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A Review of: Dorcas, M. E., J. D. Willson and J. W. Gibbons. 2010. *Can Invasive Burmese Pythons Inhabit Temperate Regions of the Southeastern United States?* Biological Invasions. Online at doi 10.107/s10530-010-9869-6

David G. Barker and Tracy M. Barker
vpi@beecreek.net

Here is another article in *Biological Invasions* about pythons with a title posed as a question. The first such article was, of course, that of Rodda et al. (2008). In it a flawed analysis based on a corrupt data set concluded that Indian pythons (*Python molurus*) and Burmese pythons (*Python bivittatus*) would find the climate of the southern third of the continental United States to be suitable for colonization. In this more recent article, which for convenience we will refer to simply as "Dorcas et al." or "Dorcas and others," the authors set out to test the conclusions of the first article.

For readers unfamiliar with Dorcas et al., it can be summarized as follows: in the Introduction, the authors argue that it is really important to test the ability of Burmese pythons currently inhabiting the Everglades National Park [ENP] to survive in more temperate regions. In the Methods section, there is a description of the "semi-natural" large enclosure that included a variety of shelters and refugia and into which ten pythons from ENP were released. The enclosure was located on the grounds of the Savannah River Ecology Lab [SREL] near Aiken, South Carolina. In the Results section, the authors describe how the pythons froze to death. In the Discussion section, the authors describe how the pythons would have survived it the weather had been warmer, the snakes had been smarter, or possibly if the snakes had been from different genetic stock.

The entire text of the article could be summarized in a single word answering the question posed in the title—NO. The article very concisely illustrates that Burmese pythons cannot inhabit at least the area of southern South Carolina. Never has a published article better described how tropical pythons freeze to death in temperate South Carolina. Further, a better title for the article would be "A Clear and Concise Rebuttal of the Analysis and Conclusions of Rodda et al. (2008)."

We note that in Dorcas et al. the word "temperate" is used in the title and 17 places in the text, yet nowhere is the term defined. Do they refer to any locality north of the Tropic of Cancer (23°26′22″N latitude) and south of the Arctic Circle (66°33′44″N latitude), that being the accepted Northern Temperate Zone? Or is it any area that does not experience average winter monthly temperatures below 0°C, or minimum monthly temperatures below 0°C? There are a number of other possible demarcations that we could propose. We can find no universally accepted definition of "temperate" and Dorcas and others do not define their use of the term "temperate." Neither do Dorcas and others define what areas in the USA they consider to be temperate or why. Clearly, however, South Carolina is "excessively temperate" for *Python bivittatus*.

The following sentence is quoted from the text and is the first use of the term "temperate"; as such we would expect that the citations are supposed to support and possibly define the use of the term: "Although large constricting snakes generally live in tropical climates, the native range of *P. molurus bivittatus* extends into temperate regions (Groombridge and Luxmoore 1991; Whitaker and Captain 2004; Zhao and Adler 1993) and recent climate-matching studies indicate that climate suitable for *P. molurus* [*sensu antiquo*] exists throughout much of the southern United States (Reed and Rodda 2009; Rodda et al. 2009)." These are the ONLY references provided by Dorcas et al. that would indicate any justification for the use of the term "temperate."

Looking at the three references in the first half of the sentence, one will find a single use of the term "temperate" in Groombridge and Luxmoore (1991) and its use seems to imply that the authors do not consider *Python molurus* (*sensu antiquo*) to be a temperate species. Whitaker and Captain (2004) do not use the term "temperate" to describe the habitat or ecology of either Burmese pythons or Indian pythons—the term does not occur in either account. Zhao and Adler (1993) do not use the term "temperate" to describe the habitat or ecology of the Burmese python—the term does not occur in the account.

In the second half of the quoted sentence, the mention of Reed and Rodda (2009) and Rodda et al. (2008) refers to their published analyses based on a data set wherein essentially all the northernmost (temperate) weather stations in the study are located outside the ranges of the species. The "studies" are based on a novel and incorrect map, incorrect taxonomy, and flawed data (see Barker and Barker, 2010c).

