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Interactive comment on "The role of mixotrophic protists in the biological carbon pump" *by* A. Mitra et al.

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Authors' RESPONSES marked like this

Referee: In many ways this is an important paper. It picks up on and carries forward the concept of mixotrophs "ruling the ocean" that was introduced by many of the same authors in a paper earlier this year (Flynn et al. JPR 35:3-11). The thrust of that paper was to conceptualize how mixotrophs should be recognized as major contributors to plankton dynamics: that it is incorrect to think of separating protists into strict phototrophs or heterotrophs. While there were proponents of the importance of mixotrophs for many years before this, there has been little inclusion at the level of ecosystem models. The current paper places mixotrophy into a mathematical model to demonstrate the importance of including this form of nutrition in ecosystem models – specifically in

the context of the biological carbon pump. I agree with the authors on the importance of mixotrophic protists and that we will find them in almost any aquatic environment.

RESPONSE: Thank you very much for your support.

Referee: But they may be overemphasizing mixotroph dominance – even in oligotrophic waters. Several recent papers cited in the manuscript clearly demonstrate that mixotrophs can be important bacterivores and the model fits this concept. And though there are relatively few papers that actually look for mixotrophs, the authors seemed to have found only those recent papers (above) that showed mixotrophs to be more important consumers than heterotrophic flagellates (HNAN). At least two papers using experimental approaches in the Sargasso Sea (and directly looking at mixotrophy) found higher abundances of HNAN than mixotrophs: Arvenovski et al. (1995, J. Plankton Res) and Sanders et al. (2000, Mar Ecol Prog Ser). There may be more. As written, the manuscript seems to imply that the model fits all the available data, which it does not. Mixotrophs were important in those studies in the Sargasso, but so were HNAN.

RESPONSE: Thank you for drawing our attention to these papers and for the need to present counter-evidence to that which we describe. We have now made reference to these observations (and thence to these papers) in the discussion.

REFERENCES ADDED Arenovski A.L., Lim E.L., Caron D.A. (1995) Mixotrophic nanoplankton in oligotrophic surface waters of the Sargosso Sea may employ phagotrophy to obtain major nutrients. J. Plankton Res. 17; 801-820.

Sanders R.W., Berninger U-G, Lim E.L., Kemp, P.F., Caron D.A. (2000) Heterotrophic and mixotrophic nanoplankton predation on picoplankton in the Sargasso Sea and on Georges Bank. Mar.Ecol.Prog.Ser. 192; 103-118.

Referee: The section on the consequences of mixotrophy on nutrient dynamics (13546-13547) was nicely summarized. It certainly argues for the inclusion of multi-nutrient

models.

RESPONSE: thank you.

Referee: On the other hand, the authors leave the "biological pump" undefined

RESPONSE: We have now included the following sentence (page 3, line 4):

"...is typically embedded. The term "biological pump" is often used, in association with the various oceanic physical and biological processes, to describe the sequestration of carbon produced by the oceanic biotic components into deeper waters via physical processes. Thus the collective..."

Referee: Constitutive chloroplasts?

RESPONSE: By constitutive chloroplasts we mean chloroplasts which are intrinsic to the protists; we have replaced this terminology now (page 6 line 8) such that the new sentence reads: "They photosynthesize using their intrinsic chloroplasts (for which they contain full genetic control; see Flynn & Hansen 2013), while obtaining additional nutrition through the ingestion of bacteria, thence competing with the HNFs for bacterial prey."

REFERENCE ADDED Flynn KJ, PJ Hansen (2013) Cutting the canopy to defeat the "selfish gene"; conflicting selection pressures for the integration of phototrophy in mixotrophic protists. Protist 164; 811-823.

Interactive comment on Biogeosciences Discuss., 10, 13535, 2013.