ISSN 2278-2575

Cobra

Volume XIV Issues 1& 2 January – December 2020

Bi-annual journal of the Chennai Snake Park Trust

Annual Subscription : Individual – Rs. 75/- . Institution – Rs. 150/-.

Cover

Green Iguana *Iguana iguana*: Exotic species. Not found in India. Native to Central and South America. Herbivorous. Arboreal. The focal animal of this special issue. Here a pair in courtship was photographed, in Chennai Snake Park.

Photo: Dr. S. Paulraj

Chennai Snake Park Trust
Rajbhavan Post, Chennai – 600 022 India.
Ph: 91-044-22353623 E-mail: cspt1972@gmail.com Website : chennaisnakepark.org

Cobra

Volume XIV Issues 1&2 January – December 2020

Due to Covid-19 pandemic curfew, two issues of year 2020 have been combined into one

CONTENTS PAGE

SPECIAL NOTE

KIND ATTN. TO FELLOW SCIENTISTS AND FIELD EXPERTS!

We are glad to share with you that after decades, the endangered gharials (*Gavialis gangeticus*) have successfully bred in captivity in Chennai Snake Park.

At this juncture, to highlight the importance of this species and to instigate further interest on this species, we now wish to make a special issue of our journal *COBRA* dedicated to the gharials. So it is requested that the scientific community may submit articles related to study of gharials, in captivity or in the wild on any aspect such as natural history, ethology ecology, population monitoring and so on. We are now soliciting the manuscripts on gharials and potential authors can send in their works to cspt1972@gmail.com or cspt.res@gmail.com mentioning it as a contribution to the gharial special issue of *COBRA* journal.

-- Editor

KIND ATTN. TO NATURE LOVERS & PHILANTHROPISTS!

We are glad to share with you that after decades, the endangered gharials (*Gavialis gangeticus*) have successfully bred in captivity in Chennai Snake Park.

You may be aware that Chennai Snake Park is one of the oldest Parks in India, established in 1972. This is a non-profitable organization managed by a group of Trustees that include, top government officials and wildlife experts. This is being run on donations, mainly in the form of Entry Fee.

However, as is known, due to the Covid-19 pandemic and the Govt. curfew our zoo was closed to the public for about 8 months since March 2020. In this situation our savings amount has been drained to quite an extent that we are barely able to make ends meet.

Thus, the new born gharials although a welcome addition to our zoo and a long-awaited, ecstatic news, has now translated itself into additional expenses. We would be pleased and thankful to anyone coming forward to meet the feeding expenses. Our donations are tax-exempted under 80G of Income tax Act. Please donate liberally: Chennai Snake Park Trust, State Bank of India, Adyar Branch, A/C No. 10792456546, IFSC Code: SBIN0013361. Many thanks in advance.

--The Executive Chairman
Chennai Snake Park Trust

MOVEMENTS AND INTERACTION PATTERNS OF CAPTIVE GREEN IGUANAS *(IGUANA IGUANA)* IN CHENNAI SNAKE PARK

Janani N, Kavitha M, Mubeena Fathima B, Punitha D, Shalini T.M.

Ethiraj College For Women
Egmore, Chennai-600008, Tamil Nadu, India

Introduction

Understanding the activity patterns of animals is fundamental to knowing the well-being and conserving a species. Movements are of many types in animals, both voluntary and involuntary. The major types of movements include locomotary modes that help the animals in getting from place to place. Other, smaller, more localised movements also serve various other functions, as in communication, signalling, prey-capture, predator-avoidance, reproductive / breeding pursuits and so on (Diwan and Arora, 1995). Apart from whole body movements, movement of certain body parts of animals play a role in visual signals, e.g. opening mouth, flaring throat pouch and head bobs, whereas the chemical and tactile signals are more subtle in usage (Vitt and Caldwell, 2009).

Reptiles in particular, being far less vocal compared to other vertebrate groups, rely more on physical bodily gestures and signalling compared to amphibians, birds and mammals. Among lizards, head bobbing and push-ups are done in a fixed sequence which helps in the identification of its species in order to avoid hybridization during mating (Mattison, 2004). Physical state and condition of individual affect its movement patterns and communication efficacy. Ontogenic changes are seen in the locomotors performance abilities which are relevant to predator encounters (Diwan and Arora,1995).The factors influencing the daily movements of reptiles are sex, size, season, predator's presence, food availability, thermoregulation and mating system (Sanches *et al.,*2018).

Lizards bluff their way out of trouble as they are handicapped by being mostly harmless (Edward and Turner, 1974). Some lizard groups, such as Iguanids tend to have lateral display. At rest they are folded along the neck and shoulders, when needed they are erected rapidly (Mattison, 2004). Iguania are also species in that they do not have a history of evolutionary limb loss. Thus they depend a lot on movement for their survival. Yet, locomotory escape is infrequent in them, but it includes running on sand, running on water and gliding (Diwan and Arora, 1995). Chemical cues are used for homing on a retreat. Both intrinsic and extrinsic factors influence movements (Vitt and Cladwell, 2009). Aggressive behaviour is usually seen as a response to stress and danger. Defensive display have been known in the helmeted lizard, an iguanid form when confronted by a snake. The compression of the body and rising of its front legs occur. Lowering of its head and expansion of nuchal crest and throat fan is seen. Sometimes the head is slowly bobbed at the end of the display (Bellairs, 1969). Strong territorial behaviour was shown by the males during the breeding season. The actual fighting is not usually seen where as head bobbing is used to establish territorial rights (Savage, 2002).

The defence mechanisms like tail display, rigid immobility, lashing with the tail and group response is less common (Diwan and Arora, 1995). Some lizards break off their tail when caught. This is used to divert the enemy's attention which will be useful for lizards to escape (Edward and Turner, 1974). In iguanas certain miscellaneous strategies are shown. Tail loss can be disastrous to the animal as it uses its tail as a counter balance during climbing and running. In order to avoid tail loss, the presence of banded tail (as opposed to uni-coloured body) is used as an alternative solution. When the iguana spots the predator, it raises its tail thus exposes the banded pattern. This sends a message that the predator as been spotted and not to waste time on stalking it (Mattison, 2004). The activity pattern and interactions studies of green iguanas not only elucidate the important aspects of its behaviour and ecology but also the type of habitat necessary to maintain their population under captive conditions. The primary goal of this study was to examine the interactions and movement patterns of *Iguana iguana* under captive conditions and to compare their movement patterns in captivity with their pattern in their natural home range.

Materials and Methods

Study Species: The green iguanas (*Iguana iguana)* belong to the family Iguanidae. It is commonly known as green iguana, but occasionally they come in other colour morphs too. They are found on the mainland of south and Central America (Mattison, 2004). It is a herbivore which grows to a length of 2m (6.5ft) from head to tail. Green iguanas are generally diurnal and are arboreal lizards. Their average life span is about approximately 20yrs under captivity. The average size of male is 6-6.5ft and weighs up to 3.5-4kg and female is 5ft in size and weighs up to 1.2-3kg. Although they are called as green iguana, they actually vary in colour. The adults become uniform in colour with age, while the young ones may appear blotchier or banded between green and brown. They are also sometimes orange-brown in colour. Many lizards including Iguana has an opening on top of the head which is been covered by skin and connective tissue. Beneath this lies an eye like structure. This is sometimes referred to as the 'third eye' or the 'pineal eye'. This is associated with the extension of the brain known as epiphysis. They also run across the surface of water and hence they are great swimmers (Mattison, 2004).

Enclosure Details: The study was done at Chennai Snake Park. The iguanas were kept in three separate enclosures and each enclosure housed two individuals (a male and a female). The size of the enclosure I and II are 60sq.ft each and the size of the enclosure III is 113sq.ft. The enclosures I and II consists of sub adults, out of which the sub adults in the enclosure I were orange brown in colour and in enclosure II were green in colour. The enclosure III consists of green adults. The male and female individuals were identified by the following secondary sexual characters: *male* – larger jaw muscle (jowls), heavier and larger body, larger femoral pore, bulge near the base of the tail (hemi penal bulge); *female* – more pronounced jowls, slimmer body than male, small femoral pore, lacks hemi penal bulge near the vent.

