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Original Research Article

Sun-basking, a necessity not a leisure: Anthropogenic driven disturbance, changing the basking pattern of the vulnerable Indian rock python in Keoladeo National Park, India

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ABSTRACT

'Basking' is the most conspicuous thermoregulatory behavior in many animals that enable them to enhance physiological performance. Several terrestrial poikilothermic ectotherms have adapted to thermoregulate through basking and seek refuge in subterranean burrows in extreme climatic conditions. Particularly in reptiles, selecting appropriate activity times and postural adjustments are critical thermoregulatory mechanisms and have been recognized as a significant element in the process of behavioral thermoregulation. The present study aims to understand the behavioral adaptation, burrow use regime, and basking pattern of the Indian rock python *Python molurus* in Keoladeo National Park which witnesses annual weather extremes. Further, the study also investigates the effect of anthropogenic disturbance on the behavioral repertoires of the species, including the changes occurring in the pattern of emergence and retreat into the burrow and basking periods of pythons. The estimated minimum population size of python in KNP was $80 \pm 10_{SD}$ individuals. During the active months of November to April, a general pattern of python activity was observed wherein pythons emerged at 09h00 to 10h00, with a peak in mean basking time of $49.3 \pm 18.4_{SD}$ min per day during 12h00 to 13h00 following retreat at 17h00 to 18h00. Also, the emergence timings positively correlated with the sunrise timing and increasing temperature. Whereas, the retreat timings positively correlated with the sunset timing in disturbed burrows with continuous tourist visits, a significant change in the emergence, retreat and basking duration was observed. The time spent for basking significantly varied between disturbed, semi-disturbed and undisturbed burrows across different time-slots. The basking time across all the time intervals of the day around the undisturbed burrows was twofold of the time spent around disturbed burrows. The present study thus highlights the change in basking regime of Indian rock python in disturbed and undisturbed habitats in KNP, during the tourist's season of October to April each year.

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1. Introduction

The physiological performances of all organisms whether an ectotherm or an endotherm is vastly temperature dependent (Huey and Stevenson, 1979; Geiser and McMurchie, 1985; Angilletta et al., 2010). All organisms have evolved and adapted to virtually all possible thermal environment of the earth (Johnston and Bennett, 2008). Particularly in terrestrial ectotherms, adaptive behavioral thermoregulation is an essential proximate factor influencing their physiology (Strelnikov, 1934; Sergeev, 1939; Cowles and Bogert, 1944; Reinert, 1993). The evolution of thermoregulation in poikilothermic reptiles particularly arose because environments thermally fluctuate both on a daily and seasonal basis with irregular heat dis-seminations within environments (Bogert, 1949). Consequently, reptiles attempt to attain physiological optimum body temperatures by exploiting the thermal distribution patterns in the environment (Shine, 1980; Huey et al., 1989; Adolph, 1990). Thermoregulatory behavior in reptiles is a critical mechanism that enables them to enhance physiological performance including running speeds, growth, reproduction and digestion (Huey and Slatkin, 1976; Saint Girons, 1980; Shine, 1980; Huey, 1991). In the temperate areas, reptiles largely rely upon behavioral thermoregulation for maintaining their body temperature within a specific range (Bulté and Blouin-Demers, 2010). The behavioral thermoregulation commonly includes behavior such as selecting appropriate activity times (Crawford et al., 1983; Sinervo and Adolph, 1994) as well as postural adjustments (Boyer, 1965; Seebacher, 1999). Several studies on thermoregulatory behavior have been recorded in many snake species including the free ranging water snake *Natrix fasciata* and *N. taxispilota* in the United States (Osgood, 1970), the captive Indian rock python *Python molurus* (Vinegar, 1973, 1974; Vyas, 1996, 1998; Walsh and Murphy, 2003), the captive Burmese python *P molurus bivittatus* (Van Mierop and Barnard, 1976a, 1976b; Brashears and DeNardo, 2013), the ball python *Python regius* (Ellis and Chappell, 1987), the free ranging diamond python *Morelia spilota* (Sup and Shine, 1988), the Brazilian boid snakes (Pizzatto and Marques, 2007), the Children's python *Antaresia children* (Lourdais et al., 2008; Loriguio et al., 2012) and the water python *Liasis fuscus* (Stahlschmidt et al., 2012).

