

## ***Interactive comment on “Bathymetrical distribution and size structure of cold-water coral populations in the Cap de Creus and Lacaze-Duthiers canyons (northwestern Mediterranean)” by A. Gori et al.***

**A. Gori et al.**

agori.mail@gmail.com

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Dear Agostina, thank you very much for your detailed review of our manuscript, for your corrections and your comments. In the next sentences we tried to address them.

1 - Pg 19059 L14: “*M. oculata* ... form colonies of 30-50 cm height”. It is not very clear to me if this information is meant as a citation by Zibrowius (1980). Most probably not because in Zibrowius (1980) there is no indication about the size of the colonies of *Madrepora oculata*. However, in the Mediterranean (and I guess in the Atlantic as well)

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colonies of this species can exceed 50 cm in height. Colonies of ca. 80 cm in height are documented for instance in Sanfilippo et al. (2012). Facies, DOI 10.1007/s10347-012-0356-7 Pg 19059 L 15-16: “*L. pertusa* polyps measure approximately 10 mm in diameter and forms colonies of more than 130 cm height...” These sentences need English editing, the subject of the verb “forms” is “*L. pertusa* polyps”, but it should be “*L. pertusa*”. Moreover, the word “height” should be replaced with “high” or “in height”. Pg 19059 L20: *Dendrophyllia cornigera* colonies in the Mediterranean can be much higher than 20 cm. I assert this on the basis of personal observations of samples from the Adriatic and the Ionian Sea, but please check literature about it.

1 - The text about the studied species in the materials and methods section has been changed according to your corrections, and new references have been added. We hope that this new version of the text results now more correct:

“*M. oculata* has polyps of 3–5 mm in diameter (Zibrowius, 1980), and forms colonies of more than 50 cm in height (Sanfilippo et al. 2012); it has been found at depths of 55–1950 m (Zibrowius, 1980). *L. pertusa* has polyps of approximately 10 mm in diameter, and forms colonies of more than 130 cm in height (Gass and Roberts, 2006), which can build reefs as high as 33 m (Mortensen et al., 2001); it has been found at depths of 40–3000 m (Zibrowius, 1980; Fosså et al., 2002; Cairns, 2007). *D. cornigera* has large polyps of 20–40 mm in diameter, and forms colonies more than 50 cm in height (Brito and Ocaña 2004); it can be found at depths of 200–800 m (Zibrowius, 1980), but locally as shallow as 30 m (Castric-Fey, 1996).”

2 - Video Survey and analyses: I agree with the authors that both number and size of coral colonies can be important indicators of health and stability of coral communities and that their assessment represents a basic tool for effective monitoring and protection programs. However, the authors apply to frame-building corals (*Madrepora oculata* and *Lophelia pertusa*) a methodology previously used for octocoral colonies which typically do not form frameworks and that can be easily distinguished as isolated colonies in ROV videos. *M. oculata* and *L. pertusa* do normally form frameworks. Counting

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single colonies does not really represent the best method to quantify their presence on the seafloor and to compare populations from different locations in the Mediterranean. This method forced the authors to exclude the extremely important *Lophelia* framework found in the LDC (pg 19062, L18-24) from the quantitative analysis. I would suggest to apply a methodology which allows to quantify both single coral colonies and coral frameworks. For instance, in future analyses, further size categories could be added: e.g. "loose coral framework" (1-5 m), "dense coral framework" (5-10 m), "very dense coral frameworks" (>10 m). This is just a suggestion, I am sure a more appropriate terminology can be found, but please take this observation into consideration in further work.