All the three enclosures contain the basic furnishing of any zoo animal such as climbing branches, water pond, gass window (sub adults-1, adults-2), rocks, lighting and sand substrate. The enclosure of sub adults (I & II) differed from that of the adult in having an earthen pot, 2 vents at the sides which was grilled, in addition to the grill, fine mesh netting was also seen. The adult enclosure –III alone had a potted plant.

Observation methods: The major aspect of our study is on movement and interaction of *Iguana iguana*. We observed the captive iguanas visually as a group of 5 members from a distance of 1 m away from the enclosure glass front. The total hours spent per enclosure was 35hrs. We observed the lizards for a period of 105 hours on all three enclosures across 10 days during the month of May from 9:00am to 4:00pm. The observation was conducted at different intervals in a day. We classified the hours of observation into morning (9:00am-11:00am), forenoon (11:00am-1:00pm), noon (1:00pm-2:00pm), and afternoon (2:00pm-4:00pm). The time duration was noted using stop watch. The movements documented during observation were broadly divided into two categories: (i) Movements involving head (tongue protrusion, jerk, mouth opening, licking, yawning, gular movement, blinking, bobbing, one eye closed, eyes closed, spitting and eye ball movement) and (ii). Other body movements (limb movement, approach and retreat, locomotion, climbing, jumping and scratching). Along with the above observed movements the interaction (in contact) between the animals was also documented.

Results

From the study conducted on the iguana the following movements, locomotion, climbing, limb movement, scratching, approach, retreat, jumping, fighting, tail raising, tongue protrusion, jerk, mouth opening, licking, yawning, gular movement, blinking, bobbing, one eye closed, eyes closed, in contact, eye ball movement, spitting, biting and head movement were observed. The movements that targeted the other individual of the same enclosure were, in contact, fighting, chasing, approach and retreat.

From the collected data it has been found that maximum duration spent by the males of all the three enclosures was, on head movement (330s) and the minimum duration was spent on tail raising (6s). The duration of other movements spent by the males were licking (75s), scratching (69s), eye ball movement (57s), bobbing (50s), blinking (40s), fighting (35s), tongue protrusion

(31s), jerk (30s), gular movement (22s),mouth opening (19s), approach (12s) , retreat (12s), jumping (10s), yawning (8s) respectively.

And in females of all the three enclosures, the maximum duration was found to be spent on head movement (382s) and minimum duration was spent on yawning(6s).The duration of other movements spent by the female were locomotion (312s), climbing(269s), limb movement (180s), jerk (90s), scratching (51s), licking (50s), blinking (35s), tongue protrusion (35s), eye ball movement (31s), mouth opening (26s), approach (24s), bobbing (21s), gular movement (17s), jumping (12s), and retreat (10s) respectively.

Comparison of the frequency of movements and interaction by the adult and sub-adult is shown in Table 1. This table excludes two activities of much prolonged frequency – i.e. the head movement and eyes closed. Their frequencies and durations are as follows: head movement (adult-24.41, sub-adult-134.21) and eye closed (adult -196.1, sub adult- 201.90).

Comparison of the duration of movements (in seconds) is shown in Table 1. This table excludes head movement, eye closed, climbing, bobbing and in contact which was of much prolonged duration. The duration values of activities were as follows: head movement (adult-28.1s, sub-adult-154.64s), eye closed (adult-573.8s, sub adult-590.81s), climbing (adult-295.3s, sub-adult-42.67s), bobbing (adult-222.4s, sub adult-9.29s), in contact (adult-249.2s, sub adult-307.02s) respectively.

The maximum duration involved in the interactions of both male and female in all the three enclosures were (1806s) amounting to 30 minutes (0.5 hour activity out of 105 h of observation). From the Table1, it has been found that the frequency and duration of climbing, bobbing and spitting is more in adults when compared to that of the sub adults. Likewise, the frequency and duration of locomotion, biting and fighting is more in sub adults than the adults. In addition to this we also observed ecdysis for once in both male and female of enclosures I and II.

Table 1. Comparison of activities of frequency and duration (in seconds) of adult and sub adult captive iguanas

Activity	Adult	Sub adult	Activity	Adult	Sub adult
In contact	0.05	1.68	Locomotion	1.26	84.42
Locomotion	0.1	6.68	Limb movement	3.52	23.8
Climbing	5.33	0.77	Licking	17.4	6.44
Limb movement	0.8	5.4	Gular movement	88.4	5.05
Licking	16.68	6.18	Jerk	0.01	7.46
Gular movement	4.73	0.27	Scratching	3.8	14.62
Jerk	0.01	5.06	Tongue protrusion	1.07	6.04
Scratching	1.22	4.58	Blinking	0.54	5.36
Bobbing	4.07	0.17	Yawning	1.18	1.73
Tongue protrusion	1	5.6	Approach	3.8	12.97
Blinking	0.54	5.36	Retreat	0.29	3.45
Yawning	0.55	0.8	Mouth opening	2.29	8.09
Approach	0.54	1.84	Spitting	0.25	1
Retreat	0.11	1.27	Jumping	0.48	5.86
Mouth opening	2.29	8.09	Fighting	0	48
Spitting	2.25	1	Eyeball movement	1.6	8.65
Jumping	2.22	2.76	Tail raising	0.24	3
Fighting	0	1.8	Biting	0	9
Eyeball movement	1.6	8.65			
Tail raising	0.08	1			
Biting	0	5			
One eye closed	2.88	6.58			

Table 2. Comparison of movements involving head of captive iguanas

Activity	Morning 9:00-11:00		Forenoon 11:00-1:00		Noon 1:00-2:00		Afternoon 2:00-4:00	
	Male	Female	Male	Female	Male	Female	Male	Female
Tongue protrusion	8.11	6.1	4.3	5.1	5.75	4.46	2.8	3.2
Jerk	54.55	11.65	2.13	5.08	4.8	3.05	2.33	7.2
Mouth opening	5.5	6.73	7.5	4.65	4.75	3.5	5.25	9.16
Licking	16.26	11.23	9.06	9.76	11.13	10.73	11.14	5.36
Yawning	1.33	2	4	1	0	2	1	0
Gular movement	3.6	3.7	5.68	4.9	5.46	7.56	5.16	4.35
Blinking	3.4	3.45	8.03	6.85	5.25	8.75	4.88	7.1
Bobbing	5.23	4.33	3.86	2.33	2.66	4.65	3.58	5.3
One eye closed	3.25	4.53	2.25	4.1	1.25	5.24	3.66	5.5
Eyes closed	5.86	5.63	3.17	5.4	5	8.6	4.79	8.03
Spitting	1	0	1	1	1	1	0	1
Eyeball movement	6.1	5.1	13	11.6	5	0	9.7	6.4

Table 3. Comparison of other body movements of captive iguanas

Activity	Morning [9.00-11.00]		Forenoon [11.00-1.00]		Noon [11.00-1.00]		Afternoon [2.00-4.00]	
	Male	Female	Male	Female	Male	Female	Male	Female
Limb movement	9.64	4.4	4.61	5.23	2.33	2.73	3.8	4.06
Approach	1.25	1.65	1.2	2	1.3	1	1	1
Retreat	1	1	1.3	2	1	1	1	1
Locomotion	7.02	7.25	5.24	6.77	9.48	8.07	4.45	5.97
Climbing	3.33	6.3	4.69	6.53	3.06	6.95	2.88	3.76
Jumping	5.3	4.25	3	1.25	1	2	0	1
Scratching	2.1	1.93	6.18	2.23	3.55	2.15	4.06	4.73
Fighting	0	0	1	0	0	0	4.5	0
Tail raising	1	0	1	0	1	1	1.5	1

