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A Critique of the Analysis Used to Predict the Climate Space of the Burmese Python in the United States by Rodda et al. (2008, 2009) and Reed and Rodda (2009)

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Summary

The map and data set that were used by Rodda et al. (2008, 2009) were also used in the USGS report by Reed and Rodda (2009). The map created to illustrate the range of *Python molurus* sensu lato [now *Python molurus* and *Python bivittatus*] is novel, and significantly expands the range in several areas. In the weather station data set, 29 of 88 records (33%) that can be referred exclusively to *P. bivittatus* are extralimital. Eleven of 50 records (22%) that refer to weather stations exclusively in the range of *P. molurus* are extralimital to the range of that species. Of the total 149 records in the data set, 43 records (29%) refer to weather stations that lie outside the range of either species. We question the validity of choosing weather stations on the basis of published altitude records for the species. We conclude that all analyses, risk assessments, predictions, and conclusions based on this map and data set in Rodda et al. (2008, 2009) and Reed and Rodda (2009) are invalid.

Introduction

Rodda et al. (2008, 2009) suggested that the climate of the southern third of the continental U.S. would be favorable for the establishment of the Burmese python, based on establishment risk and climate matching analyses. Subsequent United States Geological Survey (USGS) press releases and media interviews of the authors stated that, based on this paper, there was a strong possibility that Burmese pythons would invade and establish in the U.S. from Washington, D.C., to San Francisco. Despite various criticisms of the paper (Barker and Barker, 2008a, 2008b, 2009; Pyron et al., 2008), the results and conclusions were used directly in the report of Reed and Rodda (2009) funded by U.S. Fish and Wildlife Service and National Park Service and published by USGS.

The establishment risk assessment is based on the climate matching, which, in turn, is based on the estimate of climate space for what are now considered to be two distinct species, *Python molurus* and *Python bivittatus*. Climate space is then based on climate data obtained from weather stations scattered throughout the natural distribution of the two python species. This data is compiled in a data set on which all of these analyses in Rodda et al. (2008, 2009) and Reed and Rodda (2009) are based. This data set is not included in either publication, and was not made available to us. Our requests to the authors for the data were unanswered, thus preventing us from making an independent, objective evaluation of the analyses.

In early 2010 we received a copy of a data set that was distributed by Rodda to a private individual in June 2008. This file includes the data on which the climate space prediction, climate matching, and establishment risk assessment for *Python molurus*, sensu lato, is based in Rodda et al. (2008). More recently we received a printed copy of the data set from Reed and Rodda (2009) that was included in response to a Freedom of Information Act request made to USGS by the U.S. Association of Reptile Keepers. The two data sets appear to be identical. We have examined the data and are able to make the following comments.

The data set is flawed. One obvious problem is that the authors combined data for *molurus* and *bivittatus*. At the time of the release of the first paper, Rodda et al. (2008), the two taxa were considered as subspecies of *Python molurus*, the Asian rock python. However, Barker and Barker (2008b) criticized combining the two taxa as ill-advised because *bivittatus* was a well-recognized distinct taxon with a large discrete range; it alone was the actual purpose for and should have been the sole focus of that first paper. It appeared that *P. m. molurus* was included in the analysis for little reason other than to increase the area in the U.S. that the climate match would deem habitable.

This error of the analysis became doubly apparent when in the period between the posting of Rodda et al. (2008) and the publication of the USGS report (i.e., Reed and Rodda, 2009), a paper was published by Jacobs et al. (2009) recognizing the taxon *bivittatus* as a full species, *Python bivittatus*. This alone invalidates all analyses of *Python molurus* sensu lato in Rodda et al. (2008) and, more importantly, the USGS report.

The second problem is that the data set is only loosely based on a poorly researched and drawn map meant to illustrate the range of *P. molurus* and *P. bivittatus*; that map first appeared in Rodda et al. (2008) and was used again in the USGS report.

The map

Figure 1 on the following page is a redrawn version of the map showing the distribution of *Python molurus* sensu lato that appeared as Figure 1 in Rodda et al. (2008). This map is a novel depiction of the distribution of *P. molurus* and *P. bivittatus* in that it includes a number of substantial range increases not shown on maps published prior to 2008. This is not necessarily surprising, since earlier maps showing the distribution of *molurus* and *bivittatus* were illustrations to accompany the rather generic descriptions of the natural ranges offered by a variety of sources, including Wall (1912, 1921), Smith (1943), Daniel (1983), Luxmoore et al. (1988), Khan (2006), and others. In all of these, range was delimited by international and provincial boundaries; there was minimal or no reference to actual published localities or suitable elevations based on localities.

