Research offers new insights into cross-species parasite transmission

January 8 2014, by Beth Gavrilles

(Phys.org) —Researchers at the University of Georgia have developed a new mathematical model that helps to explain how some parasites predominantly associate with one particular host species-but are still capable of infecting other species. Their work, recently published in *Theoretical Population Biology*, could eventually help public health officials develop intervention strategies for diseases that jump between species.

The relationships between parasites and hosts have long been thought of in one of two ways: a parasite is either a specialist infecting one particular host species, or a generalist able to jump routinely between host species. But in nature, many parasites do both, infecting a primary host species and causing frequent epidemics in others.

Authors James Haven and Andrew W. Park of the UGA Odum School of Ecology, who study the ecology of infectious diseases, were not satisfied with the conventional explanations for the mechanics of parasite-host relationships, which rely exclusively on adaptation-the process by which favorable genes are selected, improving fitness.

"A lot of the evolutionary arguments on host specialization tend to be rather incompatible with the frequent cross-species transmissions that we observe," said Park, an associate professor in the Odum School and the UGA College of Veterinary Medicine. "We were interested in the mechanisms that may allow both of those things to happen."

The evolutionary explanation is that parasites that associate with just one host have specialized, or adapted, to do so: genetic mutations over time have given them a competitive advantage in that particular host. Parasites that are able to jump to more species are thought to have evolved by a similar process to become competitive in new hosts.

"People will essentially argue that generalist parasites are adapting to multiple host species again and again, but I think mutations that confer adaptive advantage are relatively rare," said Haven, a postdoctoral research associate in the Odum School. "I sought other explanations for how a parasite can appear to be associated with different host species and I thought superinfection could be a mechanism to account for it."

Superinfection-when a parasite infects a host that is already infected by another strain-happens when a spontaneous mutation makes one parasite strain more aggressive.

"With superinfection, the mutant strain takes over; whatever parasite was inside that infected host gets replaced, essentially, by the more aggressive version," he said. "That's the good news, from the parasite's point of view. The downside for the parasite is that it has a greater chance of killing its host," thus reducing its own chances of survival.

To test their theory that superinfection could allow a parasite to both specialize and infect other host species, Haven and Park created a mathematical model to simulate superinfection in a system with multiple hosts and parasites. It showed that superinfection could lead to parasite-host association while causing frequent cross-species transmission events.

"In the absence of this theory, cross-species transmissions would be explained by invoking recurrent adaptive mutations," said Haven. "The take-home message is that cross-species transmissions may be more

likely to occur in the presence of superinfecting strains."

Park said that their hypothesis offers a helpful alternative to the conventional thinking. "Previously we may have been overstating the role of adaptation," he said. "What we've done here is not predictive-it's theoretical-but it could eventually have implications for predicting disease emergence."

Haven agreed. "Anything that helps us understand parasites that are generalists, that can infect multiple host species, is important," he said.

More information: James Haven, Andrew William Park. "Superinfection reconciles host–parasite association and cross-species transmission." *Theoretical Population Biology*, Volume 90, December 2013, Pages 129-134, ISSN 0040-5809, dx.doi.org/10.1016/j.tpb.2013.09.015

Provided by University of Georgia