Evolutionary Ecology, 1996, **10**, 327

COMMENT
on 1) Frank, *Evol. Ecol.* **10**, 307–17
2) Parker, *Evol. Ecol.* **10**, 319–22
3) Frank, *Evol. Ecol.* **10**, 323–25

And now for something completely different: genetic games and Red Queens

At least two outcomes characterize the co-evolutionary race between enemies and their victims (Rosenzweig *et al.*, 1987, *Evol. Ecol.* **1**, 59). They may reach an ESS at which no further real progress can occur in either species because of trade-offs (*e.g.* pleiotropy). Alternatively, they may get locked in an eternal dynamic struggle, racing ahead at the same net evolutionary speed with no end in sight. The latter constitutes a red queen situation (Felsenstein, 1971, *Am. Nat.* **105**, 1; Van Valen, 1973, *Evol. Theory* **1**, 1; Rosenzweig, 1973, *Evolution* **27**, 89; Schaffer and Rosenzweig, 1978, *Theor. Pop. Biol.* **9**, 135; Stenseth and Maynard Smith, 1984, *Evolution* **38**, 870 and many others).

The Red Queen outcome requires two special conditions (Rosenzweig *et al.*, 1987, *Evol. Ecol.* **1**, 59).

(1) No trade-offs in the phenotypic properties that determine the coefficients of the interaction.
(2) An infinite supply of genetic variation in both the predator (*sensu lato*) and its victim.

In 1987, we thought that both these requirements were highly improbable in real species. Thus, we pronounced the Red Queen gravely ill and near death. Now I think we were wrong.

The Red Queen's miracle cure comes from all the interesting work being done by Frank (1996a, *Evol. Ecol.* **10**, 307–17) and Parker (1994, *Evol. Ecol.* **8**, 560) and many others on the genetic games played by parasites and their hosts. A gene or gene combination used only for playing this game may indeed have no other effect on its holder except the determination of its success in the game. (Frank (1996b, *Evol. Ecol.* **10**, 323–25) does speculate that elicitor molecules of parasites may have another function, but it has not yet been found.) Moreover, once a parasite has successfully countered a genetic defence, the hosts should find no further use for it. Natural selection ought to replace it with another allele, first in the victim and then in their enemy. Once gone from both species, it becomes available for future evolutionary work. Thus, the supply of useful adaptations is effectively infinite.

I do not know how the difference between the 'matching allele' and 'gene for gene' models affects the Red Queen. I leave that to others better prepared to investigate this issue than I. But the potential should be realized: gene-matching systems are good places to look for Red Queens, and the possibility that they inhere in such systems may help us to understand them better.

Thanks to Steve Frank for comments.

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