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A Preliminary Study On The Behaviour Of Blanford's Rock Agama (Psammophilus Blanfordanus) In Captivity

S. Saikrishna

N. V. Sri Survesh

S. Narender

V. Divakar

Dr. S. John William

P.G and Research Department of Advanced Zoology and Biotechnology,
Loyola College, Chennai

Abstract: ***The behavior of a species can be fundamental to effectively conserve that species. Conservation biology in the last two decades by Animal behavior in captivity as well as in the wild is negligible, because of lack of research works in that, we have tried to make an attempt on it. Captive facilities like zoos aim to create awareness, carry out research and conserve species particularly the threatened ones. Our study aims at understanding the ethology of Indian Rock Lizard in captive conditions. The work on Blanford's Rock Agama, which is an indigenous lizard of India, was done in Southern India during the summer season. While such aspects have received some attention in larger animals like mammals and even birds, not much is known about reptilian taxa. In reptiles, postures and positions are described for only certain aspects of behavior like fighting and courtship, but we have analyzed most of the external behavior pertaining to Blanford's Rock Agama.***

I. INTRODUCTION

Understanding the behavior of a species can be fundamental to effectively conserve that species. Captive facilities like zoos aim to create awareness, carry out research and conserve species particularly the threatened ones (Russo, 2013, Ward 2016). But yet, it is surprising that the contribution made to Conservation biology in the last two decades by Animal behavior in captivity as well as in the wild is negligible, because of lack of research works in that regard (Sutherland, 1998). Until recently, it has been felt that the gap between these two aspects is still not bridged and accounts little in solving the biodiversity crisis, as evidenced by joint meeting with members of behavior and conservation societies (Caro, 2007). Nevertheless, behavioral studies of animals in captivity ensures an understanding of the human impact on the natural habits of animals by studying their response to human presence, retain the population of species, promote "cultural skills" in the animals, and induce behavioral manipulations, if necessary (Sutherland, 1998) and subsequent restoring or rehabilitation in the wild (Caro, 2007).

While such aspects have received some attention in larger animals like mammals and even birds, not much is known about reptilian taxa. In reptiles, postures and positions are described for only certain aspects of behavior like fighting and courtship (Carpenter, 1961, 1962, 1969; Kastle, 1963, 1967; Carpenter and Blanc, 1969; Ferguson, 1970) and understood fully for only a few species (Carpenter, 1962; Gorman, 1968; Jenssen, 1970b, 1971; Ferguson, 1971a; Purdue and Carpenter, 1972a, b). It is only recent that the entire set of behavioral postures and positions are being researched upon (Kastle, 1967; Brattstrom, 1971).There are many studies on behavior and activity pattern of lizards in the wild. For example, studies on mating behavior was done by Noble and Teale (1930) and Noble and Bradley (1933), but literature on Indian lizards is even more scanty.

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In India, with over 200 species of lizards, some like the chameleon, the monitor lizard and other such require conservation measures (Daniel, 2002). One such species is the exclusively rock-dwelling Blanford's Rock Agama (*Psammophilus blanfordanus*). Studies on this species include field studies in its natural habitats (Venugopal, 2010; Chandra et al., 2005, Chandramouli and Baskaran, 2010) and other aspects like liver histopathology (Parida et al., 2013), embryonic development (Jee et al., 2016), male reproductive organs like epididymis and testis (Singh et al., 2016). Works were also done on a closely related species, *Psammophilus dorsalis*, including aspects such as thermoregulation (Veeranagoudar et al., 2010), escape response (Sreekar and Quader, 2013), reproductive mechanisms (Srinivas et al., 1995), and so on. The necessity for undertaking this study is to assess the behavior of the lizards under captive conditions in a terrarium set-up, with the provisions of a replicated natural habitat. We aim to study its intra-specific interactions in captivity and the spatial resource use pattern across the entire day experiencing dynamic temperature and humidity regimes. As such, we expect to shed light on the behavioral profile of these lizards in captivity.

