And what about the gelatinous zooplankton?

A preliminary look at what was going on in August 2002

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INTRODUCTION

The North-East Pacific Ocean has been the centre of interest of the programme GLOBEC NEP. Studies so far have been focusing on Euphausiids and Copepods as a major food for the salmon population. In August 2002 the lack at several station of copepods and the presence of high numbers of gelatinous zooplankton convinced us to look more into this pelagic component.

Gelatinous species frequently dominate oceanic zooplankton assemblages, at both the secondary and tertiary level (Alvariño, 1980; Miller and Daan, 1989; Matsakis and Conover, 1991; Frid et al., 1994; Hansen et al., 1994; Purcell, 1997). Gelatinous carnivores (including siphonophores, medusae and ctenophores) are characterised by high individual and population growth rates, and filtration rates that belie their small size (Båmstedt, 1990). As a consequence, they are thought to play an important role in the trophic functioning of some systems (Reeve and Walter, 1978; Purcell, 1981, 1982; Alldredge, 1984; Feigenbaum and Maris, 1984; Miller and Daan, 1989; Pagès et al., 2001). Like other gelatinous carnivores, siphonophores tend to have limited mobility and they have been used as indicators of water masses and water mass movement (Mapstone and Arai, 1992; Pagès and Kurbjeweit, 1994; Gibbons and Hutchings, 1996; Pagès, 1996; Gasca, 1999; Gibbons et al., 1999).

This paper examines preliminary data on the spatial distribution of gelatinous zooplankton and their potential impact on the pelagic food web.

METHODS

1- Vertical plankton tows were performed during the GLOBEC-NEP cruise in August 2002 NEP Ocean. Depth of sampling was 100m when possible otherwise was done between the surface and 10m off the bottom. Samples were preserved in 3% buffered formalin/sea water solution. Upon return to the lab 22 stations were examined. Total sample per station was rinsed, transferred into a graduated cylinder and allowed to settle for at least 1 hour. The sample was then examined under a dissected microscope and all gelatinous zooplankton counted. Only siphonophores were described to the species level. Total zooplankton volume and abundance of gelatinous zooplankton were converted by m^3 knowing total filtered volume.

2- Tentaculate ctenophores were collected at different stations during the cruise. Some individuals were measured under dissected microscope and preserved in 3% buffered formalin/sea water solution; they were re-measured 3 months later in order to estimate shrinkage with preservation. Another set of individuals were measured, then placed in a pre-weighed combusted aluminium boat and dried on board at 60°C for 48h. Aluminium boats were re-weighed upon return to the lab and dry weight of ctenophore calculated. Another set of individuals were directly preserved in 3% buffered formalin/sea water solution and measured (length and dry weight) 3 months after preservation to assess changes in the relationship length/dry weight with preservation.

3- Ten freshly caught Pleurobrachia were placed alive in 1 gal clear plastic container filled with surface sea water (sieved over a 200µm mesh) at ambient temperature (11°C). A known concentration of copepods was added to each container. Prey were either divided by size: large (Calanus marshallae) and small (Pseudocalanus sp.) or mixed in order to estimate prey size preference. The experiment was run for 24h. At the end of the experiment both predator and prey were preserved in formalin/sea water solution. Upon return to the lab, remaining prey were counted under dissecting microscope and feeding rates were estimated.

RESULTS and DISCUSSION

•Only a few stations have been studied so far (Figure 1) (lack of availability of any physical data will limit our explanation here).
•Richer phytoplankton area were located closer to the shore
•Total zooplankton volume (only estimate of zooplankton abundance available) showed lower values offshore on line NH.
•All gelatinous zooplankton taxa were counted from vertical plankton tows
  •Few taxa show higher affinity for offshore waters (doliolids and salps) while others appear more often sampled in onshore waters (chaetognaths and small medusae). The rest of the taxa do not appear, so far, to be showing any specific distribution, additional samples might give a better image
  •Siphonophores were represented by low number of species: Muggiaea atlantica, Nanomia bijuga, Agalma elegans and Sulculeolaria chuni). Eudoxids (sexual phase of siphonophores) were present in most of the area, often in higher numbers than the polygastric phase. M. atlantica is a neritic species, but its absence from the onshore station might be related to water temperature too cold (11°C).
•These taxa will impact the food web directly or directly by their very different feeding habits, feeding upon copepods, or copepods food (microzooplankton and phytoplankton) as well as copepods predators (fish larvae). They also feed upon fish eggs, other gelatinous zooplankton.

