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Biogeosciences Discussions

Interactive comment on "Phytoplankton diversity and productivity in a highly turbid, tropical coastal system (Bach Dang Estuary, Vietnam)" *by* E. J. Rochelle-Newall et al.

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We thank the referee for their helpful comments that will greatly improve the article and have tried to reply as fully as possible to the points raised.

The reviewer states that we did not take into account the role of nutrient availability, hydrodynamics, grazing and light on phytoplankton populations. We agree with the review that hydrodynamics can control the distributions of particles and solutes in a system. Indeed this is why we discuss this problem in the discussion and why we show the riverine discharge values for the Confluence. We also agree that the residence time in the estuary can also be important in determining biological distributions. However, it

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is clear given the large differences in riverine discharge that the two periods are highly contrasted in terms of residence time. We have chosen not to further develop the role of hydrodynamics in the estuary as this is the subject of a companion paper that is presently in preparation (Vu et al.).

The referee also states that we did not take into account light availability. We feel that given that light penetration is strongly linked to turbidity in these highly turbid environments, that the concentration of suspended particulate matter, which can be considered as a proxy for light penetration is an adequate indicator of light availability for phytoplankton on the whole. This parameter, SPM was included in the CCA. Nevertheless, we have now added the Kd values to the CCA and Table 1. It should be noted that multicolinearity has been detected in the CCA for the Kd parameter for both seasons. This indicates that this environmental variable is redundant with other explaining variables taken into account in the CCA

It is also clear from the reviewers' comments that we did not give sufficient details on the CCA. In the below figures we provide the complete CCA for both periods. All of the data were included in the CCA, however, only the data that do not show mulicolinearity (infinite value of IF) were shown on the graphs for clarity. Indeed, it is rather redundant to show the co-linear parameters for that very reason: they are co-linear and so we are unable to determine the importance of each factor separately. However, in the first version of CCA's we had selected to retain the conservative factor salinity, which is the most rigorous way of examining water mixing in estuarine systems, despite the colinearity observed during March 2009. Indeed salinity is known to be major factor in determining biological distributions and as explained in the text, nutrients and salinity often covary due to dilution effects. In the new version, we do not include salinity in the CCA for March for the reasons cited above. To summarise, in the article we do not ignore the importance of nutrients or turbidity in determining phytoplankton distributions, nor was it our goal to refute the importance of these factors in determining community dynamics. Indeed, it is interesting to note that nitrates and POC can be considered

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as explaining variables in March 2009 despite the multicolinearity detected for salinity. It was our goal in this article to highlight that other factors, such as eco-toxic heavy metals, can also play a role in determining phytoplankton diversity and activity in this system.

The reviewer also asked for a Table summarising the contributions of the major phytoplankton groups and their relative dominance, this will be added to the revised version.

The reviewer asked that we estimate that the contribution of Chla from the pico-, nano, and cyanobacterial populations as counted by flow cytometry. Sadly, we did not measure size fractionated Chla concentrations and so it is difficult to give a rigorous estimate of the amount of Chla in these fractions. Moreover, no data exist on Chla content in these fractions in this estuary and so it is difficult to even do a 'back of the envelope" calculation without resorting to data from other estuaries which are probably inappropriate due to the high turbidities in this system.

Detailed comments:

The reviewer asks that we remove the last sentence of the abstract, we will do so in the revised version.

Methods What depths were samples taken from? This is noted in the methods. Samples were taken from the surface (top 100cm).

Need to add references for nutrient measurements.

The nutrient methods are the following, these will be added to the revised version. Chlorophyll a was measured fluorometrically following the method of Holm-Hansen et al., 1965 (Holm-Hansen O, Lorenzen CJ, Holmes RW, Strickland JDH (1965) Fluorimetric determination of chlorophyll. Rapp P-V Reun Cons Int Explor Mer 30:3-15) Ammonium was measured by the indophenol method of Eaton et al. (1995). (Eaton, A. D., L. S. Clesceri, and A. E. Greenberg (ed.). 1995. Standard methods for the examination of water and wastewater, 19th ed. American Public Health Association,

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Washington, D.C.) Nitrate and nitrite was measured using the method of Raimbault et al. (1990). (Raimbault P, Slawyk G, Coste B, Fry J (1990) Feasibility of using an automated colorimetric procedure for the determination of seawater nitrate in the 0 to 100 nM range: examples from field and culture. Marine Biology 104:347-351). Phosphate was measured using the method of Grasshoff et al (1983) Grasshoff K, Eherhardt M, Kremling K (1983) Methods of seawater analysis. , Vol Second edition Verlag Chemie, Weinheim, Germany

DOC samples were stored at what temperature? As the DOC samples were fixed with H3PO4, they were stored at room temperature and out of direct light. The samples fixed by this method are considered stable at room temperature.

