MEDFLUX: COMPARISON OF POC MEASUREMENTS IN BOTTLES AND IN SITU PUMPS — TEST OF PRESSURE AND ADSORPTION EFFECTS: ARE SWIMMERS THE ANSWER?

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Introduction

Higher POC estimates from samples collected in Niskin bottles than those from *in situ* pumps are often reported. Bottle and *in situ* pump filtrations were directly compared at the DYFAMED site (France JGOFS time series station) in the Mediterranean. Two hypotheses have been proposed to explain higher POC concentrations found in bottle samples: DOC adsorption to filters particularly in small volume filtrations (Moran et al., 1999), or higher pressure differential across pump filters causing some material to be lost (Gardner et al., 2003). We also propose that particles may form during bottle filtration and that "swimmers" may be caught by bottles. These theories were tested in laboratory experiments as well as field sampling.

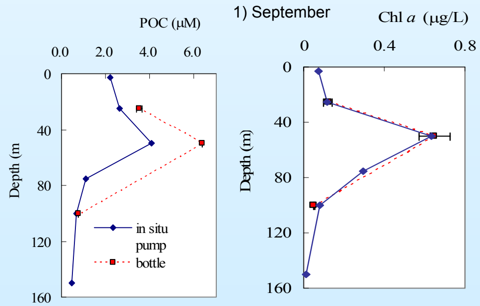
Methods

Table 1. Bottle and *in situ* pump protocols used at DYFAMED

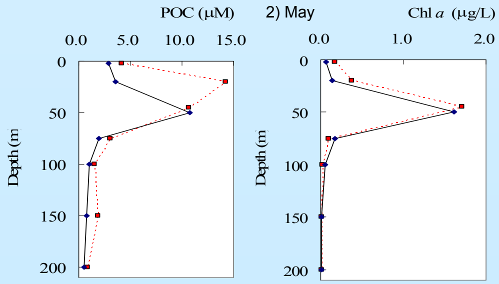
Parameters	Niskin Bottle	Challenger *in situ* Pump
Filter type	25 mm GFF filter	142 or 293 mm GFF filter (70 µm Teflon prefilter)
Pressure drop	0.2-0.9 atm.	~0.6 atm.
Filtration procedures	Seawater was sampled using a 10-liter or 12-liter Niskin bottle and transferred to a Nalgene carboy or polypropylene bottles. One liter was filtered.	293 mm GFF filter with (May) or without (September) Teflon prefiltering.
Amount filtered and filter loading	1 liter ; 0.2 liter/cm^2	~500 liters; 0.8-1.7 liter/cm^2 (292 mm); 2.7-3.3 liter/cm^2 (142mm). Punches (24 mm) were taken from the filters for analysis.

Results and Discussion

1. Niskin bottle and *in situ* pump comparison at DYFAMED

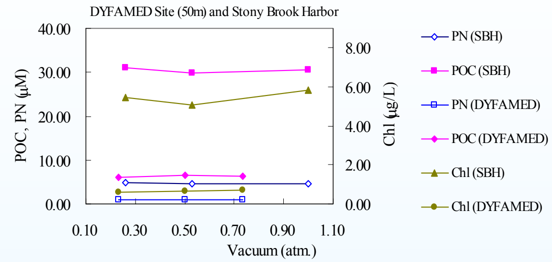


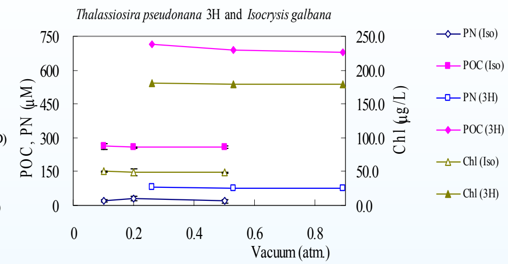
1. POC concentrations in bottles were 1.6 times higher than those from pumps in surface layer (50 m), but Chl *a* concentrations agreed well. Our results suggest that material other than phytoplankton cells are responsible for observed POC discrepancies.



