Success Stories Resulting from the Proactive Characterization of Culture Collections

Contaminant in contact lens solutions identified rapidly and accurately because of the well-characterized Fusarium culture collections of Penn State and USDA ARS. Over several years, scientists at the Fusarium Research Center (FRC) at Penn State and the Bacterial Foodborne Pathogens and Mycology Research Unit at the U.S. Department of Agriculture facility (ARS, NAURL) in Peoria, Illinois characterized genetically all *Fusarium* cultures in these two collections that were associated with human infections. *Fusarium* infections of humans include deadly, invasive infections of severely immune-compromised individuals as well as serious infections of the cornea. They are often unresponsive to antifungal drug therapies. As these studies neared completion in early 2006, an outbreak of corneal infections in Southeast Asia and the United States associated with the use of a particular contact lens solution occurred. Since the collections had been characterized, FRC and USDA scientists were able to provide the Centers for Disease Control (CDC) and the manufacturer precise, DNA-based identification of the fungi associated with the infections within a few days of the outbreak. Investigators quickly determined that multiple species of *Fusarium* were associated with the infections suggesting that the contaminants were likely introduced from the patient environment and not from a contaminated lens solution. This information was essential in the development of an infection model for this disease, and the discontinuation of the product. If clinical isolates from these collections had not been studied proactively, these investigations would have taken many weeks or months to complete rather than a few days.

Important medical and industrial products resulting from study of USDA ARS collection in Peoria:

- **Penicillin**. A high-yielding strain of *Penicillium chrysogenum* in the USDA-ARS culture collection at Peoria, ILL (NRRL) led to the commercial development of penicillin, which contributed to the Allied success in WWII and began a revolution in human disease treatment.
- **Riboflavin**. Researchers discovered that the fungus *Eremothecium (Ashbya) gossypii* was a high producer of riboflavin. *E. gossypii* continues to be used for commercial production of riboflavin (vitamin B12).
- **Xanthan gum**. The collection provided a strain of the bacterium *Xanthomonas campestris* that produces a high yield of xanthan gum, an ingredient found in nearly all salad dressings, as well as being used for secondary recovery in oil fields.
- **Dextran blood extender**. Discovered and developed a strain of the fermentative bacterium *Leuconostoc mesenteroides* for the production of this product. Every hospital emergency room in the U.S., and probably elsewhere, has bottles of dextran ready for emergency transfusions.
- **Pentose fermentation**. Discovered the first yeasts to ferment pentoses from biomass to ethanol: D-xylose, *Pachysolen tannophilus*; L-arabinose, *Candida arabinofermentans*.
- **Barcodes for microbial identification**. Developed inclusive gene sequence databases that enabled 'bar coding' of the yeasts, *Fusarium, Aspergillus, Penicillium, Listeria* and *Bacillus*. Applications have been numerous and were possible because of the strain diversity acquired and maintained in the collection.

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Cellulase and the value of orphaned collections. The USDA ARS Peoria collection has taken in a number of 'orphaned' collections to prevent loss of valuable microbial germplasm. One of the largest of these is the U.S. Army Quartermaster Collection from Natick, Massachusetts (ca. 5,000 strains). Many of these fungi are fabric and wood degraders, which will be valuable for biofuel development. One isolate of the fungus *Trichoderma* from this collection was determined to produce high yields of cellulase, used to make 'stone-washed' blue jeans and has applications in biofuel research.

Wheat exports saved. In 2000, USDA officials persuaded Brazilian officials to lift a ban on the import of U.S. wheat by showing that US wheat exports were free of a quarantined nematode. Using the inclusive and well-characterized USDA-ARS nematode collection in Beltsville, USDA demonstrated that this nematode existed in Brazil and thus saved the US wheat industry millions of dollars in trade.

Gourmet mushrooms saved from green mold disease. Green mold disease can decimate a cultivated mushroom crop within weeks. The fungus that causes the disease was thought to be a species used extensively in biological control of plant diseases. A USDA ARS scientist (Beltsville Maryland) determined that the green mold fungus was different from the biological control species, possibly because of a collection of well-characterized isolates. This knowledge helped prevent the spread of green mold and allowed the continued use of an ecologically sound biological control agent.

Missed Opportunities Due to the Loss of Culture Collections

Legionaire's disease collection destroyed. "A US congressional investigation into the destruction of more than 10,000 bacterial samples from an infectious disease laboratory has led to a call for uniform guidelines governing federally funded biobanks." (http://www.nature.com/news/2008/080910/full/news.2008.1096.html) Because of a lack of uniform guidelines and understanding of the importance of collections, 10,000 isolates of *Legionella* were destroyed after the program was shut down and before the isolates could be transferred to the researcher's new location. This collection provided vital epidemiological information and essential for forensics of new cases of Legionaire's disease.

***Fusarium* head blight collection lost.** A collection of *Fusarium* isolates associated with historical cases (1940s and 1950s) of head blight of wheat was lost when the collection of renowned scientist W.L. Gordon was discarded upon his retirement as no plan was in place to preserve and maintain his fungal collections. Head blight has reemerged in the past decades as a severe fungal disease on wheat and corn throughout the grain producing states and Canada. Dr. Gordon's collection would have been a critical resource for understanding and solving one of the decade's most important challenges to agriculture in North America.

Lack of biobank repository results in lost collections. Hurricane Katrina wiped out several valuable collections that would be available still if a back-up repository had been established. Losses include major portions of the Formosan subterranean termite collection, sugarcane germplasm collection, sugarcane insect collection, and sugarcane virus collection. The cyanobacterial (blue-green algae) collection and approximately one quarter of the fungal collection were lost completly. These losses are irreversible and severely impacts research on control of sugarcane diseases and pests, development of new sugarcane varieties, and other research important to agriculture.