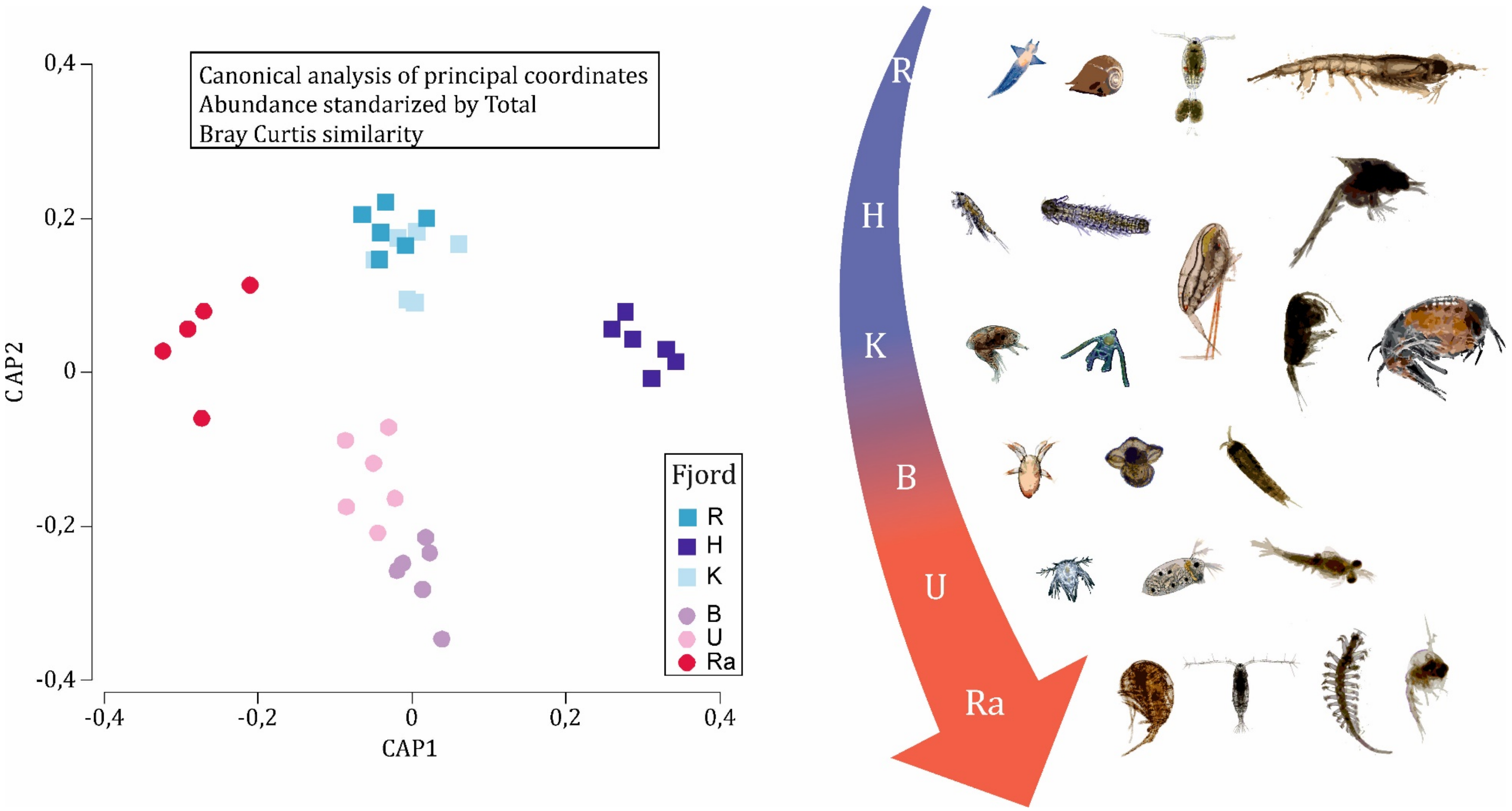
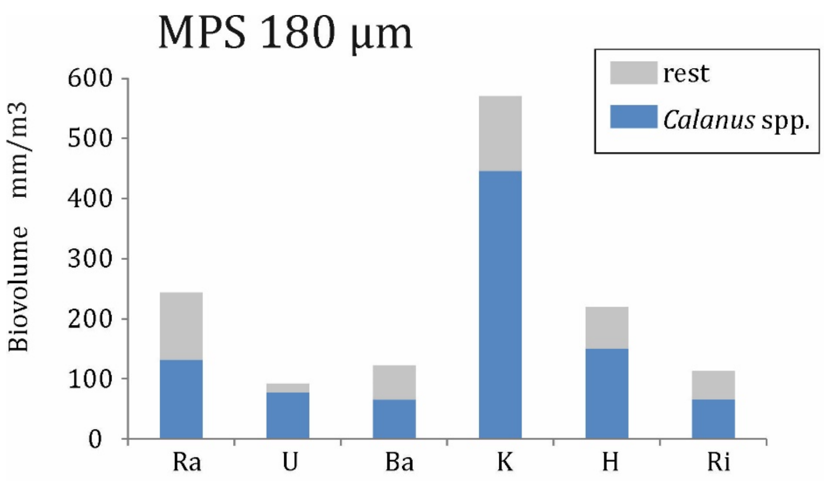
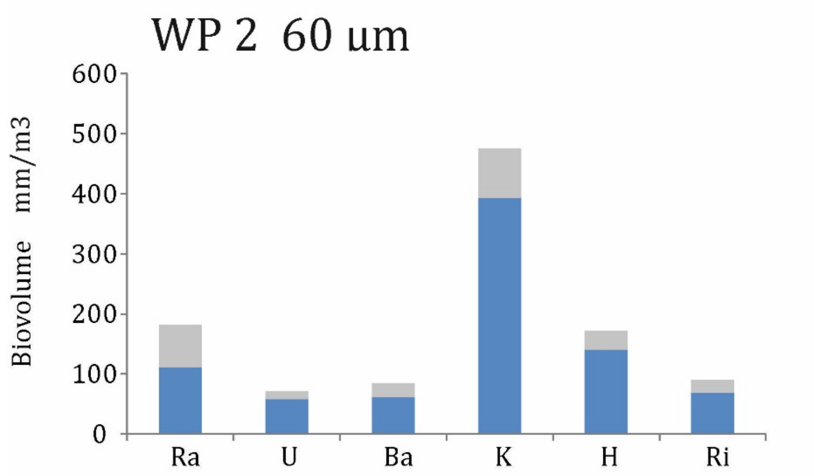
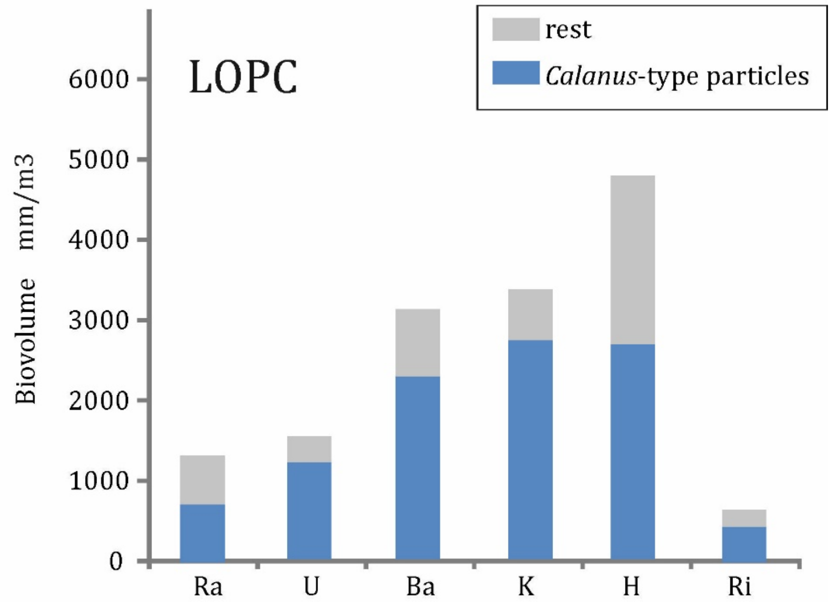
Zooplankton: Taxonomic structure



