FORUM

Microbial Genomes: Unraveling Their Potential

The lead article in this issue of *Agricultural Research* reports on the surprising genetic diversity of pathogens that cause *Fusarium* head blight of wheat and barley, a disease that is now a major threat to agriculture worldwide. Rather than being caused by a single species, the disease is now known to be caused by at least eight closely related species.

In many ways, the study of these pathogens represents a coming of age for plant pathology, mycology, and use of microbial germplasm collections to solve pressing problems in agriculture. The work uses state-of-the-art gene sequence analyses to understand the genetic diversity of the pathogens. It also serves to alert cereal breeders that multiple strains of the pathogenic lineages should be tested to ensure durable disease resistance in new varieties of wheat and barley.

The success achieved with *Fusarium* is one of many examples of the remarkable advances occurring in molecular biology—advances that serve agriculture as well as medicine. The genetic diversity of *Fusarium* could be demonstrated only by analysis of gene sequences made possible by technologies like chemiluminescent tagging of DNA and polymerase chain reaction. The success was also achieved because of the availability of a worldwide collection of *Fusarium*, which was needed to detect the genetic diversity associated with pathogens that have widespread geographic distributions.

Biological resource centers, such as the ARS Culture Collection (NRRL), which maintains 80,000 strains of agriculturally and industrially important microorganisms, are essential for solving many problems in agriculture because they provide access to an enormous number of genetic resources. The availability of so many useful strains in culture collections is also a tribute to those scientists worldwide who have made the effort to deposit strains in a publicly accessible culture collection, with the expectation that some of these strains would one day have further significant value.

Culture collections are a long-term investment that gives a high rate of return because they provide germplasm for many uses. With the advent of rapid gene-sequencing technologies, strains maintained in culture collections are being more accurately identified and their properties predicted. So the molecular age has increased the importance of culture collections.

Agencies such as ARS have taken the long view and supported germplasm collections as an integral part of their commitment to agriculture. Now that investment is paying off.

Where are molecular studies taking us?

The study of *Fusarium* head blight is just one example of using molecular genetic analyses to solve problems in agriculture. Gene sequencing is routinely used to detect plant pathogens. This activity may become ever more important in an age in which growing global travel and international trade increase vulnerability of crops to exotic pests. These same technologies are also being used to detect food spoilage organisms and those that cause foodborne diseases.

USDA is helping to ensure human health at home and abroad by concerning itself with plant and animal health. The research on *Fusarium* fungi that reduce crop yield and contaminate grains with toxins is helping to build a knowledge base needed to prevent devastating crop failures and to ensure a safe and abundant food supply.

The job is not completed. In 1994, hunger and disease associated with malnutrition claimed the lives 10 to 12 million of the world's children under age 5. This happened at a time when emerging plant diseases led to abandonment of more than 2 million acres previously planted to traditional crops in Latin America.

Other areas ripe for progress in applied microbial research include biological control of plant diseases, fruit rots, and insect pests. Many potential biological control organisms are available in culture collections. But before these organisms—especially those newly isolated from nature—can be used they must be accurately identified by molecular techniques to help assess their safety.

Using microorganisms for bioconversion of agricultural commodities to high-value products offers the potential for increased income to farmers. New microorganisms are often needed in such research, and now they may be found more readily than ever before.

An illustrative example is the recent molecular-based discovery by Stephen W. Peterson and colleagues of 40 new species of the pharmacologically and industrially important genus *Penicillium* from isolates maintained in the ARS Culture Collection. (See "In Search of Useful Fungi," *Agricultural Research*, November 1999, pp. 18-19.) This case in point further demonstrates the power of molecular identification techniques and the importance of maintaining worldwide collections of microbial germplasm.

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