II. METHODOLOGY

We observed the behavioral profiles of Indian rock agama *Psammophilus blanfordanus* maintained in captivity in the Chennai Snake Park (13.0039° N, 80.2387° E) over a period of 20 days, extending from 7th to 29th May 2017. There were six adults, four males and two females. We conducted this ethological survey in the summer month with an average temperature of 34.9°C (30.9°C-39.5°C) and average humidity of 44.5% (26%-63%). Activities were scored at different times of the day, by Time-Constrained Sampling method (Martin & Bateson, 1993; Lehner, 1996). Data collection of all activities was taken on a 2-hour duration basis. We (as a group of four) divided the time period of observation as morning (8.30am-10.30am), forenoon (11.00am-1.00pm), afternoon (1.30pm-3.30pm), and evening (3.30pm-5.30pm) and came to the spot for observation during these hours. A threshold distance of 90 cm was maintained outside the terrarium. In each of the four time periods as mentioned above, a total duration of 25 hours of observation, amounting to 100 hours duration in all was taken. For better understanding, the duration of activities which exceeded more than a minute were expressed in minutes and the duration of activities which exceeded more than an hour were expressed in hours.

TERRARIUM

The terrarium was a large glass-fronted enclosure with dimensions 6ft X 9ft X 6ft and was provided with two lateral openings of dimensions 1 ft X 0.3 ft covered by mesh top. Sand with small rock mix of about 2 inches thickness was provided as a substratum. Around 15 medium-sized (1 foot) rocks were kept inside the terrarium. Some of the rocks were aggregated towards the middle of the enclosure forming crevices. A log of wood was also provided. In addition; a mud-pot heating element and a water dish were also provided.

RECORDING OF ACTIVITIES

Duration of an activity followed by the frequency or the number of occurences, represented within brackets, was recorded. Along with the activities, the temperature and humidity for every 2-hour duration of study were recorded. Each time period of observation was conducted by two of us. While one of us observed the lizards and narrated, the other wrote the duration and frequency of activities. The total sum of all the activities subtracted from the total duration of observation (ie. 2 hours) gave the total resting time for a given time period of study. The temperature and humidity values were recorded by a Digital Hygrothermometer. Photographic documentation of certain activities were taken using Honor 6X handset from outside the enclosure. We used the stopwatch facility in mobile phones to note the time period of activities. Changes in position of body part of the lizard without involving total displacement of the lizard from one place to another was noted as movement. Up and down movement of the head was scored as head-bobbing and lifting up of the tail was scored as tail raising. A voluntary reflex to get rid of particulates was defined as scratching. Change of place or displacement of the lizard from one place to another was scored as locomotion. Active pursuing or following of lizards among one another was scored as chasing. Any vertical displacement of the animal from one place to another was scored as climbing. Inactive state of the animal when present in shade is defined as resting. Resting in sun-lit area was scored as basking and resting inside the water was scored as resting in water. If a part of the body was exposed to sunlight with the rest of it lying in shade, it was noted down as partial basking.

STUDY SPECIES

The Blanford's Rock Agama *Psammophilus blanfordanus* (Stoliczka, 1871) also called Indian Rock Lizard and Peninsular Dwarf Rock Agama, is found in rocky habitats of Indian peninsula (Kumar et al., 2002) and elevated hilly regions up to 1829 meters elevation (Daniel, 2002), mainly along the Western Ghats and Eastern Ghats (Smith 1935; Sharma 1976; Ishwar et al., 2001; Sanyal and Dasgupta 1990; Vyas, 2000; Srinivasulu et al. 2006; Venugopal 2010).The species is also common in the vicinity of Bengaluru (Daniel, 2002).It is an agile, thermophilic (sun-loving) lizard, and a close relative of its sister species, Peninsular Rock Agama (*Psammophilus dorsalis*) (see Smith, 1935) and is distinguished by a deeper anti-humeral fold, larger scales on the body from 80-100 round the middle, dorsals being distinctly keeled and imbricate (Smith, 1935), and presence of a fold in the skin of throat (Daniel, 2002). It is a common, social, diurnal, rock-dwelling (rupicolous), agamid feeding primarily upon insects (Daniel, 2002; Radder et al., 2005), rarely on other lizards (Aruna et al., 1993; Sreekar et al., 2010), etc. and categorized as a Least Concerned species by IUCN. It has also been observed that the lizard has arboreal habits and is found on large tree trunks (Ranabijuli, 2011). Adult males are larger than females with distinct scarlet red and black color of the head (Smith, 1935). Females are

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comparatively smaller with cryptic dull grey or olive brown coloration (Radder et al., 2005).

