

Researchers find genomic evidence of rapid adaptation of invasive Burmese pythons in Florida

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Researchers holding pythons. Credit: UTA

Florida has become a haven for invasive species in the United States, but perhaps the most well-known of the State's alien residents is the Burmese python. These giant snakes, native to Southeast Asia, have become well-established over the past few decades and even flourish in their new environment.

"In Burmese pythons, we observed the rapid establishment and expansion of an invasive [population](#) in Florida, which is quite ecologically distinct from Southeast Asia and likely imposes significant ecological selection on the invasive Burmese python population," said Todd Castoe, biology professor at the University of Texas at Arlington and director of the Castoe Lab. "This situation had all of the hallmarks of a system where rapid adaptation could occur, so we were excited to test for this possibility using cutting-edge genomic approaches."

The researchers originally set out to determine whether pythons could have adapted to an extreme Florida freeze event in 2010. They generated data for dozens of samples before and after the freeze event. By scanning regions of the Burmese [python](#) genome, they identified parts of the genome that changed significantly between the two time periods, providing clear evidence of evolution occurring over a very short time scale in this population.

"The 2010 Florida freeze event led to a 40 percent to 90 percent documented field mortality in invasive Burmese pythons, so if evolution and adaptation were to be occurring, we knew we should see it over this time period that imposed a very strong bottleneck of selection," Castoe said.

"We employed a technique commonly referred to as a genome scan, which identifies regions of the genome that appear to be under strong natural selection, which could contain genes important in adaptation that may have allowed a subset of this population to survive these freeze

events," he added.

The researchers expected to find genes in these regions that are important for potential adaptation to cold, but as they further scrutinized the data, a different signal began to emerge that told a more broad story about adaptation in this invasive population.

"We kept seeing evidence of adaptation in genes related to cell division, organ growth, and tissue development, which admittedly puzzled us at first. However, it eventually occurred to us that there was a connection with a parallel project in the lab that uses Burmese pythons as a model system for understanding regenerative organ growth, where tissues are downregulated when fasting and then regenerated in cyclical patterns corresponding with feeding cycles of most pythons. We began to wonder whether the signal we were seeing in the genome of Florida Burmese pythons was linked to adaptation in how they regenerated organ systems based on their feeding ecology," said Daren Card, a recently graduated Ph.D. student in the Castoe lab who worked on this project for his dissertation.

Armed with a working hypothesis that invasive Burmese pythons may be adapting to more regular feeding opportunity in Florida, the researchers gathered further ecological, functional genomic, and morphological data to understand the frequency at which pythons are feeding and whether there are physiological changes consistent with more regular feeding.

"These additional analyses showed that Burmese pythons in Florida are constantly feeding and that tissue morphological and gene expression patterns support a more up-regulated physiological state in fasted pythons—Florida pythons appear to have adapted to regulating their digestive physiology to more efficiently eat prey constantly. This is alarming because these snakes have already been shown to have major negative impacts on endemic mammalian and bird populations in South

Florida, including Everglades National Park, and our data was suggesting that, through rapid adaptation, they are only 'getting better' at being an effective invasive predator," Card added.

UTA biology chair Clay Clark congratulated the team on this work, which provides tangible evidence that evolution can occur extremely rapidly in natural populations, and that such rapid evolution can result in major changes in very complex traits that impact the physiology and ecology of vertebrates.

"These results provide an unprecedented perspective at how quickly a vertebrate population can evolve, while also providing new links between genomic adaptation and complex physiological change related to the ecological impacts of invasive species," Clark said. "It is particularly important work given UTA's strategic focus on global environmental impact."

More information: Daren C. Card et al, Novel ecological and climatic conditions drive rapid adaptation in invasive Florida Burmese pythons, *Molecular Ecology* (2018). [DOI: 10.1111/mec.14885](https://doi.org/10.1111/mec.14885)

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