

# Synchronized breeding events in sympatric marine invertebrates: role of behavior and fine temporal windows in maintaining reproductive isolation

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**Abstract** While breeding synchrony among conspecifics is increasingly well understood with regards to the reproductive success of vertebrate and invertebrate taxa, the occurrence of simultaneous multispecies breeding events remains intriguing. The fairly recent discovery of mass annual spawnings in reef corals has provided a first glimpse at putative strategies of reproductive isolation during such events. However, the mechanisms and advantages of same-day heterospecific breeding are still poorly understood and have not yet been investigated in non-coral taxa with different life history strategies. In an effort to bridge this gap, we investigated spawning periodicity and synchrony among 26 sympatric species of free-spawning, capsule-laying, and brood-protecting macroinvertebrates belonging to six different phyla. Twenty-four of these species released gametes or larvae between early March and late April. We analyzed the events over fine temporal scales to test the hypothesis that breeding activities were not random in time or relative to each other. We found that the two main reproductive pulses followed a lunar periodicity and that consistent species- and gender-specific modulations in

the timing of spawning occurred during same-day episodes involving up to six free-spawning species. Mass spawning accounts from the literature were reviewed and compared. This work suggests that many species participate in synchronous heterospecific spawning events either because they respond to the same environmental cues or rely on cross-cueing and that reproductive isolation is favored by species-specific circadian patterns, spawning behaviors and cross-gender signaling.

**Keywords** Breeding synchrony · Spawning behavior · Marine invertebrate · Species interaction · Lunar periodicity · Reproduction

## Introduction

The culmination of reproductive activity into gamete release is one of the most important and widely studied life history features in aquatic animals. For species that breed annually, reproductive success largely depends on highly synchronized processes between individuals at the level of gamete synthesis and spawning. This synchronization is generally believed to be mediated by exogenous cues which may act directly or indirectly, alone or in synergy, to reset or maintain biological clocks (Himmelman 1999; Mercier and Hamel 2009). Beyond well-known aspects of breeding synchrony among conspecifics of a population or between populations of a species, synchronous breeding in marine invertebrates can encompass single-site same-day multispecies spawnings that leave us wondering: (1) how are these mass spawnings orchestrated and (2) what is the adaptive value of such a strategy? While same-day mass spawnings have mainly been documented in reef corals (Babcock et al. 1986; Carroll et al. 2006; Guest et al. 2005;

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