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Alteration of population size during oviposition influences reproductive performance in a haplodiploid mite*

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Animals are sensitive to changes in social environments and may adjust their life history traits accordingly. Population size, for example in spider mites, is one of the key socio-environmental factors that affect female reproductive performance, including fecundity, egg size, and offspring sex ratio. Previous studies tested the reproductive plasticity of females in response to the various social environments by maintaining females under constant levels of population size/density (*e.g.*, Weerawansha *et al.* 2020; 2022a, b, c). Yet, it is largely unclear whether females could adjust their reproductive strategies in response to the fluctuations of social environments during the breeding period. Using a haplodiploid spider mite, *Tetranychus ludeni* Zacher, we examined whether and how alterations of female population size with a consistent density (i.e., 1 ♀/cm^2) during the ovipositing period modified their reproductive investment. We set up six treatments during the experimental period (6 days): (1) females were transferred from a large group of 16 ♀ to small groups of 1, 5 and 10 ♀ on the 4th-ovipositing day; (2) females were transferred from small groups of 1, 5 and 10 ♀ to a large group of 16 ♀ on the 4th-ovipositing day; and (3–6) females were maintained at consistent group sizes of 1, 5, 10 and 16 ♀, respectively. We show that (1) after females were shifted from a large group to small ones, they laid fewer and larger eggs with a higher female-biased sex ratio; (2) after females were shifted from small groups to a large one, they laid fewer and smaller eggs with a higher female-biased sex ratio; (3) when females were maintained at small groups of 1 and 5 ♀ for six days, they laid more eggs with a higher female-biased sex ratio in early reproductive episode (1st–3rd day) than in later reproductive episode (4th–6th day) without change in egg size; (4) when females were maintained at large groups of 10 and 16 ♀ for six days, they had similar fecundity with similar egg size during the two reproductive episodes but had a higher female-biased sex ratio in the later episode; and (5) when all data were pooled for analysis, increasing egg size significantly increased the proportion of daughters. In spider mites, the mated females could adjust egg size and fertilize relatively larger eggs that will develop to daughters (Macke *et al.* 2011). Our results suggest that females fertilised more larger eggs laid in a small population but fertilised more smaller eggs laid in a larger population by lowering the fertilization threshold, above which eggs were fertilised. Our studies provide evidence that spider mites can manipulate their reproductive output and adjust offspring sex ratio in response to dynamic social environments.

Keywords: social environment, population size, reproductive plasticity, sex ratio

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