Zooplankton: Biovolume







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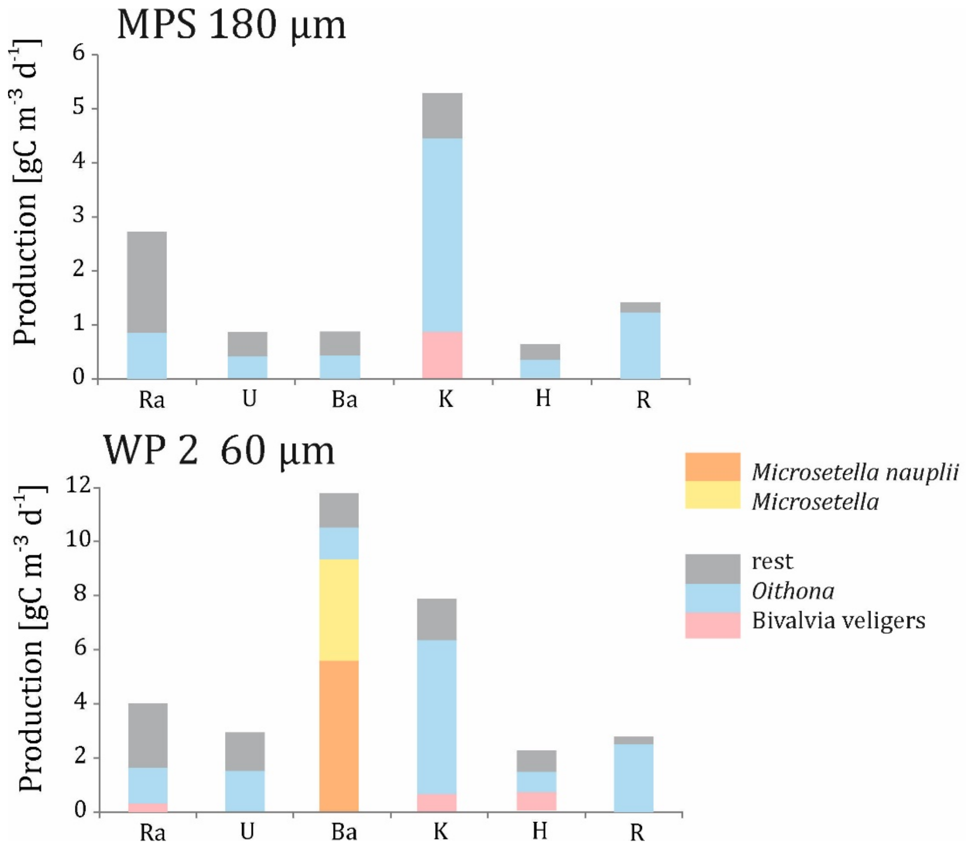
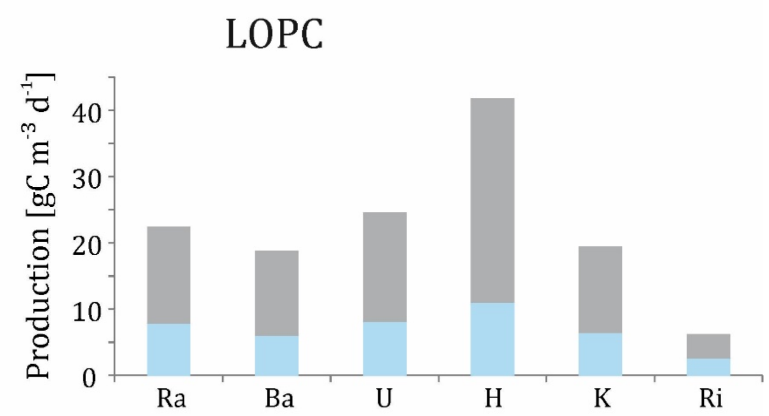
Zooplankton: Potential Production



