Population and reproductive ecology of the direct-developing sea stars *Parvulastra parvivipara* and *Cryptasterina hystera*

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Abstract

The population dynamics and reproductive ecology of direct-developing marine invertebrates are poorly understood. The absence of an ecologically decoupling dispersive larval stage between adults and offspring in these species was thought to increase population stability relative to species with complex life-histories, but recent evidence suggests that they are less stable because population fluctuations are not dampened over time by recruitment of larvae from other populations. Recent studies have also shown that some marine invertebrates adaptively alter offspring phenotype (size) in response to environmental conditions experienced by the adults. Offspring size has profound implications for all life-history stages of marine invertebrates, as well as their population dynamics. The capacity to adaptively alter offspring phenotype should be greater among direct developers than species with dispersive larvae because their offspring are more likely to experience similar conditions to adults, and there are no conflicting selective pressures acting on life-history stages that occupy different ecological niches. I examined the population dynamics and brood characteristics of two Australian intertidal asterinids that reproduce via direct development—*Parvulastra parvivipara* (3 temperate populations, South Australia) and *Cryptasterina hystera* (4 tropical populations, Queensland). High structural complexity of tide pools predicted the likely presence and high abundances of both species; however, while population sizes of *P. parvivipara* and *C. hystera* were stable over 3 and 2-years, respectively, their distributions were highly dynamic. Both species disappeared from large proportions of tide pools that offered ideal conditions and recolonised these pools with no apparent periodicity. I suggest that metapopulation dynamics operating among tide pools stabilise population abundances in circumstances where unpredictable changes in tide pool conditions can lead to 100 % mortality. Small proportions of *P. parvivipara* gave birth during autumn and winter, but most individuals gave birth in late spring to summer. Offspring size was greatest and brood sizes smallest during summer. Experiments showed that larger

offspring had greater fitness (survivorship) than smaller offspring during this period. I suggest that *P. parvivipara* adaptively alters brood characteristics during summer to maximise offspring fitness during this period. Intragonadal cannibalism among siblings may facilitate these changes in brood characteristics. I also suggest that *P. parvivipara* exhibits plasticity in the timing of births; that is, mean offspring fitness is maximised by matching the characteristics of an individual's brood and timing of births to prevailing environmental conditions. The coefficients of variation in offspring sizes of both species were high, but based on this sampling *P. parvivipara* was more variable than *C. hystera*. The higher variability exhibited by *P. parvivipara* may be a bet-hedging strategy that maximises mean offspring fitness in a temperate habitat that is more variable than the tropical habitat of *C. hystera*. The CV in offspring size of *P. parvivipara* did not differ among intertidal zones as would be expected if a greater offspring size was used as a bet-hedging strategy in the more variable upper areas of its intertidal zone. I suggest that intertidal habitats are inherently variable and the high CV in their brood characteristics may increase mean offspring fitness via bet-hedging.

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Lana M. Roediger

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