Dorcas et al. provide no references that define or justify the use of the term "temperate" with regard to the natural distribution of *P. bivittatus*. They make no reference to plant communities, annual temperature regimes, critical winter temperatures, latitudes, or any other criteria to define or justify just exactly to what they are referring with their use of the term "temperate." In fact, other than recent articles written by invasion biologists regarding the presence of *P. bivittatus* in Florida, we can find no instance in herpetological literature where Burmese pythons are described as a temperate species, or as occurring in temperate climates.

Dorcas and others persist in identifying the Burmese python as a subspecies of *Python molurus*, a usage that has plagued many of the publications of invasion biologists. It's not clear why these invasion biologists clearly consider themselves to be superior taxonomists and why their opinions on the classification of the Burmese python should supersede the conclusions of taxonomists published in taxonomic papers in peer-reviewed journals (Jacobs et al., 2009; Schleip and O'Shea, 2010). Other recent authors have accepted this change (Avery et al., 2010; Barker and Barker, 2010a, b, c; Cota, 2010). It has been demonstrated that the use of correct and current taxonomy is of the utmost importance to environmental and invasion biology (Bortolus, 2008).

The change in the classification of the Burmese python, now recognized as the species *Python bivittatus*, constitutes one of

several reasons why the the analyses and conclusions of Rodda et al. (2008, 2009) and Reed and Rodda (2009) are fundamentally incorrect and suspect on many points (Barker and Barker, 2010c). This, in turn, brings into question the basis for and validity of this research—if *P. bivittatus* is not, in fact, a temperate species, then there seems to be little justification for allowing these tropical pythons to freeze.

Regarding the points made in the Discussion: Dorcas and others express surprise that the Burmese pythons in their enclosure did not seem to react to cold temperatures by seeking shelter. This despite previous reports by Barker (2008), Avery et al. (2010), and Mazzotti et al. (2010) that exactly described this inability of Burmese pythons and other large constrictors to correctly estimate and react to the dangers of critically cold temperatures. The authors propose that evolutionary changes to the physiological tolerances of the pythons to cold are possible and support this statement with two references (Hoffman and Weeks, 2007; Bertoli et al., 2010), both of which pertain to fruit flies (*Drosophila*).

Continuing, Dorcas and others then theorize that perhaps thermoregulatory behaviors appropriate to the temperate climate "can evolve relatively rapidly, provided it is a product of heritable behavioral traits" and cite for support the theoretical paper of Angiletta (sic) et al. (2002). There are several problems with this line of reasoning, among which include: (1) The time frame indicated by "relatively rapidly" does not refer to any defined time period and could extend to thousands or millions of years. (2) There is no evidence that the thermoregulatory reaction of large tropical constrictors is a product of heritable behavioral traits. It may be that large constrictors simply cannot overcome their physiological limitations by behavioral changes. After all, the largest constrictors are all restricted to the tropics. (3) Burmese pythons in nature have not expanded their natural range northward in human memory or recorded history. (4) After 30 years living in ENP, Burmese pythons died by the thousands when the weather got cold; three decades and numerous generations of pythons growing up in temperate Florida didn't seem to have created any particular tolerance for a Florida winter cold snap behaviorally or physiologically.

The suggestion of Dorcas and others that Burmese pythons "originating from more temperate localities" than the founders of the Florida population "might" be able to colonize temperate areas of this country is no more than specious and unfounded speculation. Here the authors have committed the logical fallacy of ignoring the question. Ostensibly the question is "can Burmese pythons in the ENP spread into the southern third of the United States, as posed by Rodda et al. (2008, 2009) and Reed and Rodda (2009)?" This they very clearly proved to be highly unlikely, at least in southern South Carolina. The question is NOT "can specifically selected Burmese pythons from elsewhere in the natural range survive in South Carolina?" The question is NOT "does there exist, somewhere in the world, a Burmese python that could live in southern South Carolina?"

