The Endless Race Between Plant and Pathogen

Like the Red Queen in Lewis Carroll's *Through the Looking-Glass and What Alice Found There*, both disease-causing microbes and their hosts have to keep running frantically just to stay in place. As described by Matt Ridley [*The Red Queen: Sex and the Evolution of Human Nature* (Viking, London, 1993)], this seemingly futile race reflects the evolutionary forces that keep the lineages of pathogens and their targets alive, as each evolves new strategies for attack and defense. In this special issue on plant pathology, we explore just a few of the exciting lines of progress now yielding new insights into the evolutionary forces driving plant-pathogen interactions, as well as the practical outcomes in terms of pathogen management.

Perhaps we shouldn't be surprised, considering the audacity of pathogens as a whole, but recent discoveries have shown that the great divide between plants and animals is not unbreachable from the view of the pathogen. As Staskawicz *et al.* describe (p. 2285), some pathogens use the same strategies to interact with plant and animal cells.

Showing similar obliviousness to distinctions between kingdoms, the cellular strategy of gene silencing is making itself apparent in a variety of developmental and disease responses. Vance and Vaucheret (p. 2277) discuss how plants use RNA silencing to degrade foreign RNAs, particularly the genomes of invading viruses. For their part, the viruses, participating enthusiastically in the Red Queen's race, are evolving means to suppress this degradation defense.

The success of a disease interaction, whether from the point of view of the surviving plant or of the victorious pathogen, depends on mechanisms of evolution. Bergelson *et al.* (p. 2281) analyze the case of the resistance (*R*) genes, a highly divergent class of plant genes that confer resistance to specific strains of pathogens. Mechanisms of genetic exchange and adaptive evolution are intertwined to provide plants with a supply of newly divergent *R*-gene alleles, with new pathogen specificities.

Researchers trying to combat rapidly evolving plant pests also find themselves in the situation of the Red Queen. Two of the three articles in the News component of this special issue (pp. 2270 and 2273) focus on the many strategies—everything from high-tech genomics and genetic engineering to new agronomic practices—those researchers are using as they run to keep pace with the pests. The third (p. 2275) deals with what happens when a plant disease—citrus canker in Florida—slips out of control in a new territory.

The stakes in this battle against plant diseases are high, because a huge portion of agricultural production is lost to pathogen and pest damage. In compensation, farmers plant more land. The implications, as Briscoe and Somerville point out in the Editorial (p. 2217), are far-reaching: Not only are more land and labor used by agriculture, but more water is also needed —so much more that in regions where water is scarce, it may be worthwhile to address plant disease as a way to conserve on water usage.

–PAMELA J. HINES AND JEAN MARX

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