Psammophilus blanfordanus shows social behavior. Social hierarchy in these animals is established by a 'Peck order' whereby the dominant male occupies the most elevated spot with the maximum perch height. The perch height occupied by males is higher than that of females with the possibility of variation during breeding season (Radder et al., 2005). *Psammophilus blanfordanus* shows the following behavior in the wild: 1) Territoriality (Pianka and Vitt, 2003), 2) Mating Behavior (Pianka and Vitt, 2003), 3) Interspecific behavior like feeding and undergoing predation, 4) Intraspecific behavior involving visual signals, chemical signals, and tactile communication (Pianka and Vitt, 2003). Among these, visual signals and response is the most highly developed, as indicated in case of *Psammophilus dorsalis* (Sreekar and Quader, 2013). As with the case for agamid lizards generally, they are diurnal and have high cone cell density in their eyes, and are capable of detecting and discriminating colors and even UV light (Pianka and Vitt, 2003).

III. RESULTS

The set of activities that were observed out of 100 hours included resting (89 hours), in-water resting (18 hours), basking (2 hours), tail raising (~2 hours), partial basking (~2 hours), movement (~30 min), locomotion (15 min), climbing (12 min), head bobbing (9 min), feeding (3 min), scratching (~2 min), chasing (46 sec), drinking (37 sec), biting (6 sec), dewlap display (3 sec), and excretion (1 sec). Highest activity was recorded at temperature and humidity level of 33.1°C and 48% respectively (48 min) while lowest activity recorded was at 35.3°C and 38% temperature and humidity level respectively (6 sec). Major activities except for resting (outside and inside water) include basking, tail raising and partial basking (Refer Fig.1). Minor activities include biting, dewlap display, excretion (Refer Fig.2). Because of varying temperature and humidity levels, we segregated the time period of observation into morning, forenoon, afternoon and evening hours.

The morning duration activities of lizards (8.30 am-10.30 am) were characterized by average temperature and humidity levels of 33.4°C and 48% respectively. Except for resting (inside and outside water), the most observed activies during this time period of observation included basking (46 min), tail raising (20 min), and movement (11 min). The occasionally occuring activities were locomotion (3.2 min), head bobbing (~3 min), and feeding (~2 min). The rarely occuring activities included scratching (33 sec), climbing (29 sec), chasing (8 sec), drinking (5 sec), and excretion (1 sec). The total duration of activities was 1 hour 42 minutes (Refer Fig.3).

The forenoon duration activities of lizards (11.00 am-1.00 pm) were characterized by average temperature and humidity levels of 35.6°C and 40% respectively. Except for resting (inside and outside water), the most observed activies during this time period of observation included partial basking (1 hour 40 min), basking (1 hour), and tail raising (17 min). The occasionally occuring activities were feeding (7 min), movements (6 min), locomotion (3 min), climbing (2 min) and head bobbing (~2 min). Rarely observed activities include scratching (34 sec), drinking (9 sec), and chasing (9 sec). Total duration of activities was 3 hours 18 minutes (Refer Fig.4).

The afternoon duration activities of lizards (1.30 pm-3.30 pm) were characterized by average temperature and humidity levels of 35.9°C and 43% respectively. Except for resting (inside and outside water), the most observed activies during this time period of observation included basking (35 min), tail raising (25 min), climbing (10 min), and partial basking (10 min). The occasionally occuring activities were movement (~6 min), locomotion (3 min), head bobbing (2 min). The rarely occuring activities included scratching (22 sec), feeding (15 sec), drinking (13 sec), chasing (12 sec) and biting (2 sec). Total duration of activities was 1 hour 54 minutes (Refer Fig.5).

