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Masting is uncommon in trees that depend on mutualist dispersers in the context of global climate and fertility gradients

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Supporting information

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Supplementary text

limitation of meta-analysis in understanding masting Use of data referenced to individual tree years in our study was motivated by limitations of synthesis across methods that lack such reference. In addition to a reliance on population- or species-level data, meta-analysis is challenged by data reference ranging from counts per-time, per-tree, or per-area of ground surface or even ordinal methods that lack scale ('low', 'high'). Observations per-time offer relative abundance, but not seed production per tree. Other crop counting methods yield a distribution of seeds per tree-year, with error depending on visibility or effort (fraction of the crop that is counted) (LaDeau and Clark, 2001; Abrahamson and Layne, 2003; Redmond et al., 2012). Counts per area, including seed traps, yield a distribution of seeds per m^2, with error depending on area counted (or seed trap area) and transport from trees to traps (Clark et al., 1999; Canham et al., 2014; Muller-Landau et al., 2008; Shibata et al., 2020). These methods cannot be directly combined due to dimensional differences. For a probabilistic interpretation, each observation must be assigned a distribution that has an implicit reference to a time, a tree, or an area. For example, noisy data come from small seed traps (area basis) and from extrapolating crop counts from a single branch or small part of the tree crown (tree basis). Area-based estimates from seed traps must integrate the variable transport from neighboring trees, each differing in production and distance from the observation location (e.g., a seed trap) (Clark et al., 2004; Jones and Muller-Landau, 2008).

Measures of volatility and periodicity must operate on data that are often dominated by zeros, contributed both by limited detection and failed seed crops; zero years in Fig. 1 alternate with hundreds of cones per tree. The coefficient of variation (CV) (standard deviation over year-to-year or tree-to-tree divided by the mean seed production) and its derivatives are avoided in some studies because they ignore frequency (Clark et al., 2004, 2019; Fernández-Martínez et al., 2018). A lag-1 autoregression (AR(1)) (Fernández-Martínez et al., 2018) includes a time dimension, but masting is not an AR(1) process (it is quasi-periodic), mast data are non-Gaussian, and there are long-term cycles that are not stationary within a tree (Fig 1a, b of the main text). Methods based on log counts add an arbitrary constant to avoid undefined values for the common occurrence of zeros (Fig 1c of the main text) (see also Shibata et al. (2020)). This practice precludes interpretation of effects: the smaller the added value, the more extreme the estimated slope coefficients for effects. Alternative time-series methods include wavelet analysis applied to seed-trap averages (Shibata et al., 2020) and a power spectrum applied to randomly selected individual crop counts (Abrahamson and Layne, 2003).

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