However, because the map of Rodda et al. (2008) was cre-

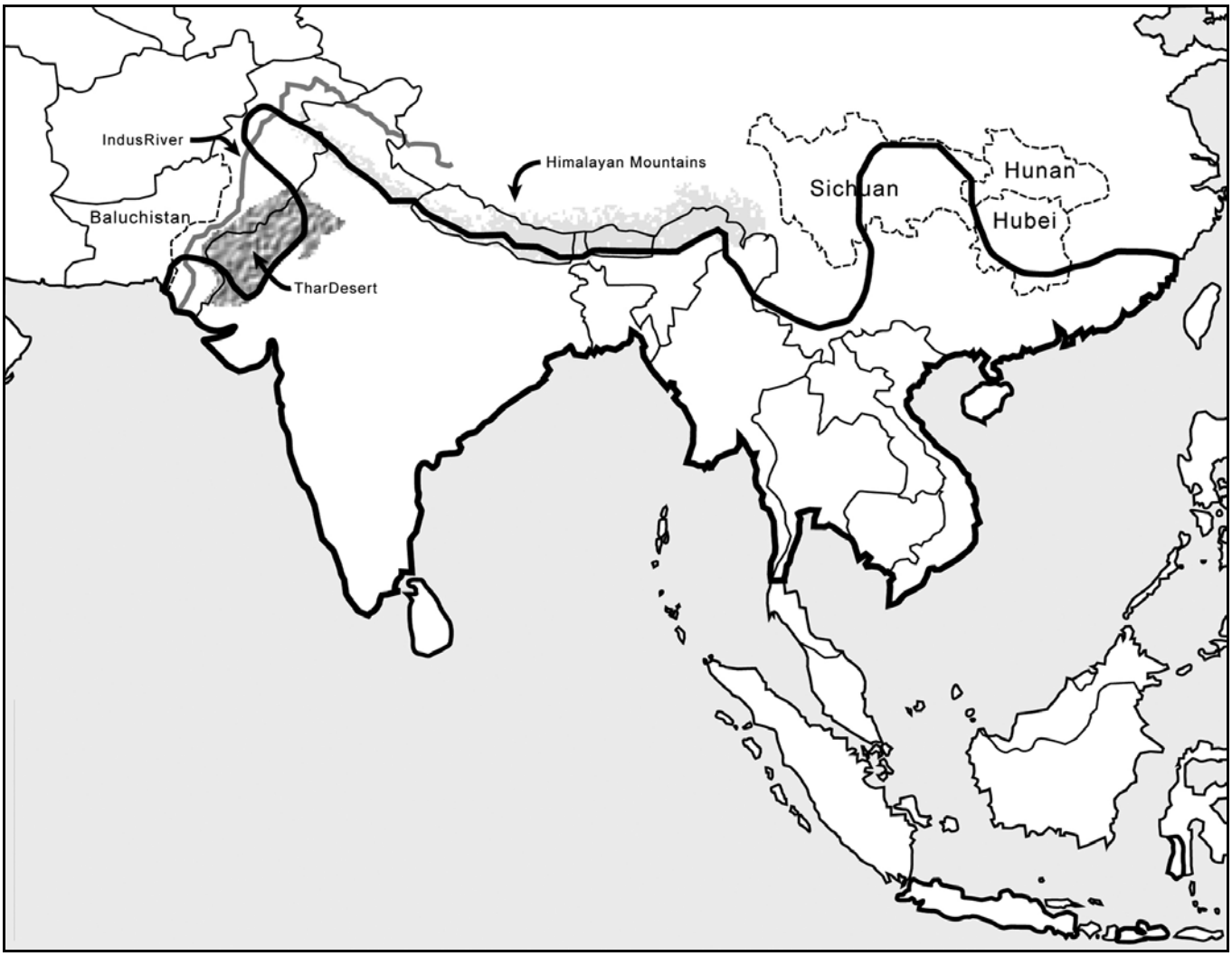

Figure 1. Range of *Python molurus* sensu lato, modified from Rodda et al. (2008) and Reed and Rodda (2009). The only modification we have made is to identify the states, provinces, and geographic features that relied on color in the legend of their version. The heavy outline denotes their putative range limits.

ated to properly locate the weather stations that provide the data on which all analyses are based, it seems especially important that every effort should have been made to create the most accurate and detailed map possible. When and where exact locality data was unavailable, a conservative approach would have been the best and most defendable action.

The boundaries of much of the mainland distributions of *P. molurus* and *P. bivittatus* are well defined, being the Arabian Sea, Bay of Bengal, South China Sea, Thar Desert, and Himalayan Mountains. The insular distributions also are generally agreed upon, with *P. bivittatus* found on four islands in Indonesia, and in China on Hainan, Hong Kong and associated small islands, and Queymoy Island and small islands in the Kinmen Archipelago. The presence of *P. molurus* in Sri Lanka is well documented.

There are two general areas where the creator of a range map for *P. molurus* could take many liberties in illustrating the periphery of the distribution, and one larger area in the case of *P. bivittatus*. We find all three areas in the map of Rodda et al. (2008) to be exaggerated in a manner as to incorporate into the map areas of low precipitation or low temperatures that likely are extralimital to the range of the species. The authors also included areas of unsuitably high elevations in the data set, to further incorporate cool climate data into the analyses, the effect being to exaggerate the climate match.

The areas of contact and sympatry between the two species are not well described in the literature. It is not known how much, if any, overlap exists between the two in Bangladesh, Assam, the terai of southern Nepal and Gangetic Plains of northern India; there seems to be complete agreement among authors that one or both of the species are found in those areas, but which species is where has yet to be untangled (Kock and Schröder, 1981; O'Shea, 1998; Whitaker, pers. com.). However, the type or location of the zone of contact between the taxa would not affect the climate match in Rodda et al. (2008).