The evening duration activities of lizards (3.30 pm-5.30 pm) were characterized by average temperature and humidity levels of 34.8°C and 45% respectively. Except for resting (inside and outside water), the most observed activies during this time period of observation included tail raising (36 min), and movement (7 min). The occasionally occuring activities included locomotion (~5 min), head bobbing (2 min) and feeding (44 sec). The rarely occuring activities included climbing (30 sec), chasing (17 sec), drinking (10 sec), scratching (8 sec), biting (4 sec) and dewlap display (3 sec). Total duration of activities was 52 minutes (Refer Fig.6).

Basking was highest in forenoon (1 hr) followed by morning and afternoon hours; it was not observed in the evening. Partial basking was highest in forenoon (1 hr 40 min) followed by afternoon hours; it was not observed during morning and evening. Tail raising was highest in the evening hours (36 min) followed by afternoon, morning and forenoon. Movement was observed throughout the observation period. It was highest in the morning hours (11 min) followed by evening, forenoon and afternoon hours. Locomotion was highest in the evening hours (~5 min) followed by morning, forenoon and afternoon hours. Head bobbing was highest in he morning hours (~3 min) followed by forenoon, afternoon and evening hours.

Feeding occurred throughout the observation period, but mostly towards forenoon hours and rarely in the afternoon hours. Drinking was also common throughout the observation period, but mostly in the afternoon sessions. Chasing and scratching were also distributed throughout the observation period. Climbing onto walls and tree logs were common throughout the observation period, but mostly observed in afternoon session. Biting was rarely observed in late afternoon and evening sessions, while excretion and dewlap display were the rarest of all, with single occurrence in morning and evening sessions respectively. The duration of activities was highest in the forenoon (3h 18 min vs. 1h 54 min in the afternoon, 1h 42 min in the morning and 52 min in the evening), and inactivity increases towards evening time (52 min). Although activities occur, most of the time is spent in resting, that happened frequently in water too.

IV. DISCUSSIONS

In *Psammophilus blanfordanus*, postures and actions are the most important stimuli as suggested in case of most diurnal lizard species (Brattstrom, 1974). Under captivity, the Blanford's Rock Agama showed similarities in certain aspects of behavior as already mentioned by earlier workers. Basking was seen to occur mostly in the morning and forenoon sessions as suggested by Parida and Mukherjee (2014). Resting usually occurs in shady areas and rocky crevices in the afternoon due to increased heat preceded by basking in the morning hours as similar to *Psammophilus dorsalis* (Radder et al., 2005). Resting inside water can be attributed to lower body temperature as suggested in case of *P.dorsalis* (Veeranagoudar et al., 2010) or it may be related to water uptake through the skin similar to *Moloch horridus* (Sherbrooke,1993; Withers, 1993). As with other activities like head-bobbing, which is considered as most observed activity in case of sister species *Psammophilus dorsalis*, (Radder et al., 2006) our findings are similar in that context.

Tail raising behavior in *P.blanfordanus* doesn't seem to have a role in courtship interactions as suggested in case of Phrynosomatid lizards (Martins, 1991, 1993), and confirmed in case of *Psammophilus dorsalis* (Radder et al., 2006), but instead might have a role in male-male interactions. No occurrence of mating and reproductive behaviour was observed during the study period. Some of the lizards in the enclosure were more active than others and performed frequent 'push-ups' as previously suggested in case of captive iguanid lizard genera *Callisaurus, Cophosaurus* and *Holbrookia* by Clarke (1963). The lizards were shy and would run away so we could not have a closer look on them as previously described (Radder et al., 2005). Dominant males in captivity prefer to establish greater perch heights, similar to that in the wild (Kumar et al., 2002). Territories, in the usual sense of term, do not apply to captive lizards because of less scope of competition for food and hence space. Biting was a rare activity because individuals were mostly submissive when confronted by a displaying dominant male. Head bobbing also occurs frequently before and after locomotion (personal observation).

