Zooplankton sampling in the Labrador Sea region

Zooplankton samples have been collected at stations along a section (AR7W) between southern Labrador and Cape Desolation (Greenland) since 1995. This sampling will continue into the foreseeable future.

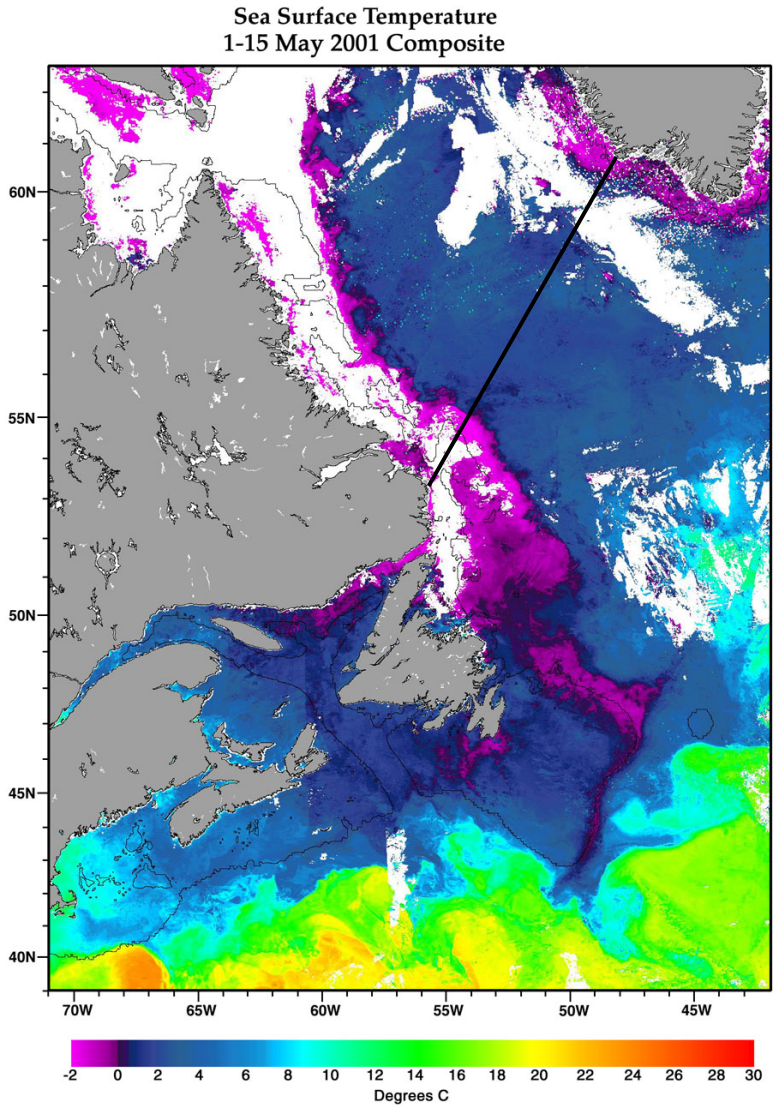
Sampling was in late May (’96,’97,’01,’04,’05, ’06,’07,’08,’09), early June (‘01), late June (‘98), early July (’95,’99,’02) and late July (‘03). There were “extra” cruises in October (‘96) and December (‘02).

Sampling was generally by vertical net tow (200 μm mesh, 0-100 m) at 20+ stations.

There were vertically stratified vertical net tows (by Multinet) to 1000 or 2000 m in July ’03 and December ’02.

There were 76 μm mesh vertical net tows (0-100 m) in May ’05-’09.

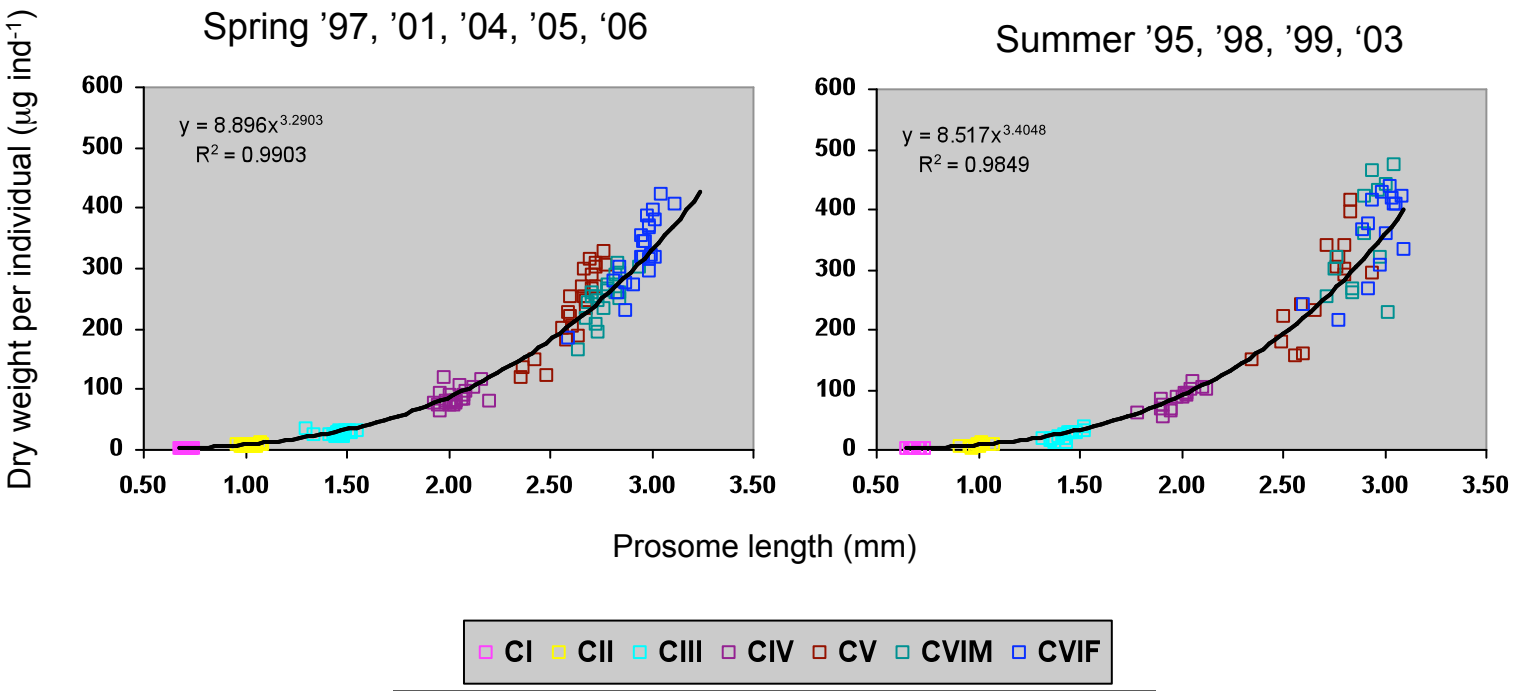
Hydrographic profiles and water sampling are also carried out at all stations (T, S, Chl., nuts etc.).