2 - We totally agree with your comment about the utility to use coverage categories to quantify abundance of these species, when they form framework structures. Indeed, we recently used coverage to quantify *Lophelia pertusa* in Norwegian reefs (Purser et al. 2013). However, in the case of the studied canyons, every single colonies of both *Madrepora oculata* and *Lophelia pertusa* was always clearly identifiable, also in the cases of higher abundances (see also Orejas et al. 2009). The only case when it was not possible to discriminate among the different colonies was in the unique coral framework observed on a cliff in Lacaze-Duthiers Canyon. We preferred to highlight this particular framework structure in the manuscript (even is this means that we would not be able to consider it in the others analyses), because in the video transects that we analyzed it only occurred once, and it can be of particular interest. At the same time, the fact that we did not use the % coverage (as a supplementary category), allowed the study of the size structure of the coral populations, otherwise impossible with % coverage categories. We considered that this was the best option, since the study of population size structure gives important information on population state, habitat suitability, as well as on the recruitment rates over time, not only in gorgonians, but also in scleractinian corals species (e.g. Edmunds 2005).

Edmunds, P.J.: Patterns in the distribution of juvenile corals and coral reef community

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structure in St. John, US Virgin Islands. *Mar. Ecol. Prog. Ser.*, 202, 113–124, 2000.

Orejas, C., Gori, A., Lo Iacono, C., Puig, P., Gili, J.M.: Cold-water corals in the Cap de Creus canyon, northwestern Mediterranean: spatial distribution, density and anthropogenic impact, *Mar. Ecol. Prog. Ser.*, 397, 37–51, 2009.

Purser, A., Orejas, C., Gori, A., Tong, R., Unnithan, V., Thomsen, L.: Local variation in the distribution of benthic megafauna species associated with cold-water coral reefs on the Norwegian margin, *Cont. Shelf Res.*, 54, 37–51, 2013.

3 - Pg19060 L5: "All colonies of the studied coral species ... have been counted". I guess that only live colonies were counted, but this is not specified in the material and methods paragraph. Wouldn't be interesting to quantify also dead colonies and the ratio live/dead coral colonies?

3 - The text has been changed to clarify that only live colonies of the studied species were counted:

"All live colonies of the studied coral species appearing within the 1.5 m-wide observational transects were counted..."

Yes, we totally agree with you that indeed it could have been interesting to quantify also dead colonies and the ratio live/dead coral colonies, and certainly is something that we will consider in future works. However, we did not see dead colonies during the video analysis in both canyons. Probably dead colonies, due to its fragility, especially considering *Madrepora*, broke in fragments and this is the coral rubble we record in most places. In the case of the *Lophelia* in Lacaze Duthiers canyon, we think that the growth of the colonies, mainly in overhangs, would promote that dead fragments of the colonies just broke and fall.

4 - Pg19060 L13-15: About the orientation of coral colonies, I fully agree with Veerle Huvenne that in the paper it is not indicated the angle of the colony growing axis (or colony height) versus the substratum, but versus the vertical. However, I am not sure

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that the suggestion by Veerle to introduce the terminology “vertical orientation” helps in clarifying this issue, because an object which has a “vertical orientation” is supposed to be vertical... Andrea, why don't you simply use the word “orientation” and add a figure similar to Fig.2a by Rossi et al. 2008? If you include (as you suggested in your last posted comment, 15th of February) also information about the colony substrate/location, you could write something like “The colonies were classified into four categories according to their location (or substrate) and orientation, in particular: on top of rocky boulders, facing straight up (0°), perpendicular to (sub)vertical rocky walls (90°), on the edge of rocky outcrops, facing downwards (135°), and below subhorizontal rocky outcrops, facing downwards (180°), see Fig. X. for details”.

4 - Your suggestion has been included in the corrections previously made to this part of the manuscript following the comments from Veerle. We hope that this improved version of the text can now results clearer and in agreement with comments from both reviewers:

“Colony position with respect to the substrate was classified into four categories according to their location and orientation: on top of rocky boulders, facing straight up (0°), perpendicular to vertical rocky walls (90°), on the edge or rocky outcrops, facing downwards (135°) and below rocky outcrops, facing downwards (180°), following Rossi et al. (2008)”

Since many figures are already presented in the manuscript, we consider that the improved explanation in the text, together with the reference to the figure and manuscript from Rossi et al. 2008, should be enough. However, if you consider it better, we can also add a new figure similar to the one in Rossi et al. 2008. Please, let us know your thoughts about this. . .

