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Interactive comment on "Spring distribution of shelled pteropods across the Mediterranean Sea" *by* Roberta Johnson et al.

Anonymous Referee #1

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Whilst this study provides an interesting dataset, there are significant issues in the design of the study and the analysis of the results that bring into question the findings.

Whilst the dataset used in this paper is definitely a useful resource, I regret that I do not think that it can be used in the way that the authors have outlined. My impression is that the sampling was not designed with the study question in mind, rather that the dataset already existed, and the study undertaken as an attempt to use it in some way. As a result, there are several issues with the use of the data to infer environmental controls on pteropods. I understand the limitation of field studies and appreciate the time, effort and resource required to acquire samples however, I do not feel that the dataset can be applied in this way to answer this study question.

The sample depth of 200 m is relatively shallow for sampling many of the species. The

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early work of Rampal (1975) very clearly showed that many species exhibit seasonal depth preferences, with some populations spending many months of the year at depth in excess of 700 m. I do appreciate the difficulties in accessing this work as it is an unpublished thesis (in French) but it is available by request from a number of international libraries and is absolutely essential reading for this type of work in the Mediterranean. I suspect this is why Cavolinia inflexa were underrepresented and did not appear to be tied to any environmental parameter as, at this time of year, most of the population is found below the sampling depths and the samples will have just picked up the odd individual.

Rampal J. Les thécosomes (molluques pélagiques). Systématique et évolution - Écologies et biogéographie Mediterranéennes [These doctoral]. Université Aix-Marseille I1975.

Mediterranean pteropods have also been shown to undertake diurnal vertical migrations. At least two of the main species found in the nets exhibit a strong diurnal vertical migration and the sampling of each station was undertaken at different times in the day/night cycle, thus potentially skewing the data. See papers:

Andersen V, Francois F, Sardou J, Picheral M, Scotto M, Nival P. Vertical distributions of macroplankton and micronekton in the Ligurian and Tyrrhenian Seas (northwestern Mediterranean). Oceanol Acta. 1998;21(5):655–76.

Tarling GA, Matthews JBL, David P, Guerin O, Buchholz F. The swarm dynamics of northern krill (Meganyctiphanes norvegica) and pteropods (Cavolinia inflexa) during vertical migration in the Ligurian Sea observed by an acoustic Doppler current profiler. Deep-Sea Res Pt I. 2001;48(7):1671–86.

Introduction: The introduction seems to lack a depth of research, especially of older material which is still useful background on pteropod ecology. Would be good to see the original references, e.g. Lalli and Gilmer, Rampal, as well as the more modern ones, to support statements, as many of the modern studies referred to merely added

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to the field of knowledge already in place.

It would be good to include some indication of why the Mediterranean is a 'climate change hotspot'.

An organism's suitability for use as a sentinel species depends on a number of factors, not only a perceived sensitivity to a climate driver, but also a sound understanding of its ecology which I am not convinced we have yet for pteropods.

Line 30: pray should be prey Note throughout: ar should be subscript when following Omega to denote saturation state of aragonite. There should be a space between the distance and the unit, e.g. 200 m Line 33-34: This is a strong statement, there are many other factors that contribute to an organism's suitability for use as a sentinel organism, make this statement more precautionary. Line 37: there is extensive work on Mediterranean pteropod distribution by Rampal which is not covered in this introduction. Lines 43-44: again, the work of Rampal should be considered here.

Methods: Line 123-125: what direction was the tow? Vertical, oblique?

It would be useful to know the depths of the stations.

Please indicate what pH scale was used.

Depth of tow is pretty shallow for many of the pteropods listed here, see Rampal 1975 for average depth distributions throughout the year. Could be that many of the species have been under-sampled.

I am not familiar with varimax rotation, please clarify for the reader.