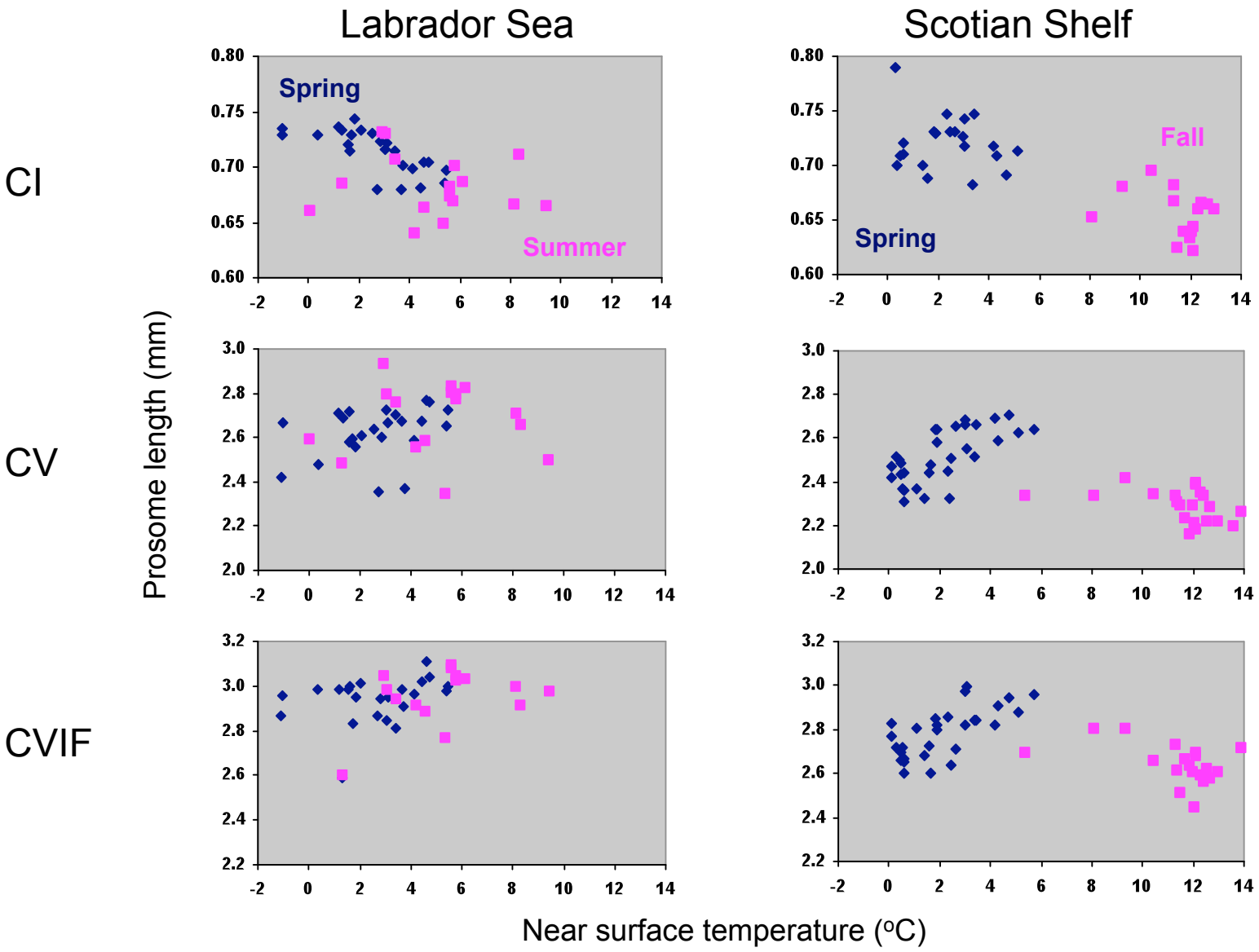
Length/weight relationships for *Calanus finmarchicus* stages in the Labrador Sea

Analysis of preserved samples between 1995 and 2006 included measuring prosome lengths on ~30 individuals of all available stages of three *Calanus* species for every ring net tow and dry weights for the groups of ~30 individuals.

Data for each year have been averaged over stations within regions of the L3 line that correspond to the Labrador Shelf, Labrador Slope, Central Labrador Sea, Eastern Labrador Sea and Greenland Shelf.