Of all the thermoregulatory behaviors, 'basking' is the most conspicuous, wherein the animal exposes whole or at least a part of their body to thermal radiation while being immobile (Bulté and Blouin-Demers, 2010). Some reptiles spend up to 80% of their time inside their burrows or other microrefugia in cold climates, which is also a thermoregulatory behavior where the primary function is avoiding critically low body temperatures (Pearson and Bradford, 1976). Upon favorable ambient conditions, the reptiles then emerge from their burrows and spend long and frequent basking periods acquiring appropriate body temperatures (Boyer, 1965; Hammond et al., 1988; Janzen et al., 1992). In arid and semi-arid regions, burrows appear to be crucial micro-refuges to several species of reptiles, providing protection against temperature extremes and predation (Kinlaw, 1999; Mukherjee et al., 2017a). Thus, the study was designed to investigate the adaptive strategies of a poikilothermic serpent in extreme weather condition that prevails in the arid and semi-arid region of northern India. For this, we selected the Indian rock python as a model species. The Indian rock python of Pythonidae family is found in many tropic and sub-tropic areas of southern and southeast Asia ranging from Pakistan, India, southern Nepal, Sri Lanka, Bhutan, Bangladesh and probably in the north of Myanmar (Whitaker and Captain, 2004). It is listed as 'Schedule I' species in Wildlife Protection Act of India, 1972. The Indian rock python is one of the large bodied charismatic non-venomous species and they often use the burrows in the winter in arid and semi-arid regions as a refuge site (Bhupathy and Haque, 1986). However, they often come out of the burrows and bask to regulate their body temperature (Bhupathy and Haque, 1986). When several individuals come out for basking, they are more easily visible and often highly disturbed by people (Daniel, 1983).

We selected Keoladeo National Park (hereafter, KNP) to conduct this study, since the park is known to have one of the highest populations of India rock python in India (O'Shea, 2007). In KNP, the pythons also have been reported to occupy the existing burrows of the Indian crested porcupine *Hystrix indica* in semi-arid areas of KNP, India (Bhupathy and Haque, 1986; Mukherjee et al., 2017a). Only short-term assessment of Indian rock python population is available for KNP where Bhupathy and Vijayan (1989) reported 105 individuals and Krishnan et al. (2009) reported 112 individuals. The species in its range is recorded to have unimodal diurnal activity pattern during winter and a bimodal crepuscular activity pattern during the summer (Bhatt and Choudhury, 1993). Daniel (1983) reported increased nocturnal activity with an increased level of disturbance. The cost-benefit model of thermoregulation (Huey and Slatkin, 1976) which has support from numerous studies on lizards and snakes (Blouin-Demers and Weatherhead, 2002) predicts that ectotherms should invest more in thermoregulation when the costs of doing so are low in a thermally superior habitat (Huey and Slatkin, 1976). In KNP, the open basking grounds provide the desired high quality of thermal habitat to the thermoregulating pythons during the winters. However, despite the availability of such superior conditions, the continuous disturbance caused by the tourists can differ the central prediction of the cost-benefit model. Hence the second objective is to investigate whether any anthropogenic disturbance set fundamental limits on behavioral repertoires, including patterns of emergence and retreat into the burrow and basking periods by Indian rock python.

2. Material and methods

2.1. Study area

KNP (27° 7.6'–27° 12.2' N and 77° 29.5'–77° 33.2' E, Fig. 1) is in Bharatpur District of Rajasthan and falls under Semi-Arid Zone (Province 4A) of India (Rodgers et al., 2002). The total area of the KNP is 29 km², of which 20.5 km² is terrestrial and 8.5 km² is a wetland area. The KNP has a mosaic of habitats which includes physiognomic types of forest, woodland, scrub

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