

***Interactive comment on “Short term changes in zooplankton community during the summer-autumn transition in the open NW Mediterranean Sea: species composition, abundance and diversity” by V. Raybaud et al.***

**V. Raybaud et al.**

Received and published: 22 September 2008

We wish to thank reviewer #3 for helpful comments, which improved our manuscript.

1. Specific comments

Page 2240, "Study area": What are the water depths in the area of sampling?

The water depth was 2350m. It was added in the revised paper.

Page 2240, "Study area": It is stated that the position of the time series station was decided on the basis of a transect from the coast to offshore waters. How was this

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decided? I cannot find the data from the transect in the manuscript.

"The positioning of the Time Series Station (TSS) was decided on the basis of a transect from coast to offshore waters. During the transect, CTD casts were performed to determine the position of the hydrological front and the central part of the Ligurian Sea. No biological samplings were performed during the transect. The objective was to locate the TSS offshore of the front. This was already performed during DYNAPROC 1, in May 1995 (Andersen and Prieur, 2000)." These sentences were added in the revised paper.

Page 2241, "Zooplankton sampling": Add a table with haul data. Add numbers to the grid stations and then give details about the dates and times of sampling at each grid station. Also add information about how the data was further treated (Was the data pooled? Were the whole samples counted or were some samples split?).

All zooplankton sampling were performed at the TSS (no zooplankton sampling in the grid station). Concerning the counting: Largest animals were picked up individually from samples, measured and counted. Each sample was diluted to the volume of 50, 60 or 40 mL -depending on visually determined total zooplankton abundance. After that, 1 ml sub-sample was taken with a calibrated Stempel-pipette (Hensen, 1887) in two replicates. In the sub-sample all organisms less than 1.5mm were counted. Animals with a size larger than 1.5mm and rare animals were counted in 1/2, 1/4 or 1/8 of a sample. Rare and larger animals were counted in the whole sample. These details were added in the revised paper.

Page 2242, lines 18ff, "In WP2 samples": Why was it not possible to determine the individuals at species level? Were mainly juveniles caught with the smaller net? If yes, what was the ratio adult to juveniles?

Yes, the WP-II net (200  $\mu\text{m}$  meshsize) caught a large number of juveniles (ratio adult to juveniles: 0.6) in comparison with the BIONESS net (500  $\mu\text{m}$  meshsize). The identification to species level is very difficult (often not possible) with juveniles, which explains

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that only 42% of total number of organisms sampled with WP-II have been determined to species level. A sentence has been added in the revised paper to make clear this point.

Page 2246, "Total zooplankton biomass": How was the biomass determined? Is it wet weight or dry weight?

The biomass is in dry weight. We have added it in text and in figure caption. The procedure of biomass determination is explained in details in Mousseau et al (2008). We have added the reference in the revised version.

Page 2247, first two sentences: Delete these sentences. They are not necessary.

The two sentences have been removed.

Pages 2247 and 2248: Do not jump between the nets. Rearrange this paragraph! First describe the results obtained by the WP2 net and then the BIONESS results or vice versa.

This paragraph was rearranged. We present first WP-II data and then BIONESS results.

Page 2249, lines 17-25: This sentence leads to the impression that copepods actively favour different salinities. Make clear that salinity is used as an indicator of different water masses and that the distribution of zooplankton taxa is related to the water masses.

This sentence has been added in the text to make clear this: "Here, salinity is used as an indicator of different water masses and a significant influence of salinity on zooplankton abundance doesn't mean that these organisms actively favour different salinity but it mean that the distribution of zooplankton is related to the different water masses."

Page 2251, last paragraph of results: Sixteen stations were sampled three times during the cruise, but the sampling period is divided into four time intervals. Why are the differences time-related? Also spatial differences within the sampling grid are possible.

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Please clarify!

"All zooplankton sampling were performed at the TSS. There was zooplankton sampling neither during the transect, nor during grid station. So, no spatial differences are possible." This sentence was added in the revised version. The choice of the four time intervals derived from the method called "Cumsum" (Ibañez et al., 1993) in the second paragraph "Data analysis". "This method allows dividing a temporal series each time that a slope reversal occurred in the cumsum curve." We have added this sentence to explain that in the revised paper.

Page 2252, lines 6-9: The taxa listed here are very common in the zooplankton. It is not very surprising that the periods share a great number of taxa. It would be better to present numbers of these taxa for Dynaproc 1 and 2 in a Table. Then these abundances could be compared with other regions in the Med and elsewhere.

A comparison of major copepods taxa between DYNAPROC 1 and 2 in terms of abundance was added in a table in the revised paper. We compared only WP-II data because BIONESS' one are not concerning the same layer (0-980m for DYNAPROC 1 and 0-250 in our study). We have chosen to limit the comparison with DYNAPROC 1 cruise because it is the only study with the same sampling strategy. The other studies which are dealing with zooplankton in the Ligurian Sea do not have the same sampling strategy and the same time and space scales than DYNAPROC 2. For example, Pinca and Dallot (1995) explored the geographical distribution of zooplankton in the Ligurian Sea but they present the abundance (in ind.m<sup>-3</sup>) in the whole collection, including coastal, frontal and offshore stations. Sardou et al. (1996) studied the seasonal abundance of macroplankton in the NW Mediterranean Sea but they used a 1cm mesh-size net; Gasser et al. (1998) studied zooplankton sampling from a coastal-offshore transect in the Ligurian Sea but they focused their study on the vertical distribution and don't considered the short time-scale variations like in our study. McGehee et al. (2004) studied several physical and biological parameters in the whole Ligurian Sea (37 stations) but zooplankton was counted at only 3 stations and they didn't study

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temporal variations of zooplankton abundance. So, DYNAPROC 1 cruise appears the only study which presents short-term variation of zooplankton abundance during one month, in the central part of the Ligurian Sea, using WP-II and BIONESS net.