2. In contrast to September, POC concentrations in bottles were 4 times higher than those from pumps at 20 m. This pattern suggests that the cause of the POC difference is greater in May than that in September.

2. Test of pressure hypothesis





We found no evidence that filtration pressure affected POC estimates under vacuum pressures between 0.2 and 1 atm., encompassing the range of both lab and pump filtration. The samples we tested included open-ocean seawater from 50 m at the DYFAMED site, coastal seawater from Stony Brook Harbor (SBH), plankton cultures of *Thalassiosira pseudonana* 3H and *Isocrysis galbana*.

3. Test of adsorption hypothesis

Experiments filtering different amounts of seawater showed that only a small amount of DOC (around 2 µmol) was adsorbed onto the filter. The amount of organic carbon adsorbed was not enough to explain the POC difference observed. We corrected for adsorbed carbon by using stacked filters.

4. Test of particle formation hypothesis

We did not observe particle formation during bottle filtration procedures. Instead, POC decreased upon agitation suggesting that particles can be broken down by relatively strong physical turbulence.

5. Are "Swimmers" the answer?

1) Small zooplankton with 20-500 µm body size, "swimmers", can be caught by Niskin bottles. However, their swimming speeds are generally much higher than the speed at which the *in situ* pump operates (upper estimate 3-4 cm/s). Therefore, we hypothesize that swimmers caught by Niskin bottles could contribute the POC difference between Niskin bottle and *in situ* pumps.

2) Our preliminary data from the DYFAMED site in November show that zooplankton were more abundant in Niskin bottle samples than in those from *in situ* pumps (Table 2).

3) Using Niskin bottles, Anderson et al. (2001a; 2001b) found the maximum abundance of copepod nauplii (>50 µm), the dominant zooplankton (71% of the total standing stock), to be between 25 and 40m. About 25,000 individuals/m^3 were found in these layers at the DYFAMED site in May. If we convert the biomass to carbon values, this is approximately the magnitude of the POC differences that we found between bottles and pumps at 20 m.

4) This "swimmer" hypothesis explains why Chl *a* agrees well, but POC and PN are different, between bottle and pump samples in our direct comparisons at the DYFAMED site. In addition, it also explains well, why the biggest POC difference always occurs in surface layers, and why differences are greater in summer than winter. The observed higher $\delta^{15}N$ signals in the bottle than those from pumps in surface layers (Altabet et al., 1992) is also supported our hypothesis, since zooplankton have higher $\delta^{15}N$ signals than detrital organic matter .

Table 2. Comparison of zooplankton recovered from Niskin bottles and *in situ* pumps.

Sample	Depth (m)	Mesh (µm)	Volume filtered (l)	Radiolarians (#)	Radiolarians (#/liter)	Copepods (#)	Copepods (#/liter)	Copepod Nauplii (#)	Copepod Nauplii (#/liter)
Bottle (1)	20	20	9.69	16	1.65	8	0.83	4	0.41
Bottle (2)	20	70	10.8	7	0.65	11	1.02	5	0.46
Pump	20	70	484	23	0.05	32	0.07	12	0.02
Bottle (1)	50	20	10.1	6	0.59	13	1.29	13	1.29
Bottle (2)	50	70	10.8	6	0.56	4	0.37	2	0.19
Pump	50	70	529	17	0.03	27	0.05	2	0.004

References

Altabet et al., 1992. *Deep-Sea Research* 39, S405-S417

Moran et al., 1999. *Marine Chemistry*. 67, 33-42

Anderson et al., 2001(a; b). *Journal of Plankton Research* 23, 227-261

Gardner et al, 2003. *Deep-Sea Research* II *47, 3423-3449* ,

Liu et al. submitted

The poster is also available: **http://www.msrc.sunysb.edu/MedFlux/**

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