Study shows invading toads adjusting rapidly to different environmental conditions

January 23 2018

A new paper published in *Conservation Physiology* examines the thermal tolerance of Cane Toads in Hawaii and Australia and finds that some of them are adapting very quickly to lower temperatures. This has serious implications for the spread of the toad within Australia, a major and persistent ecological problem.

Physiological plasticity, the ability to adjust characteristics in response to local environments, may facilitate animals' invasion into new habitats, but researchers have wondered whether such plasticity is present in all populations of the invader or if it is produced only by specific climatic challenges. In cold-climate areas of Australia, invasive cane toads (*Rhinella marina*) can rapidly adjust to new environments. To investigate whether this plasticity is found in all invasive cane toads or is only seen in those cool climates, researchers measured the acclimation ability of toads from Hawaii and from across Australia.

The cane toad is one of the world's most successful invasive species. Although native to Central and South America, this large toad now appears in more than 40 countries across a wide range of environments. Cane toads were introduced to northeastern Australia (from French Guiana, via Hawaii) in 1935 in an attempt to limit the country's cane beetle population on sugar plantations.

Northeastern Australia is humid and tropical, and provides a climate relatively similar to that of French Guiana. Cane toads spread rapidly westwards, reaching Darwin, Australia, in the Northern Territory, in

2005, and entering Western Australia in 2010. The invasion reached the border of New South Wales in 1978, and has since moved southward. Mountain sites in this region are colder than most of the species' native range in tropical America.

Cane toads became a pest rapidly. The toads have no natural enemies beyond Central America, and from the original 102 toads descended some 1.5 billion animals now ravaging Australia. The toads, which can grow to the width of dinner plates, are serious threats to ecosystems because they deplete resources and secrete a poison that can kill other animals in minutes. The species is so rampant that its spread was lampooned in a 1995 episode of The Simpsons.

Understanding how invasive species flourish in particular environments is important for accurately predicting the invader's impact. Mathematical models often use information on average characteristics of a species in combination with fine-scale climatic data, to predict the potential extent of a biological invasion. Such approaches, however, neglect the possibility of different adaptive behaviours from animals in different places. Rapid shifts in traits may occur when an invader encounters new environments either via plasticity (direct modifications in response to environmental factors) or through the evolution of traits over time.

It was not known whether this ability to acclimate is a trait of all cane toads, or is only seen in populations that experience cool conditions. To answer this question, researchers looked into the acclimation ability of cane toads from across Australia, and also from populations in Hawaii. Cane toads have been present in both Hawaii and Australia for about 80 years. Both Hawaii and Australia have wide ranges of thermal conditions.

Researchers tested the thermal tolerance of adult cane toads from Northern Australia in November 2015, Queensland in May 2016, and

from two sites in New South Wales February 2016. All Australian sites were significantly above sea level. Researchers also tested the lower thermal tolerance of adult cane toads from four sites on the Big Island of Hawaii in June 2015. In the Hawaiian Islands, even nearby areas may differ strongly in wind speed, cloudiness and rainfall.

The researchers collected toads from the field and placed them at different temperatures before measuring their response. Toads from the coolest Australian region (New South Wales) demonstrated plasticity. Toads from other Australian populations were unaffected by the thermal treatments. Hawaiian toads from a cool, wet site also rapidly acclimated to cool conditions, whereas those from warmer and drier Hawaiian sites did not. Thermal plasticity has diverged among populations of invasive cane toads, with rapid acclimation manifested only in two cool-climate populations from widely separated sites.

These results demonstrate not only the remarkable ability of cane toads to rapidly adjust to different thermal conditions, but also the importance of predictive models of toad spread to consider variation in traits between populations. If data on the relevant traits of an invasive species are based on only a limited range of populations, without considering geographic spread, the eventual spread of an invasive species may be grossly underestimated.

"This new research confirms that cane toads' ability to rapidly adjust their thermal tolerance in response to cool conditions is present not only in cool climate populations of the toads in Australia," said lead author Samantha McCann, a PhD Candidate at the University of Sydney. "We know that this characteristic has evolved in an invasive toad population more than once, also presenting itself in high elevation areas of Hawaii. This discovery highlights the remarkable ability of cane toads to adjust to novel conditions, and is important for understanding the role of physiological plasticity in facilitating biological invasions in general."

More information: "Physiological plasticity in a successful invader: rapid acclimation to cold occurs only in cool-climate populations of cane toads (Rhinella marina)" *Conservation Physiology* (2017). DOI: 10.1093/conphys/cox072

Provided by Oxford University Press