The map of the range of *Python molurus*

The first of two areas where the range of *P. molurus* is exaggerated is the area southwest of the Thar Desert where the range of *P. molurus* centers around the Indus River delta in the Sindh Province of southern Pakistan. The second area is the northernmost periphery of the range, referring to the few known localities in the state of Jammu and Kashmir, India, and adjacent Punjab Province in Pakistan. Both of these general areas repre-

sent the extreme limits of the natural distribution of the species, as well as the most extreme climatic conditions in which the species can be found. In both areas, pythons are found in scattered small populations, restricted to areas of microclimate and habitat not necessarily typical of the overall area (Minton, 1966; Sharma, 1972; Khan, 2006).

Minton (1966) and Khan (2002, 2006) stated that pythons in the Sindh were uncommon, and found at scattered small localities closely associated with the Indus River delta and lower valley, mostly found along the river in areas of cane and brush. Whitaker (1993) stated that pythons were extremely rare, approaching extinction, throughout Pakistan. In the Sindh, the species shows a strong association with permanent water, including man-made reservoirs and irrigation canals (Minton, 1966; Khan, 2006). The species is more commonly found east of the Indus River, and the range extends up the river valley north to the Nawabshah District (Minton, 1966; Khan, 2006). Khan (2002) shows three localities on his map for *P. molurus* in southern Sindh; one in the vicinity of Hyderabad, another in the vicinity of Mirpur Kas, and a third along the margin of the desert in the vicinity of southwestern Thar Parkar District. The map of Khan (2006) shows two localities in the Sindh, one in southwestern Thar Parkar, and the other in the vicinity of Nawabshah District.

Immediately to the west of Sindh Province, along the eastern Baluchistan border, the species may occur along the lower reaches of the Hab River; Minton (1966) stated he received reliable reports of *P. molurus* at Dureji, a locality about 50 km from the coast along the Hab River, but was unable to obtain specimens from that locality.

In Figure 1, the area in the Sindh that is demarcated as range exaggerates what is probable habitat for *P. molurus*. We note that the map in Figure 1 excludes Thar Parkar District without explanation. The map of Rodda et al. (2008) includes as range all of southern Sindh, north to include the districts of Dadu, Naushahro Feroze, and Khairpur, all north of the district of Nawabshah. We can find no record of pythons from those districts. It also includes eastern Khairpur, eastern Sanghar, Umerkot, and northeastern Thar Parkar; this area where the southwestern Thar Desert extends into southern Pakistan is sandy desert with dunes—we are unable to locate records of pythons from this harsh, dry area. We note that Ghalib et al. (undated) state that *P. molurus* is found in the desert area of Thar Parkar; Thar Parkar District includes the transitional southern margin of the vast Thar Desert. Khan (2006) includes *P. molurus* on the list of herpetofauna from the Thar Desert; although this seems to conflict with the description of python habitat provided elsewhere in that publication; he also states that there are scattered isolated oases in the Thar Desert with permanent or semi-permanent water and dense forest or scrub. It seems likely that these isolated and scattered mesic refugia provide the only habitat for pythons, rather than the more xeric sand dune areas.

The second problematic area mapped for *P. molurus* is at the northern limit of the distribution. The northernmost known localities of *P. molurus* are those reported by Sharma (1972) and Sharma and Sharma (1977) in the region of Jammu Province,

Figure 2. The shaded area denotes the distribution of the Indian python, *Python molurus*.

India. These localities are in protected valleys at 600–800 m elevation in five small districts—Poonch, Rajouri, Jammu, Udhampur and Kathua. The northernmost locality is the Poonch [Punch] Valley in the drainage of the Jhelum River; Sharma (1972) reported that pythons were uncommon at this northernmost locale. The Chenab River provides drainage for the valleys in Jammu, Rajouri and Udhampur districts. The Kathua Valley is drained by the Ravi River. The only locality records from northern Pakistan we can locate are a locality on the Chenab River in Punjab Province in the vicinity of Gujranwala District (Khan, 2002, 2006) and a second locality in the drainage of the Ravi River in the vicinity of Lahore (Khan, 2002).

In Figure 2, we have mapped the range of *P. molurus* in this area as following a similar elevation from western Nepal, skirting the rise of the Tibetan Plateau north through Himachal Pradesh and into Jammu Province, bounded on the west by the northern reaches of the Thar Desert, identified on some maps as the Great Indian Desert. The distribution reaches its northern maximum in the lower reaches of the Poonch valley in the Poonch District. There our map shows the distribution to follow the drainages of three rivers to the southwest. The northern river is the Jhelum River, the middle is the Chenab River, and the southern of the three is the Ravi River. We have illustrated the distribution to follow the drainages of these three rivers to their junctures, considerably farther south than is supported by reported localities. The limits to the territories where pythons might be encountered along these rivers are not reported, but Khan (2006) states that pythons may be moved along these drainages by flood waters. We are not aware of pythons occur-