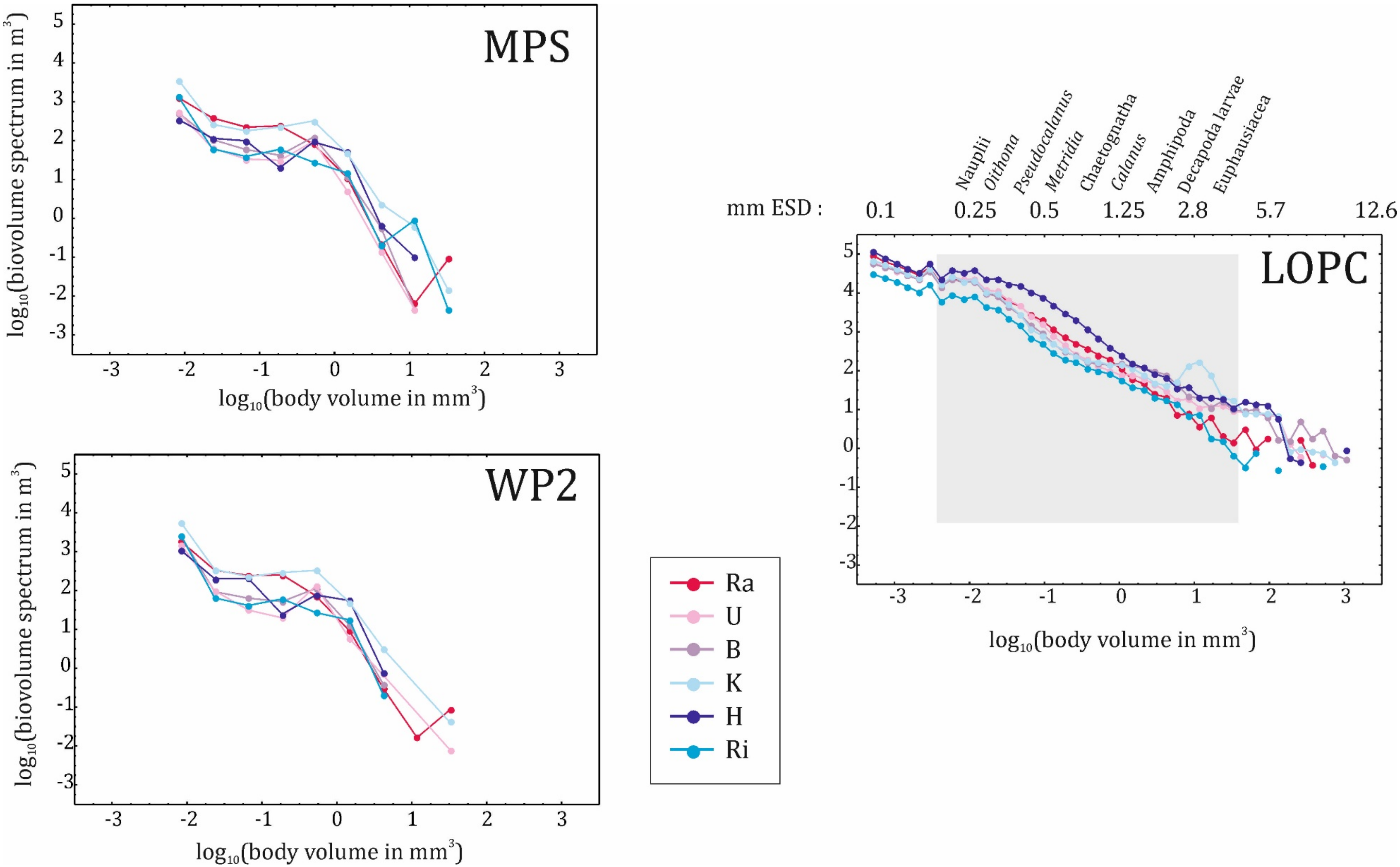


T- temperature
w – biomass of the individual
chl a – chlorofil a
N – abundance

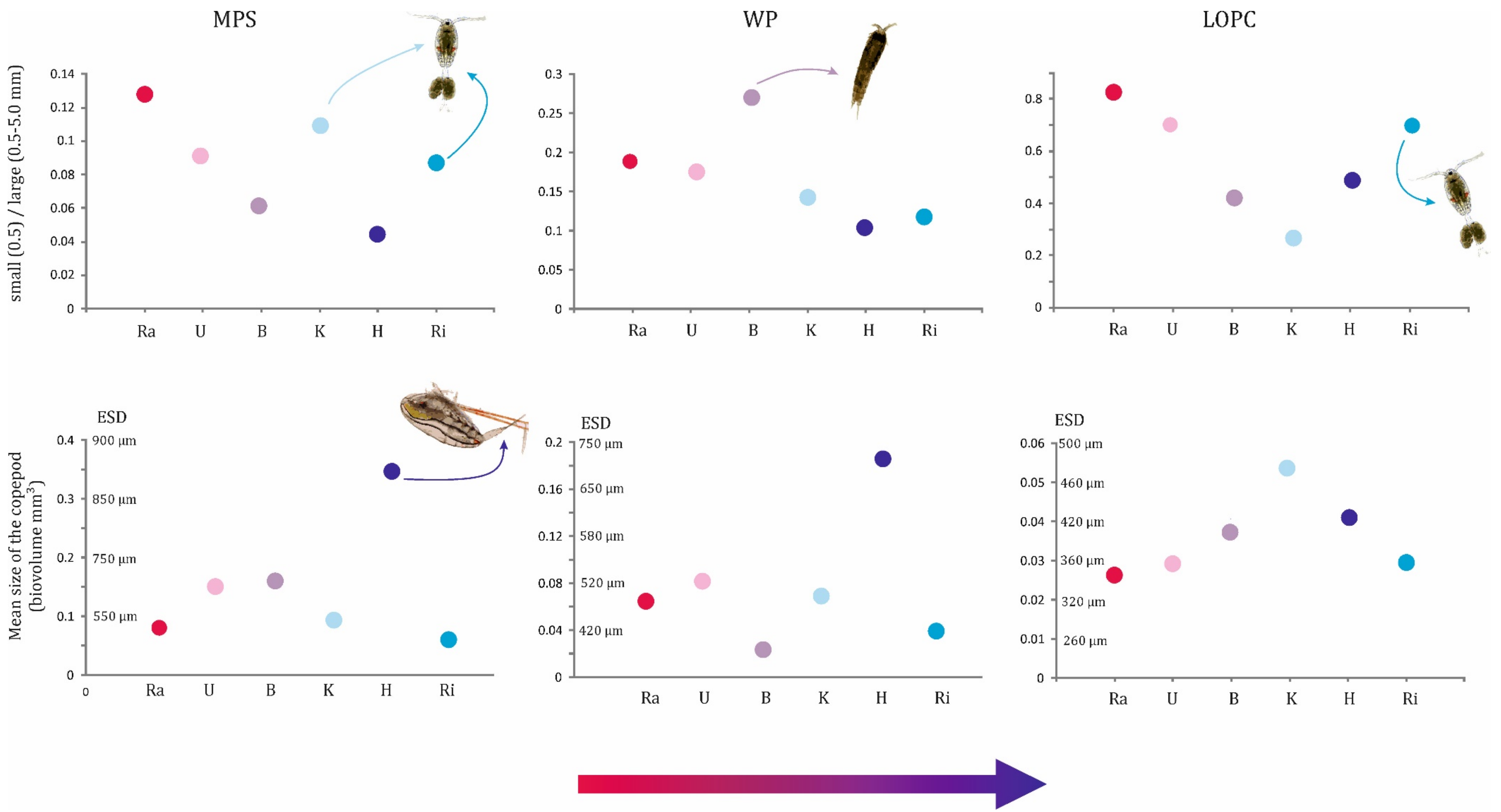
$$P = \frac{(10^{0.0186T} * w^{-0.288} * chl\ a^{0.417} * 10^{-1.209}) * N * w}{dw}$$