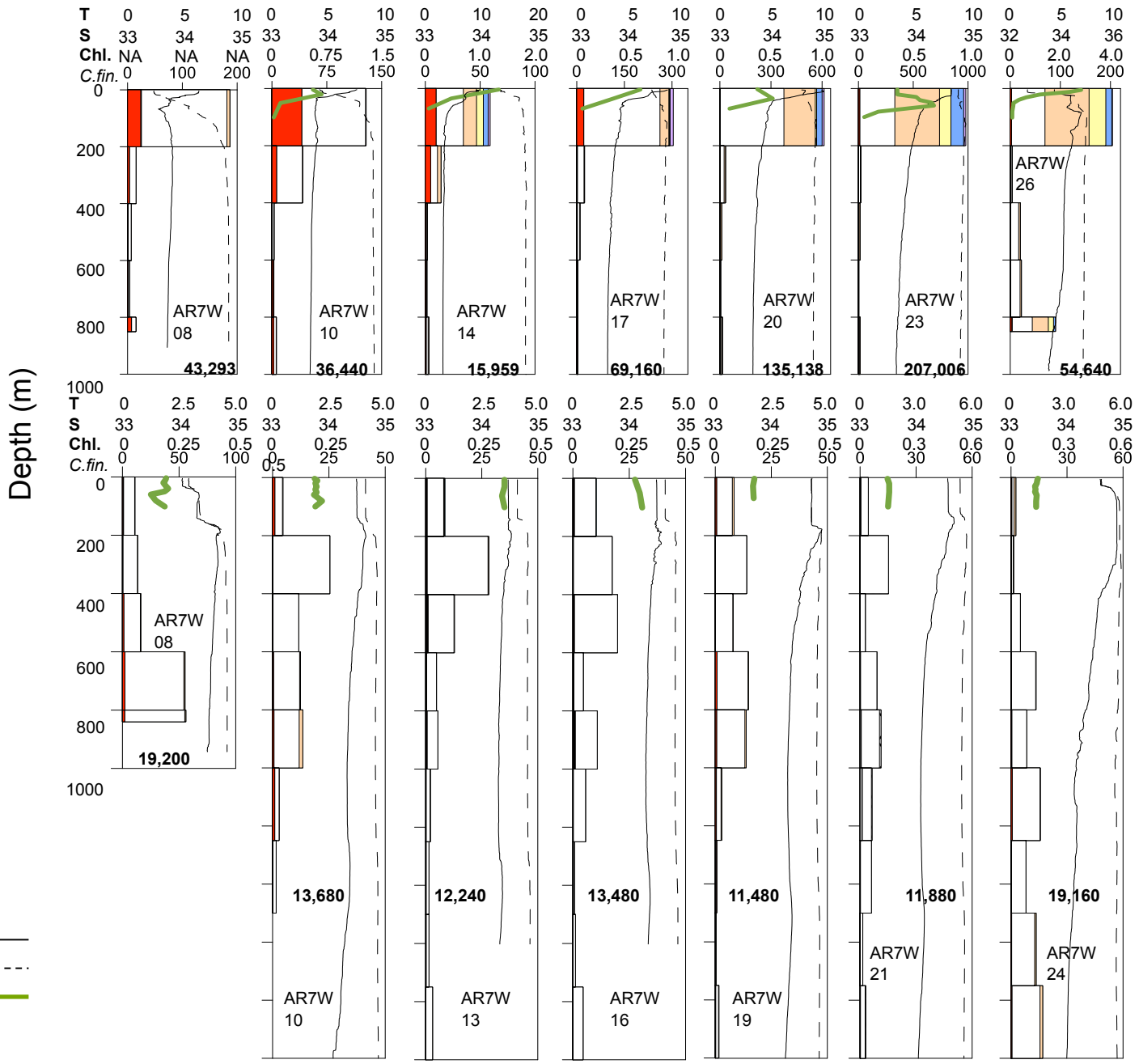
Prosome length versus near surface temperature for *C. finmarchicus* in the Labrador Sea and Scotian Shelf regions



Vertical distribution of *C. finmarchicus* in late July (upper row) and December (lower row) along the AR7W section (from Head et al. 2010)

C. finmarchicus have not started their downward migration by late July.

Overwintering depths (December) are variable.

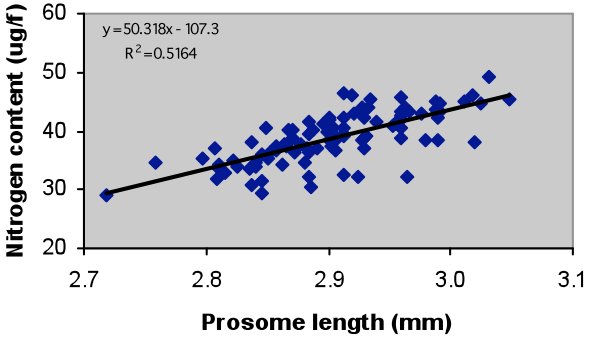


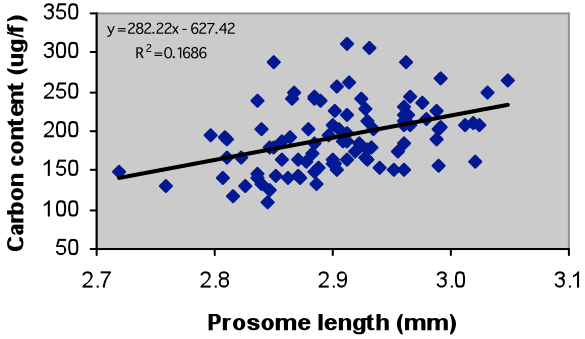
Egg production rates for *Calanus finmarchicus* in the Labrador Sea

Egg production rates (EPRs) were measured for female *C. finmarchicus* incubated individually in petrie dishes at 89 stations of the AR7W section in May 1997, 2000, 2004, 2005, 2006, 2007 and 2008 and June/July 1999, 2001, 2002 and 2003.

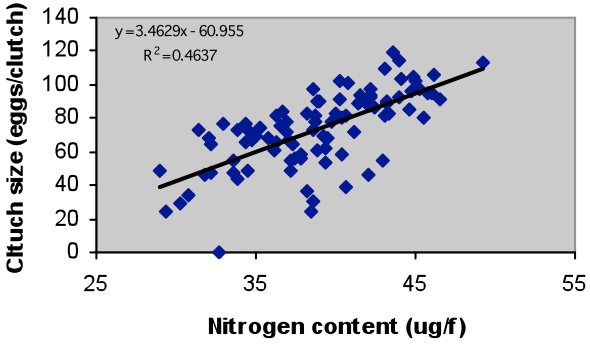
Data shown here are for individual stations, averaged over the 20-30 experimental females.