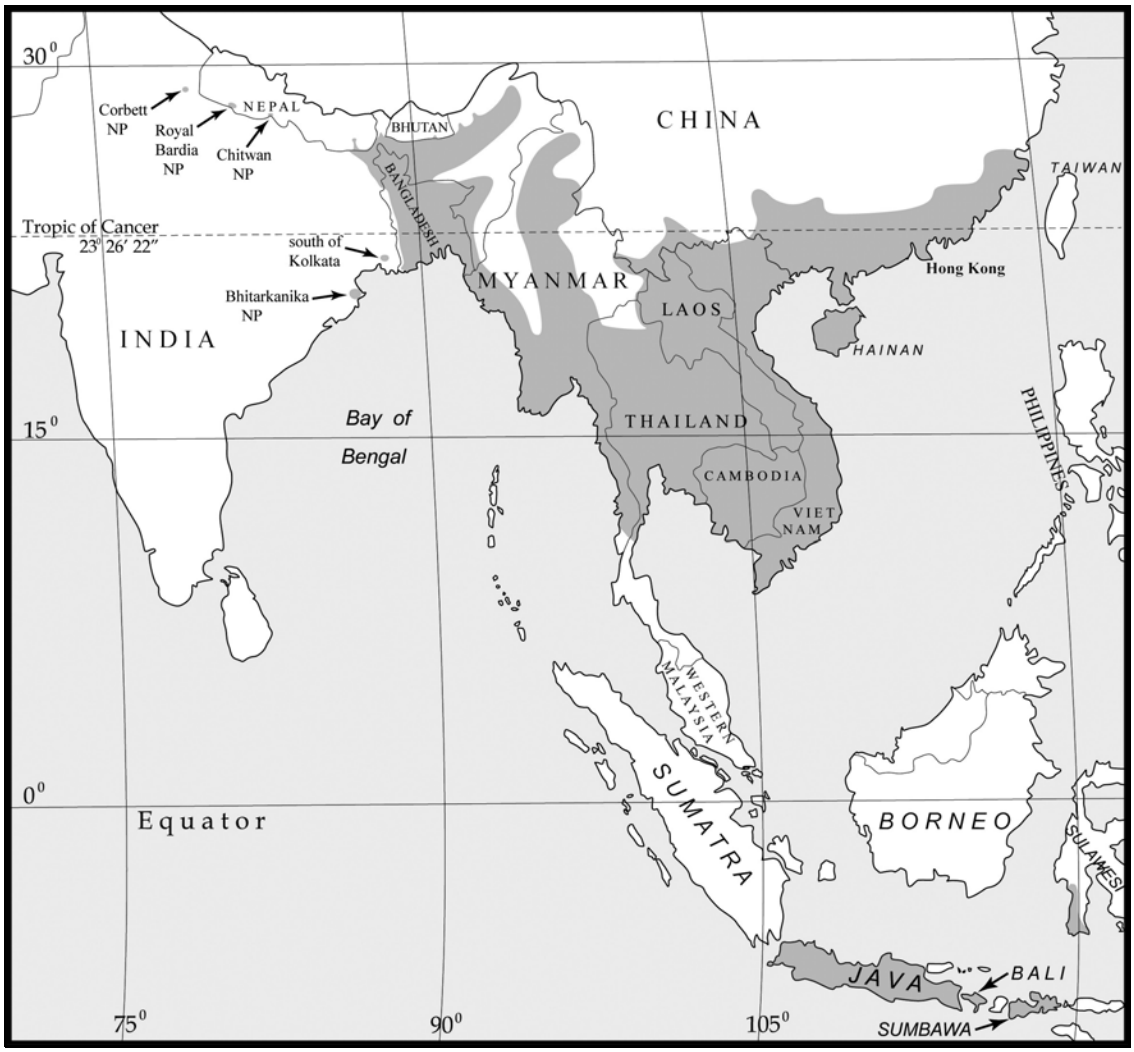

Figure 3. The shaded area denotes the distribution of the Burmese python, *Python bivittatus*.

ring in the lower reaches of the Sutlej River, also a significant southern tributary of the Chenab River, but populations of pythons may exist along the upper drainages of this watercourse in India.

In Figure 1, the northwestern range of *P. molurus* is illustrated as projecting northwest from Jammu Province in India into Pakistan across the northern reaches of Punjab Province, along the southern boundary of the Pakistan Capital Territory, and on across the province of Khyber-Pakhtunkhwa, including the capital of Peshawar, to the northern Tribal Areas along the Afghanistan border. This is a dramatic increase in area of the distribution of the species as reported in the literature and previously mapped in all accounts. *Python molurus* is unknown in the province of Khyber-Pakhtunkhwa and the Tribal Areas.

Our map of the distribution of *P. molurus* (Figure 2) shows more conservative estimates of the python's range both in southern Pakistan and in northern Pakistan. Our boundaries in those areas are based on the few published localities of pythons in those areas of which we are aware, on suitable habitat, elevation and routes of dispersal, and on the comments of authors specifically describing the range of pythons in those peripheral areas.

The map of the range of *Python bivittatus*

The distribution of *P. bivittatus*, as given in Rodda et al. (2008), is shown by the eastern portion of their map (Figure 1). East of the Himalayan Mountains the range of *P. bivittatus* extends across southern China. The northern limits of this expanse have only been generally described and mapped. Prior to 1986 in China, and 1992 elsewhere, all authors described the species as being restricted to extreme southeastern China, from southern Yunnan east to Fujian.

