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Interactive comment on "Lunar periodicity in the shell flux of some planktonic foraminifera in the Gulf of Mexico" *by* L. Jonkers et al.

J. Bijma (Referee)

jelle.bijma@awi.de

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This paper uses high resolution sediment trap flux data to demonstrate the lunar based reproduction cycle of many species of planktonic Foraminifera. It addresses relevant scientific questions within the scope of BG. Although, the paper does not present novel concepts, ideas or data, it confirms earlier papers and convincingly demonstrates a lunar based reproduction cycle in many species of planktonic Foraminifera. The scientific methods and assumptions are valid and most of it is clearly outlined. The authors give proper credit to related work and clearly indicate their own contribution. The title clearly reflects the contents of the paper and the abstract provides a concise and complete summary. The overall presentation is well structured and clear, and the language fluent and precise. There are a few concepts in the method section that require

clarification.

Overall, I rate the scientific significance and quality, as well as the presentation as excellent. Below are some general and more specific comments. Please forgive me when this is "Bijma et al. biased", but we have been looking into planktonic foraminiferal population dynamics at depth (one of the papers you missed: Bijma and Hemleben, 1994).

general comments

Except for the first four comments, which I think should be addressed, the rest is cosmetics. Up to the authors. Great paper!

1. The fluxes considered in this study are based on the TOTAL numbers in the size fraction >150 μm. However, total numbers may not be the most sensitive parameter to demonstrate the TIMING of reproduction within the lunar cycle. This can be demonstrated using data on G. sacculifer. Bijma et al. (1990; fig. 1) show that the lowest and highest TOTAL abundance are reached between 3-7 days after full moon and about 8 days before full moon, respectively. However, juvenile mortality is very high and an exponential decrease in abundance towards later ontogenetic stages ("larger size fractions") can be observed (see fig. 2 in Bijma and Hemleben, 1994). In fact, the most abundant size fraction in the standing stock in Bijma et al, 1994 is between 100-200 μm (table 2). As a result, the abundance in this size fraction determines the total abundance of G. sacculifer. However, in this species gametogenesis is very rare below 250μm and the percentage of mature specimens, i.e. those that can undergo gametogenesis, increases exponentially between 300 to 400 μm (Bijma and Hemleben, 1994). Hence, the peak of maximum abundance does not coincide with the reproduction event but rather with the result of a reproduction event that must have occurred earlier. Therefore, the reproduction event itself is shifted in time by as much as it takes for the population to grow from zygote to ca. 150μm plus the time required for this size fraction to settle to 700m water depth (where the sediment trap is placed). For

the most abundant fraction (100-200 μm), the settling velocity is less than 170m/day (Bijma et al., 1994), resulting in a delay of more than 4 days to a trap at 700m. We don't know how long it takes for a zygote to grow to 150μm but a week seems a reasonable educated guess. Hence, the timing of the reproduction event would be about 11 days before the flux arrives in the trap. I suggest that the authors include something along these lines.

2. A lunar based flux could not be demonstrated for all forams under consideration. However, it seems realistic to assume that ALL planktonic foraminifera must have mechanisms to synchronize their reproduction in time and space! Asexual reproduction has never been observed in planktonic foraminifera. Based on the fact that, in almost 40 years of culture studies, only gametogenesis has been observed, the assumption that they can only reproduce sexually seems very reasonable. At average densities of ca. 10 specimens/m3, and realizing that the gametes of these protists have a limited life-time of ca. 24 hours, during which they do not get dispersed that far from the parent cell, there simply is no other way to explain the dominance of planktonic Foraminifera in pelagic sediments than by a strategy of simultaneous gamete release at a defined point in space and time.

3. In the method section, please explain the concept of "Nyquist frequency". Further, it was unclear to me how the authors "linearly detrended and normalised to unit variance"? Could you please rephrase? With regard to REDFIT, the authors state "which takes reddening of spectrum due to memory effects into account". It would be good to spend a few words on what that means.

4. In the figure caption of Fig. 3 the authors state: "Raw shell flux (grey) overlain with the squared power of continuous Morlet wave transform at the lunar frequency (black)." This should be explained in the main text : What is "the squared power of continuous Morlet wave transform at the lunar frequency"?

5. All ontogenetic stages within a life cycle of planktonic Foraminifera are found at any

time and every depth, and understanding what the majority of the population does, in space and time, can best be resolved by looking at the residuals of the relative frequencies of size classes as a function of time and depth (see Bijma and Hemleben, 1994). If it can be done easily, I suggest to add an additional plot based on Fig. 1 by overlaying the residuals of the fluxes on a lunar basis, i.e. one lunar cycle on the x-axis (1-29.5 days) and average the residuals of six years of lunar months on the y-axis (i.e. the average of each day within a lunar month, normalized to the total flux of that month). I'm not sure if this will improve a conclusion with regard to the timing of maximum flux but it may be worth a try and might even help to resolve semi-lunar cycles (G. ruber; G. siphonifera type 1 and 2?)

6. If possible, it would be interesting to separate the fluxes of G. trilobus and G. sacculifer senso stricto. Bijma and Hemleben (1994) found that reproduction of the "sac-like" morphotype was linked to new moon whereas "trilobus" seemed to peak around full moon.

7. When the authors talk about G. siphonifera, can you specify if this is type I or II (see Huber et al., 1997 and Bijma et al., 1998).

8. The authors state that "In G. siphonifera the ratio is >1, indicating that the lunar cycle has a larger amplitude than the annual/seasonal cycle. This clearly highlights the importance of lunar periodicity on shell flux variability." Maybe it is worth mentioning that therefore this species may be best suited to provide the best annual mean geochemical data for paleo reconstructions (as opposed to species that experience stronger seasonal variability).

9. Several times in the discussion, the authors refer to the fact "that lunar periodicity on the shell flux at a site also exhibits substantial temporal variability in amplitude.". I assume that this might be due to temporal differences in mortality during ontogeny (i.e. between the different size classes) which affects the contribution of each cize class to the total number of shells collected every week in the trap cups (cf. my first comment).

Technical corrections

1) Page 7; line 14: “and Be, 1984) and differences settling time between the two species are unlikely. . .." should be " and Be, 1984) and differences in settling time between the two species are unlikely".

2) In the caption of Fig. 2 it is stated that “The horizontal black line indicates the 6 dB bandwidth". I do not see this black line?

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