(Hirst and Bunker, 2003; Zhou et al., 2010)

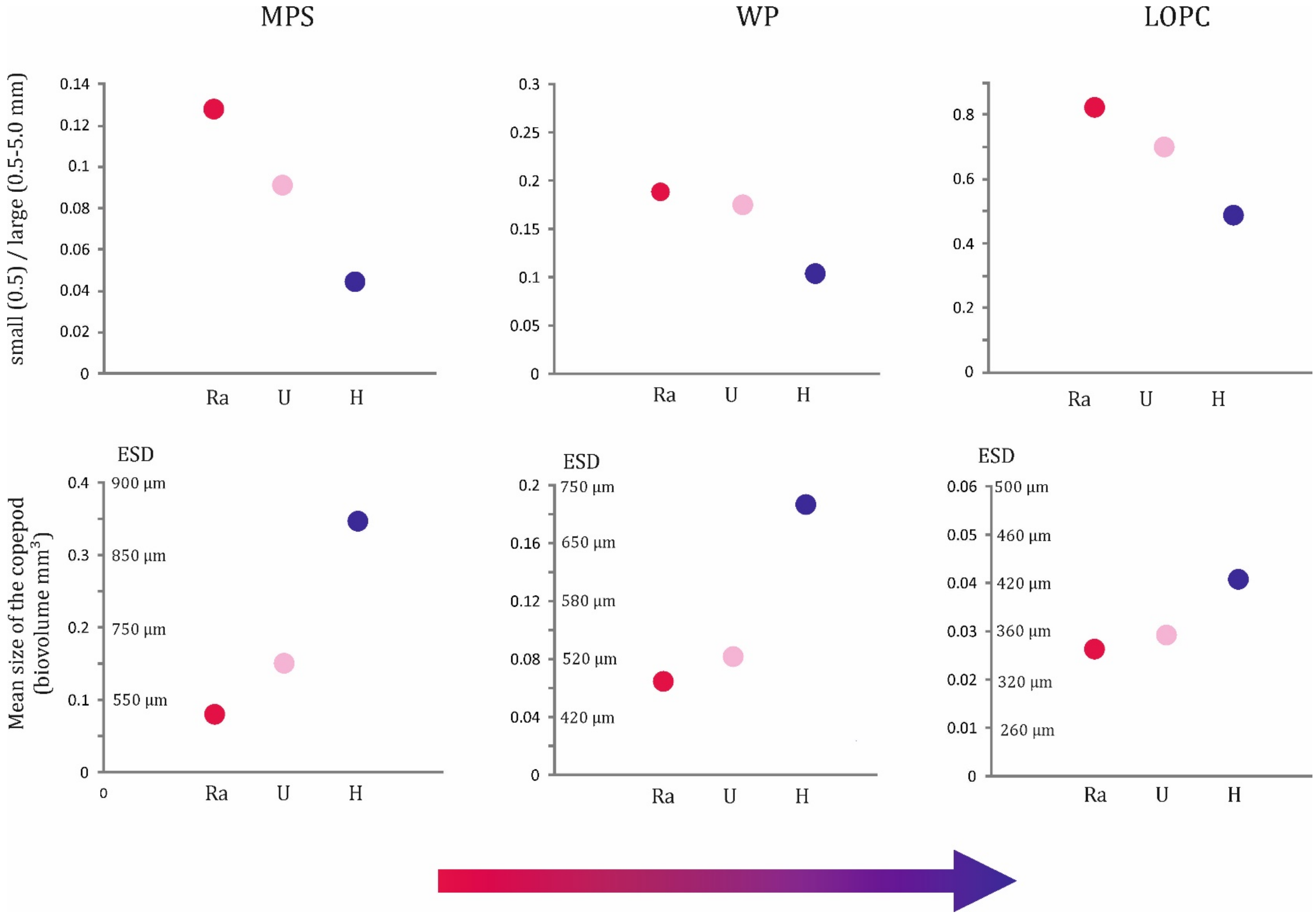
Zooplankton: size spectra (NBSS)