Dorcas and others repeatedly state that the winter in South Carolina was "appreciably colder than typical." Nowhere do they mention that it was far from being the record coldest winter—in fact the cold weather was just a regular cold snap of the kind that every few years grips the Southeast. Even as this manuscript is prepared in late November and early December 2010, the low temperatures in Aiken, South Carolina, have been in the range of 20–30°F—lethally cold for Burmese pythons.

There is ample physiological and behavioral evidence to show that the Burmese python cannot survive a more extreme climate than that of south Florida (Avery et al., 2010; Mazzotti et al., 2010; Pyron et al., 2009; and this paper here in review). Technically Florida, located north of the Tropic of Cancer, is a temperate locality—Americans may refer to it as "subtropical" but it is actually located in the Temperate Zone. The northernmost record of Burmese pythons in the natural range is probably the record of Wall (1921) at Dibrugarh, Assam, at 27°48′N latitude; that is about the same latitude as Sarasota, Florida. As proven by Dorcas et al., Burmese will not survive above 33°N latitude in South Carolina.

Referring to the papers of Avery et al. (2010) [two survivors of nine Burmese pythons in outdoor enclosures in a USDA facility in Gainesville, Florida] and Mazzotti et al. (2010) [only one of ten radio-tagged pythons living in the ENP survived], Dorcas and others make the statement that "some snakes also *adopted* behaviors that allowed them to survive the unusually cold temperatures" [italics ours]. The "behavior" that the two survivors in Avery et al. (2010) "adopted" was to stay inside their artificially heated shelter. The surviving free-ranging radio-tagged python in Mazzotti et al. (2010) was rescued as it was dying from the cold and revived in captivity by the researchers. One wonders what Dorcas and others consider to be the inheritable behaviors that these survivors might possess. Will Florida pythons evolve a strong innate urge to be radio-tagged by sympathetic researchers and find a heated kennel for shelter?

Barker and Barker (2010a) point out that a serious and fundamental flaw in the climate-matching analyses of Rodda et al (2008, 2009) and in Reed and Rodda (2009) is their use of "mean monthly temperatures" from the weather reporting stations as the data used in all climate-match analyses in those papers. The problems of the use of mean monthly temperatures in place of daily temperatures are detailed in Barker and Barker (2010a); the statements made there are convincingly corroborated by Dorcas et al. Figure 1 in Dorcas et al. well illustrates the problems of performing a climate match for reptiles using mean monthly temperatures, the point being that while the "climate" might appear suitable for a species, the daily weather may be completely hostile. Although it is probably unintended, this report of Dorcas et al. perfectly illustrates that the climate-matching analyses of Rodda et al. (2008, 2009) and Reed and Rodda (2009) are fundamentally flawed and invalid.

It is not difficult to infer from the discussion in this paper that the authors expected and, perhaps, even hoped that the ten pythons would survive their winter outdoors in Aiken, South Carolina. Like all invasion biologists studying the "python problem in Florida," they have strong incentives to support and continue the media hysteria that has been purposely created, based on countless unfounded statements and exaggerations, and supported by invalid research. The authors guarded the fact that all their pythons died until the recent online publication of this paper, nearly a year after the completion of the experiment. The research results completely contradict countless statements and

predictions made to the media by the authors and other invasion biologists. The timing of the release of the information past the close of the comment period (in mid-August 2010) for the proposed USFWS action to list nine constrictors as Injurious Wildlife suggests to us that there was purposeful intent to keep the results from being known to the committee that rules on the proposed action.

Further, it seems curious that in this report, authored by academics and published in a peer-reviewed journal, when 100% of the study animals in a research experiment died, that most of the discussion is devoted to just how pythons could evolve and change so that they could survive. The authors appear oblivious to the published facts that 400 miles to the south, the pythons in Gainesville also died in the cold; even further south, the radio-tagged pythons died in the ENP along with hundreds, maybe thousands, of wild Burmese pythons. Nevertheless, in an online article of the *Christian Science Monitor*, posted 24 October 2010, Michael Dorcas is quoted as stating that "there certainly is a possibility that pythons could survive in South Carolina and possibly even farther north." That may be the hope of an invasion biologist, but it is a denial of his own research.

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