Table 4. Frequency of contact between captiveiguanas across the parts of the day

Timings	Frequency	Duration
Morning [9.00-11.00]	1.21	233.81
Forenoon [11.00-1.00]	1.16	387.57
Noon [11.00-1.00]	1.1	102
Afternoon [2.00-4.00]	1.25	273.58

Discussion

The duration of head movement is maximum in both male and female when compared to rest of the movements. This occurred due to increased distractions like sound and visual cues in the animal's enclosure. By inferring the result, ecdysis was seen once in all the sub adults (enclosure I and II). In iguana the shedding of the skin is done in large patches (Vitt and Caldwell, 2009). Likewise we observed the shedding does not occur at a stretch instead it occurred as patches. We observed that the iguanas licked various substances like mud, food, wall, glass, trunk and other iguanas. And it was predominantly observed in adult iguanas than in the sub adults. These individuals recognize the surroundings not only by seeing and hearing but also by licking with their tongue and vomeronasal (Jacobson) organ (Kaplan, 2002). Iguana obtains water by drinking or licking the moisture of plants or other objects when available (Savage, 2002). The licking behavior of Iguana upon another Iguana might be due to the pheromones present in their skin. It is a form of chemical communication (Vitt and Caldwell, 2009).

Head jerk in Iguana was usually performed as a result of signaling to other individuals. We opine that head jerk of iguanas in enclosures might be caused due to certain movements in the surrounding. Chasing behaviour (fighting and biting) was observed in sub adults. It might be due to the defensive behaviours exhibited by them. Territory is actively defended by the males, through the visual display like head-bobbing in its natural habitat (Vitt and Caldwell, 2009).

By inferring the result, this behaviour was shown more by the adult iguanas than the sub adults. Sub adults usually establish areas lower in the canopies while older mature iguanas reside higher up (Mattison, 2004). Though of limited interpretation here in captivity, with shorter trees, this was hinted so, where climbing was predominantly seen in adults whereas; locomotion on ground was seen more in sub adults. Iguanas live in a dynamic social group (Kaplan, 2002). In natural habitat they leave from their resting site in group of 2-8 or singleton which is followed shortly by another. They remain in groups i.e. whenever an iguana was spotted; the chances of spotting the other iguanas are high. Social behaviour like migration, foraging, selection in sleeping sites and leaving the hatch sites are seen even in new born iguanas (Berghardt, 1977).

In this preliminary work, with limited season of observation, we are constrained to touch upon such long-term aspects that demand year-round observations. We believe this preliminary study will reveal some insights into the behavioural patterns of captive Iguanas.

Acknowledgements

We thank the HOD, Zoology Dept., Ethiraj College for Women and the authorities of the Chennai Snake Park Trust for their valuable guidance and strong support in completing this internship.

References

Bellaris, A., 1969. *The life of reptiles, volume III. Weidenfeld & Nicolson Natural History Series. PP: 503-504.*

Berghardt, M. G., 1977. *integrative and comparative biology (volume-17),* pp: 182-186.

Coborn, J., 1991. *Snakes and lizards (their care and breeding in captivity),* Tetra Press, Morris plain, New Jersey, U.S.A.

Diwan, A. P and Arora.D .K., 1995. *Ecology of reptiles.* Anmol publication, New Delhi, India.

Edward and Turner, C., 1974. *Snakes and lizards.* Priory press limited, U.S.A.

Kaplan, M. 2002. "Journal Abstracts: Iguana iguana Visual and Chemical Reception" (On-line). http://www.anapsid.org/iguana/sight2.html.

Mattison, C., 1992. *The care of reptiles & amphibians in captivity.* Anmol publication, pp: 19, 73.

Mattison, C., 2004. *Lizards of the world.* Facts of Files inc. New York, U.S.A.

Sanches, V. Q. A., & Grings, D. R. 2018. Daily movement and habitat use of Iguana iguana (Linnaeus, 1758) in an urban second growth Amazonian forest fragment in Brazil. *Herpetology Notes*, *11*, 93-96.

Savage, J. M., 2002. *The amphibians and reptiles of Coast Rica (a herpetology between two continents, between two seas).* University of Chicago press pp: 412.

Vitt, L. J and Caldwell, 2009. *An introductory biology of amphibians and reptiles; Herpetology –III edition.* Elsevier academic press publication, U.S.A.

FEEDING BEHAVIOUR OF CAPTIVE GREEN IGUANAS (*IGUANA IGUANA*) IN CHENNAI SNAKE PARK

Abiramy Neveda T.R, Geethanjali A, Kaviyarasi A, Priyanka P, Saraswathi A
Ethiraj College For Women
Egmore, Chennai-600008, Tamil Nadu, India

Introduction

Food and feeding are one of the most fundamental components that need to be monitored to ensure the health and well-being of a species. This is particularly true in captive conditions as not always is it possible to provide the natural or near-natural feed of wild animals. Growing animals also need a higher intake, for construction of body tissues, than do mature animals. Hatchlings and juveniles iguanas do not have higher relative capacities of the digestive tract than mature iguanas, nor do they digest plant materials more effectively (Troyer, 1984). Food selection was studied in free living green iguana throughout a year in a semiarid environment. Food intake was determined by direct observations and converted into biomass intake. Comparison between intake and biomass availability of the various food items revealed that the lizards were selective, and that changes in seasonal food availability led to periodic switching of food plants (Lichtenbelt, 1993).

Lizard show wide variation in their dietary requirements. They eat almost anything organic but many species are highly specialized and feed on one or two type of prey (Mattison, 2004). The majority of herbivores reptiles are to be found among the largest number of the Iguanid family, they include Green iguana (*Iguana iguana*), Ground iguana (*Ctenosaura*), Galapagos land iguana (*Condylophus*), Marine iguana (*Amblyrhunchus*), Desert iguana (*Dipsosaurus*), Chuckwala (*Sarcomalus*) (Bellaris, 1969). Iguanids have a strong correlation between the size and diet, the smaller species such as spiny lizards (*Sceloporus*) and the Anolis species etc., are mostly insectivorous and the larger ones are mostly herbivorous, although they may also feed on insects when young. Iguanids are more adapted regarding their diet (Mattison, 2004). A whole range of vegetables and fruits can be given, chopped into bite-sized species. Foliage of edible trees; various garden weeds and flowers will also be appreciated (Coborn, 1987).The green iguana, Iguana iguana, is herbivorous throughout life, and depends on a microbial fermentation system in the hindgut to degrade plant fiber.

Most insectivorous species are either active foragers or sit-and-wait ambush predators; and when their prey species presents itself while they are resting or basking they feed invariably. Unlike insectivorous lizards the iguanas, being herbivores have much lesser foraging effort. Typically they invest only a few minutes for searching the food at their visiting sites (Example- flowering plants). Herbivorous lizards, generally being larger in size have comparatively lesser predators. Hence they need only a less speed and agility to escape from the predators. Many herbivorous lizards have characteristically blunt snouts, which adapt to grazing (Mattison, 2004).

The feeding behavior of the species differs from that of insectivorous lizards in the cropping action which separates a piece from the whole plant. The food is manipulated by fleshy tongue and by movements of the whole head. There is no mastication of food. The cropping action involves movement of both the upper jaw around the atlanto-occipital space joint and the lower jaw around the mandibular joint. The feeding apparatus has been modified to facilitate cropping. In Iguana the pleurodont dentition is multicusped and laterally compressed. Each tooth forms a shearing blade whose function does not require contact with other teeth (Throckmorton, 1976).

Potential constraints were the requirements for water, digestible crude protein, and metabolizable energy. During the dry period, when the iguanas had no access to drinking water they consume flowers to increase water intake, through the amount of flowers consumed was too low to cover maintenance requirements for either energy or protein. After the young leaf flush, following early rains in May, the biomass increased free surface water was available during showers, and the linear programming solutions indicate that food selection conformed to the protein maximization criterion (Lichtenbelt, 1993).