Zooplankton: Size structure metrics



Zooplankton: Size structure metrics



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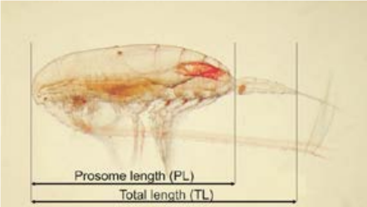
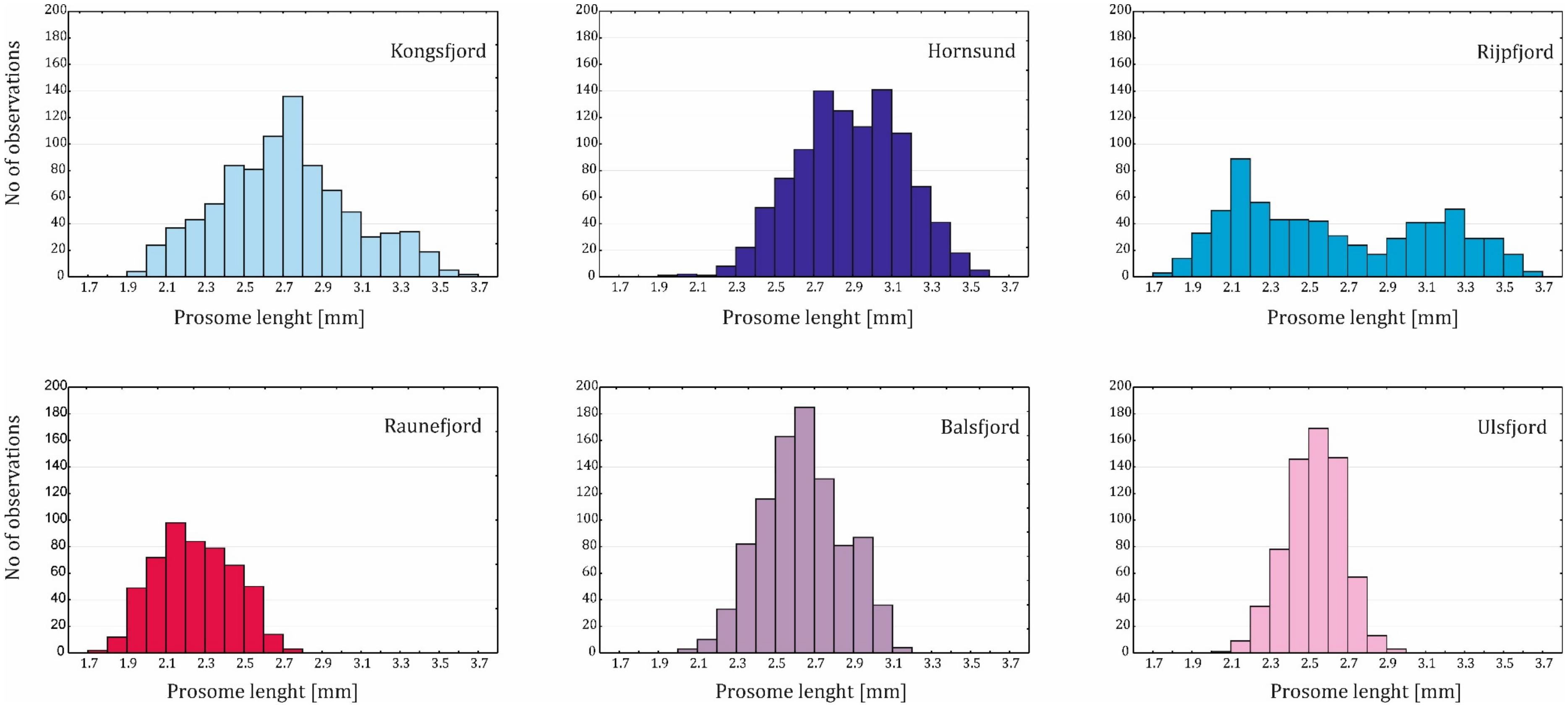
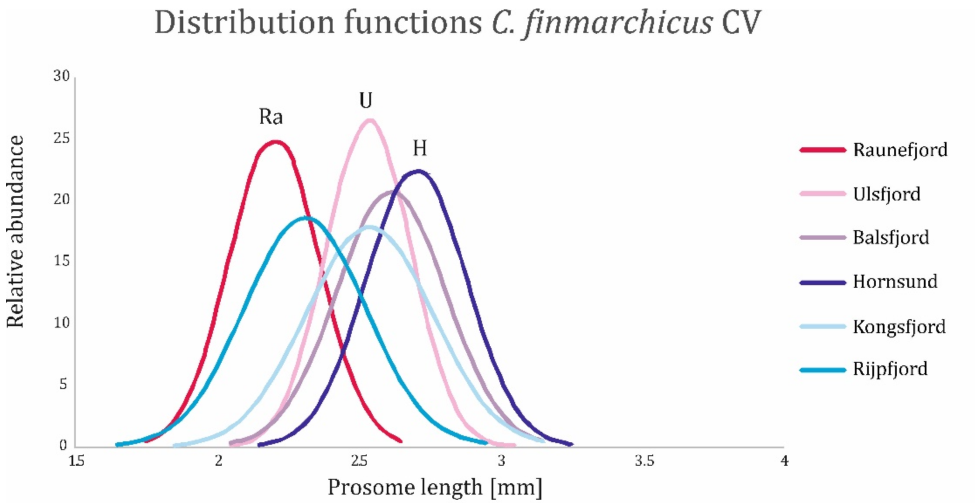
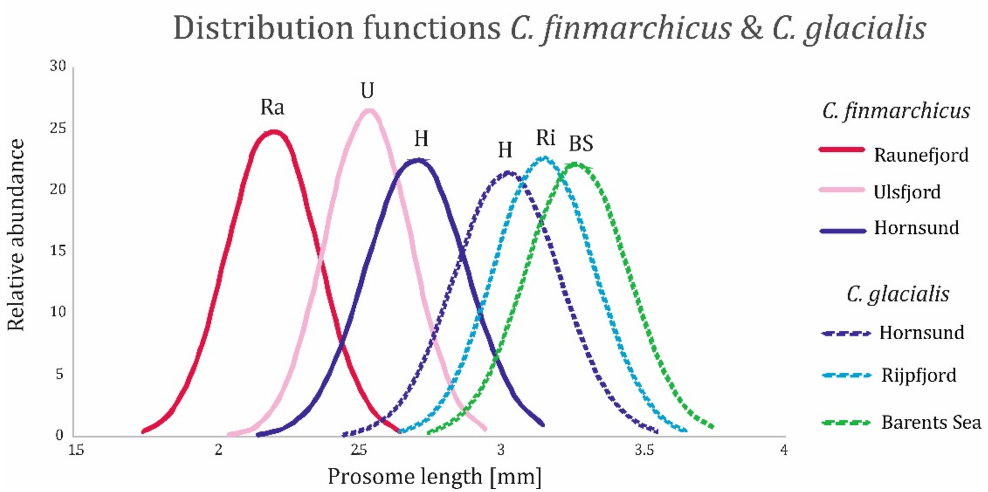
Individual: Calanus CV PL distribution

