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Trait composition of the plankton community across environmental gradients.

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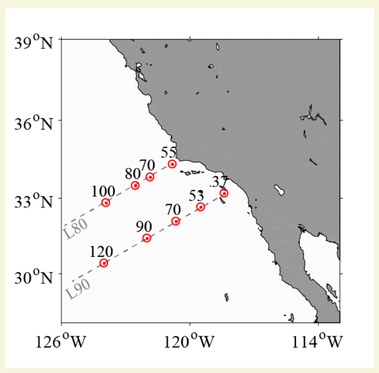
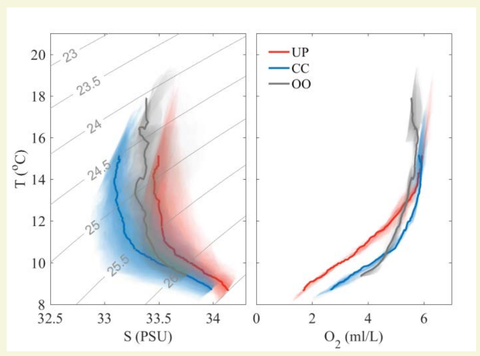
Abstract

Contrasts in the community composition are usually attributed to differences in the underlying environment; however, predator-prey interactions often play an equally important role in structuring communities. Systematic differences observed between nutrient-rich and poor environments, cascade further up the food chain, which is particularly evident in planktonic systems. We analyse plankton communities across the California Current, Ecosystem which span multiple trophic levels, from bacteria to meso-zooplankton, and experience contrasting environmental conditions, from nutrient-rich upwelling to oligotrophic oceanic environments. We focus on traits related to resource acquisition that affect predator-prey interactions. The level of biomass varies 5-fold across environmental regions, yet, size distributions remain similar. The relative trait composition remains comparable between regions, with significant differences being confined to a small range of size or trait groups. Our trait-based analysis demonstrates that the relative trait distribution is remarkably conserved across the environmental gradient, even in the face of large differences in biomass.

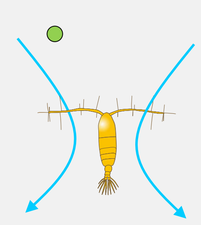
Classifying ecosystem provinces in time and space

Random forest classifier based on T, S, O_2 used to classify observations into 3 categories; Upwelling waters (UP), California Current (CC) and Open Ocean (OO).



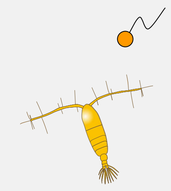


Mechanistic predator–prey coupling in activity traits



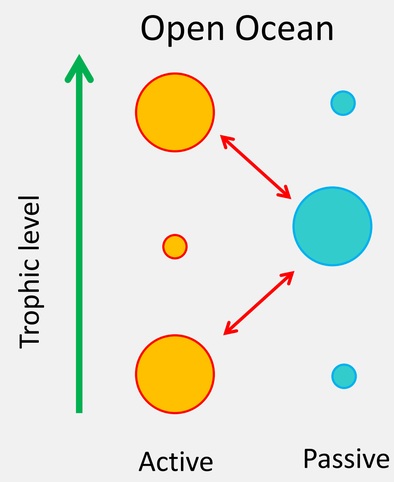
Active feeding mode (e.g. suspension feeding or cruising): relatively high cost and high risk but greater search volume.

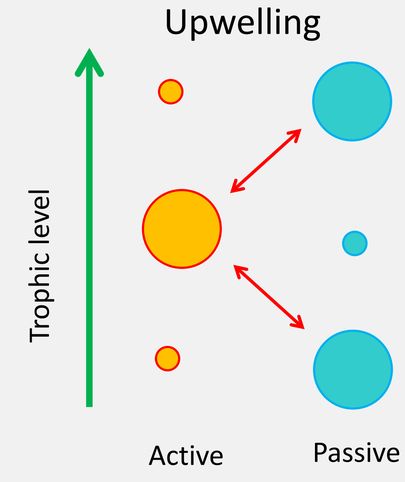
Targets non-motile prey



Passive feeding mode (e.g. ambush): relatively low cost and low risk but rely on prey motility for encounters.