The English-speaking world became aware of records of the species in Sichuan from Zhao and Adler (1993); in the account for *P. bivittatus* they included "Sichuan" listed as a locality separate from the described range without other details. The Sichuan reference refers to two published reports (Liu, 1986; Zhao, 1987); these reports are in Chinese, and generally have been overlooked (see Barker and Barker [2010] for partial translations). Some texts, but not all, that followed include Sichuan in the written description of the Chinese range of *P. bivittatus*, most notably McDiarmid et al. (1999), Zhao et al. (1998), and Ji and Wen (2002). Ji and Wen (2002) included a roughly drawn map in which the range of *P. bivittatus* extends northward to the level of the southern boundary of Sichuan. Other maps, such as O'Shea (1998), Henderson and Murphy

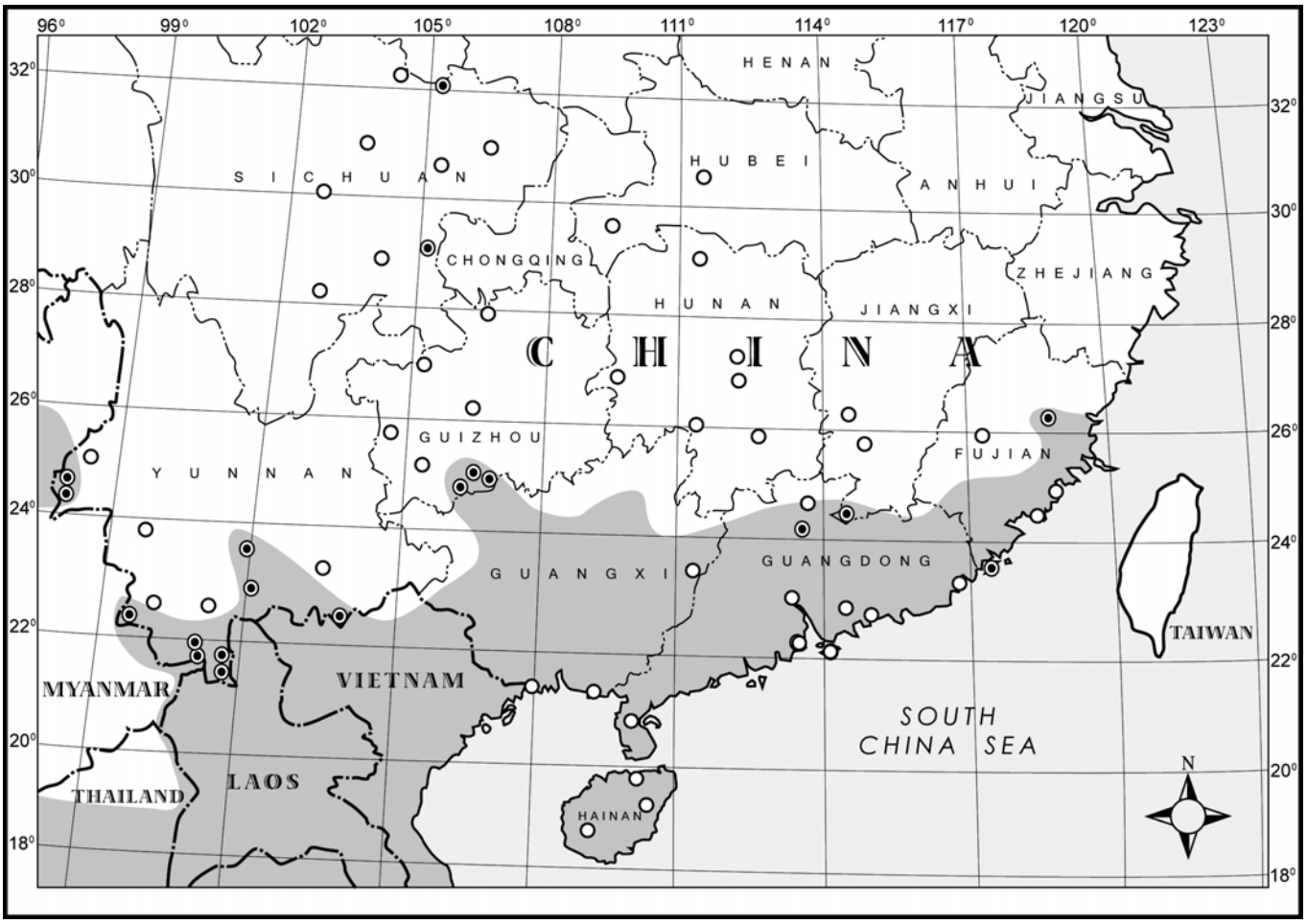

Figure 4. The shaded area denotes the range of *Python bivittatus* in China and adjacent countries. The black-centered circles denote published localities of *Python bivittatus*. The open circles denote the locations of the Chinese weather stations in the data set of Rodda et al. (2008) and Reed and Rodda (2009). Note that 27 of the weather stations from which these authors used data lie outside the range of the species.

(1997) and Kabisch (2002) correctly do not incorporate Sichuan into the distribution of *P. bivittatus*.

As drawn, the map of Rodda et al. (2008) more than doubles the area of the range of *P. bivittatus* in China illustrated in any other map. In response to this publication, Barker and Barker (2008a) published a more detailed map representing the probable distribution of *P. bivittatus* (Figure 3).

