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Interactive Comment

Interactive comment on "Historical records of coastal eutrophication-induced hypoxia" *by* A. J. Gooday et al.

B. Sen Gupta (Referee)

glbarun@lsu.edu

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Hypoxic areas have attained alarming dimensions along many coasts, and the question of historical trends has become significant not just to academic investigators but also to framers of public policy. Sustained research on hypoxia proxies in the sedimentary record started only in the 1990s, but the published results, although from a relatively small number of locations, have been based on many approaches, paleontological/ecological, sedimentological, mineralogical, and chemical, and they may involve arguments not easily comprehensible to the non-specialist. In this context, the authors of this exhaustive review have (a) discussed the principles behind the chosen techniques, (b) expertly summarized the results, and (c) drawn justifiable conclusions, thus bringing a needed clarity to the state of the art. This would be a most useful publication.

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Interactive Discussion

Discussion Paper

My comments below relate to some aspects of the manuscript.

Hypoxia vs. anoxia. Moderately hypoxic waters, with oxygen just below 2mL/L, are far from being anoxic. Thus, seafloor faunal or geochemical changes observed at or close to anoxia (lower end of dysoxia), are not necessarily attained at hypoxia. A considerable part of the manuscript ("Chemical and Mineralogical Indicators") justifiably relates to "absence of oxygen," but it should be stated unequivocally that hypoxia could exist without in-situ production of pyrite or anomalous concentration of certain trace metals, and that biomarkers of severe hypoxia at OMZs may not to be found in coastal hypoxia.

Foraminifera. Forams have been emphasized in the review because there is substantial data on them from hypoxic area sediments. We must remember, however, that forams are useful in paleohypoxia studies simply because their shells are abundant in sediment cores (and counting them makes sense); in general, they are less sensitive than metazoans to the effects of oxygen depletion. To my knowledge, there is no coastal foram species whose mere presence/absence would indicate hypoxia. Also, some foram indices of hypoxia have been based only on observed stratigraphic trends, without corroborative correlations with values of bottom-water oxygen or those of putative oxygen stand-ins such as sedimentary TOC. In addition, there are no dependable laboratory experiments on the effect of oxygen depletion on populations of foram species. Microhabitats of many species are variable, and species considered as "typical of oxygenated habitats" do occur in waters that are definitely hypoxic for larger metazoa. It would improve matters if, in future studies, reasons (including microhabitat considerations) are given why particular species or species groups were chosen to formulate a foram index. Use of geographically restricted species is necessarily limited. Eubuliminella morgani is endemic to the Gulf of Mexico, and is abundant in its present hypoxic belt. Even if the stratigraphic trends of the species provide us with clues on temporal variations of bottom-water oxygen, the findings would be inapplicable elsewhere.

Other benthic organisms. The only other group of well-preserved, shelled meioben-

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thos is the Ostracoda. As the review shows, some tolerant species seem to be good indicators of worsening hypoxia. However, unlike forams, if most ostracods "usually are intolerant of hypoxia," their changing abundances hold real promise as markers of hypoxia trends; their historical distribution in undisturbed, rapidly deposited, coastal sediments needs to be studied more thoroughly.

Sediment laminations. Since we are talking about coastal hypoxia, it would help if water depths were given for cores that show such laminations.

Eutrophication vs. hypoxia. If coastal hypoxia is "eutrophication-induced" (as in the title of the manuscript), the best way to separate the influence of oxygen depletion from that of organic enrichment would be through controlled laboratory experiments; this has not been done. Population statistics on abundant species (forams, e.g.,) obtained from localities affected by eutrophication but not by hypoxia may help, but still may not provide unequivocal answers, because species living in organic-rich substrates may also be hypoxia-tolerant. (Are there foram species that thrive well in organic-enriched substrates but are intolerant of hypoxia, or vice versa?) The subjectivity in the interpretation of faunal data in cores (re. eutrophication vs. hypoxia) is almost unavoidable.

Corrections.

p. 2575, line 8. Change rotaliids to Rotaliida (to avoid confusion with Rotaliidae).

p. 2582, line 6. Change Pautuxet to Patuxent.

p. 2589, line 4. Change hematite to maghemite.

p. 2389, lines 5-6. Change ferromagnetic to ferrimagnetic.

p. 2389, lines 21 & 22. Change remnant to remanent.

p. 2389, line 24. Change elements to compounds.

p. 2611, line 8. Change Navqui to Naqvi.

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p. 2643, figure caption. Change “tolerant or intolerant of” to “with different tolerances to.”

Interactive comment on Biogeosciences Discuss., 6, 2567, 2009.

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