Landmark study details demographic, ecological and genetic spread of rabies in raccoon outbreak

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Analyzing 30 years of data detailing a large rabies virus outbreak among North American raccoons, researchers at Emory University have revealed how initial demographic, ecological and genetic processes simultaneously shaped the virus's geographic spread over time. The study appears online in the *Proceedings of The National Academy of Sciences*.

"Our study demonstrates the combined evolutionary and population dynamic processes characterizing the spread of a pathogen after its introduction into a susceptible host population," says Leslie Real, PhD, Emory University Asa G. Candler professor of biology. During invasion, emerging pathogens, such as rabies, ebola and hantavirus, undergo rapid evolution while expanding their numbers and geographic range; yet, it is difficult to demonstrate how these processes interact, says Dr. Real.

However, this particular outbreak, which went largely unchecked until relatively recently, was unusually well documented both spatially and temporally. Data were methodically collected and stored since the outbreak began in the mid-1970s. In addition, the Centers for Disease Control and Prevention (CDC) had been stockpiling viral samples from the outbreak since 1982, giving scientists a treasure trove of genetic data ripe for analysis.

"Together these data offer a rare chance to examine how the demographic and spatial processes of spread and population expansion

over 30 years have shaped viral evolution on a geographic scale," says Dr. Real. "Landscape features, such as rivers and mountains, can have a pronounced effect on the rate of rabies' spread and may therefore affect viral dynamics on a large scale," he says.

The study, for example, showed that because mountain ranges make for a poor raccoon habitat especially at higher elevations, raccoons did not cross the Appalachian mountain chain during the first part of the outbreak, which clearly limited the virus's westward expansion, says Dr. Real. Likewise, it was found that the Allegheny Mountains appear to have slowed the virus's expansion to the north. The study area ranged from North Carolina to Vermont, as far east as Chesapeake Bay, and westward into Tennessee and Ohio.

"These results provide important insights into the geographic scale of rabies persistence and will be increasingly important in understanding the epidemiology of rabies and other emerging zoonotic diseases, those diseases that can be transmitted between animals and people, in a geographic context," says Dr. Real. "We can then use these insights to predict where and when zoonotic disease outbreaks will occur so we can target surveillance and intervention," he says.

For example, in the United States, the western expansion of rabies is currently controlled through the distribution of an oral rabies vaccine stretching from Ontario, Canada, down to Alabama. But should the rabies breech this barrier, there are no natural settings to keep the virus from spreading across the entire Midwest. "However, we can now model what the spread of the virus would look like and then intervene," says Dr. Real.

Although raccoons are common throughout North America, their impact as a rabies host before the 1970s was limited to the southeastern United States, particularly Florida. However, this situation changed dramatically

in 1977 when a raccoon-specific rabies virus variant (RRV) was detected in West Virginia. The RRV later spread quickly along the mid-Atlantic coast, and by 1999 infiltrated thousands of square kilometers.

It is estimated that rabies causes more than 50,000 human deaths annually worldwide, and roughly $30 million is spent each year to treat patients exposed to rabies in the United States. The estimated public health costs associated with rabies detection, prevention and control exceed $300 million annually in the United States, according to the CDC. These costs include vaccination of companion animals, animal control programs, maintenance of rabies laboratories and medical costs.

Source: Emory University