The map in the USGS report

For the USGS report, Reed and Rodda (2009) elected to use the exaggerated map and the associated climate data created for Rodda et al. (2008). They defended the action to disregard the map of Barker and Barker (2008a) with the following statement in Chapter 4, Subsection 3.1: "Associated with a call for unrestricted importation, Barker and Barker (2008a) argued for a more restricted distribution, partially relying on non peer-reviewed or unpublished information about current distributions." We have no idea as to what the first half of this sentence refers—no "call for unrestricted importation" is found in that paper, nor does that correctly portray our beliefs or public stance on the matter. This appears to be an attempt to call into question our reputation, and by inference the validity of our methods. With regard to the second half of the sentence, our research included most references cited in Rodda et al. (2008) as being the basis of the exaggerated map, plus others. The reference to "unpublished information" apparently refers to data we received from Kraig Adler, Indraneil Das, and Romulus Whitaker, all respected authorities on Asian herpetology. We note that among the 40 references on which the exaggerated map is based, one is incorrectly cited [Deyang (1986) = Liu (1986)], several are not peer-reviewed (Caras, 1975; Whitaker, 1978; and probably Pope, 1961; Minton and Minton, 1973; and McKay, 2006), one is apparently overlooked (McKay, 2006), and one is curiously irrelevant [Vinegar et al. (1970) offers only a review of other citations and adds nothing other than a very general map].

The recent publication of Barker and Barker (2010) amends and further delimits the range of *P. bivittatus* in China (Figure 4) with arguments for the exclusion of the Sichuan localities as being irrelevant to the natural distribution of the species.

Elevation

We question the generally accepted altitudinal limit of 2000 m that is often published for *P. molurus* and *P. bivittatus*. Rarely is any reference or citation made for the source of this figure. We believe that the original source of this limit can be credited to Wall (1921). The exact statement of Wall is as follows: "It is a denizen of the plains, but ascends into hills, on rare occasions, I believe up to about 6,000 feet." This is an

anecdotal statement, not based on locality records or specimens. Wall does not specify where pythons are found at this elevation, as was reported by Murphy and Henderson (1997).

Most subsequent published accounts of the species do not list an altitudinal limit for the two taxa (including Smith, 1943; Taylor, 1965; Daniel, 1983; Zhao and Adler, 1993). Pope (1935, 1961) and Murphy and Henderson (1997) list the maximum elevation as 6000 feet, referenced to Wall (1921). Pope (1935) does not report python localities in China at 1500+ m, as incorrectly reported in Reed and Rodda (2009)—he reports elevation in "feet," not "meters." In some accounts where maximum elevation is included in metric, the 6000 ft limit has been converted to 2000 m; we are not aware of any reference that has been provided for that figure (e.g., Whitaker, 1978; Khan, 2002; Whitaker and Captain, 2004; Kabisch, 2002). Zug and Ernst (2004) cite an altitude maximum of 2400 m without reference to locality or specimen. Whitaker (1993) states that in undisturbed areas *P. molurus* may ascend to 2500 m, but does not provide localities or specimens for reference. Shah and Tiwari (2004) state that *P. bivittatus* has been observed at 2800 m, but do not provide localities or specimens for reference.

We can find no basis for the statement of Reed and Rodda (2009:50) that "some of the highest elevations in their native range are located at the highest occupied latitudes of their native range. . . ." This statement is unfounded and apparently included to support the fact that when creating their data set they selected weather stations at the highest elevations in the highest latitudes without regard for the presence of pythons.

In our review of the literature, we find only one record that exceeds 1000 m for *P. molurus*. Hutton (1949) records an observation of *P. molurus* at an elevation of 5500 ft (1676 m) in the High Wavy Mountains. This locality is in the state of Tamil Nadu in southern India at approximately 10°N latitude.

A second report of a possible high locality is that of Morris (1933) of a python killed in the Nagiri Hills "near Kotagiri"; Kotagiri, located at about 11°N latitude, is at 1800 m, but two kilometers to the south is a valley that quickly descends to 500 m.

Even at southern and tropical latitudes, pythons apparently are not common at high elevations. We note the report of the Oxford Survey where more than 100 person-days of herpetofaunal survey in the Western Ghats of western Tamil Nadu at 9.30°N latitude at elevations of 910–1690 m failed to find any pythons (Anonymous, 1987). Kabisch (2002) lists the elevation maximum in Nepal as 550 m.

We are aware of three records for *P. bivittatus* that exceed 1000 m. The localities of Luchun, Yunnan, China, and Ziyun, Guizhou, China (Zhao et al., 1998; Barker and Barker, 2010), are both at elevations of 1100 m. The highest record is 1200 m, reported by Orlov et al. (2000) on the Tam-Dao Mountain Ridge in northern Vietnam; we note that the maximum elevation of the study site was 1500 m, but pythons were never observed at that elevation. All three localities are in areas where significantly lower elevations are nearby.

The problem with noting "maximum elevation" is not necessarily the elevation—it is where the elevation is located. We know from their maintenance in captivity that neither *P. molurus* nor *P. bivittatus* suffer metabolic or physiologic problems due to reduced atmospheric pressure or lower oxygen levels at 2000 m elevation. The problem pythons face in nature at high elevations is that it is cold up there, and it becomes substantially colder the further north one progresses.

It is reported by Harvey et al. (2008) that *P. bivittatus* is capable of moving significant distances—exceeding 50 miles—in about three months. In nature there are many areas where *P. molurus* and *P. bivittatus* are found where a lateral migration of only 1 km can mean an elevational change of 1000 m or more. This calls into question the presence of pythons at elevations of 500–1000 m and higher as evidence that those snakes are resident at those elevations if lower elevations are nearby. This also calls into question the actions of the authors to use data from weather stations at elevations in excess of 500 m without records of pythons in the near vicinities of those weather stations and evidence that those pythons are in permanent residence in those localities. To have done otherwise is evidence of a bias based on their unproven and incorrect a priori assumptions.