Page 2252, lines 11-14: It would be interesting to see the relative abundance of these taxa during Dynaproc 1.

During DYNAPROC 1 (Andersen et al., 2001a), the relative abundance of these species with BIONESS net was: *C. helgolandicus*: 28.5% *C. typicus*: 1.3 % *M. typical*: 4.5 % These data were added in the revised paper.

Page 2252, line 17: Information about the biology of *Mesocalanus* would be useful. Is this species an indicator of low salinity waters? What was the abundance of this species in coastal areas? Was it also found on the transect from the coast into the Dynaproc area?

During DYNAPROC 2, there was zooplankton sampling neither in coastal stations nor during the transect. All samplings were performed at the time series station, in the central part of the Ligurian Sea. *Mesocalanus tenuicornis* is an oceanic species which was founded in all temperate and subtropical waters (Beaugrand et al., 2002; Keister et al., 2003; Morgan et al., 2003; Mackas et al., 2005). In the Ligurian Sea, Pinca et Dallot (1995) suggested that the central part is favourable environment for the development of the large copepods species like *M. tenuicornis*. However, McGehee et al. (2004), who studied the spatial distribution of copepods in the Ligurian Sea, shows that (i) this species is not totally absent from the coastal zone, (ii) in two stations of the central part of the Ligurian Sea, this species is absent in one station and present in large numbers in the neighbour station. Meanders in the frontal structure might explain the differences in the spatial position of the maximum of abundance for some copepod species (Boucher et al., 1987). For DYNAPROC 2 cruise, we suggest that *M. tenuicornis* founded favourable conditions in the low salinity water mass and have been trained by the water displacement We have added more discussion about this species in the

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revised paper.

Page 2253, lines 19ff: Does a transport of coastal species into open waters also occur in other regions? I would like to see a discussion on this topic! For example, the transport of *Calanoides carinatus* from coastal upwelling regions into the open ocean in the Atlantic and the Arabian Sea.

Kelly-Gerreyn et al. (2006) studied low salinity water intrusions in the western English Channel but their study has only a physical orientation. They were dealing with the origin, the transport and the occurrence of such intrusions but did not address the biological aspect; they didn't study the organisms living in such intrusions. The offshore transport of coastal species was extensively studied in upwelling systems. Some copepods species have a life cycle linked to transport water from the coast to offshore, such *Calanoides carinatus* (Peterson, 1999). For such a system, there must be a match between the upwelling time scale and the life cycle of copepods time scale. In our study, the time and space-scale is much smaller than in an upwelling system. We studied a coastal water lens with a thickness not exceeding 50m, who crossed the sampling area in only 9 days, which is shorter than the lifetime of large copepods. The time and space-scale are so different that we cannot compare our study to a system of upwelling. Moreover, even if we observed 2 lenses during the one-month cruise, they are sporadic phenomena: thereafter, the ecosystem returns to its initial characteristics. Nevertheless, we agree with referee 3 that transport of coastal species into open waters was extensively studied. So, we have added, in the revised paper, a paragraph to explain the differences between the upwelling regions and the transport of organisms in the LSW during DYNAPROC 2.

Page 2254, lines 22-23: How is the flux of matter affected by the offshore transport of zooplankton? Give more details! How much material is transported? How big is the increase in organic matter flux? Enhance the discussion on this topic. Also use other literature sources for comparison. This is a critical point in the manuscript and a sophisticated discussion on this topic is necessary to accept the manuscript for

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publication.

"Miquel et al. (2008) studied the particle flux with sediment trap during DYNAPROC 2 cruise. At 200m depth the total mass flux shows important changes during LSW-1, when zooplankton abundance increased. From day 262 to 268, the average total mass flux was 30 mg.m<sup>-2</sup>.d<sup>-1</sup>. On the contrary, after the low salinity event, the average total mass flux was twice lower (it was fluctuating around 15 mg.m<sup>-2</sup>.d<sup>-1</sup>). Zooplankton greatly contributes to matter flux to deep layer by its faecal pellets and its daily migration (Conte et al., 2001)." This was added in the discussion of the revised paper.

Table 1: Add the number of day and night samples.

"During day, 18 samples with WP-II and 18 with BIONESS net were performed; during night, 17 samples with WP2 and 20 with BIONESS." This sentence was added in the caption of the table 1.

Appendix: These tables are useless without a temporal resolution because the paper deals with temporal changes. Modify the tables accordingly.

The temporal changes in the abundance of each zooplankton taxa could not be presented because of the great number of taxa counted. Nevertheless, as you have suggested in the end of technical comments, we have presented the data with number instead of categories. For each taxa, we give the average abundance, minimum and maximum.

## 2. Technical comments and suggestions for rewording

All technical comments and suggestions for rewording were followed in the revised version of the manuscript.

Page 2254, line 21: "frequent than previously thought". Add a citation!

We have reformulated this sentence and added a citation: "The cruise lasted only one month but two coastal water intrusions were observed, which suggest that the central

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part is not so isolated than thought by Béthoux and Prieur (1983).

References :

Miquel et al. Particle flux in the open NW Mediterranean Sea in autumn 2004. *Biogeosciences Discuss.*, to be submitted, 2008.

Interactive comment on *Biogeosciences Discuss.*, 5, 2237, 2008.

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