Targets motile prey



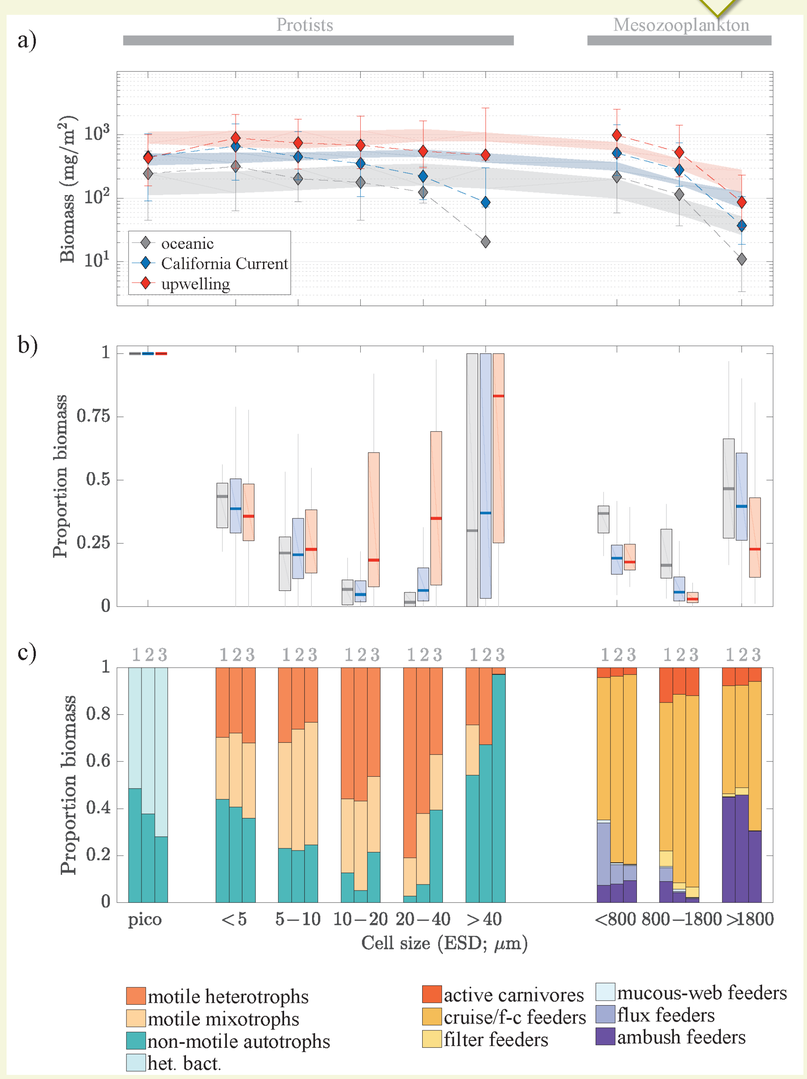


Hypothesis: resource acquisition along an active – passive axis will show district patters in the dominant trophic trait alignment from nutrient rich upwelling waters to the oligotrophic open ocean.

Plankton Community Traits

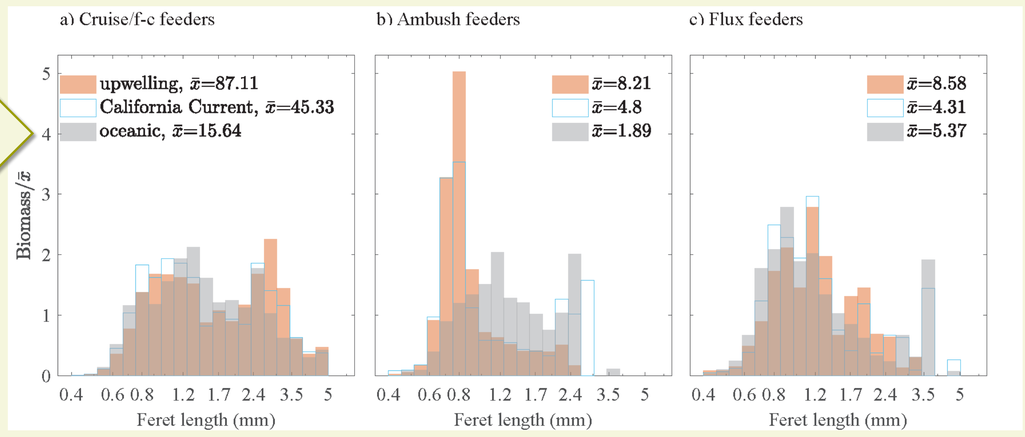
Taxonomic groups classified according to activity level:

Trait classification		Taxonomic group
PICOPLANKTON		
Passive	Heterotrophs	Heterotrophic bacteria
Passive	Non-motile autotrophs	*Synechococcus* spp *Prochlorococcus* spp
NANO- AND MICROPLANKTON		
Active	Motile heterotrophs	Heterotrophic dinoflagellates Heterotr. flagellates Ciliates
Active	Motile mixotrophs	Dinoflagellates Flagellates Cryptophytes
Passive	Non-motile autotrophs	Diatoms Prymnesiophytes
MESOZOOPLANKTON		
Active	Other	Cnidaria+Ctenophora Ostracoda Polychaeta
Active	Cruise/ feeding-current feeders	Euphausiacea Calanoida
Active	Filter feeders	Doliolida+Salpida Appendicularia
Passive	Mucous-web feeders	Pteropoda
Passive	Marine snow/ flux feeders	Harpacticoida Poecilostomatoida
Passive	Ambush feeders	Oithonidae Chaetognatha



Plankton community structure for the 3 provinces (1: OO, 2:CC, 3: UP)
(a) plankton biomass for each size class
(b) proportion of the biomass characterized by the passive traits
(c) annual mean trait composition of each plankton size group
based on resource acquisition for protists and feeding strategy for mesozooplankton.
Passive traits are indicated in cold colours, and active traits in warm.
Total biomass within each size group is corrected for uniform, logarithmically-spaced size bins.

Copepod community



Size distribution of copepod taxa grouped according to their dominant feeding strategy for Oceanic, California Current and Upwelling: a) cruise/feeding-current feeders (active), b) ambush feeders (passive) and c) marine snow/flux feeders (passive)

Conclusions

Comparable biomass distribution slope; 5 times higher biomass in the upwelling regions across community size classes.

Increase in proportion of autotrophic protists observed only for cells >10µm; constant proportion of mixotrophs across regions.

Passive feeding strategy of zooplankton favoured offshore

Overall, the relative traits distribution is remarkably conserved across environmental gradient, even in the face of large differences in biomass

This is a collaboration between the Technical University of Denmark and Scripps Institution of Oceanography funded by the Gordon and Betty Moore foundation. Its goal is to develop a mechanistic, trait-based model of marine plankton ecosystems spanning multiple trophic levels from bacteria to zooplankton.

http://www.mecano-plankton.dtu.dk/