5 - Pg 19061 L19 and 25: As also exposed in Tab. 1, corals are absent in some video transects (CCC: T8, T9, T10 and LDC: T17, T18). This information is provided in the results section but it is not discussed afterwards. Why didn't you find any corals in

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those transects?

5 - We really do not know. To our opinion there are many possible causes for the absence of corals from some places, ranging from some ecological limiting factor, to the simply hazard. Since corals reproduce by means of a planula larvae, the dispersion of the planula plays a main role in determining where corals can occur. This dispersion process is very random and can change depending on the conditions of each moment (e.g. the flow speed and direction). Moreover, it can change from one year to another, and places currently showing no presence of corals could be colonized in the next future. Overall this is the spatial population dynamics of the species. Not in all places which could be considered suitable for the presence of a species, actually the species occur, and this can change over time.

6 - Pg 19061 L23: “with a dense patch located...” Could you please better explain what you mean for “dense patch” of *Dendrophyllia cornigera*? How dense? Which is the average distance between colonies or the colony number per square metre?

6 - The text has been changed to: “Colonies of *D. cornigera* were observed from 160 to 300 m depth, with a dense patch (~ 10 colonies m<sup>-2</sup>) entirely composed by colonies with a single polyp, located at 190 m depth (Fig. 3).”

7 - Pg 19063 L4-9: Here you describe the results of the correspondence analysis shown in Fig. 7 (relationship between colony size, depth and orientation), highlighting some differences between the two canyons, at least about depth/colony size relationship. However these results are not commented in the discussion section. Please note that at Pg 19066 L6 you assert that “no clear differences were observed in the CWC populations of the two canyons”, it sounds slightly contradictory. Moreover, in Fig. 7 you use the abbreviations D1, D2, D3, D4. From the text I deduce that the depth increases from D1 to D4, but it would be useful to add this information in the figure caption.

7 - Differences highlighted by the correspondence analysis are now discussed in the

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text (see the following answer number 8). Moreover, the sentence about the lack of clear differences between canyons has been modified to clarify that we observed no clear differences in the abundance of CWC between canyons, despite the main differences between canyons, especially in terms of fluxes of particulate matter (potential food availability). We hope the modified text is now clearer and anymore contradictory with the differences observed in the depth/colony size relationship: "Overall, no clear differences were observed in the abundance of CWC, as well as in their population structure in CCC and LDC, despite the main differences between canyons in terms of hydrodynamic conditions and especially fluxes of particulate matter"

Following your suggestion, the caption of Figure 7 has been change to: "Correspondence analysis showing the relationship between *Madrepora oculata* and *Lophelia pertusa* colony size, colony orientation and depth in the Cap de Creus Canyon (CCC) and the Lacaze-Duthiers Canyon (LDC). Samples are shown by dots; the ordinal categories of size and depth (increasing from D1 to D4) are connected by solid and dashed lines respectively."

8 - Pg 19064 L7-8: Observing Fig. 3, the bathymetrical distribution of *M. oculata* doesn't seem to be too "homogenous" in the two canyons. In the LDC this species seems to occur preferentially in two depth ranges, ca. 250-280 m and 330-360 m, and to be absent above 220 m depth whereas in the CCC it appears already at 190 m depth and it is more uniformly distributed (and rather abundant) till 320 m depth. Actually, also *L. pertusa* and *D. cornigera* occur above 220 m water depth in the CCC but not in the LDC, however this datum is not commented in the discussion section.

8 - Following your comments, the text has been changed, and completed with the results of the correspondence analysis for *Madrepora oculata*. We hope that this new version of the text can now results more correct and complete:

"Our results showed different bathymetrical distribution patterns of the three species, which are all present from shallower depths (~180 m depth) in CCC than in LDC (~220

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m depth). A wide tolerance to environmental conditions could also explain the shallower distribution of *M. oculata* in both canyons, with high abundances mainly between 180 and 360 m depth. Although, its colonies were larger in the shallower zone of this depth range in the CCC (~200 m depth), while they were larger in the deeper zone of this range in the LDC (~340 m depth)."