Materials and methods

Refer to Janani et al. (2020) for the details of the study animals and its maintenance regime at the Chennai Snake Park during the study period.

Result

Among the six iguanas, the adults were fed with 338.2 g of feed per day on an average. Comparatively less feed was given to the sub adults in the enclosure I and II each (107 g per day on an average). When compared to sub adults, the adults showed rapid feeding behavior soon after the introduction of feed inside the enclosure. The initial feed given to the adult iguanas weighed 440g greens, cucumber weighed 426g, carrot weighed 358g, radish weighed 344g, broccoli weighed 123g. The initial feed given to the sub adults was greens 165g, cucumber 170g, carrot 170g, radish 186g, broccoli 48g. The entire initial feed given to the iguana was consumed by them. The feed consumed by the sub adults were as follows- greens 15g> cucumber 14.9g> carrot 8.4g> radish 7.8g> broccoli 4.8g.

Since, during the period of observation the entire feed given was consumed by the adults there is no feed left over in enclosure III. The feed left over by the sub adults in enclosure I and II on an average was calculated to be radish 128g> carrot 108g> cucumber 60g> greens 58g> broccoli 12g. The adult takes approximately 5-7 hours to consume the entire feed given. But the sub adultstake more time to finish the feed. This behavior depended on the other activities they indulged like movement, thermoregulation. The iguanas here were observed to drink only a few ml of water per day. The excretion in iguanas depended on their feeding behavior. The adults seem to have excreted only twice during the course of observation. The sub adults excreted on an average of two times per day.

Table 1. Summary of introduced and consumed feed by adult and subadult captive iguanas

Adult iguanas				
vegetables	introduced feed (g)	consumed feed (g)	percentage utilized (%)	inference
carrot	71.6	71.6	100	highly preferred
cucumber	85.2	85.2	100	highly preferred
greens	88	88	100	highly preferred
radish	68.8	68.8	100	highly preferred
broccoli	41	41	100	highly preferred
Sub adult iguanas				
vegetables	introduced feed (g)	consumed feed (g)	percentage utilized (%)	inference
carrot	17	8.6	50.5	fairly preferred
cucumber	21.25	14.66	68.98	highly preferred
greens	16.5	14.84	89.93	highly preferred
radish	23.25	11.5	49.46	fairly preferred
broccoli	8	3.15	39.37	less preferred

Table 2. Enclosure-wise introduced and consumed feed in captive iguanas

Enclosure	Enclosure- 1			Enclosure- 2			Enclosure-3		
Feed items	before feeding	after feeding	feed consumed	before feeding	after feeding	feed consumed	before feeding	after feeding	feed consumed
carrot	18.8	12.6	6.2	15.2	9	11	71.6	0	71.6
cucumber	17.5	12	7.33	25	4	22	85.2	0	85.2
greens	19.6	7.2	20.67	13.4	5.5	9	88	0	88
radish	27	21	12	19.5	11	11	68.8	0	68.8
broccoli	9.33	3.67	5.67	6.6	1	6.3	41	0	41

Table 3. Relative abundance of consumed feed of the vegetables fed by both adult and subadult captive iguanas

Feed	Adults (g)	Sub adults (g)
greens	26	15
cucumber	25.1	14.9
carrot	21.1	8.4
radish	20.3	7.8
broccoli	7.2	4.8

Discussion

The act of feeding involves the use of their head, mouth, tongue, jaw, jaw muscles and teeth. They have movable jaws that enable them to pick up food and sometimes they might also use their forelimbs. This was studied by Bellaris (1969). The iguanas we observed used their jaws and tongue to feed but never used their limbs.

The correlation between size and diet was studied by Mattison (2004). From the observation we can infer that the adults consumed the entire feed given. They invariably feed on all the vegetables because the adults need to maintain their size. Food selection in Iguanas was studied by Lichtenbelt (1984). The sub-adults prefer greens more than any other vegetable given. They prefer carrots, cucumber and radish more or less equally. Broccoli, depending on the quantum given, had lower consumed percentage, on an average. The various types of feed preferred by Iguanas were discussed by Coborn (1987).

The sub-adults tend to feed on the greens primarily because of their soft nature and they are easily digestible. They go for the radish and broccoli only after feeding on the other vegetables because of their hard texture. The relative capacities of digestive tract in adults and sub-adults were studied by Troyer (1984). The colonic pattern was studied by Arora and Diwan (1995). The sub-adults possess developing teeth and hence they find the greens more comfortable to chew. Each tooth forms a shearing blade whose function does not require contact with other teeth. The dentition in Iguanas was studied by Throckmorton (1976).

During the dry period, when Iguanas have no access to drinking water, they consume flowers to increase water intake, though the amount of flowers consumed would be too low to cover maintenance requirements for either energy or protein. This was studied by Lichtenbelt (1993). From the observation, we can infer that, when the water in the pits dried up, they tend to lick the mud and rocks surrounding the pits indicating their need for more water. The adults sometime chew the leaves of the potted plant inside the enclosure.

From the study we conclude that the adults feed on all feeds equally but the sub adults they first prefer greens and feeds on other vegetables. They consume water mostly from the feed and they lick the mud, when there is no availability of water.

Acknowledgements

We thank the HOD, Zoology Dept., Ethiraj College for Women and the authorities of the Chennai Snake Park Trust for their valuable guidance and strong support in completing this internship.

References

Angus, B. 1969. *The Life of Reptiles Volume I.* Great Britain by Unmin Bros Limited working, 118-126.

Coborn, J. 1987. *Snakes and Lizards: Their care and breeding in captivity.* Tetera press, Morris plain, New jersey, 115-125.

Diwan, A.P., D.K. Arora. 1995. *Ecology of reptiles 1st edition.* Anmol Publications Private Limited, 30-31.

Gaylord S.T. 1976. Oral food processing in two herbivorous lizards, Iguana iguana (Iguanidae) and Uromastix aegyptius (Agamidae). *Journal of Morphology*, 148(3), 363-390.

Janani N, Kavitha M, Mubeena Fathima B, Punitha D, Shalini T.M. 2020. Movements and interaction patterns in captive green iguanas *(Iguana iguana)* in Chennai Snake Park. *Cobra*, 14:1-10.

Mattison, C. 1992. *The Care of Reptiles And Amphibians In Captivity*. Anmol publications. 58-59.

Mattison, C. 2004. *Lizards of the world*. Cassell Illustrated, a member of octopus publishing group, 53-54,125.

Pianka, E. & E.J. Vitt. 2003. *Lizards: Windows to the Evolution of Diversity*. Library of congress cataloging in publication data, 156.

Troyer, K. 1984. Diet selection and digestion in *Iguana iguana*: the importance of age and nutrients requirements. *Journal on Oecologia*, 61(2), 201-207.

Vitt L.J & P. J. Caldwell. 2009. *Herpetology 3rd edition*. Library of congress cataloging in publication.

Wouter D. & van Marken, L. 1993. Optimal foraging of a herbivorous lizard, the green iguana in a seasonal environment. *Journal on Oecologia* 95 (2), 246-256.

THERMOREGULATORY BEHAVIOR OF CAPTIVE GREEN IGUANAS (*IGUANA IGUANA*) IN CHENNAI SNAKE PARK

Akshaya S, Logeshwari J, Priyadarshini S, Shasuriya R, Sundaravalli K
Ethiraj College For Women
Egmore, Chennai-600008, Tamil Nadu, India

Introduction

Squamates are ectotherms obtaining their bodily heat from the external environment rather than generating it metabolically, in the manner of endotherms. Snakes and lizards regulate it i.e., body temperature behaviourally. When it is too hot they look for shade and cooler place (Gale, 2003). Thermal variation is of fundamental importance to forecasting the impacts of environmental change on lizard diversity (Chown, 2014). Biological functions are dependent on the temperature of the organisms. Thermal biology influences most physiological and ecological relationships (Seebacher, 2005). Temperature is known to affect whole-organisms performance capacities significantly in ectotherms (Lailvoux, 2007). The principal method by which reptiles regulate their body temperature is by moving into and out of sun and shade. Behavioural thermoregulation of this kind is developed in the highest degree in day-active lizards (Nielsen and Dawson, 1964). Physiology of reptiles is significant to the range of specific body temperature between closely related species even when they inhabit sites with different thermal condition (Alcaide et al., 2014).

