Defining Risk From Meatborne Parasites

PEGGY GREB (K9857-1)

Examining an electrophoresis gel, zoologist Benjamin Rosenthal identifies fragments of genes isolated from related species of parasites. Genes common to all such species provide a good basis for comparing and diagnosing them.

A single-celled parasite called *Toxoplasma gondii* likely infects more than 60 million people in the United States, according to the Centers for Disease Control and Prevention. While most of the infected don't have any symptoms, the parasite can cause serious damage in developing fetuses, people with AIDS, and others with compromised immune systems.

A common route of infection is exposure to egglike oocysts in the feces of infected cats. But *T. gondii* can infect tissues of domestic and wild animals, and people can ingest the parasite by eating or handling raw or undercooked meats, including pork, lamb, or venison. According to rough estimates, about 3 percent of U.S. market-age pigs have *T. gondii* tissue cysts. But improvements in how swine are fed and housed are reducing exposure.

Still, "it looks like foodborne infection is a major route," says Benjamin M. Rosenthal with the Agricultural Research Service in Beltsville, Maryland. He notes that members of a vegetarian religious denomination living in suburban Maryland were one-half to one-tenth as likely to have been exposed to *T. gondii* as their neighbors. And a large European study attributed between one- and two-thirds of toxoplasmosis-related birth defects to consumption of undercooked or inadequately cured pork, lamb, or beef. Thorough cooking—to 160-170˚F—can prevent transmission.

Toxoplasma parasites have close relatives that can also form cysts in the muscles of domesticated animals and primates. These include parasites belonging to the genera *Neospora*, *Hammondia*, *Besnoitia*, and *Sarcocystis.*

"We know far less about their actual or potential public health risk," says Rosenthal. "These other cyst-forming parasites may contribute to the estimated 86 percent of U.S. foodborne illnesses that currently go undiagnosed." There are many reports of *Sarcocystis* infection in humans worldwide, he adds, but the

animal sources of those infections are poorly defined.

That's why Rosenthal, a molecular systematist, joined ARS' Parasite Biology, Epidemiology, and Systematics Laboratory nearly 3 years ago. He is defining the distribution of these cyst-forming parasites in domestic and wild animals and in people. And he's doing it by looking for variations in their genes.

"You have to know who's who before you can make effective risk assessments," he says.

Until recently, for example, researchers didn't have sensitive tests to diagnose or distinguish *Neospora caninum* infections from those caused by *T. gondii*.

"Many of these other parasites also cause miscarriages in cattle, goats, sheep, and nonhuman primates," Rosenthal says. "Do they pose a direct risk to human health? To begin to answer the question, we first have to tell them apart and determine how many species exist. Learning how they are related to one another will help us assess their potential to infect people and cause disease."

Genetic comparisons may also shed light on the evolutionary age of these parasites and the conditions that let them flourish. For instance, there are only three main genotypes of *T. gondii* worldwide. And there's very little genetic variation within each genotype, which is unusual for such an especially abundant organism.

These facts suggest that *T. gondii* may have relatively recent evolutionary origins, says Rosenthal, and may have taken advantage of opportunities for transmission that came with the domestication of animals.

"Parasite adaptations to particular agricultural practices may explain why infection with *T. gondii* is so common in our cats and in certain food animals," he says.

But such a conclusion will rest on a better understanding of the genetic variation of other, related parasites, says Rosenthal. A recent study led by Stanford University scientists may help explain *T. gondii's* success. The team reported strong evidence that the most virulent of the three genotypes appears to be the offspring of a sexual recombination between the other two.

In this case, it looks like Mother Nature selected a whole new strain rather than selecting by individual gene mutations, says Rosenthal.

With *Toxoplasma*, he says, "every gene you look at exists in only one or two forms. Is the genetic uniformity of *T. gondii* extreme when compared to its closest parasitic relatives?"

Rosenthal's research will help answer that question while developing the diagnostic tools necessary to evaluate any food-safety risks posed by these "poorly understood but intriguing parasites and their relatives."—By **Judy McBride,** formerly with ARS.

This research is part of Food Safety, an ARS National Program (#108) described on the World Wide Web at http://www.nps.ars.usda.gov.

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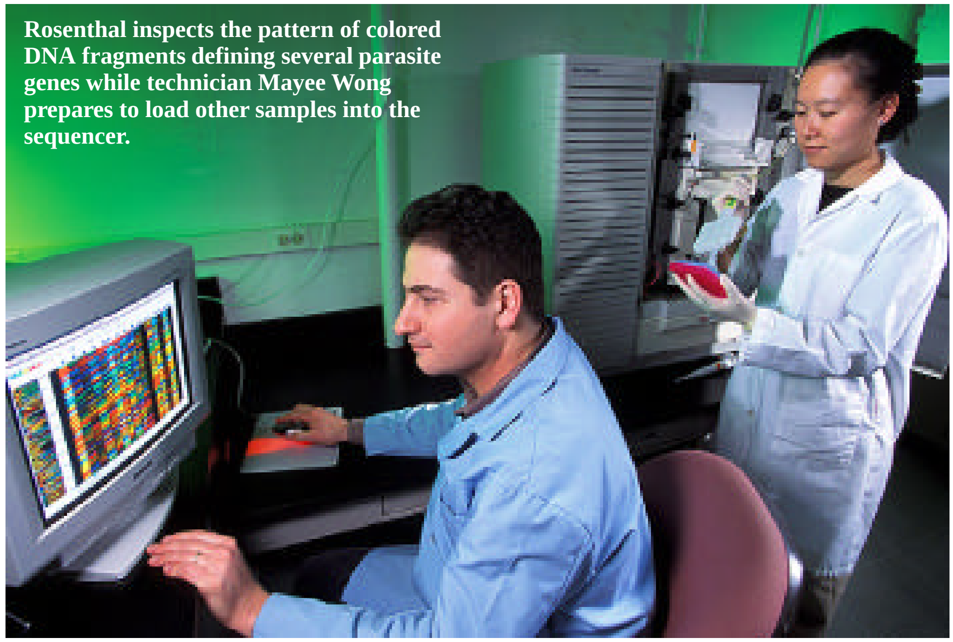

Rosenthal inspects the pattern of colored DNA fragments defining several parasite genes while technician Mayee Wong prepares to load other samples into the sequencer.

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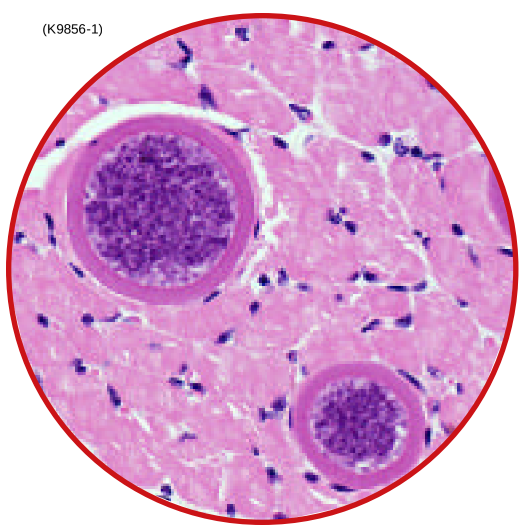

Microscopic cysts of *Sarcocystis hominis* nestled in a sliver of beef tongue. Proper cooking prevents the parasites bundled in these cysts (stained dark purple) from infecting people. Magnified about 400x.