

The Association and Dissociation of Genes for Virulence in Wheat Stem Rust

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Wolfe and Knott (7) discussed the analysis of populations of plant pathogens and some of the problems that can occur. In particular, they noted that in using the methods of population genetics, the assumption is made that the data are from "a defined and discrete pathogen population in which there is a random genetic exchange (sexual or asexual)," but that this requirement is often not met in survey data. Analysis of such data can lead to misleading conclusions.

In a paper presented at the Fourth International Congress of Plant Pathology in Melbourne, Knott (*unpublished*) pointed out that Vanderplank (8,9) had fallen into the trap. He had analyzed the Canadian and United States' wheat stem rust (*Puccinia graminis* Pers. f. sp. *tritici* Erikss. & Henn.) survey data as though they came from a single, randomly mating population. In fact, because of the absence of barberry (*Berberis vulgaris* L.) in the main Puccinia Path of central North America, the population is essentially asexual. In addition, the fact that race frequencies often change from the southern to the northern areas of the Puccinia Path shows that the rust is not from a single, uniform population (Roelfs et al [1-6]).

Based on his analyses, Vanderplank (9) concluded that certain combinations of virulence genes associate and others dissociate, and that this is related to their durability. In particular, he divided the *Sr* genes into an ABC group and an XYZ group, plus a group of apparently neutral genes. The ABC group includes *Sr6*, *Sr9a*, *Sr9b*, and *Sr15* while the XYZ group includes *Sr7b*, *Sr9d*, *Sr9e*, *Sr10*, *Sr11*, *SrTt1* (*Sr36*), and *SrTmp*. Virulences on *Sr* genes that are in the same group tend to be associated, while virulences on genes in different groups tend to dissociate from one another. However, an examination of the rust survey data for the United States for 1975-1980 shows that a single race, 15-TNM, has made up 38-72% of the isolates collected in a given year (Roelfs et al 1-6). Race 15-TNM has the virulence formula (effective/ineffective genes) *Sr6*, 9a, 9b, 13/5, 7b, 8, 9d, 9e, 10, 11, Tt1, (*Sr36*), and Tmp. Thus, race 15-TNM is avirulent on each of the ABC genes and virulent on each of the XYZ genes and its virulence formula determines which

genes appear to be associated and which dissociated. Even though only a few other races are detected each year, their frequencies are sufficiently low that no race other than 15-TNM has a major effect. According to Vanderplank (9) virulences on three genes that are not in the ABC and XYZ groups, *Sr5*, *Sr8*, and *Sr13*, are neutral. In fact, almost all races were virulent on *Sr5* and *Sr8*, while none was virulent on *Sr13*. Thus, there was no real opportunity for association or dissociation to occur. Vanderplank's association and dissociation are artifacts that result from the fact that North American wheat stem rust is an asexual population that was dominated by one race in the years that he analyzed.

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