Lizards thermoregulate by behavioural and physiological adjustments (Huey and Slatkin, 1976). At the individual level, the thermal properties of them in many case, may be the most important factor in determining the consequences of using a particular habitat (Smith and Ballinger, 2001). Temperature is regulated by the behaviour mechanisms such as selection of thermally appropriate microhabitats and posture environment have a major influence on performance, and adjustments (Vidal et al., 2010). Basking by ectothermic vertebrates is thought to have evolved for thermoregulation. Sun exposure is the benefit in the endogenous production of vitamin D, (Ferguson et al., 2003).

The term 'Poikilotherm' means, literally, 'variable temperature'. It does not necessarily imply that the body temperature is the same as that of the ambient medium, air or water. The term 'ectotherm' indicates that most of the body heat is derived from the environment, rather than from metabolic sources as in endothermal or homeothermic animals. Environmental temperature exhibits profound effects on the activity and ecology of ectotherms through its impact on muscle contractile physiology (Deban, 2013). Many reptiles pant in response toheat stress. Even in these animals, therefore, thermal and water relations are by no means independent. Cowles and Bogert (1944), Colbert, Cowles and Bogert (1946), Bogert (1949a; 1959), Bogert and Del campo (1956) and Dawson (1960a,b) were among the first to point out that the behaviour plays a major role in the thermoregulation of ectothermal animals.

Animals distribute in space for all their life processes. This distribution may be direct or indirect in response to predator presence, competitor or mate abundance, patchiness of a resource (Jain and Balakrishnan, 2010). A strategy of precise thermoregulation may require flexible use of the structural habitat to cope up with the thermal environment. Conversely, inflexible preference for particular structural microhabitat may restrict a species to a narrow range of thermal environments (Adolph, 1990). Evidence that morphological traits associated with particular environment are functionally adapted to those environments is a key component to determine the adaptive nature of radiation. This adaptation is measured by the performance of organisms in diverse habitat associated, with locomotion being the most ecologically relevant (Silva et al., 2014). This study aims at describing the thermoregulatory behavior of the American green iguanas (*Iguana iguana*) maintained in captivity in terrarium enclosures.

Materials and Methods

Refer to Janani et al. (2020) for the details of the study animals and its maintenance regime at the Chennai Snake Park during the study period. Observation of thermoregulation in Green Iguanas were made during summer time. When the temperature and humidity were sumamrised in Table 1.

Table 1. Temperature and Humidity in sun and shade during the study period

Time am/pm	Temperature Sun	(in 'C) Shade	Humidity Sun	(in %) Shade
9 – 10 am	36.2	35.2	52.2	52.4
10 – 11 am	38	35.9	52.3	50.5
11 – 12 am	38.3	36	51.8	52.8
12 – 1 pm	37	36.1	52.8	54.8
1 – 2 pm	38.5	37	48.8	52
2 – 3 pm	38.3	37.3	48.9	50.6
3 – 4 pm	36.8	35.4	51.9	53.6

Direct observations by naked eye were made for thirty five hours on each enclosures. No binoculars were used. The temperature ('C) and humidity (%) of the enclosures were noted using Thermo hygrometer at regular intervals. The thermoregulatory behaviours such as Basking, Partial basking, Resting on ground and Resting on tree trunk were noted and tabulated for all three enclosures. The activities were plotted against time in minutes. The observations were made at regular intervals as follows: 9 hrs – 11 hrs: Morning; 11 hrs – 13 hrs: Forenoon; 13 hrs – 14 hrs: Noon; 14 hrs – 16 hrs: Afternoon. The average frequency and duration of Thermoregulation was calculated and compiled.

Results

The Iguanas thermoregulate by shifting between sun light and shade matrix in its habitat to maintain relatively constant body temperature. Frequency and distribution of basking, partial basking, resting on tree trunk and resting on ground were noted with the mean values for males and females separately and have been tabulated respectively.

Climatic Settings: Overall temperature ranged between sun – 36.7 to 38.5'C shade – 35.53 to 37.0 and the average was 37.58'C in sun and 36.12'C in shade matrix. Overall humidity ranged between sun – 48.8 to 52.25% shade 52.0% to 53.2% and the average was sun – 51.24% shade – 52.38%.

Activities: The total sampling duration for the observation of thermoregulation per day was 420 minutes from 9:00 am to 4:00 pm. The mean value of thermoregulation in ***male*** was 225.39 minutes per day. Out of this duration, 71.07 minutes were spent on basking, 63.1 minutes were spent on partial basking, 114.28 minutes were spent by resting on tree trunk and 34.5 minutes were spent by resting on ground. Similarly, the mean value of thermoregulation in ***female*** was 217.19 minutes per day. Out of this duration, 59.38 minutes were spent on basking, 45.17 minutes were spent on partial basking, 60.8 minutes were spent by resting on tree trunk and 51.84 minutes were spent by resting on ground.

Thermoregulatory behaviour in juvenile male: The frequency of basking was found to be the highest (3.25) between 9a.m to 11 a.m. the highest basking duration was 23.4 minutes between 2 p.m to 4 p.m in the afternoon (table). The frequency of partial basking was found to be the highest (2.3) between 1 p.m to 2 p.m in the noon. The highest partial basking duration was 22.06 minutes in the morning between 9 a.m to 11 a.m. The highest frequency of resting on tree trunk was found to be 4.56 times between 9 a.m to 11 a.m in the morning. The highest duration of resting on tree trunk was 40.24 minutes in the noon between 1p.m to 2 p.m. The highest frequency of resting on ground was found to be 4.1 times between 9a.m to 11.a.m in the morning. The highest duration of resting on ground was 10.23 minutes in the afternoon between 2 p.m to 4 p.m.

Thermoregulatory behaviour in juvenile female: The frequency of basking was found to be the highest (2.93) between 9a.m to 11 a.m. The highest basking duration was 21.63 minutes between 2p.m to 4p.m in the afternoon (table). The frequency of partial basking was found to be the highest (3.36) between 1p.m to 2p.m in the noon. The highest partial basking duration was 15.39 minutes in the noon between 1p.m to 2 p.m. The highest frequency of resting on tree trunk was found to be 4.415 times between 1p.m to 2p.m in the noon. The highest duration of resting on tree trunk was 28.24 minutes in the afternoon between 2p.m to 4 p.m. The highest frequency of resting on ground was found to be 3.5 times between 9a.m to 11.a.m in the morning. The highest duration of resting on ground was 22.13 minutes in the morning between 9a.m to 11 a.m. The charts on Thermoregulatory behaviour of male shows that the maximum frequency of thermoregulation in male were in the morning between 9a.m to 11a.m (table) and the maximum duration of thermoregulation in males was between 1p.m to 2 p. m in the noon. The charts on thermoregulatory behaviour of female shows that the maximum frequency of thermoregulation in female were in the morning between 9a.m to 11a.m (table) and the maximum duration of thermoregulation in males was between 2p.m to 4 p. m in the afternoon.

The frequency of basking was found to be the highest (4.6) between 1p.m to 2 p.m. The highest basking duration was 30.5 minutes between 2 p.m to 4 p.m in the afternoon.(table). The frequency of partial basking was found to be the highest (2.3) between 9 a.m to 11a.m in the morning. The highest partial basking duration was 23.9 minutes in the morning between 9a.m to 11a.m. The highest frequency of resting on tree trunk was found to be 13.1 times between 9 a.m to 11a.m in the morning. The highest duration of resting on tree trunk was 61.8 minutes in the morning between 9 a.m to 11 a.m. The highest frequency of resting on ground was found to be 2.3 times between 2 p.m to 4 p.m in the afternoon. The highest duration of resting on ground was 18.0 minutes in the noon between 1 p.m to 2 p.m.

