

**Title:**

“Zooplankton diel vertical migration in the Corsica Channel (north-western Mediterranean Sea) detected by a moored ADCP”

by Davide Guerra, Katrin Schroeder, Mireno Borghini, Elisa Camatti, Marco Pansera, Anna Schroeder, Stefania Sparnocchia, Jacopo Chiggiato.

**General comment:** the paper deals with the analysis of backscattered acoustic ADCP data in the Corsica Channel during a period of two and half years to provide understanding on zooplankton behavior and evidence of its vertical migration. The paper contains interesting analysis and findings, but it's lack in some parts and in some discussions. It seems to me that it has been written in a hurry, neglecting some aspects and argumentation on several items with the consequence of not being always clear and correct. Moreover, biological measurements are not really linked to other data. There are several main corrections to do or parts to explain. As the items treated in the paper are interesting, I recommend the publication after all the main following issues have been addresses.

**Main points:**

- 1) There is at least one other recent publication on this item in the Mediterranean Sea (page 3, lines 25-27), that is the 2018 paper by Ursella et al. published in Progress in Oceanography on the Southern Adriatic Sea.
- 2) Potiris et al. 2018, and Pinot et Jansà 2001 also studied the link between DVM and lunar cycle (page 4, line3).
- 3) At lines 12-18, page3, it is not totally clear what is referred to the whole Mediterranean Sea and what to the Ligurian (also the reference list at line 13 is mixed, but then you speak of the Mediterranean, with a parenthesis on the Ligurian). Please rewrite the sentence.
- 4) At page 4, Line 10 you write: "to determine how much zooplankton"; this sentence means that you are able through backscattering energy data to measure quantitatively how much zooplankton is present, that is not true, as you also mentioned few lines above. Please change.
- 5) At line 12, page4, you write: "to identify the drivers": this is a final sentence. As the driving mechanisms of DVM are not totally understood, I would suggest a softer sentence: "to identify the possible drivers". The same at lines 18-21, page 9: the sentence it is very definitive/strong and should be softened and contextualized.
- 6) you speak of two general and widely accepted assumptions in zooplankton studies (page 5, lines 29-31), but this is not really true. In reality, the sentence found in Heywood 1996 has a slightly different meaning from the one in your text. He says:” For vertical velocities, the water upwelling or downwelling is usually small under general oceanic conditions, except during events such as internal waves... “. I think you should better explain why in your case you can consider the upwelling/downwelling negligible, or change the sentence. Moreover, the second assumption is not generally true: in the case of strong phyto blooming, the layers interested by it, “produce” quite strong signal. The same happens in zones rich in particulate as it could be the layer near the bottom. Anyway, there is no reference for this second assumption. Please explain.
- 7) the sentence at page 6, Lines 1-2, is not a consequence of the previous one. Moreover, data of zooplankton biomass are not “obtained by the ADCP”. Please rewrite the sentence.

- 8) The paragraph at page 6 from line 25 to line 31 is quite confusing and it should be rewritten. There are not-explained variables in the definition of the two slant range limits, and also the reference is inappropriate. Moreover, the sentence at lines 27-28 is quite twisted. In addition, which “values detected” (line 29) do you mean? As it is, sentence at lines 30-31 is not appropriate as you use eq. 2 to calculate R. Finally, as state by Deines 1999 and Bozzano et al. 2014, the lower limit for the slant range is defined as  $\pi \cdot R_0/4$ , in order to be used it in the formula of backscatter coefficient ( $S_v$ ) and not as a general criteria of quality control. Therefore, I would move all this discussion in the following paragraph after definition of R, also for clarity.
- 9) Do you really have percent good greater than 90% also for data during the day in the parts of the water column where zooplankton has migrated away?
- 10) The paragraph 3.2 is nested and difficult to follow. Why don't you give formulas 3 and 4 when you mention them the first time at lines 14-15? Eq.2 and 3 are not correct, maybe typing error. Please re-write the paragraph. Moreover, why do you use the formula by Deines 1999 to calculate  $S_v$  instead of the upgraded/corrected one suggested by Gostiaux and van Haren 2010 (also in Bozzano et al. 2014)? Please explain.
- 11) At line 18, page 9, you speak of biomass, but previously, at page 5, you said that you assume that the signal comes only from zooplankton. In many other parts of the text you use biomass in different meanings; this generates some misunderstanding on the word biomass. However, this item should be better explained in the whole text and/or define the terms at the beginning. Please explain and change accordingly.
- 12) lines from 21 to 28, page 9, are superfluous.
- 13) Why do you speak of Deep Chlorophyll Maximum if it is seen in the surface layer (line 3 page 10)? The same in conclusions.
- 14) At line 19, page 10, you say that you use  $w$  and  $S_v$  “to characterize different migratory behaviours of different zooplanktonic migrator groups”, but it doesn't seem to me that you perform this kind analysis, except saying that there are probably two different communities at surface and bottom. Moreover, the following sentence (“To this aim....”) is very generic and should be rephrased and the concepts better explained.
- 15) The lack of information you mention at page 10 line 27 concerns  $w$  and MVBS not biomass and migration, except as a consequence. It is quite confusing to a reader.
- 16) At page 10, line 30, you speak of surface values, but you have just said that there is a lack of data in the surface layer. As this misunderstanding with the term “surface” is found quite often in the text, please fix it throughout the text.
- 17) at line 31 page 10 you write “since MVBS is a proxy”: since this is your assumption and not a general one, it should be changed to “since we use MVBS as a proxy”
- 18) Why do you affirm that the behaviour observed in MVBS (lines 8-9 page 11, fig.3b, surface layer) is consistent with twilight migrating organism? It is not consistent with the definition you give in the introduction. The same is found at line 18 when speaking of intermediate layer, at line 24 page 13 and in conclusions. Please explain and/or change.
- 19) It seems to me that in the  $w$  plot (fig.3c) the persisting positive values are better seen in January-February than February-March (line 11 page 11).
- 20) The sentence at line 22-23 of page 11 is not totally true (not for all periods daily vales are slightly higher...). And, are you sure there is no effect of the bottom (like resuspension or particulate) at this quote? please explain.
- 21) I am not so sure that in Fig.4a the MVBS has a peak in February –March that involves all the water column as you write at line 1 page 12. Maybe in March, but February is not very different from April, except at about 300m.