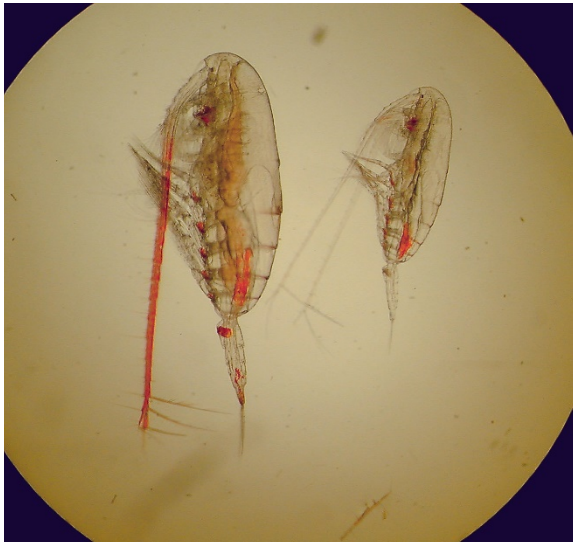




Individual: Calanus CV PL distribution

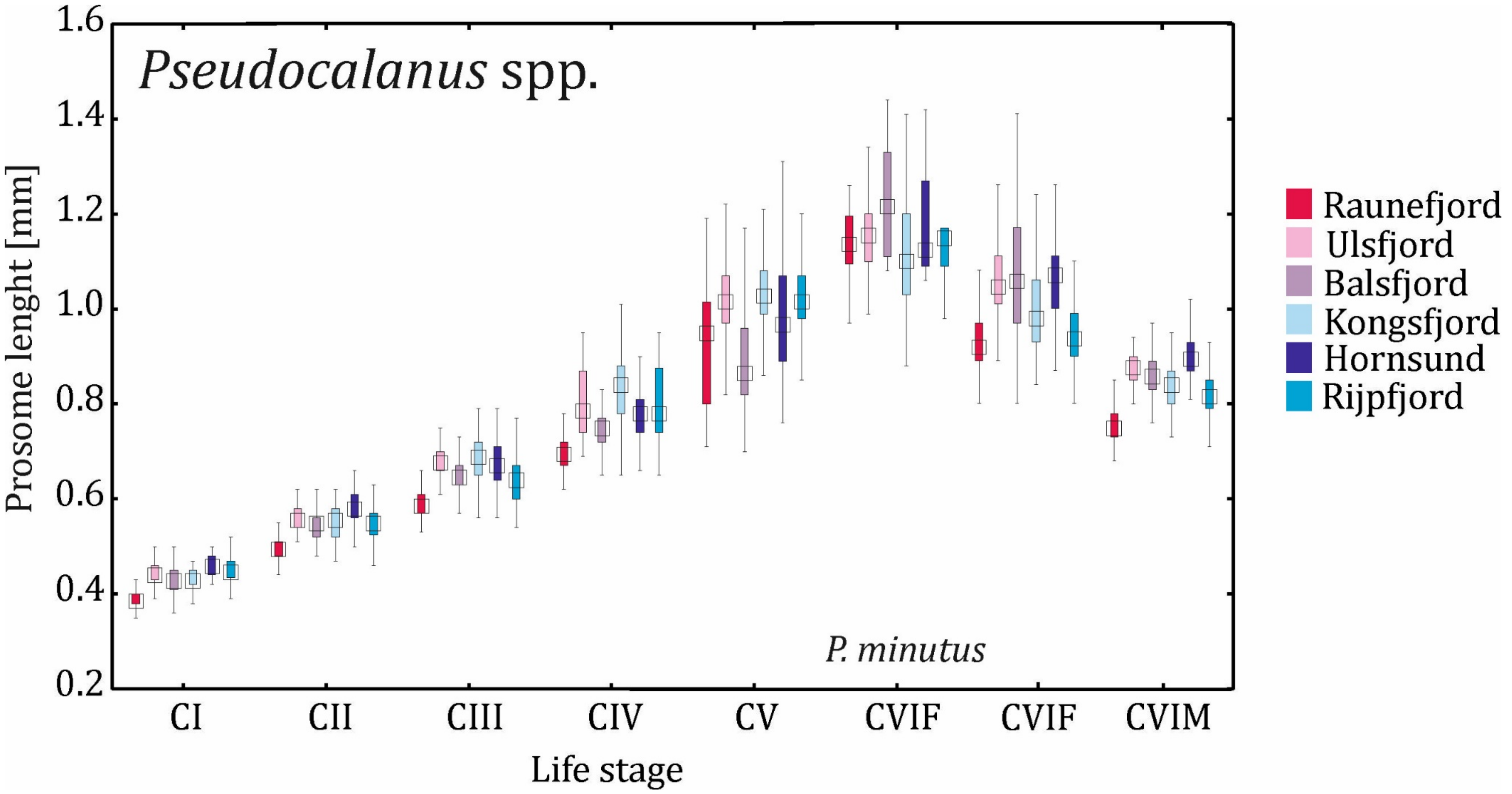






	Cf Raunefjord	**Cf** Ulsfjord	**Cf** Hornsund	**Cg** Hornsund	**Cg** Rijpfjord	**Cg** Barents
mean PL =	**2,20**	**2,54**	**2,71**	**3,03**	**3,15**	**3,27**
s=	0,16	0,15	0,18	0,19	0,18	0,18