Why measure dissolved primary production? Dissolved primary production was measured as well as particulate primary production as this can represent a significant proportion of the organic carbon fixed during photosynthesis. Moreover, in situations where contaminants are present, rates of dissolved primary production can be elevated (e.g. Rochelle-Newall et al. 2008, AME 52:57-68). Furthermore, the relative proportions of dissolved primary production to particulate primary production provide interesting data on the relative importance of allochthonous verses autochthonous carbon inputs in coastal estuarine systems, and in this case it is particularly interesting as it provides information on these processes in a tropical, deltaic estuarine system that has been little studied. Moreover, we also provide concurrent information on the phytoplankton species present and on the potential bioavailability of that freshly produced organic matter to bacterial heterotrophs. The reviewer has also proposed that we deleted the section on phytoplankton-bacterioplankton coupling. However, we feel that it is important to leave this section in the article as it brings together taxonomic information with the biogeochemical information. Indeed, as we point out in this section, the bioavailability of organic matter is not only dependant on the concentrations of DOM of allochthonous origin in the system but that it is also potentially due to the phytoplankton populations present and, potentially to the presence of contaminants.

Moreover, previous studies have shown that phytoplankton-bacterioplankton coupling can be significantly affected by metal exposure (e.g. Rochelle-Newall et al. 2008) How did you calculate depth-integrated primary production and bacterial production? Depth integrated primary production was calculated using the primary production measurements obtained in the simulated in situ incubations using light screens (100, 50, 25, 12.5 and 6.25, 0%), that were then reported to the corresponding depths in the water column obtained from the CTD light profiles and taking into account the depth of the water column. In many cases, the 1% light level was attained before the bottom of the water column. As bacterial production was only measured at two depths, the same method (trapezoidal method, as noted in the methods section) was used, only with two depth sections.

Results Show the vertical changes in salinity and temperature for each station in order to show the hydrodynamic conditions. As these conditions will be addressed in the Vu et al. paper and given that we only measured phytoplankton diversity and metal concentrations in the upper 50cm, we prefer not to add these vertical profiles to the paper. Nevertheless, for information for the reviewer, please see the profiles from July (upper graphs) and March (lower graphs) for the most inward (St.04) and more saline stations (St. 30), black line indicates salinity and the red line, temperature.

Describe the spatial and temporal patterns in nutrient concentrations.

In the first version, and in the interests of space, we had chosen to present the nutrient data in Table 1. However, for clarity and easy of reading in the revised version we will add a paragraph that briefly describes the surface distributions of nutrients.

The sentence âĂŤ ‘Chl-a flux was negative, indicating a marine or estuarine, rather than a freshwater source’ – is not clear.

We apologise for this lack of clarity. The flows given are total net flow calculated from riverine outflows and marine inflow. These values were calculated from transversal current measurements (measured from bank to back across the channel during various

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tidal positions) conducted during 24h cycles on the river. Thus, if a value is positive, i.e. the netflow is going in the seaward direction, we consider that the source is riverine. Conversely, if the net value is negative, that is, it is going upstream (we assume that net river flow is always seaward), we assume that the source is marine or estuarine. We hope this clears up the confusion. These clarifications will be added to the revised version

Where are the data on the contributions of the dominant species to the phytoplankton assemblage?

We have put in the text the dominant species and the data of the species present is in the Supplementary materials. We will provide a new table with the dominant groups and in the interests of space in the article we propose to add these data to the supplementary materials section.

Discussion They did not consider the effects of nutrient availability, hydrodynamics, grazing and light on phytoplankton community structure and productivity, when they talk about the factors regulating phytoplankton diversity and productivity. Hence, it is difficult to convince the reader that heavy metals and/or salinity are the primary factors regulating phytoplankton distribution.

In our responses to the referee's comments above we hope we have clarified some of these points. We will of course integrate these comments into the revised version.

The section on 'phytoplankton-bacterioplankton coupling' is focused on bacterial production, which is not closely related to the topic of this paper. It is suggested that this section be shortened.

Although, as mentioned above, we do think that this section is useful, we can shorten it in the revised version if the editor wishes.

Interactive comment on Biogeosciences Discuss., 8, 487, 2011.

