



## **Holocene stasis in bivalve shell size magnified by time averaging and a major punctuation in size pattern driven by Anthropocene eutrophication**

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Mass extinctions and global climatic perturbations are associated with major shifts in eco-evolutionary patterns. Present-day anthropogenic disturbances associated with ecosystem collapses and regime shifts provide unique opportunities for assessing the magnitude and timing of such shifts because Holocene cores allow high-resolution age calibration and direct estimation of time averaging. Here, we test whether an increase in eutrophication and hypoxia in the Adriatic Sea generated shifts in eco-evolutionary modes in bivalve body size and assess how is the nature and magnitude of size shifts modulated by time averaging. We find that (1) body size of a major opportunistic bivalve species (*Corbula gibba*) was in stasis during the whole Holocene, and (2) increased in maximum size within a single decade in the middle of the 20th century, shifting to (i) directional increase followed by another stasis at sites with high sedimentation and (ii) punctuated increase at sites with slow sedimentation. Holocene stasis can be explained by models invoking environmental fluctuations that selected for small sizes and were rarely affected by repeated seasonal hypoxia. The increase in maximum size can be related to rapid, yearly-scale demographic shift to low juvenile mortality driven by release from predation and competitive pressures due to higher frequency of hypoxia in the late 20th century. The stasis is magnified by time averaging that correlates negatively with the magnitude of size change in sediment cores, and the rapidity of the 20th century shift can be expected to translate to punctuations unless associated with high sedimentation.