The frequency of basking was found to be the highest (3.8) between 11a.m to 1p.m in the forenoon. The highest basking duration was 14.8 minutes between 2p.m to 4 p.m in the afternoon (Table 1). The frequency of partial basking was found to be highest (4.6) between 11a.m to 1 p.m in the forenoon. The highest partial basking duration was 36.05 minutes in the noon between 1 p.m to 2 p.m. The frequency of resting on tree trunk was found to be highest 5.2 times between 1 p.m to 2 p.m in the noon. The highest duration of resting on tree trunk was found to be 22.17 minutes in the afternoon between 2 p.m to 4 p.m. The highest frequency of resting on ground was found to be 5.6 times between 9a.m to 11 a.m in the morning. The highest duration of resting on ground was 17.2 minutes in the forenoon between 11 a.m to 1 p.m. The charts on Thermoregulatory behaviour of adult male shows that the maximum frequency of thermoregulation in adult male were in the noon between 1 p.m to 2 p.m (table) and the maximum duration of thermoregulation in adult male was between 9 a.m to 11 a.m in the morning. The charts on Thermoregulatory behaviour of adult female shows that the maximum frequency of thermoregulation in adult female were in the morning between 9 a.m to 11 a.m (table) and the maximum duration of thermoregulation in adult female was in the noon between 1 p.m to 2 p.m.

Table 1. Thermoregulation in captive male and female iguanas

Males	Basking		Partial	basking	Resting	trunk	Resting	ground
Timing	Freq.	Dur.	Freq.	Dur.	Freq.	Dur.	Freq.	Dur.
Morning	3	10.87	2.3	23.92	13.1	61.87	2.2	17.91
Forenoon	3.8	23.12	1.9	16.51	4.5	9.18	2.1	5.55
Noon	4.6	28.39	2.2	21.08	1.6	24.75	1.6	18.04
Afternoon	2.3	30.51	1.5	9.48	2.3	26.47	2.3	16.63
Females	Basking		Partial	basking	Resting	trunk	Resting	ground
Timing	Freq.	Dur.	Freq.	Dur.	Freq.	Dur.	Freq.	Dur.
Morning	2	1.27	1.4	1.14	3.1	4.76	5.6	1.51
Forenoon	3.8	9.20	4.6	25.25	3.1	6.68	3.1	17.23
Noon	3	25.51	3.2	36.05	5.2	10.68	3.7	5.45
Afternoon	2.7	14.86	1.5	9.94	4.3	22.17	1.7	3.51

Discussion

In the present study thermoregulatory behaviour of adult green iguanas and juvenile green iguanas was the aspect observed. This species is widely distributed in the parts of America especially South America and has been kept in captivity in India.

Biological functions are dependent on the temperature of the organism. Animals may respond to fluctuation in the thermal environment by regulating their body temperature and by modifying physiological and biochemical rates. Phenotypic flexibility (reversible phenotypic plasticity, acclimation, or acclimatisation) in rate functions occurs in all major taxonomic groups and may be considered as an ancestral condition. Within the Reptilia, representatives from all major groups show phenotypic flexibility in response to long-term or chronic changes in the thermal environment (Seebacher, 2005).

Whole animal responses are comprised of variation in individual traits such as enzyme activities, hormone expression, and cardiovascular functions. The challenge now lies in connecting the changes in the components to the functioning of the whole animal and its fitness. Experimental designs in research on reptilian thermal physiology should incorporate the capacity for reversible phenotypic plasticity as a null-hypothesis, because the significance of differential body temperature–performance relationships (thermal reaction norms) between individuals, populations, or species cannot be assessed without testing that null-hypothesis (Seebacher, 2005).

Although *Iguana iguana* is one of the largest and probably the most widely known lizard in tropical America, very little detailed information concerning its ecology and physiology is available. Swanson (1950) was the one of the first to devote a paper exclusively to the natural history of this species. He did not, however, attempt to study its behavioral responses to various temperatures. The most thought-provoking comments concerning thermal behavior of the green iguana were made by Bogert (1959). Bogert speculated that be-cause most tropical temperatures" fluctuate in the narrow and comfortable range from 68 to 86 degrees year in and year out... it is doubtful that there has ever been sufficient stress from heat fluctuations.

Habitat can mean a number of things and its meaning can depend heavily the scale one is considering (Morris, 1987ab). This was proved with various study on different habitats like tree, shrubs and a soil to make a natural environment in captivity. The uses of different microhabitats were observed during the period. Different habitats can influence thermoregulatory behavior. For instance increase the body heat chameleons bask mostly in top of the tree and it displaced to the shade area to reduce the body heat. The basic habitat of this reptile is terrestrial. Many lizards indeed live on the soil, occasionally hiding bet small plants or rocks or under dead leaves (Bobrov, 1993).

The thermal dependence of biochemical reaction rates means that many animals regulate their body temperature so that fluctuations in body temperature are small compared to environmental temperature fluctuations. Thermoregulation is a complex process that involves sensing of the environment, and subsequent processing of the environmental information. We suggest that the physiological mechanisms that facilitate thermoregulation transcend phylogenetic boundaries. Reptiles are primarily used as model organisms for ecological and evolutionary research and, unlike in mammals, the physiological basis of many aspects in thermoregulation remains obscure. Here, we review recent research on regulation of body temperature, thermoreception, body temperature set-points, and cardiovascular control of heating and cooling in reptiles (Seebacher, 2005).

Data from both telemetry and estimation with the model showed that green iguanas maintained relatively constant body temperatures (minimum 32.9 ± 1.4°C; maximum 36.6 ± 2.9°C; mean ± 1 sd) during the midday period (0945–1545). Temperature measurements of taxidermic mounts and ambient air showed that body temperatures between 29°C and 40.5°C could readily be attained on Curaçao. Hence, the range of potential body temperatures was much greater than the range of actually achieved body temperatures (van marken, 1997).

Body temperature is often influenced by activity time (Paulissen, 1999) and the daily thermal cycle (Winne and Keck, 2004) to maximize prey ingestion, digestive efficiency, reproduction and growth (Ibarguengoytia, 2005). Though these aspects were not studied in the work, the prey ingestion (11 times) and the water intake (2 times) by the animal was observed. It was influenced by the body temperature by which the feeding activity was lesser in the increased temperature. In general, lizards are cool in the early morning time just after they emerge from their refuges and warm up at different temperature at which they will remain active for the rest of the day (Habit and 01996; Paulissen, 1999; Ibarguengoytia, 2005; Labra et al., 2008). With reference to these, American green iguanas both adult and juveniles bask mostly in the morning time. Noticeably this has been seen during the entire day sampling where the animals bask for a long time and continue its activity. So the activities were also based on the temperature of its body rates until they have reached the optimal body condition.

Acknowledgements

We thank the HOD, Zoology Dept., Ethiraj College for Women and the authorities of the Chennai Snake Park Trust for their valuable guidance and strong support in completing this internship.

References

Anon. Eating Invasive Iguanas. The Plate. Retrieved 2015-09-05.

Anon. *Iguana iguana* (Linnaeus, 1758). Integrated Taxonomic Information System. Retrieved 4 September 2008.

Bebler, John L., King & F. Wayne. 1979. *The Audubon Society Field Guide to Reptiles and Amphibians of North America*, New York: Alfred A. Knopf, pp. 511–512, ISBN 0-394-50824-6.