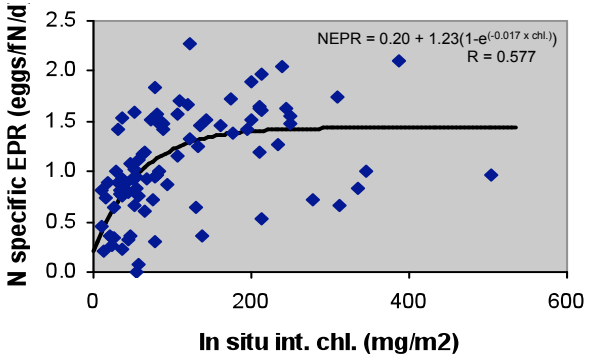
Individual female prosome lengths were closely related to N content, and less so to C content.



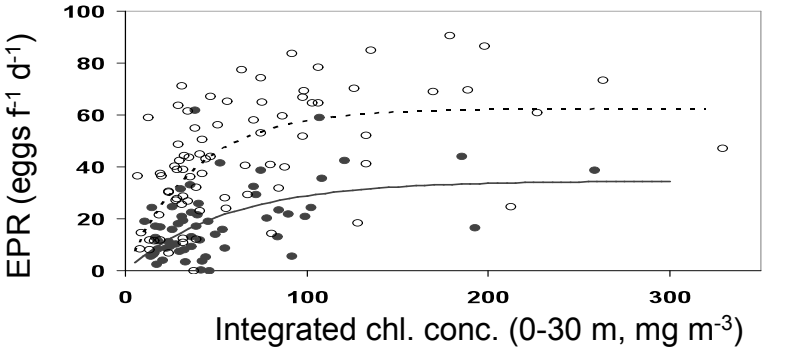


Clutch sizes (no. of eggs produced per spawning female in 24 h) were related to female N content, and N-dependent EPRs were dependent on *in situ* chlorophyll conc.

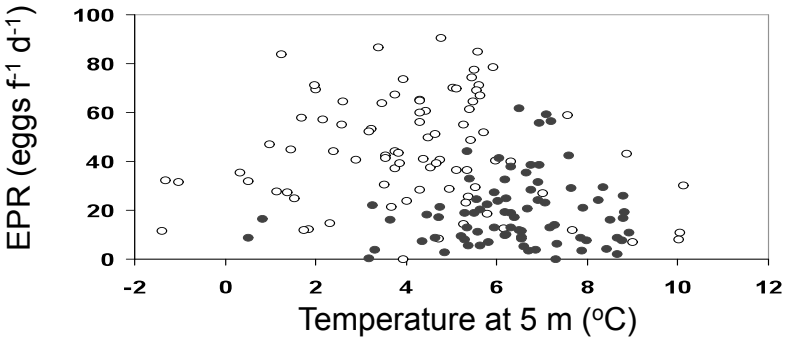




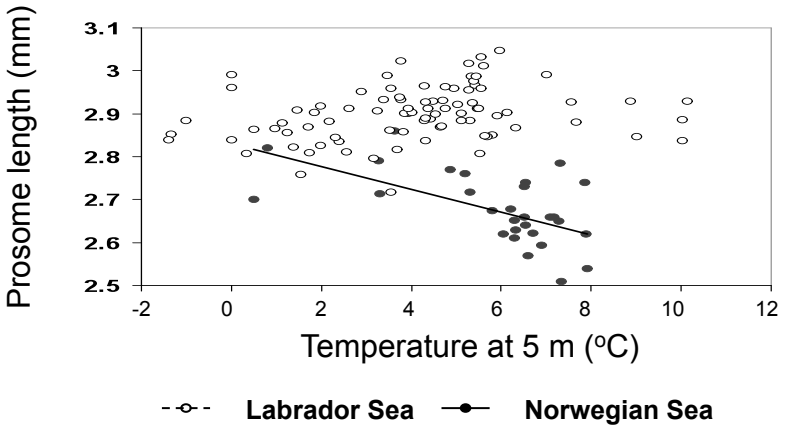
Comparison of egg production rates (EPRs), food and temperature conditions for individual female *C. finmarchicus* in the Labrador Sea and Norwegian Sea regions (from Head et al. 2010)



Individual EPRs were higher in the Labrador Sea.



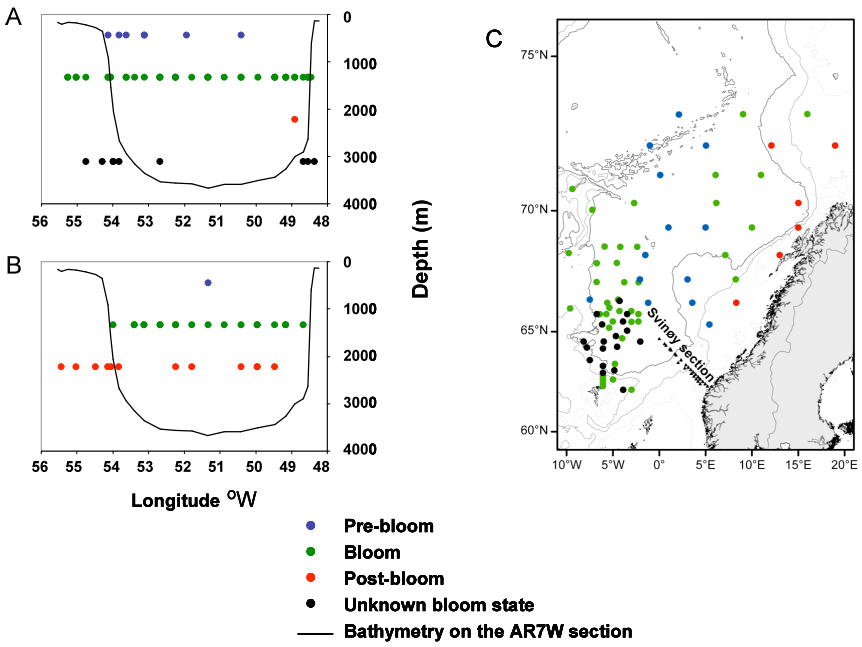
Individual EPRs peaked at temperatures characteristic of bloom conditions – cooler in the Labrador Sea than in the NS.



