Sexual Plasticity and Self-Fertilization in a Clonal Sea Anemone

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Schlesinger A, Kramarsky-Winter E, Rosenfeld H, Armoza-Zvoloni R, Loya Y. 2010. Sexual Plasticity and Self-Fertilization in the Sea Anemone *Aiptasia diaphana*. *PLoS ONE* 5(7): e11874.

Many anthozoans reproduce both sexually and asexually, providing an interesting model for understanding the evolution of reproductive strategies. Sexual reproduction is achieved through the release of sperm or both sperm and eggs into the water column. While sexual reproduction can increase genetic diversity of offspring, asexual reproduction provides the ability for a successful genotype to rapidly colonize a new area. As a result, populations that rely more on asexual reproduction tend to have lower genetic diversity because they consist of a relatively small number of clones. Self-fertilization within a group of locally isolated clonemates (a genet) could be an important reproductive option when opportunities for sexual reproduction decline.

Schlesinger et al. (2010) used experiments to evaluate the importance of these reproductive methods in the population stability of the sea anemone *Aiptasia diaphana*. This clonal organism is a common part of fouling communities that are often isolated to sides of docks, marinas, harbors and boats, making them ideal candidates for studying the dynamics of isolated populations. In particular, they investigated whether seasonal changes in temperature and light-availability affect rates of both sexual and asexual reproduction. In addition, they asked whether asexually produced clones display sexual plasticity (the expression of different sexes within a clone) and engage in self-fertilization.

In order to determine seasonal effects on sexual reproduction, field populations of *A. diaphana* were collected from the Mediterranean Sea over a period of 16 months. Five were randomly chosen at each collection to determine reproductive condition. The remaining specimens were used as founders for experiments. Six genetic lines were founded in separate cultures (three by males and three by females), and cultures were exposed to similar temperature and light conditions as in their natural habitat. To determine seasonal effects on asexual reproduction, they simulated the effect of summer (June-August) and winter

(December-February) temperature and light conditions in the laboratory and counted the ramets (individuals) produced as a result of cloning. To estimate spawning and self-fertilization, the cultured lines were subjected to a regime that simulated conditions at the time of peak reproduction. Ramets of each genet line were removed before spawning and placed in separate dishes to spawn. On the mornings following gamete release, gametes were siphoned and closely examined as zygotes developed. Post-fertilization planula larvae were transferred to dishes and further examined to determine their viability.

Based on their results, Schlesinger et al. (2010) concluded that the rates of both asexual and sexual reproduction are biased toward summer conditions. In field populations, gametogenesis was recorded between April and August. In laboratory cultures, the rate of asexual reproduction was ten-fold higher under summer conditions than under winter conditions. They also found evidence for sexual plasticity within genet populations. Five out of the six genet lines produced members that were a combination of males and females, with a female/male ratio that was biased in favor of the founder sex (Table 1). In addition, one genet population produced not only males and females, but also seven hermaphroditic individuals. Finally, they showed that self-fertilization between members of the same genet is a common occurrence. Gametes spawned from within each genet line produced swimming planula larvae.

The fact that both sexual and asexual reproduction occur under summer conditions suggest that metabolic processes affected by light and temperature may play a role in regulating both types of reproduction. Studies on other sea anemones have shown similar evidence that rates of asexual reproduction are dependent on temperature and light. Contrary to expectations, Schlesinger et al. (2010) also found that sexual plasticity of clones could lead to sexual mating opportunities. Interestingly, they note that sexual reproduction within clones may not limit genetic diversity to the extent seen in other animals. Because anthozoans lack germ cell-lines, somatic mutations can become incorporated into gametes, increasing the genetic variation of offspring produced by self-fertilization, as in plants. The internal processes that have allowed for the evolution of both sexual plasticity and self-fertilization, however, are poorly understood.

The presence of hermaphroditic individuals was also puzzling, as *Aiptasia* had been considered gonochoric, with separate males and females. In is unclear whether the hermaphroditism observed in the laboratory cultures was an unnatural condition induced by the experimental manipulation or whether it could be a common characteristic. Thus, more research and sampling may be needed to determine the ecological relevance of this trait.

Table 1. Sex of ramets derived from six different founder genets of known sex.

Founder genet	Female ramets	Male ramets	Hermaphrodite ramets	Total ramets	% changed sex
Female 1	34	3	0	37	8
Female 2	22	15	7	44	50
Female 3	36	8	0	44	18
TOTAL	**92**	**26**	**7**	**125**	**26**
Male 1	2	42	0	44	5
Male 2	0	71	0	71	0
Male 3	25	39	0	64	39
TOTAL	**27**	**152**	**0**	**179**	**15**