Breuil, M. 2000. *Taxon reports: I. delicatissima and I. Iguana,* West Indian Iguana Specialist Group Newsletter, IUCN, 3 (1): 4–5, retrieved 14 February 2012

Cogger, H & Zweifel, R. 1992. *Reptiles & Amphibians*, Sydney, Australia: Weldon Owen, p. 140, ISBN 0-8317-2786-1

Coles, W. 2002. *Green Iguana, U.S.V.I. Animal Fact Sheet #08,* Department of Planning and Natural Resources US Virgin Islands Division of Fish and Wildlife, archived from the original (PDF) on 2007-12-11

De Vosjoli, P, Susan D, Roger K & David B. 2003. *The Green Iguana Manual*, Advanced Vivarium Systems, ISBN 978-1-882770-67-0

Falcón, W, Ackerman, J.D., Recart, W & Curtis, D. 2012. March of the green iguana: Non-native distribution and predicted distribution of *Iguana iguana* (Squamata: Iguanidae) in the Greater Caribbean Region". IRCF Reptiles and Amphibians. 19 (3): 150–160.

Falcón, W, Ackerman, J.D., Recart, W & Daehler, C.C. 2013. Biology and Impacts of Pacific Island Invasive Species #10: *Iguana iguana*, the Green Iguana (Squamata: Iguanidae). *Pacific Science* 67 (2): 157–186.

Hollingsworth, B. D. 2004. *The Evolution of Iguanas an Overview and a Checklist of Species, Iguanas: Biology and Conservation*, University of California Press, pp. 40–41, ISBN 978-0-520-23854-1

Janani N, Kavitha M, Mubeena Fathima B, Punitha D, Shalini T.M. 2020. Movements and interaction patterns in captive green iguanas *(Iguana iguana)* in Chennai Snake Park. *Cobra*, 14:1-10.

Jeanette, V. 2015. Forestry Department. Alien Invasive Green Iguana; a Threat to Iyanola, St. Lucia's Iguana. Retrieved May 15, 2015. Protecting the St. Lucian Iguana - An endangered species! Retrieved May 15, 2015.

Krysko, K L, Enge, K M., Donlan, E M. & Seitz, J C. 2007. Distribution, Natural History, and Impacts of the Introduced Green Iguana in Florida, Iguana: Conservation, Natural History, and Husbandry of Reptiles. *International Reptile Conservation Foundation*, 14 (3): 142–151.

Lazell, J.D. 1973. The lizard genus Iguana in the Lesser Antilles. *Bulletin of the Museum of Comparative Zoology*, New York, 145, pp.

Mani, B. 2002. Wild Blue Iguanas plummeting towards extinction. (17 July 2002),

Rosenfeld, A. 1989. *Exotic Pets*, New York: Simon & Schuster, p. 105.

Samuelson, P. 1995. The Lizard King, *Reptiles Magazine*, 3 (2): 64–84.

Seidel, M & Franz, R. 1994. Amphibians and reptiles (exclusive of marine turtles) of the Cayman Islands, Nature Books.

Seebacher, F. 2005. A review of thermoregulation and physiological performance in reptiles: what is the role of phenotypic flexibility?. *Journal of Comparative Physiology B*, *175*(7), 453-461.

Stephen, C. 2006. Genetic Studies Update: Iguana. *Journal of the International Iguana Society*, 13 (2): 127

Swanson, P L. 1950. The iguana: *Iguana iguana iguana* (L). *Herpetologica*, 6: 187–193.

INITIAL POST-PARTURITIONAL FEEDING BEHAVIOUR OF CAPTIVE, HATCHLING GREEN IGUANAS (*IGUANA IGUANA*) IN CHENNAI SNAKE PARK

Sarkar Sukanya
Loyola College (Autonomous)
Nungambakkam, Chennai- 600034, Tamil Nadu, India

Introduction

Hatchlings of oviparous reptiles derive their nutrition from their absorbed egg yolk initially for few days. Later, the babies start to acquire the nutrition from the external feed. Especially there has to be a proper nourishment provided to the species when they are kept in captive conditions. Juvenile creatures during their growth stage need a higher intake of digestible protein enriched components, for proper construction of body tissues (Marilyn & Charles, 1976). Most reptiles are carnivores except a few specialised herbivores. Iguanas are a group of completely herbivorous lizards and studies on their feeding will fetch important information on reptile herbivory. Here again ontogenic diet shifts complicate the already murky picture of reptilian herbivory. In iguanas, juveniles do not have higher relative capacities of the digestive tract than the mature iguanas, nor do they digest plant materials more effectively (Susan, 1994). Comparison between the intake and biomass availability of various food items revealed that the green lizards were quite selective of the food and that changes in seasonal food availability led to periodic switching of food plants (Lichtenbelt, 1993).

The green iguanas are herbivorous throughout their life and depend on a microbial fermentation system in the hindgut to degrade plant fibres. Iguanas unlike many other insectivorous spp. have lesser foraging capacity and also like other herbivorous lizards, they have characteristically blunt snouts adapted for grazing (Mattison, 2004). The food is manipulated by a fleshy tongue and by the movements of the upper atlanto-occipital jaw and lower mandibular jaw. The dentition in iguanas are of pleurodont type and found to be multicusped and laterally compressed (Throckmorton, 1976). Potential constraints were the requirements for water, digestible crude proteins and metabolizable energy (Susan, 1994).

Juveniles are found to eat the leaves on which the droppings of the adults have fallen and thus acquiring interstitial endosymbionts that synthesize cellulases, aiding digestion of plants (Pianka & Vitt, 2003). Iguanas have a unique colonic pattern. There found an elongated wall from the small intestine heading to an expanded smooth, thin walled ante chamber. A part of this chamber is partitioned off to form a caecum, following it the colon guarded by conspicuous valves. This region has five consecutive pockets like invaginations. The folds start immediately behind the valves and get reduced in size posteriorly. The rest of the colon is free of folds. The few irregular folds are present can be loitered when the wall is distended (Arora & Diwan, 1995). Food selection in iguanas were studied by Lichtenbelt (1984). The various types of food preferences by the iguanas were discussed by Coborn (1987).

Among the iguanids, there is a strong correlation between size and diet. Whereas, the smaller species, Sceloporus and the Anolis spp. etc. are mostly insectivorous, the larger ones such as common iguanas (*Iguana iguana*), the chuckwallas, *Rhinocerosobsus*, the Fiji iguanas, *Brachylophus* and the Rhinoceros iguanas, *Cydura* spp. are herbivores, although they may also intake some insects when they are young. Some iguanids are extreme specialists for instance; lizards of the genus *Dracaena*, the caiman lizards feed only on molluscs (Mattison, 2004). In captive conditions the iguanids are found more habituated to their diet. In most captive facilities, iguanas were fed chopped vegetables and greens. Juveniles unlike the adults are not given fruits in their diet as these feeds contain higher amount of sugars and carbohydrates which the hatchlings cannot digest. Therefore, they can be provided with edible tree foliages; various garden weeds and also flowers would be appreciated (Coborn, 1987). The aim of the present project is to study the feeding behaviour of captive hatchling green iguanas (*Iguana iguana)* during their very first phase of feeding soon after parturition.

Materials and Methods

For details about the study animal, see Janani et al. (2020). There were 10 juvenile iguanas kept in an enclosure of height 150cm; length 78cm and breadth of 72cm. The study was conducted for 15 days from 30th May to 15th June in Chennai Snake Park. The 10 of the hatchling iguanas were 10 days old and were housed in a quarantine enclosure away from public exhibit. The feeding behaviour of the hatchlings were noted every alternative day when the feed was given. The temperature and humidity of the enclosure were noted using a digital thermohydrometer. The feeds were categorised as different types of vegetables so as to note down their feed preferences. Vegetables were weighed separately after putting them in a carry bag and weighed using a spring balance (LC 10g; Max. 100g). The initial mass and the remaining mass of the feed were weighed and noted down accordingly. The mass of the remaining feed was subtracted from that of the initial feed to calculate the mass of the consumed feed. Remaining mass was calculated after the feed remained inside the enclosure for half a day. Number of iguana hatchlings that readily approached the vegetables to feed were noted down as a proxy for their feeding cues during transition stage from egg-yolk nutrition. During the study period (June), the temperature and humidity readings were noted to be beyond the favourable conditions for this neotropical species. They were brought back to normalcy by spraying adequate water into the enclosure using a water spray jar. The water for drinking and bathing were changed regularly during their feeding time.