Females were generally larger in the Labrador Sea, where prosome length did not vary with temperature, than in the Norwegian Sea, where it did.

Comparison of community egg production rates for *C. finmarchicus* in the Labrador and Norwegian seas (from Head et al. 2010)

Stations at which EPR rates were measured, classified by “bloom state”, along the Labrador Sea section in late May (A) or June/July (B) and in the Norwegian Sea (C) in Apr-July.

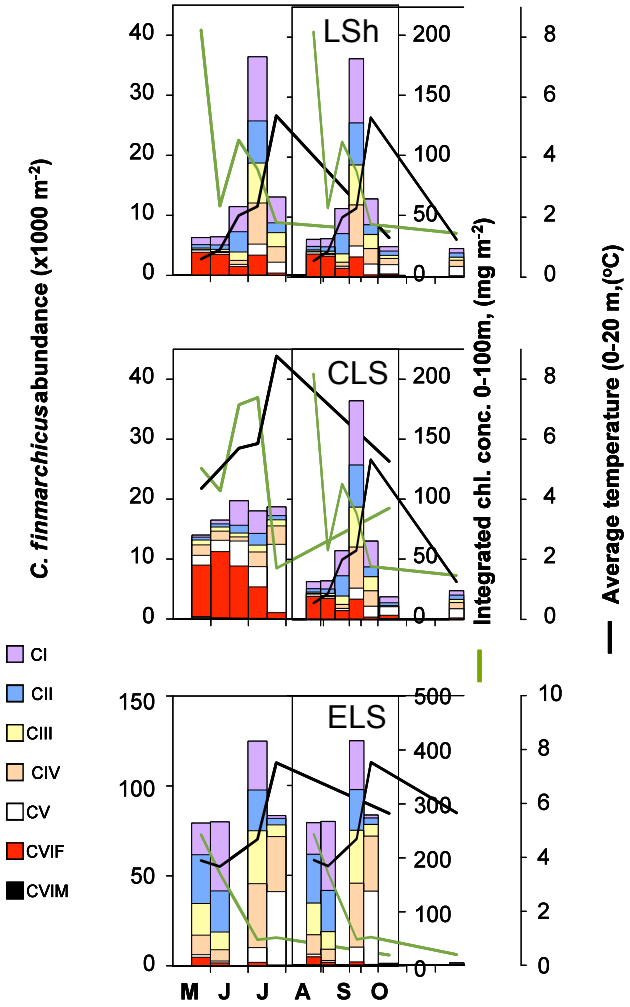


Community (areal) egg production in relation to the state of the spring bloom in the Labrador Sea (LS, red) and the Norwegian Sea (NS, black)

	Pre-bloom		Bloom		Post-bloom	
	LS	NS	LS	NS	LS	NS
Spawning frequency (% d^{-1})	40	60	60	74	41	75
Clutch size (eggs f^{-1})	87	14	78	30	57	24
Female EPRs (eggs f^{-1} d^{-1})	36	10	49	22	25	18
Areal EPRs (1000s eggs m^{-2} d^{-1})	280	150	300	220	70	150

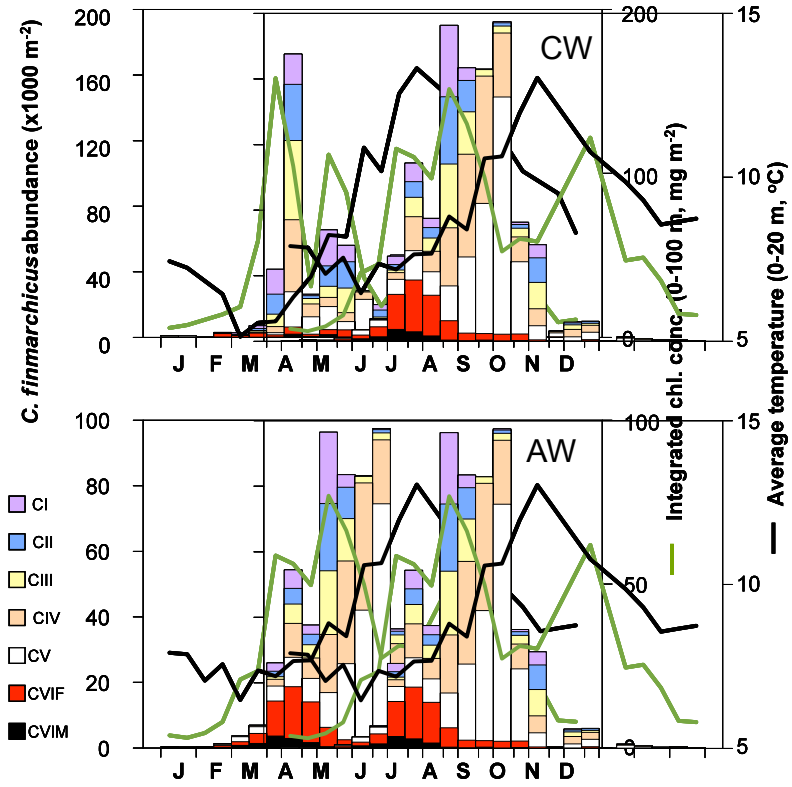
Seasonal cycles of *C. finmarchicus* in the Labrador Sea and Norwegian Sea regions (from Head et al. 2010)

LSh = Labrador Shelf, CLS = Central Labrador Sea, ELS = Easter Labrador Sea
CW = Atlantic waters (Svinoy section), AW = Coastal waters (Svinoy section)



In the CLS EPRs are high (~ 300,000 m^{-2} d^{-1}) in late May but thereafter there are never large numbers of young stages, unlike other areas.