- 22) Are you sure that the reference of Pinot et Jansà 2001 at line 10 page 12 is correct? Their measurements reach 220m depth.
- 23) It would be clearer if you define what you mean by blooming period and no-blooming period, at the beginning of the discussion on the differences in MVBS between the periods (i.e. end of page 11). Moreover, it is not clear what do you mean with the definition of the blooming and no-blooming periods given at page 12 lines 19-22. How do you calculate the periods? Please explain.
- 24) At line 6 page 13 you mention the fact that the timing of the downward motion in the blooming period is later than in the no-blooming situation due to the later sunrise. But what about the upward motion that happens at the same time in the blooming and no-blooming periods? And what is the timing of sunset in the blooming period: the time written in red in the figures? This is also related to what you write at lines 22-23: it would mean a different timing of reverse migration in the two periods, i.e. 4 hours and 2 hours after upward motion. Please explain.
- 25) It is hard to understand your affirmation at lines 7-9 page 13, after the discussion just done: DVM is not just presence of more zooplankton in the water column (here again, are you using the term "biomass" instead of zooplankton?); moreover, the upward vertical velocities are stronger in the blooming period, but during the no-blooming period the downward velocities are stronger. What do you exactly mean with "DVM is intensified"? Please explain.
- 26) The affirmation ("During both periods...") at lines 23-24 page 13, is not so evident to me when looking at figure 4d and 4f: in the no-blooming period it is really weak and should be taken with caution taking into account errors; moreover, these values cover the entire daytime.
- 27) In order to calculate the FFT, did you interpolate linearly the time series between one deployment and the other? Are you sure that the peaks you find in Fig. 5a and 5b are related to physical phenomena and are not fictitious features? And what about the error bar? Because some of the peaks are really small. The 12-hour peak at 353m is quite evident in  $w$  power spectra (lines 32-33 page 13). What do you mean with "taken singularly" at line 33 page 13? Moreover, your discussion at the beginning of page 14 is not convincing me: the reverse migration should be masked by the nocturnal one if it happens exactly at the same time and it is weaker (the bins measure the average movement). Please explain it and give more evidence. Also, the discussion on 4.75 and 8 hours peak (lines 8-10 page 14) is not convincing: the variability you discuss seems not to be a cyclic one with that period. Finally, the spectra of low pass data contain peaks that sometimes are not very evident, and as there are no error bars it is difficult to distinguish them from the surroundings. Please re-do all this part regarding power spectra.
- 28) I do not understand what is the sense of table2 with the list of all the species, if this feature is not used for the discussion in relation to MVBS and  $w$ , and if it is just a snapshot of a summer situation. Also, the small discussion at page 14 is superfluous. The affirmation at lines 30-31 is quite strong and partially not true (evidences of the contrary are found in literature).
- 29) It is not evident to me the descent during the day between 150 and 250m (fig.6b) as described at line 4 page 15. Moreover, at lines 6-7 page 15, you explain the migration from 100 to 300m citing two references, but you do not say whether you found these organisms in your sampling. You should use your data at least in this discussion. Finally, the sentences at lines 9-12, page15, should be better explained: where do you see the

zooplankton descent? Which behavior do you mean? A reference for it is needed. Here you use "biomass" for phytoplankton.