An ideal terrarium for lizards in general has been described (Conant and Collins, 1998). The terrarium for *P.blanfordanus* consisted of 2 inches of sandy dry soil and small rock mix, with pebbles and larger rocks to maintain an arid habitat. This is because a rocky habitat was necessary for the survival of this species (Das 2002, Daniel, 2002). Next, a log of wood with concave-side facing down was arranged to make a good shelter and a shallow mud-pot with water up to brim was kept as suggested (Conant and Collins, 1998). In addition, water was sprayed inside the enclosure to help the lizards in maintaining an optimum body temperature as far as possible.

To the best of our knowledge, behavioral studies of Indian Rock Lizard (*Psammophilus blanfordanus*) in captive conditions are very scarce. As such, we believe that these captive lizards behave similarly when compared in the wild, as resting predominates total duration of activities drastically (personal observation). This may be attributed to smaller body size which is suggested to have higher heating rates as suggested generally in case of high altitude lizards (Carrascal et al., 1992). The activity patterns are mostly influenced by temperature and humidity levels. They require a suitable temperature and humidity range (Present study: 31.5°C-36.7°C & 33%-49% respectively) within which they show highest activity (personal observation). Inactivity is seen to increase after rapid feeding bouts (personal observation). High temperature of substratum may also be a reason for inactivity, because of which the lizards may have been resting inside water for longer durations, which is a rare occurrence in the wild (Rao et al., 2015). Certain activities like head bobbing, tail raising, etc. may serve more than one purpose but it is difficult for us to interpret (personal observation); so further studies are required on aspects such as circadian rhythm (body clock), roosting behavior at night, behavior of juvenile lizards and similar studies across other seasons.

ANNEXURE-1

Activity pattern of captive *Psammophilus blanfordanus* in 100 hours

Except Resting (outside or inside water)

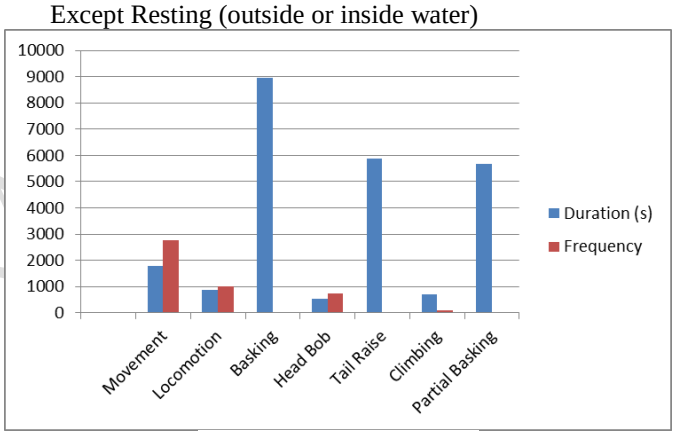

Figure 1: Major Activities

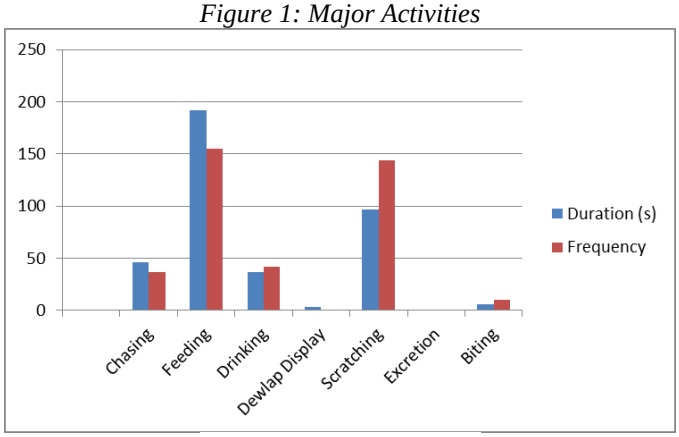

Figure 2: Minor Activities

Activity patterns of captive *Psammophilus blanfordanus* during various time slots except Resting (outside or inside water)