What happens to all these eggs?



Estimation of mortality rates for *C. finmarchicus* eggs in the Labrador Sea

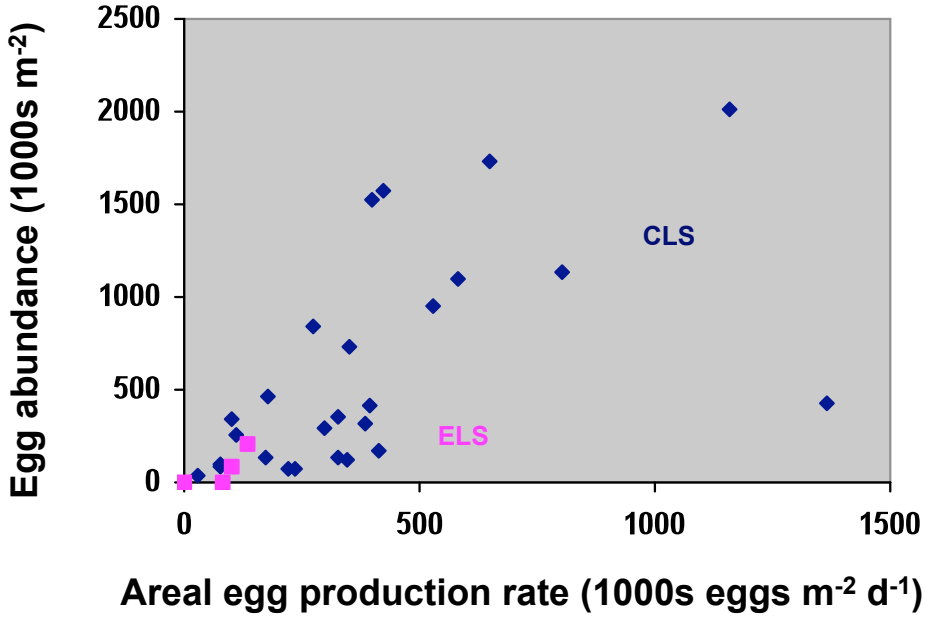
Egg mortality rates can be estimated from calculations of *in situ* community egg production rates and measurements of *in situ* egg abundances according to the following expression (units are d^{-1}):

AEPR/Egg abundance = Hatch rate + Mortality rate

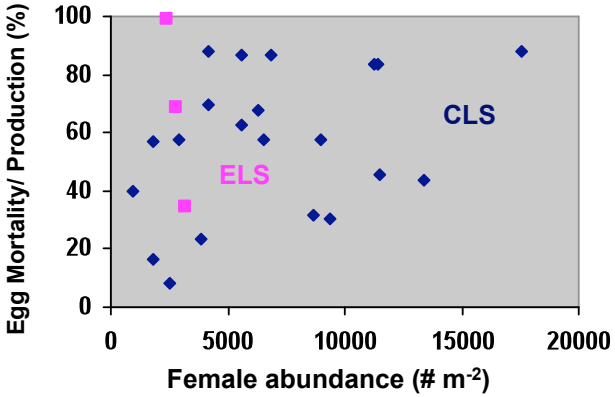
Hatch rates were assumed vary to with temperature according to Corkett et al. 1986. Observations of hatch rates of 0.33 d^{-1} at 4°C and 0.14 d^{-1} at -1°C fit well with Corkett et al. 1986, but not with Campbell et al. 2001.

Abundance of *Calanus* eggs versus areal egg production rates (AEPRs) by station in the Central and Eastern Labrador Sea

Data from May 2005 and 2006 (Labrador Shelf stations excluded)

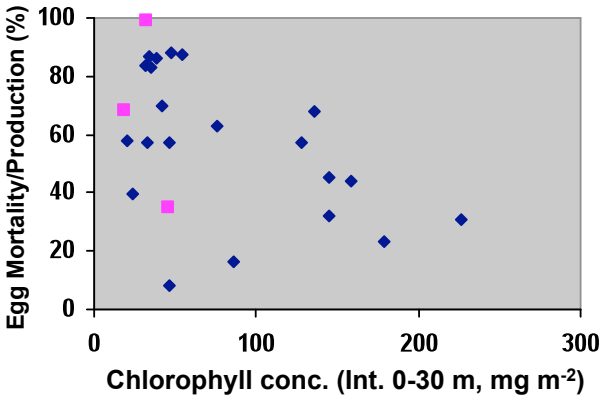


Egg mortality rates as percentages of production rates in May in the Central and Eastern Labrador Sea

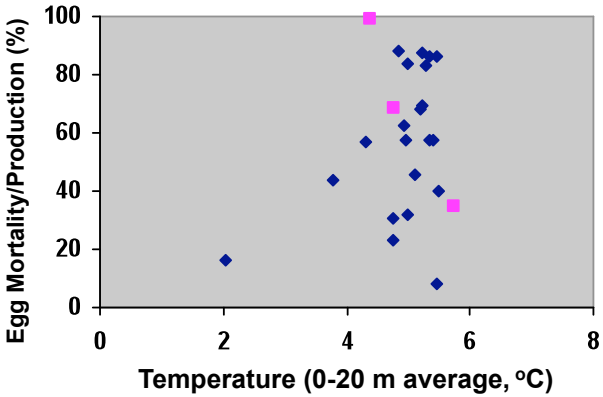


Egg mortality is variable, but

-generally increases with increasing female abundance.
(Cannibalism?)