- 30) From line 31 page15 to line 13 page 16, you try to explain the unexpected result (zero-lag correlation) with different considerations. It is not clear to me why one of these arguments is the lack of data in the very surface layer if the correlation in the surface layer is ok (by the way, which is the depth of the euphotic layer?). Moreover, why do you cite Warren et al 2004 if they found no correlation or negative one, contrary to your results? Finally, why the changes in the amount of zooplankton should be related to lateral current only in the bottom layer and not in the surface one where the correlation is as you expect? Maybe the MVBS is not always a good proxy for zooplankton biomass, in the sense that it can include other signals? Please, rewrite this part explaining better the concepts.
- 31) At page16 line you mention an analysis of the behavior of zooplankton in relation with oxygen concentration, but in reality, this kind of analysis is not performed.
- 32) Taking into consideration all the points above, please change conclusions.

### **Minor changes:**

#### **Abstract:**

Line 14: "Biomass evolution": maybe do you mean "biomass distribution"?

Line 20: cancel "near"

Line22: "others" is quite too general. Please rewrite the sentence.

#### **Introduction:**

Page1:

Line 26: "At dawn...." It seems a general feature, indeed it is just one type of migration. Please rewrite the paragraph.

Line 31: you are speaking of twilight migration, aren't you? It is not clear.

Page 2

Line 28: does phytoplankton perform vertical migration?

Page 3:

Line3: instead of "an ADCP" write "an upward-looking ADCP"

Line 15: cancel "are"

Page 4:

Line 5: please correct "by the depth of the depth of"

Line 7: change "calibration" in "calibrate"

## **2. Study Area:**

Page 5:

Line 4 and 5: I think that the units are m/s and not cm/s.

## **3. Material and Methods:**

Page 5:

Line 20: change "proportional to how fast particles move and it is used to infer the velocity" in "proportional to the velocity of the moving particles and it is used to infer the speed "

Line 23: change "how much sound reflection" in "how much of the sound reflected signal"

Lines 23-26: what you are saying is certainly true, but there is some confusion on the terms you use here (reflection and scatter) and above/below (back-scatter). Please, try to uniform the language.

Page 9:

Line 2: add “:” after “These parameters are”

Lines 2-10: the list of parameter would be more readable if a list number/letter is added (i.e. i) ii) etc.) or it is listed in bullets.

Line 4: cancel “here”

Line 8: cancel “here”

Lines 9-10: moon phases are obtained from where?

#### 4. Results and Discussion

Page 10:

Line 13: “Fig 2d-2e” should be “Fig.2e-2g”

Line 24: the acronym has already been defined at page 7.

Line 29: add “approximately” before “between”

Line 30: change “whole” in “the greatest part of the”;

Page 11:

Line 3: “Less evident in fig.3a”: I think that it is impossible to see the daily cycle in this panel.

Line 11: change “persisting” in “quite persisting”.

Line 19: change “very high” in “quite high”

Line 21-22: cancel “which is below the depth of the ADCP.”

Line 24: change “is much lower” in “is hardly seen”, also because of what you write few lines below at line 27 (“is not clearly correlated with sunlight etc...”).

Line 29: change “from noon to sunset and” in “from noon to sunset in some periods and”

Lines 30-32: the sentence is redundant. Please rewrite it. Moreover, what are DVM parameters?

Line 33: cancel “integrated over the whole investigated water column”: the figs.3a and 4a show MVBSs that vary along the water column.

Page 12:

Line 14: cancel “which the ADCP data .....”: it is a repetition

Page13:

Line20: change “Fig 3b-3g” in “Fig3b-g”

Line 20: what is “Fig 4-4f”?

Page 14:

Line 9: maybe “Fig.4d”?

#### 5. Conclusions

Page16:

Line 33: a reference for the last part of the sentence would be appreciated

Page17:

Line 1: change “surface” with “upper”

Line6: change “daily” with “diurnal”

Line 20: maybe 2000 is 2001?

#### Figures:

Fig. 3: in panels b→g numbers, letters and labels are unreadable. Also, the lines with times of sunset and sunrise are difficult to see.

Fig 4c→f: numbers and letters are too small and units are missing.

Fig. 5: units on the y axis are missing.

Fig. 6 the moon, the sunset and the sunrise symbols are not visible. Fig 6b can be a bit larger and 6a smaller. The use of symbols for sunset and sunrise at the base of the plot makes the plot difficult to interpret.

In general: units are missing in various figures.

**References:**

Potiris et al. 2018: the reference is not complete

Ringelberg 2009: the reference is not complete