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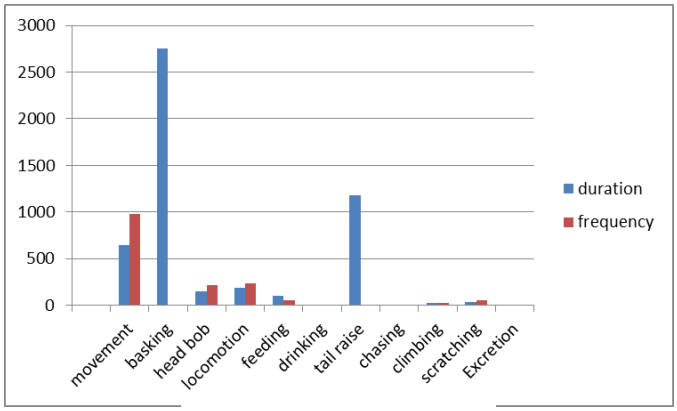

Figure 3: 8.30 AM-10.30 AM

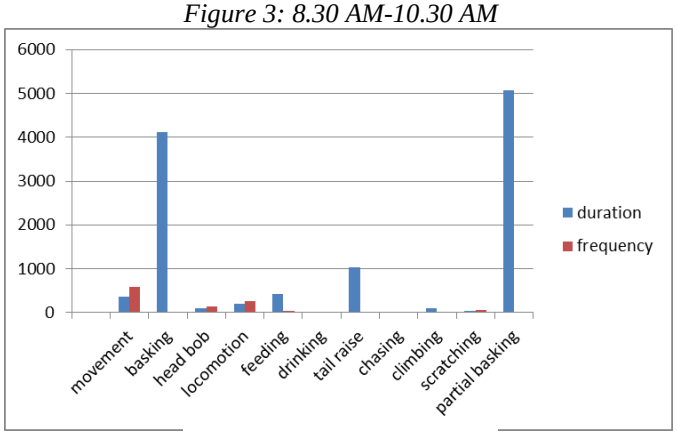

Figure 4: 11.00 AM-1.00 PM

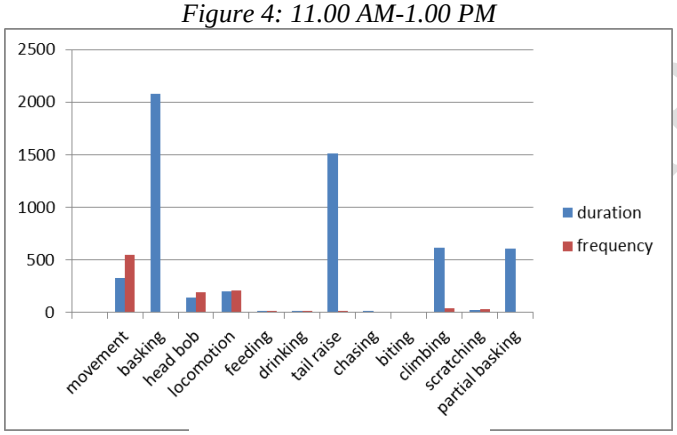

Figure 5: 1.30 PM-3.30 PM

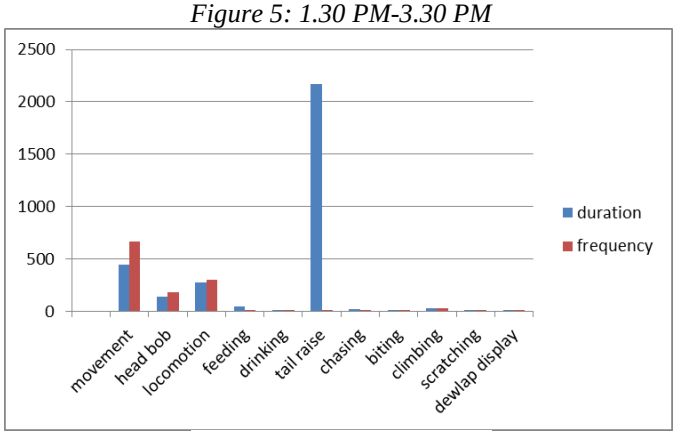

Figure 6: 3.30 PM-5.30 PM

ANNEXURE - 2

Water Dish | Terrarium Housing P.blanfordanus

Resting | Resting in water

Climbing | Feeding

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