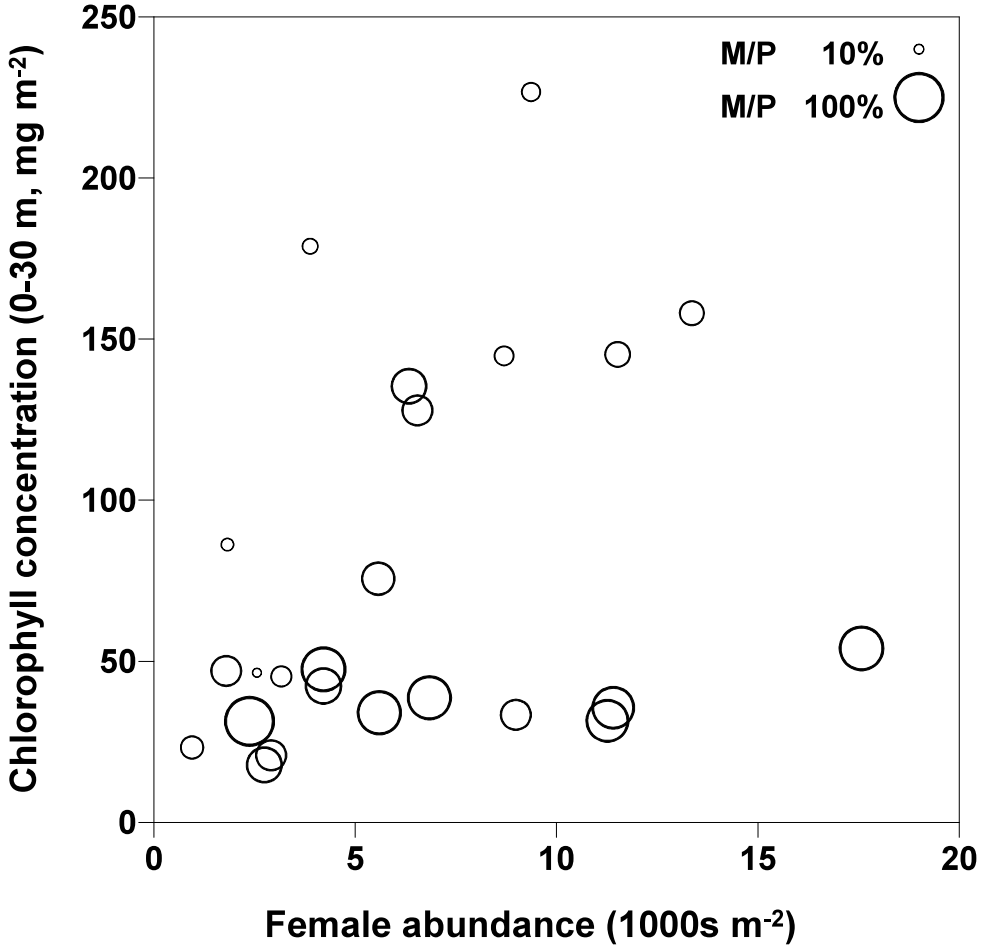
-generally decreases with increasing chlorophyll concentration.
(Adequate food supply reduces cannibalism?)



-shows no systematic change with temperature.

Changes in the egg mortality:production ratio with female *C. finmarchicus* abundance and chlorophyll concentration

Chlorophyll concentration seems more important than female abundance, but eggs do not eat, so the effect of increasing food may be via a reduction in cannibalism.



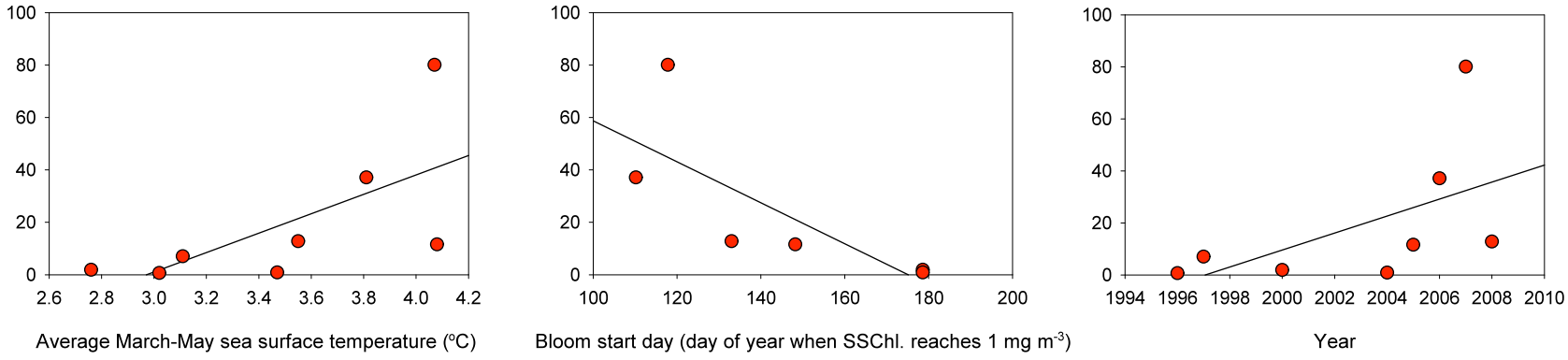
M = Egg Mortality
P = Egg Production

Population development index (PDI) for *Calanus finmarchicus* in the Central Labrador Sea in late May

PDI (%) = Sum(CI-CIII)x100/Sum(All stages)

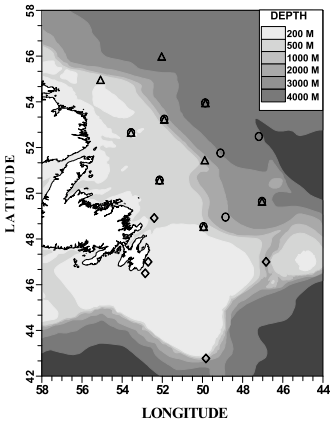
The *C. finmarchicus* population development index (PDI) provides an index of the timing/state of its production cycle calculated using measurements made at a fixed time of year. In the Central Labrador Sea the PDI appears to be related to temperature and the timing of the spring bloom, although linear regressions are not significant.

An unusually high PDI (and abundance of young stage copepodites) was associated with a peak in overall abundance in 2007, although the bloom start date was not the earliest that has been recorded; neither was the sea surface temperature the warmest.