To summarize, 2000 m elevation at the equator is a very different climate than 2000 m in the state of Jammu and Kashmir in northern India. To state that the elevation maximum for a widespread species is 2000 m doesn't mean that everywhere in the distribution that elevation would be suitable. It means that at some particular place within the range of the species, someone witnessed or collected a specimen at that record elevation. In this study in particular, to have chosen weather stations at excessively high elevations at high latitudes in the absence of any records, specimen or sightings of pythons at any of those locations is completely irresponsible.

The data set of Rodda et al. (2008) and Reed and Rodda (2009)

The file we received is an Excel spreadsheet. It has 189 lines and 49 columns. Scattered though the file are lines that are referenced to a country, province or region where Burmese pythons naturally occur, with a literature citation on which the localities are based. The bulk of the file is the 160 lines that are records for weather stations at specific localities supposedly within the natural distribution of *molurus* and *bivittatus*. Two records are for weather stations in Florida, one is for Borneo, and eight have incomplete data. There are 149 lines of complete data; we consider each line as a record. The 149 records are from 11 countries.

The 149 records can be divided into the following categories: There are 88 records from weather stations that are clearly intended to represent the range of *P. bivittatus*, and 50 records that can be clearly assigned to *P. molurus*. There are 11 records of weather stations in Bangladesh, northern India and Nepal at localities where either or both taxa might be present.

Locality matching

It is stated in Rodda et al. (2008) that when possible, specific reported localities for pythons are matched to a weather station in the same 1-degree latitude/longitude cell. Each record has two spaces for the map coordinates for python localities to which

the weather station is matched. However, only 7 records of the 149 in the data set contain map coordinates referring to python localities, and three of those are either approximate or incomplete. In other words, 145 of the localities (97.3%) selected by the authors are not based on actual python records.

Problematic weather station locations

We mapped out the locations of the 149 weather stations. A substantial number of weather stations are located outside the distributions of the two species.

In the area of the range of *P. molurus* in the Sindh Province of Pakistan, we find that three of the five weather stations, 60%, at Chor, Jacobabad and Padidan are clearly outside the range depicted in Figure 2. In Figure 1, Padidan would be located at the northern margin of the range in the Sindh, and Jacobabad remains distinctly outside the range depicted by Rodda et al. (2008). In the data set, Padidan is identified as being in Nawabshah District—in fact it is in Khairpur District and outside the reported range of *P. molurus* (Minton, 1966; Khan, 2006).

There is a notation in the data set that the Jacobabad locality is based on a specimen in the California Academy of Science collection collected by J. A. Anderson. A search of the museum collection of the CAS finds one specimen of *P. molurus* from Pakistan, deposited in 1965 by J. A. Anderson—however it was collected at Sujawal, not Jacobabad. Sujawal is in the delta region on the east side of the Indus in the lower reaches of the drainage and well within the range of the species in the Sindh.

Chor, in northeastern Thar Parkar District is in sand dune desert, and seems an unlikely locality for pythons. Pythons in southern Pakistan are found in small, scattered localities with restricted mesic conditions not typical of the sand dune deserts of northeastern Thar Parkar. Randomly located weather stations in such areas of environmental extremes do not correctly reflect the conditions of microclimate required by pythons.

Eight weather stations in the data set are found from the area of the Punjab Districts of Pakistan and India, then north through Himachal Pradesh and into the Jammu Province. Of these, four (50%) lie outside the ranges as depicted in both Figure 1 and Figure 2. The problem locality farthest to the northwest is the weather station at Murree (2126 m elev.), located about 40 km northeast of Islamabad. East and slightly north of Murree is the weather station at Srinigar (1585 m elev.) located in the Kashmir Valley north of the Pir Panjal Range of mountains (4000 m to 6221 m). South in Himachal Pradesh is the weather station at Simla (2205 m elev.), in the mountains on the eastern edge of the Tibetan Plateau. All three of these extralimital weather stations are high latitude, high elevation and very cold. There is no evidence that pythons occur anywhere near them. The fourth problematic weather station is at Multán, Punjab, Pakistan. Multán is located along the lower stretch of the Chenab River at the southern end of the Thal Desert; the locality is extremely hot and dry and there are no records of pythons.

In the northern Indian state of Uttarakhand, just to the west of Nepal, there is one weather station in the data set in the Kumaun District at Mukteswar (2310 m elev.). About 80 km to the west of Mukteswar is Corbett National Park, the westernmost known locality for *P. bivittatus* (Barker and Barker, 2008a). The pythons are found there at elevations of 250–500 m. At 2310 m of elevation, there are no records or other evidence of pythons near Mukteswar. It is an extremely high elevation and extremely cold.

There are six weather stations in Nepal. Three (50%) are outside the range of the species in both Figure 1 and Figure 2. The stations at Pokhara (833 m elev.), Kathmandu (1337 m elev.), and Taplethok (1372 m elev.) all are north of the ranges drawn along the terai of Nepal in both maps, and two of the stations are more than double the elevation of the maximum record in the country of 550 m (Kabisch, 2002). Again, these weather stations are too high, too cold, and not even in the range of the species that are the subject of the study.

There is a data set record for a weather station in Darjiling (2127m ele.), just to the east of Nepal, where the state of West Bengal rises to contact Sikkim in the area between Nepal and Bhutan. About 20 km away there are more suitable elevations of 200–300 m in the Teesta [Tista] River drainage that flows south to the Brahmaputra River. We can find no records that pythons naturally inhabit Darjiling or have ever been found at that elevation anywhere in northern West Bengal.