Individual/Population: Psudocalanus



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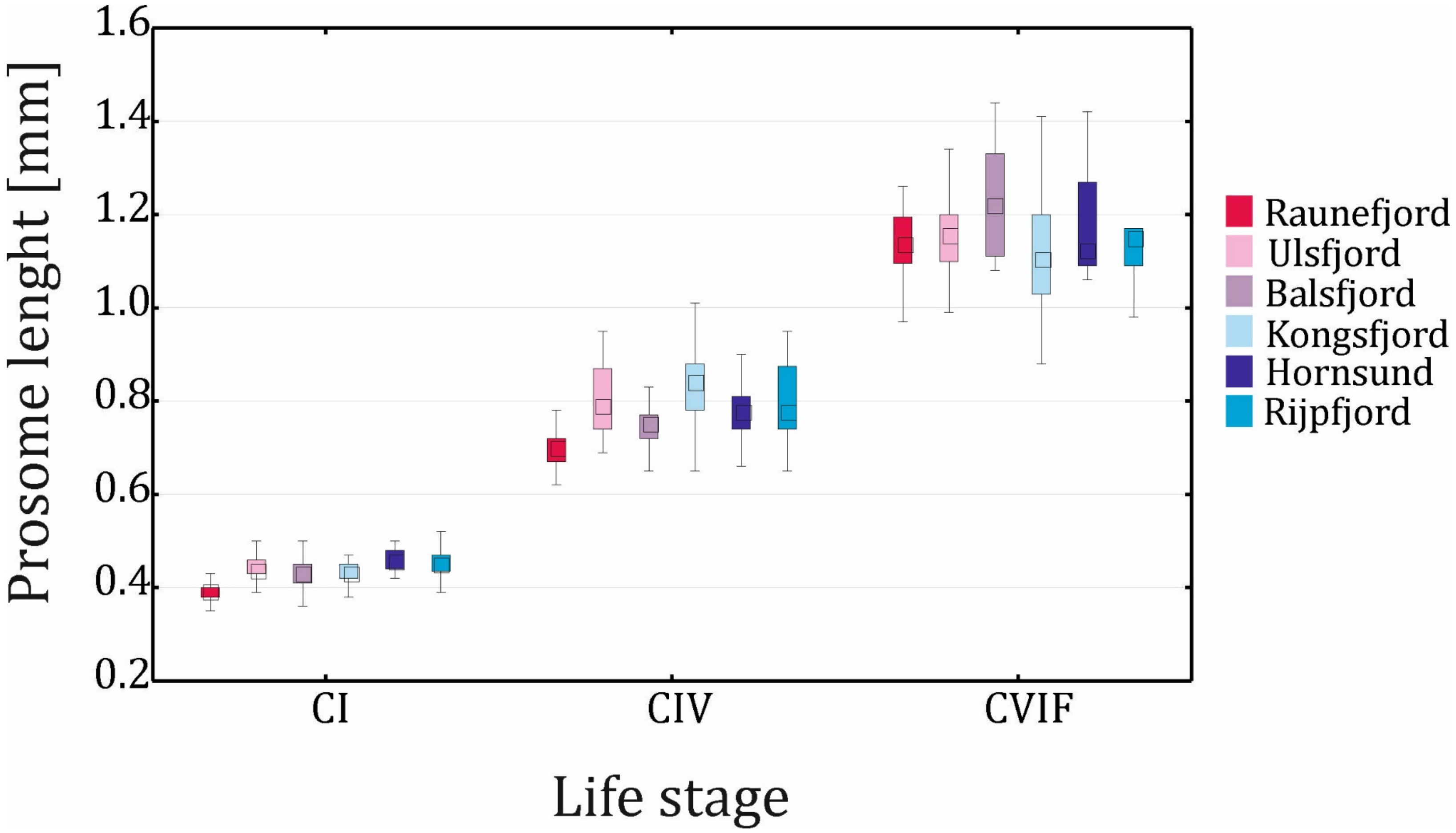
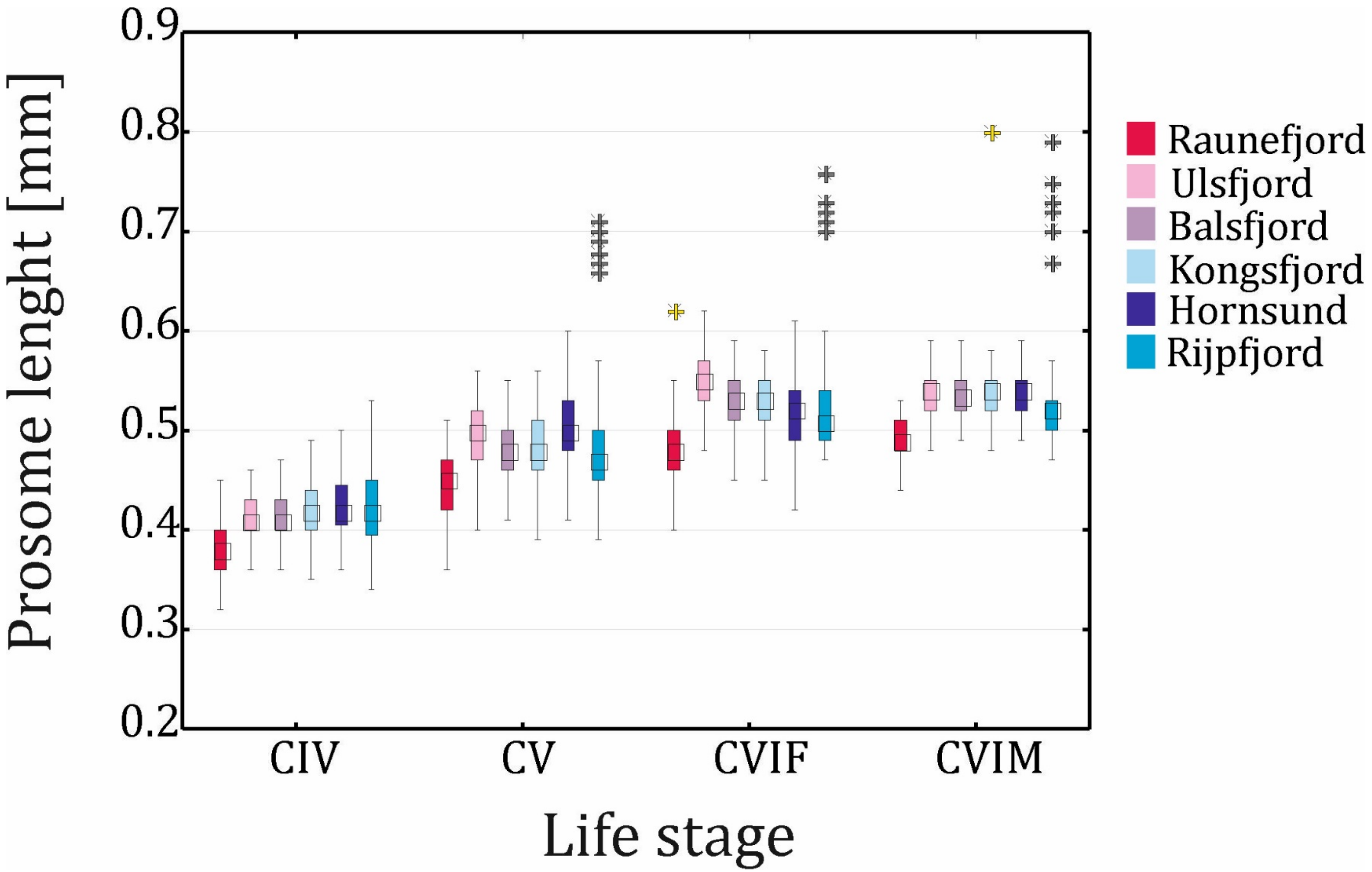
Individual/Population: Psudocalanus