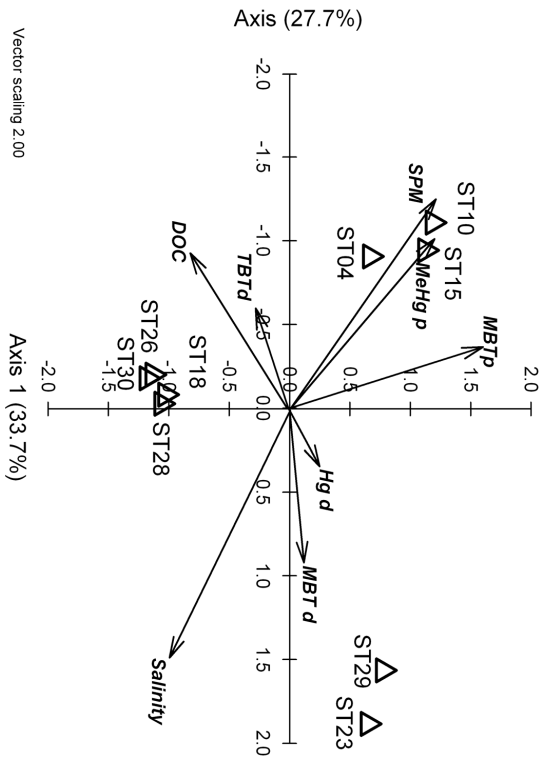

Fig. 1. Canonical correspondence analysis (CCA) of phytoplankton distribution and environmental factors for July 2008.

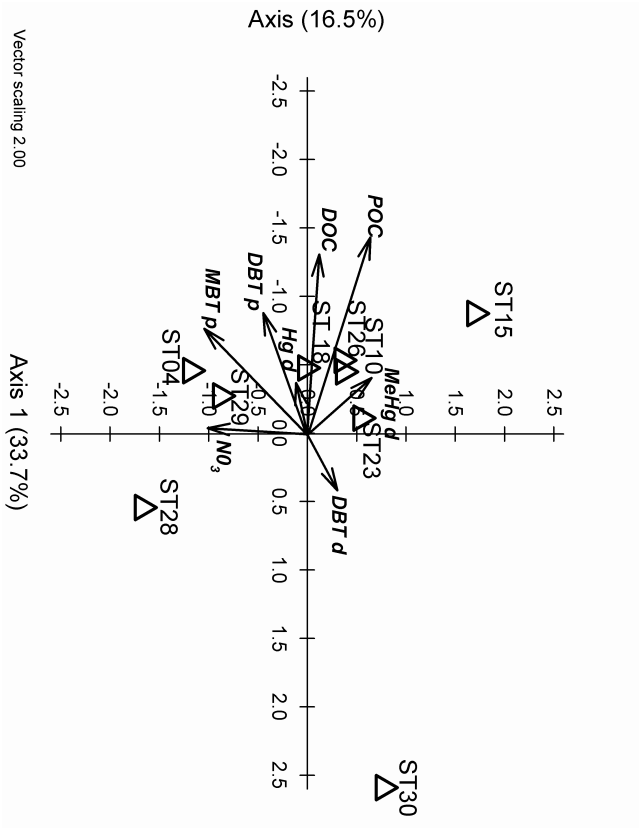

Fig. 2. Canonical correspondence analysis (CCA) of phytoplankton distribution and environmental factors for March 2009.

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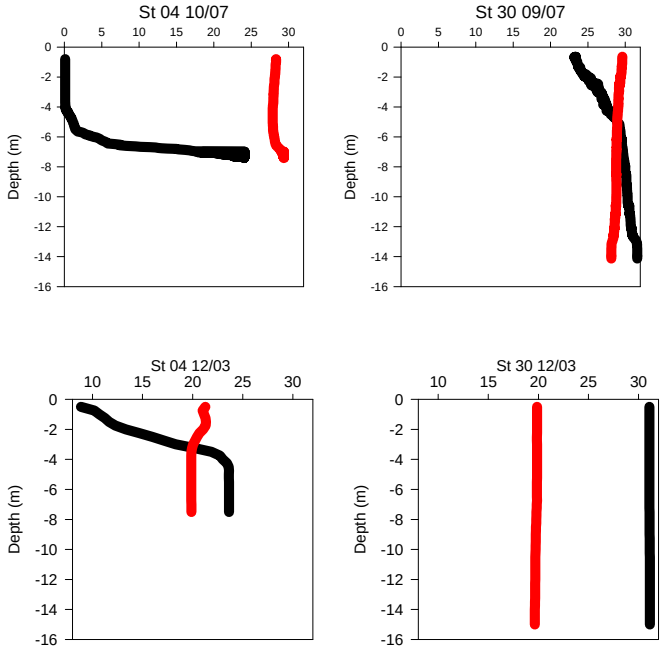
Profiles from July (upper graphs) and March (lower graphs) for the most inward (St.04) and more saline stations (St. 30), black line indicates salinity and the red line, temperature.



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