9 - Pg 19063 L25 - 19064 L3: For your information, coral frameworks mostly composed of very large colonies of *L. pertusa* can be found also in some locations of the SML province, in the Ionian Sea (unpublished data) but, as far as I know, they don't exceed 5 m in lateral extension.

9 - Thank you for this information, which is very important and could be added (of course if you agree with this), as personal communication to the text, especially with the aim of assess, all together, the current state of CWC in the Mediterranean Sea:

"Moreover, *L. pertusa* frameworks up to 5 m in extent were also observed in the Santa Maria di Leuca CWC province, in the central Mediterranean (Vertino, pers. comm.)."

10 - Pg 19065 L15 - 17: "The preferential orientations with respect to the substrate (90° and 135°) of *M. oculata* and *L. pertusa* colonies in both canyons are probably related to the main currents as well as to the sediment transported by them." Yes, but can't the % of colony orientation shown in Fig. 6 be biased by the % of vertical wall or overhang observed in each transect? I try to explain better what I mean: if in a video transect which explores 400 linear m of sea bottom, 380 linear m are along a vertical wall, I expect a very high % of corals with a 90° orientation. If the video transect explores 50% of subhorizontal surfaces and 50% of vertical ones, and I find 90% of corals oriented 90°, I can assert the corals prefer vertical wall than subhorizontal surfaces. As also suggested by Andrew Davies, I think that your results about coral distribution and orientation should be related to the topography of the seafloor explored in each transect. Probably in the text you could refer to some of the results from Lo Iacono et al. (in prep.) (see your comment, 15 January 2013) to provide information about the

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seafloor slope.

10 - We really think that there is no bias in the orientation analysis, because all the possible locations (top of boulders, vertical walls, margin of rocky outcrops and below rocky outcrops) were largely represented along each transect. This is due to the very large considered areas in each transect (1.5 m width and several hundred meter length, see Table 2), but especially to the fact that a rocky bottom is never really homogeneous. This means that, for example, when the bottom is mainly composed of rocky boulders, there are, at the same time, horizontal bottoms (on top of the boulders), vertical walls (on the flanks of the boulders), as well as frequent outcrops and indentations that can be used by corals to settle. In the same way, when the main bottom is a rocky wall, it normally presents a lot of outcrops and indentations that can be used by the corals to settle above, on the margins or below. This means that, also in a vertical rocky wall, the great part of the colony may be settled on the margin of outcrops (135°), below them, or even on their top (0°). Overall, the heterogeneity of the rocky bottom offers to corals the opportunity to settle in any orientation, and this is also why we had to assign an orientation category individually to each of the studied colonies, looking at its specific position on the substrate.

11 - Pg 19066 L2-5. "The frequent 90° orientation of coral colonies... might explain the observed low frequency of very large colonies since whenever a certain large size is exceeded, strong currents and the own weight of the corals may detach or break down from the substrate these larger colonies". Yes, it can be that colonies settled on vertical wall, when too large, detach due to their own weight, bioerosion, strong currents, etc. On the other hand, on the LCD vertical walls, you found the largest colonies of *Lophelia pertusa* which form very robust frameworks (Fig. 5). How do you explain this? (Please check the caption of Fig. 5, maybe in the first line the word "with" needs to be replaced with "which"...?)

11 - We totally agree with your comment, the observation of the *Lophelia* framework on a vertical wall in LDC shows that coral detachment or break down from vertical walls

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cannot be a reasonable reason for the observed low frequency of very large colonies. Consequently, this part of the text has been removed from the discussion. Thank you for highlighting this contradiction.

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Interactive comment on Biogeosciences Discuss., 9, 19053, 2012.

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