The Pakistan bias

There is a strong bias in Pakistan and western India for weather stations that are located in areas with low annual precipitation and that are extralimital to the range of *P. molurus*. The nine driest weather stations out of the total of 149 in the data set are, in order of driest first: Jacobabad, Sindh; Padidan, Sindh; Multán, Punjab; Hyderabad, Sindh; Chor, Sindh; Karachi, Sindh; Sahwal, Punjab; Bikaner, Rajasthan; and Jodhpur, Rajasthan. Of these weather stations, five are extralimital to the range of *P. molurus* in Figure 1 (56%); those being Jacobabad, Padidan, Multán, Bikaner, and Jodhpur. One additional weather station is extralimital to Figure 2, Chor—in other words, 67% of the driest weather stations in the data set are located outside of the range for the species.

The China bias

The data set includes 43 weather stations in China. Of these, 27 (63%) lie well outside the range of *P. bivittatus* illustrated in Figure 4. Perhaps even more surprising is that 11 weather stations lie distinctly outside of the range as described in Figure 1.

Regarding the Chinese weather stations: all Sichuan localities should be considered extralimital (Barker and Barker, 2010). No pythons are recorded from Hubei Province, yet two Hubei localities are sources of weather data; no pythons are known from Hunan, but there are five Hunan weather stations in the data set that contribute to the analyses. In Jiangxi Province, both weather stations are outside the range as illustrated in Figure 4.; one is outside the indicated range in Figure 1.

The bias in China is for weather stations in high, cold places where there are no records of pythons. In Yunnan there are Tengchong (1648 m elev.), Lancang (1500 m elev.), Simao (1500 m elev.), Lincang (1520 m elev.) and Mengzi (1301 m elev.). In Gizhou there are Pan Xian (1527 m elev.), Tongzi

(972 m elev.), Guiyang (1071 m elev.) and Xingren (1379 m elev.).

In the record for Leibo, Sichuan (1475 m elev.), Rodda et al. (2008) insert a comment into the data set that it's "doubtful that the station is occupied" [by pythons]. For Nanyue, Hunan (1309 m elev.), the authors inserted "lowland adjacent occupied" and "Siberian winters." The nearest records for *P. bivittatus* are hundreds of kilometers from these localities; apparently even the authors had doubts on the validity and relevance of data from these stations because of the elevation and latitude, yet this data is included in the data set and then used in all analyses and assessments. By including these cold temperature data from extralimital sites, Rodda et al. (2008) inflated their numbers of cool and temperate climate-spaces, and the climate match that followed thus included much more of the southern U.S. than is reasonable.

Additional problems and oversights

Mapping the coordinates of the weather station identified as "Telukbetung, Beranti" shows that this reporting station is located in Sumatra. *Python bivittatus* does not occur in Sumatra.

Similarly, the coordinates for the weather station identified in the data set as "Sumbawa" are such that the reporting station is on the neighboring island Lomboc.

It is reported that *P. bivittatus* are on Bali (McKay, 2006) but this island was not included in the range on the map created by Rodda et al. (2008).

In summary: 29 of the 88 records (33%) that refer to *P. bivittatus* are based on extralimital weather stations. Eleven of the 50 records (22%) that refer to weather stations in the range of *P. molurus* are extralimital to the range of the species. Of the total 149 records in the data set, 43 records (29%) refer to weather stations that lie outside the ranges of the two species.

Comments and conclusions

The map of Rodda et al. (2008) was the basis for all analyses, assessments, conclusions, and recommendations drawn from that paper and the USGS report that followed (Reed and Rodda, 2009). Despite the critical importance of the map to the study, the scholarship behind it is poor, and constitutes either careless disregard or purposeful exaggerations in every area of the range that could be open to interpretation.

Such variations in this map that differ from other published depictions are drawn with little or no regard to actual specimens and localities, suitable elevations, suitable habitats, routes of distribution, or other sound zoogeographic bases. The data set is error-filled, and padded with inappropriate data records. An unexplainable 29% of the weather stations in the data set do not lie within the geographic boundaries of either python species and many weather station localities far exceed reasonable limits of habitable elevation. The authors didn't even go to the effort of restricting their weather station locations to within the boundaries of their own exaggerated range map.

This report has been held up in the highest legislative committees and touted as all the "science" necessary to enact the addition of nine species of constricting snakes to the Injurious Wildlife List of the Lacey Act. Quite frankly, this report is an example of the inadequate editorial protocol of the USGS and an insult to the credibility of the USGS. The U.S. Fish and Wildlife Service and the National Park Service paid biologists in the USGS a large sum of money to create this report, and both these agencies, to say nothing of the American taxpayer, are thus owed a high quality and credible report.

One has to look no further than the deep-sea oil leak crisis in the Gulf of Mexico so see how the Department of the Interior, the Senate, and the Administration have problems getting good and truthful reports and data from government agencies—this USGS report of Reed and Rodda is yet another glittering example. This report is unacceptable because the data set on which all calculations and assessments are based is unsound.

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These are the references cited in this paper, and also used to create the map in Figure 2. The data set of Rodda et al. (2008, 2009) and Reed and Rodda (2009) can be downloaded at http://www.usark.com.

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