Please explain why a CCA was chosen as opposed to another correspondence analysis, e.g. RDA? It is my understanding that CCAs are better in more controlled environments when there is a high confidence that the community has been exhaustively sampled as CCA inflates the importance of rare species. Looking at the sampling depths of used here study, I am not confident that this is the case and several common

species may have been under sampled.

Please explain why a BLRM was chosen for the analysis as opposed to, for example, a GLM?

It might help to reassure the reader that the depth or sampling time did not skew the results by including these as variables and assessing any correlation with pteropod abundance.

Results: I am not clear where the foraminifera appeared from, there is no mention of foraminifera collection in the methods or any rationale for their inclusion in the analysis prior to this point, please include in methods and some rationale for their inclusion in the introduction. Please report on the results of the BLRM in the main body of text, a p value should be reported, at least.

Some way of distinguishing whether the station numbers are located in the east or the west would be helpful.

Line 197 (and throughout): please use correct terminology to avoid confusion, this should be principle components 1 and 2.

Fig 3: this figure is very unclear and I struggle to relate the description of the figure in the text to the figure, itself. I assume that this is essentially two plots overlaid which is why there are two different axes? If not, I don't understand how the red axis relate to the PCA coordinate and the black to station coordinates as both colours cover factors 1 and 2.

Fig3 A and B: Please add to the figure description to make it clear what the coloured circles relate to, I assume that they are abundance at station and that red is east and blue is west? The overlapping of the circles renders them meaningless as it is impossible to assign the circle to the corresponding station number.

Fig 3 C: If the analysis was performed on the community as a whole, I am unclear how am unclear how C. inflexa was removed. Was it removed from just the plot or the full

analysis?

Discussion: The authors rightly point out that this study represents a “snapshot” in time and, as such, I would be wary at relating the results so strongly to ocean acidification factors and the inferring pteropod suitability as an indicator species. It is my opinion that we simply do not understand enough about pteropods to use them as an indicator species. How do the mean pteropod abundances found in this study compare to other abundance estimates from the Mediterranean? There are several timeseries that might provide a more temporally averaged estimate of abundance that could be used to validate this ‘snapshot’.

Pteropod abundance is patchy and highly seasonal, we are not entirely sure what controls their lateral distribution on the water column but we do know that there are strong seasonal variations in their depth profiles (See Rampal, 1975) which may be skewing the results due to relatively shallow depth of the tow.

Comparison with foraminifera: It would be more useful to compare the pteropod abundance and distribution with a non-calcifying species to really provide some insight as to whether the differences observed are due to calcification energetics. The depths sampled are also relatively shallow for some planktonic foraminifera, e.g. O. universa, which prefer deeper waters.

Linking pteropod abundance to environmental parameters The study does not make mention of the fact that several other studies of pteropod abundance (time series) have found that pH does not have a significant effect on the abundance of pteropods through time, therefore it seem unlikely that it would have a significant effect through space. Notably, Howes et al (2015) did not find any negative effect of decreasing pH on Eastern Mediterranean pteropods. Logically, one would assume that if the effects of a gradient on pH was impacting the distributions such that pteropods were favouring the Western Mediterranean, that a decrease in the already less favourable Eastern basin would lead to a decrease in their numbers there, however this is not the case.

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The authors mention that the significance of the results are being driven by the Limacinidae, but how do they explain this? I find it strange that the effects of Omega ar would be affecting one family of pteropods but not another when (as far as we know) they both have the same method of calcification and they both calcify the same polymorph of CaCO3. Looking at Fig 3C, only L. trochiformis appears to be strongly positively correlated with Omega ar, while S. subula seems to be telling the opposite story, please discuss these results. Please also include a discussion on the reasons why C. inflexa are not correlated to any variable.

Conclusions: I do not think that the results of this study can be taken to indicate that pteropods display suitability as an indicator species and I think that the assertion that they are correlated with Omega ar is an oversimplification of the results, especially when this is driven by one pteropod family and not others included in the analysis. It seems likely that the results have been skewed by sampling technique and station depth and this should be investigated before assigning the results to Omega ar.

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