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Interactive Comment

Interactive comment on "Explosive demographic expansion by dreissenid bivalves as a possible result of astronomical forcing" *by* M. Harzhauser et al.

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Reply to Anonymous Referee #1

The reviewer pointed out some important aspects, which will be addressed in the new version of the MS; in the following we discuss each of the points in detail:

(1) The mollusk-data have not been analyzed in previous publications and implications of resulting diversity patterns have not been discussed elsewhere so far. Thus the present paper represents the original results. Beyond that, the severe concern about current worldwide explosive demographic expansion of originally endemic dreissenid bivalves results in highly increased interest in papers dealing with mechanisms behind

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that phenomenon. Yet, despite of numerous studies on the topic, this is for the first time that their distribution patterns can be related to sunspot activity.

(2) The human-induced range-expansions referred to in the introduction-chapter provide only one example within a general overview of important dreissenid autecology-features. In particular, the present case study stresses climatically forced population density-patterns at the deep-time scale and leaves the geographical patterns out of scope. Natural range dynamics are still poorly understood. In future it might be possible to disentangle the impact of natural climatic changes and to better quantify the role of human impacts in this contexts. The concern that our study is based on a single core (1D) and not on data on geographic range (2D) is correct but would fit to nearly all paleontological studies of the IODP and ICDP programs. As stated in the MS, the characteristic succession of dreissenid coquinas can be observed across a large area of the clay pit area, documenting that the observed pattern is not purely local. Harzhauser and Mandic (2004, Fig. 4) showed that coeval mass-occurrence-layers of dreissenids are documented from the entire shelf of Lake Pannon (e.g. Hungary, Serbia, Slovenia). These occurrences document that the core-record is an expression of a wide-spread phenomenon. In the new version of the MS we will strengthen this point and will add references. The reviewer doubts that the observed "boom-and-bust" pattern is of relevance for existing invasion models. This is incorrect in our opinion as the modern range expansions of invasive dreissenids result from exactly that "boom-and-bust" ability probably inherent to this entire bivalve family. Moreover, these species-intrinsic characteristics are even triggered/enhanced by the contemporary human activities.

(3) As stated in the MS bioturbation is nearly absent aside from minor traces in the lowermost part of the core. Therefore, the fine-scale fluctuations of bottom water oxygenation is clearly unrelated to bioturbation as discussed by the reviewer. On the other hand, the striking coincidence with the clearly oxygenation-related magnetic-susceptibility signal suggests a tight link to that parameter.

There seems to have been some confusion on the mode of life of Sinucongeria primiformis for the reviewer: Sinucongeria primiformis is the earliest known species of this genus and is still an epifaunal species (Harzhauser & Mandic, 2004). Although millions of specimens were detected in the Vienna Basin, not a single specimen was found burrowing in the sediment (and consequently no such bioturbation occurs). Harzhauser & Mandic (2004) documented examples of such an in-situ pavement of fully articulated specimens, including data on size-distribution. These pavements are identical with those counted in the core. Therefore, there is no doubt about the autochthonous occurrence of the shells in census-assemblages. Much later, during the Late Pannonian, the decedents of S. primiformis start to get infaunal, coinciding with a change in pallial line. Consequently, these younger species are indeed documented in burrowing position in the sediment. Its monotypic mass-occurrences documented by the latter study provide strong evidence on its r-strategist life-mode. The same study documents finally the shell-articulation within the coquinas that strongly supports our interpretation as autochthonous in-situ census-assemblages. The documentation on fluctuating environmental parameter such as the bottom-water oxygenation is additionally provided in Kern et al. 2012 and 2013. The revision of the MS will address this point to avoid misunderstandings.

(4) The detrending of the data was performed with the program PAST. The function implemented into PAST (Hammer et al., 2001) removes any linear trend from a data-set by means of subtraction of a linear regression line from the values. This procedure was necessary to dampen the overall trend towards higher abundance of shells throughout the record, which would have masked the higher frequency cycles. The fit-evaluation has its statistical support in the analyses of wavelet power-spectrum where the pattern-significance is indicated by the color-scale (red for high, blue for low significance). Clearly, however, the “visual inspection” should allow evaluating if the filtered record is still in agreement with the supposed cyclicity. The phenomenon, that high-frequency cycles are more prominent or weaker in maxima or minima of the lower-frequency cycles is well known from the Milankovitch cycles in which the expression of precession may be very weak during eccentricity minima, or expression of obliquity is suppressed

within 1.2 My obliquity nodes. In the revised MS we will include the significance level (p=0.05) in the wavelet-powerspectra and will add some sentences concerning the figure caption as requested by the reviewer: Morlet wavelet power spectrum based on the 3-point-running mean data set (white line indicates significance level, p = 0.05). The Lomb–Scargle (left) and the REDFIT (right) periodograms illustrated previously on Fig. 3 are now drawn along a log2-scale (vertical axis) for easier comparison of frequency peaks in the power spectra in Fig. 3 with those in the wavelet spectrum (orange and red lines = 95% and 99% confidence intervals). The color scale represents the strength (i.e. power) of the signal in the wavelet spectrum - red for the high, blue for the low power. Horizontal scale of the wavelet analysis plot represents the core depth in meters.

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