Individual/Population: Microcalanus



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Summary & Conclusions

- The zooplankton size spectra did not differ considerably among the studied locations. This suggest the communities were functioning at relatively similar, semi-steady states.
- The taxonomic composition of zooplankton was changing, though not radically, the diversity was decreasing with latitude.
- Several of the investigated body size related characteristics of zooplankton showed decreasing pattern with increasing temperature over the 20° latitude and 8 °C ecological gradients. This is supportive to the study hypothesis and the Bergmann's Rule.

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POLISH-NORWEGIAN RESEARCH PROGRAMME
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norway grants
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Summary & Conclusions cont.

With the increasing temperature:

- At the level of community, the contribution of small copepods decreased and the mean biovolume of copepods increased;
- At the level of population, the mean size and biovolume of, e.g., *Pseudocalanus* or *Microcalanus* groups, increased;
- At the level of individual, the mean PL of, e.g., *Calanus finmarchicus* and *C. glacialis* CV, increased;
- There were departures from the expected pattern, which can be partially understood with regard to site specific environmental characteristics. Explanations of the departures may involve: influence of „phenology", „disturbance" (advection, food shortage), individual variation, inverse relation or lack of response.

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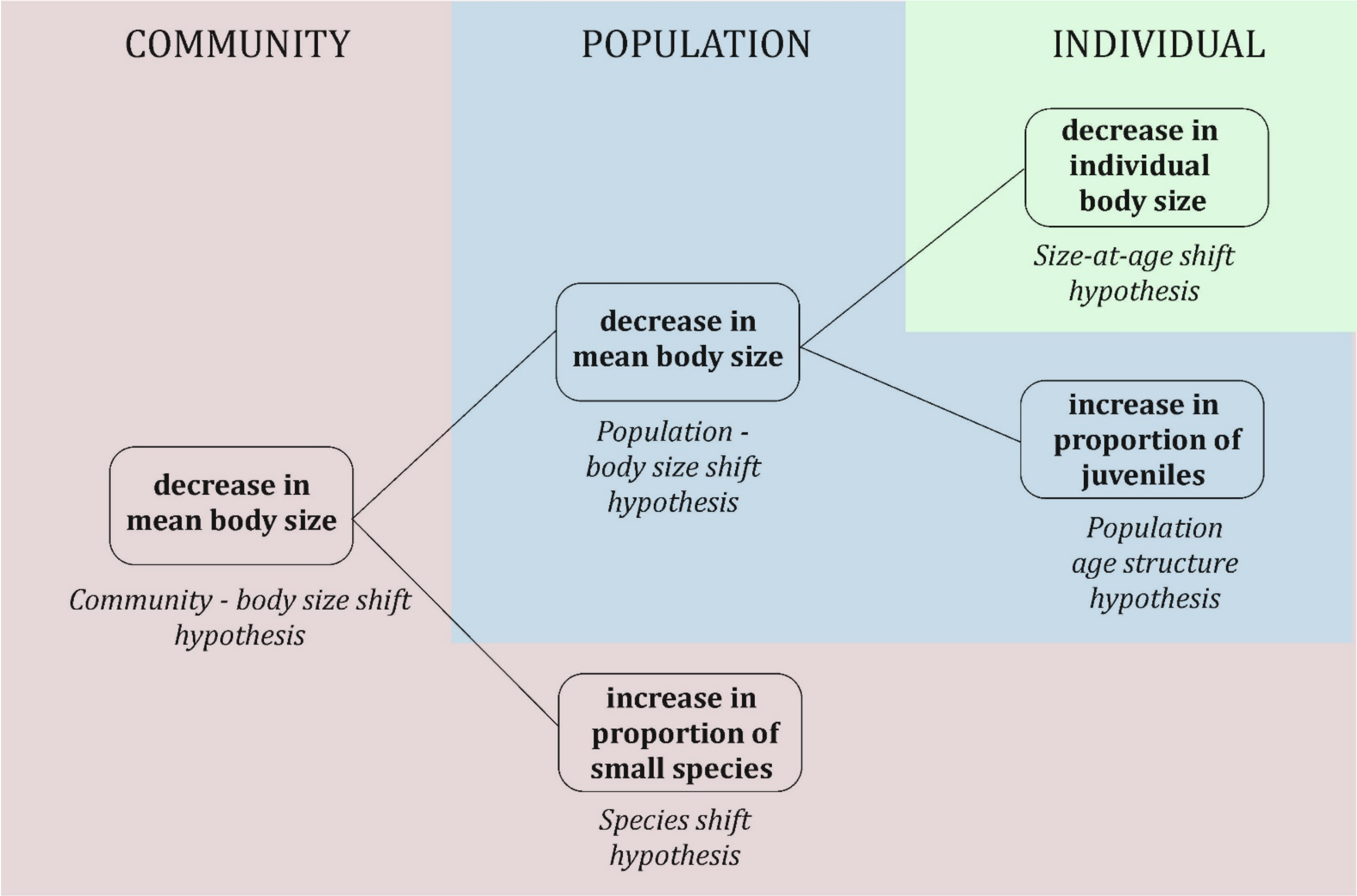
Summary & Conclusions cont.



Modified from Daufresne et al. 2009

Thank you for your attention

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

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