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LOTUS CORNICULATUS SELECTIVELY ABORTS FRUITS RESULTING FROM SELF-POLLINATION

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Lotus corniculatus is typical of many hermaphroditic plants in that it regularly aborts a large portion of its immature fruit crop. Apparently these species are incapable of providing the resources necessary to produce mature fruits from all of their flowers (see Stephenson, 1981). Typically, only 30 to 50% of the flowers in each inflorescence produce a mature fruit -- even when each flower is outcrossed and the plants are growing under nutrient enriched conditions (see Stephenson, 1984). This apparently wasteful and inefficient production of "surplus" flowers and fruits on plants such as *L. corniculatus* has long been the subject of speculation among evolutionary biologists. Recent studies, however, reveal that the surplus flowers serve to attract pollinators and to increase the amount of pollen removed by pollinators (e.g., Willson and Rathcke, 1974; Queller, 1983). In essence, the surplus flowers decrease the probability that fruit and seed production will be limited by pollination and, simultaneously, increase the chances that a plant will donate pollen to conspecifics. In addition, Darwin (1877) and others (Janzen, 1977; Charnov, 1979; Lee, 1984) have hypothesized that the surplus flowers provide plants with a "choice" of offspring to mature. Darwin, for example, predicted that plants overproduce fruits in order to mature only those that result from cross-pollination (and abort those that result from self-fertilization).

Because *L. corniculatus* is reported to be incompletely self-incompatible (some individuals are partially self-compatible) (Tome and Johnson, 1945; Seaney, 1964), we performed a pilot project designed to determine if the partially compatible plants selectively abort fruits resulting from self-fertilization. We selected three shoots on each of twenty plants. All of the flowers on one shoot from each plant were outcrossed (the outcrossed shoots) while all of the flowers on a second shoot were self-pollinated (selfed shoots). On the third shoot, half of the flowers on each inflorescence were outcrossed and half were selfed (half shoots). We found that 14 of the plants produced no fruit following self-pollination -- these were omitted from further analysis. On the other 6 plants, 8% of flowers on the "selfed shoots" produced mature fruit while 35% of the flowers on the "outcrossed shoots" produced mature fruit. On the "half shoots," however, 55% of the outcrossed flowers produced a mature fruit (a significantly higher proportion than on the "outcrossed shoots") while only 1.4% of the selfed flowers (1 out of 74 flowers) produced a mature fruit (a significantly lower proportion than on the "selfed shoots"). In short, outcrossed flowers are more likely to produce a mature fruit when they are competing against selfed flowers for the limited maternal resources than when they are competing against other outcrossed flowers. Selfed flowers are also more likely to produce mature fruit when they are competing against other selfed flowers for maternal resources than when they are competing against outcrossed flowers. Apparently, partially self-compatible *L. corniculatus* plants appear to selectively abort fruits resulting from self-fertilization when both self and cross fruits are present on the same inflorescence.

Previous studies that we have conducted reveal that *L. corniculatus* cv Viking selectively aborts, from each inflorescence, those fruits with the fewest seeds (Stephenson and Winsor, 1986). Self-pollen is less likely than cross pollen to effect fertilization, due to a partial incompatibility expressed in the ovary (Tome and Johnson, 1945; Wojciechowska, 1963; Spiss, 1969); and those seeds that are produced from self-fertilization are more likely to abort (Wojciechowska, 1963). It seems possible, therefore, that fruits resulting from self-fertilization are selectively aborted because they tend to have low seed numbers.

Our findings have important implications concerning the flexibility of the breeding system. For example, estimates of the degree of self-incompatibility on a particular plant or cultivar will depend upon the distribution of the cross and self-pollinations within and among the shoots on a plant. More importantly, the degree of self-incompatibility will change with the structure of the population. For example, an isolated plant that receives only self pollen will produce more selfed progeny than would the same plant growing in a large, genetically diverse population that has both self and cross pollinated flowers. In the large population, the fruits from the self-pollinated flowers would be selectively aborted.

We currently have plans for a series of experiments using clones of partially self-incompatible *L. corniculatus* plants. These experiments are designed to (a) repeat the prior study with improved methods and larger sample size, (b) to determine if the fruits from self-pollinations contain fewer seeds than outcross fruits and, therefore, are more likely to abort, (c) to examine the vigor of cross- and self-fertilized progeny and (d) to determine if the timing of self- and cross-pollination affects seed number per fruit and the probability of fruit maturation.

REFERENCES

Charnov, E. L. 1979. Proc. Natl. Acad. Sci. USA. 76: 2480-2484.
Darwin, C. 1877. Effects of cross- and self-fertilization in the vegetable kingdom. D. Appleton, London.
Janzen, D. H. 1977. Amer. Nat. 111: 365-371.
Lee, T. D. 1984. Amer. Nat. 123: 427-432.
Queller, D. C. 1983. Nature 305: 706-708.
Seaney, R. R. 1964. Crop Sci. 2: 81.
Spiss, L. 1969. Genet. Polon. 10: 114-116.
Stephenson, A. G. 1981. Ann. Rev. Ecol. Syst. 12: 253-279.
Stephenson, A. G. 1984. Ecology 65: 113-121.
Stephenson, A. G. and J. A. Winsor. 1986. Evolution, in press.
Tome, G. A. and I. J. Johnson. 1945. J. Amer. Soc. Agron. 37: 1011-1023.
Willson, M. F. and B. J. Rathcke. 1974. Amer. Midl. Nat. 92: 47-57.
Wojciechowska, B. 1963. Genet. Polon. 4: 53-63.

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