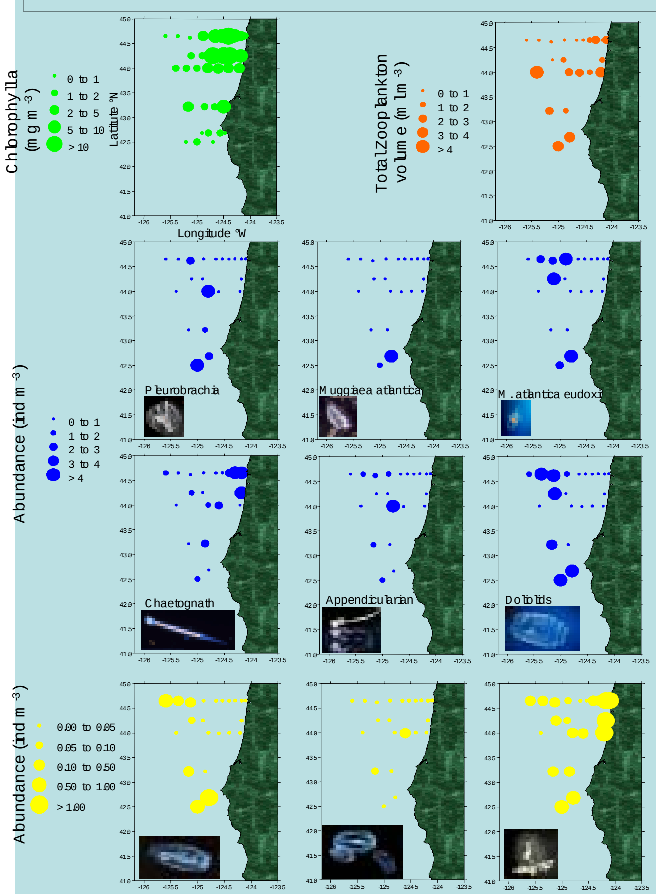

Figure 1. Distribution of the total zooplankton biomass (ml m -3) and of the abundance (ind m -3) of the main gelatinous zooplankton group in the NEP Ocean in August 2002

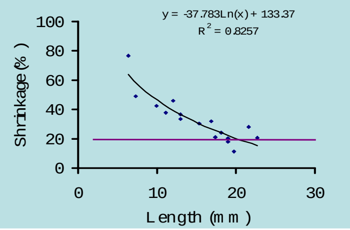

Figure 2. Impact of preservation with formalin/sea water solution on the length of Pleurobrachia bachei

•Pleurobrachia bachei individuals will shrink in length and weight when preserved in formalin solution due to osmotic reaction.
•Shrinkage in length (Fig 2) is a function of the size of the specimen with smaller ones loosing proportionally more water than larger ones. This result contradicts previous works (Oorthuyzen & Sadée, 1982; Yip, 1982) that reported a constant shrinkage of 20%.
•Length/weight relationship (Fig 3a) for P. bachei in the NEP region is similar to previously reported data.
• Shrinkage in weight occurred too (Fig 3b), but because we were unable to weight specimen before placing them in formalin solution we can only deduce this from the change in the length/weight relationship.

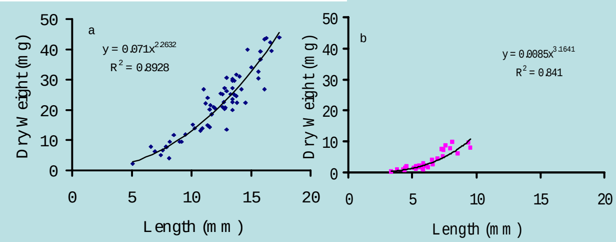

Figure 3. Length-Dry Weight relationship between (a) freshly caught specimen of Pleurobrachia bachei and (b) specimen preserved in formalin/sea water solution for 3 months

•Pleurobrachia feeds on both size zooplankton offered. It appear to be removing small copepods at a higher rate, which rate increase with abundance of food supplied. This species removed the same fraction (~40%) of the large copepods whatever level of food supplied.
•Predation rates by Pleurobrachia on the local population of copepods increase with increase in food supply for both size classes of prey. Overall Pleurobrachia appears to be feeding more on small size copepods. But the ingestion in term of carbon through small preys only reached the same level of that through larger preys under high food level condition (Table 1).
•If we apply the rates (Table 1) to the rest of the study area where gelatinous zooplankton have been counted we can estimate the potential impact of predation by Pleurobrachia and Muggiaea atlantica on the copepods population in August (Table 2). Predatory pressure of Pleurobrachia appear stronger on both size of prey than that of M. atlantica. Predation by eudoxid phase of this siphonophore were not included in the calculation.

Type of preys	Nb of predators ind m^{-3}	Prey offer prey gal^{-1} (n)	Prey eaten %	Feeding rate prey $predator^{-1}$ d^{-1}	Prey removed prey m^{-3} d^{-1}	Carbon removed µg C m^{-3} d^{-1}
small copepods	4.91	300 (3)	59	16.87	82.82	559.02
small copepods	4.91	900 (9)	74	122.09	300.14	2025.91
large copepods	4.91	100 (3)	42	3.98	19.53	1749.87
large copepods	4.91	150 (9)	41	10.08	23.44	2025.91

Table 1. Predation rates of Pleurobrachia sp. on copepods measured with two prey size (small: Pseudocalanus sp., large: Calanus marshallae) and prey concentration. Prey carbon contents, 6.75 µg C for Pseudocalanus, 89.6 µC for C. marshallae.

Type of predator	Type of preys		Predation rates Average (max.) Prey m^{-3} d^{-1}
Pleurobrachia bachei	small copepods	Low food supply (90 cal L^{-1})	17 (96)
		High food supply (240 prey L^{-1})	122 (694)
Muggiaea atlantica	small copepods *		1.30-2.60 (16.54-33.07)
Pleurobrachia bachei	large copepods	Low food supply (30 cal L^{-1})	4 (22)
		High food supply (35 prey L^{-1})	10 (57)
Muggiaea atlantica	large copepods *		0.60-0.95 (7.63-12.08)

Table 2. Impact of gelatinous zooplankton predation on the copepods population in August 2002. Daily in situ prey consumption values for Muggiaea were taken from Purcell (1982), 2.6-5.2 for small copepods and 1.2-1.9 for large copepods

CONCLUSIONS

•Gelatinous zooplankton were present in most of the study area, and some of them appear to be playing an important on the local food web.
•We will need to get physical and other biological data (such as copepods abundance and biomass) to quantify properly the role of these taxa
•It will be interesting to extend this study of the gelatinous world to previous NEP cruises in order to estimate, if possible, seasonal/annual variations as well as spatial distribution and relate them with changes in the physical/biological conditions occurring in this region
•Cystonects species of siphonophores (Nanomia, Agalma) were observed in high numbers close to the surface. With their pneumatophore they may interfere with stock [illegible]

So are we going to do something about those guys?