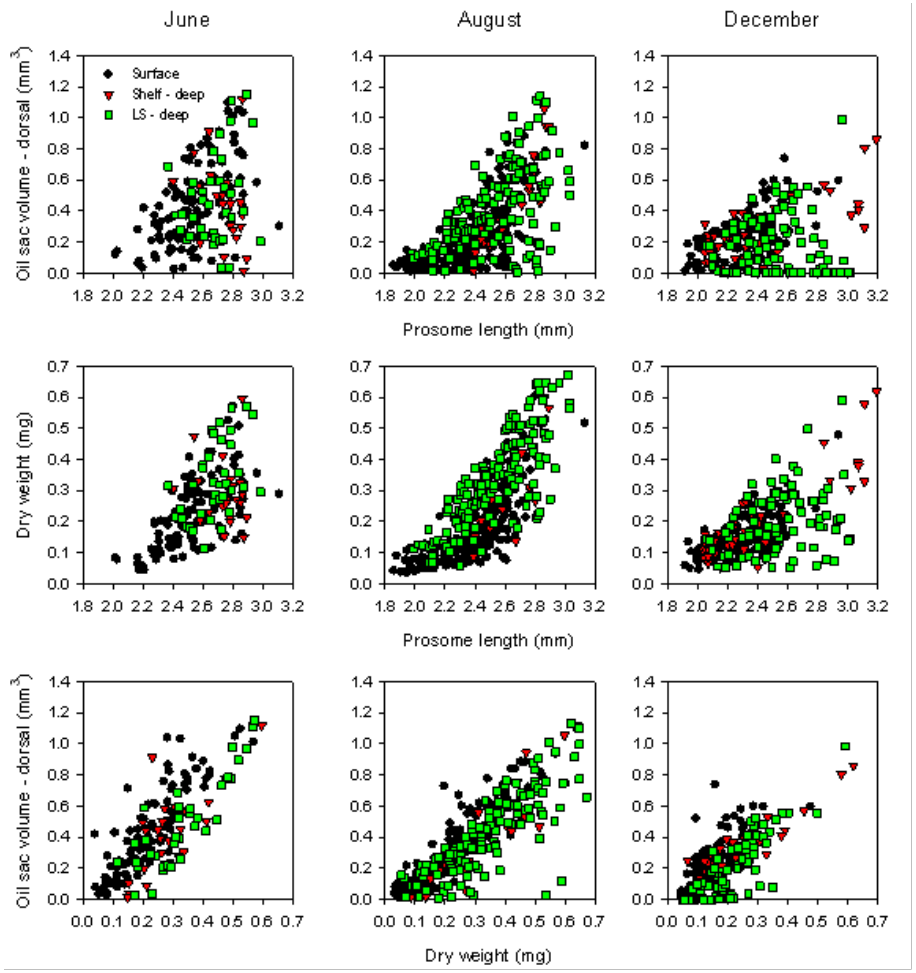


Size and lipid content of CV *C. finmarchicus* on the Newfoundland Shelf and in the SW Labrador Sea

Zooplankton were collected in vertically stratified tows in June, August/September or November/December 2006, using the Multinet.

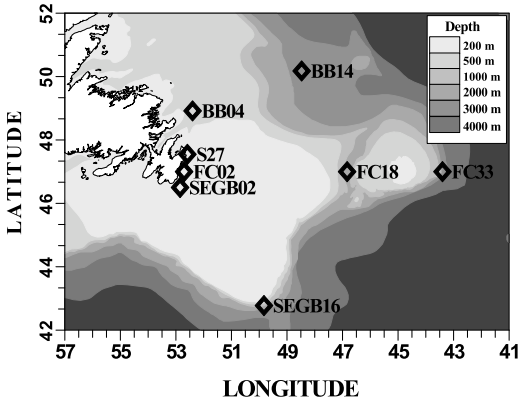


Prosome lengths, dry weights and oil sac volume/areas and C and N content were measured for CV *C. finmarchicus* from surface and deep depth strata.



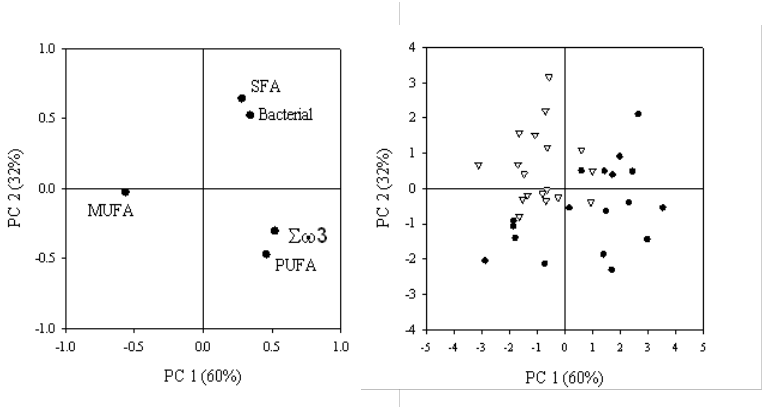
Pepin, P. and Head, E.J.H. (2009) Seasonal and depth-dependent variations in size and lipid contents of stage 5 copepodites of *Calanus finmarchicus* in the waters of the Newfoundland Shelf and the Labrador Sea. Deep-Sea Res. I. 56: 989-2002

Fatty acid composition of CV *C. finmarchicus* on the Newfoundland Shelf and in the SW Labrador Sea



Zooplankton were collected in vertical ring nets (0-100m, 0-bottom to a max. of 1000m).

Prosome length and oil sac volume were measured on individuals and fatty acid composition of extracted lipid was measured for groups of 10 individuals.



Plots of first (PC1) and second (PC2) principal components showing the position of fatty acid groups (left panel) and observations (right panel). Circles and inverted triangles in the right panel represent samples collected at stations on the shelf and continental slope respectively

CVs in the slope waters were large and had more lipid and the fatty acids were derived from diatoms and omnivory.
CVs on the shelf were small and had less lipid and the fatty acids were derived from dinoflagellates and prymnesiophytes.

From Pepin, Parrish and Head (in prep.)

The End