Results

The length of the baby iguanas ranged from 31-35 cm and weight from 30-40 g. It was seen that, of all ten hatchlings, the value of weight fluctuated more as compared to their lengths. This suggested the individual of the least weight feed comparatively less and on the other hand, the individual of the maximum weight feed the most.

An amount of 140-160 g of feed were given on regular basis to the hatchlings. It was observed that types of chopped vegetables were cabbages of 40-50g; cucumbers 40-50g; carrots of 35-40g; pumpkins of 35-40g and the green spinach of 20-30g. It was also noticed that there was an increase each day in the number of juveniles that came down and readily consumed the feed as soon as they were given. The activity of snatching the feed from each other's mouth were also observed at times especially, with regard to pumpkins and carrots which were mostly preferred more as compared to other vegetables given to them.

More interestingly, the juveniles were mostly found to lick the water droplets fallen on branches and leaves whenever water was sprayed, rather than showing interest to use the water provided inside the enclosure. The best temperature and humidity preferences for the hatchlings were noted to be < 35'C and above 70 % respectively.

There was an increase in the no. of hatchlings which readily started to feed along with the amount of feed consumed and percent of food utilization between the first and last days of observation spanning two weeks. From these preliminary observations, it appeared that the temperature and humidity had an impact on the amount of feed taken by the juveniles. It was noted that during the dry days, the amount of feed taken by them were very low when compared to the days with more humidity. The hatchlings were found to take more time in finishing the entire feed, that is, they generally took 10-12 hrs of time. The excretion of the juveniles depended much on their amount of food intake each day and they were observed to excrete once or sometimes even not during the course of observation.

Table 1. Measurements of length & weight of captive hatchling green iguanas

S.No.	Length (cm)	Weight (g)	S.No.	Length (cm)	Weight (g)
1.	31	35	6.	33	34
2.	35	37	7.	34	40
3.	31	37	8.	33	33
4.	33	36	9.	33	38
5.	35	35	10.	32	30

Table 2. Amount of food consumption and percentage utilization by the hatchling green iguanas during the initial and later days of feeding trials

Date	No. of feeding hatchlings	Total consumed mass	% utilization
3.6.19	2	23	17.38
5.6.19	3	108	27
7.6.19	5	50	49.16
9.6.19	8	118.2	72.8
11.6.19	8	155	92.85
13.6.19	9	138	87.5

Discussions

Pianka and Vitt (2003) have reported the length and weight of the hatchling iguanas to be 31-35 cm and 37-40g respectively. During the study, these hatchlings matched with the reported lengths but deviated in mass. Six hatchlings weighed 30-36g, below the least reported mass (37g). This could possibly be due to the first-time output of their young parental lizard.

As hypothesied originally, there was a marked increase in the readiness to feed (20%-90%) and the food consumption (17%-92%) from the first to last days of observations, spanning two weeks. There is a dip in these values from the second and third days of observations. Further studies are necessary to confirm / explain such anomalies.

The hatchlings which were observed by me, were noted to use their head to take the food mostly and they were even noticed to fight over the feed and snatch the feed from each other's mouth especially with regard to pumpkins; carrots; spinach and also the cucumbers which were occasionally been given to them and thus, these feeds were noted to be on highly preferred feeds of the juvenile iguanas. There found a strong correlation of their size and diet which was studied by Mattison (2004).

Table 3. Initial, remaining and consumed mass (in grams) of different vegetables fed to captive hatchling iguanas

Date	Time	Vegetables	Initial Mass(g)	Remaining Mass(g)	Consumed Mass(g)
3.6.19	10:30	Cabbages	32	28	4
		Pumpkins	52	47	5
		Spinaches	18	12	6
		Carrots	50	42	8
5.6.19	01:30	Spinaches	30	16	14
		Pumpkins	40	7	33
		Carrots	35	14	21
		Cucumbers	40	0	40
7.6.19	02:30	Pumpkins	30	18	12
		Carrots	30	15	15
		Spinaches	40	17	23
9.6.19	11:00	Carrots	35	26	9
		Spinaches	40	3	37
		Cucumbers	44	11	33
		Cabbages	40	0.8	39.2
11.6.19	10:00	Spinaches	45	0	45
		Carrots	35	10	25
		Pumpkins	35	0	35
		Cucumbers	50	0	50
13.6.19	11:00	Spinaches	40	0	40
		Carrots	40	12	28
		Pumpkins	30	0	30
		Cucumbers	50	10	40
15.6.19	11:00	Spinaches	27	25	2
		Cabbages	25	20	5
		Raddishes	37	30	7
		Carrots	34	33	1
		Pumpkins	34	19	15

Table 4. Temperature, humidity and number of lizards readily approaching the feed and percentage utilization of various vegetables across the many days of observations

Vegetables	Temp.	Humidity	No. Lizards	% Utilization	Inference
Cabbages	33.1	78	2	12.5	Highly preferred
Pumpkins				7.69	Highly preferred
Spinaches				33.33	Fairly preferred
Carrots				16	Highly preferred
Spinaches	34.1	72	3	46.66	Fairly preferred
Pumpkins				82.5	Highly preferred
Carrots				60	Highly preferred
Cucumbers				100	Highly preferred
Pumpkins	35.7	70	5	40	Fairly preferred
Carrots				50	Highly preferred
Spinaches				57.5	Highly preferred
Carrots	32.4	81	8	25.71	Least preferred
Spinaches				92.5	Highly preferred
Cucumbers				75	Highly preferred
Cabbages				98	Highly preferred
Spinaches	31.2	72	8	100	Highly preferred
Carrots				71.4	Highly preferred
Pumpkins				100	Highly preferred
Cucumbers				100	Highly preferred
Spinaches	35.4	52	9	100	Highly preferred
Carrots				70	Highly preferred
Pumpkins				100	Highly preferred
Cucumbers				80	Highly preferred
Spinaches	33.4	67	9	7.4	Fairly preferred
Cabbages				20	Fairly preferred
Raddishes				18.92	Highly preferred
Carrots				2.94	Least preferred
Pumpkins				44.12	Highly preferred

The juveniles were invariably noticed to feed on all the vegetables as it would maintain their body growth and weight. From my preliminary observation, it appears that, there is a decrease in feeding activity whenever the temperature raised > 35'C and humidity fell < 70 % and vice-versa.

Food selection in iguanas was studied by Lichtenbelt (1984). The various types of food preferences by the iguanas were discussed by Coborn (1987). From my observations, it was also noted that the hatchlings preferred to lick the water droplets which was sprayed to bring down the enclosure temperature, instead of using the water trough. It is hoped that these preliminary observations on captive juvenile iguanas will pave way for much larger studies in future, so as to better address its ethology and natural history.

Acknowledgement

I thank the HoD and the faculty of Advanced Zoology & Biotechnology Loyola College for their support. At the Chennai Snake Park I gratefully thank Executive Chairman, Director of Research & Training, Director and the Deputy Director for their valuable guidance and support in completing this project.

References

Coborn, J. 1987. *Snakes and Lizards: Their Care and Breeding in Captivity.* Terata press, Morris plain, New Jersey, 115-125.

Diwan, A.P. & D.K. Arora. 1995. *Ecology of Reptiles.* Anmol publications Private Limited, 30-31.

Janani N, Kavitha M, Mubeena Fathima B, Punitha D, Shalini T.M. 2020. Movements and interaction patterns in captive green iguanas *(Iguana iguana)* in Chennai Snake Park. *Cobra,* 14:1-10.

Marilyn A. & Charles C. 1994. *Nutritioal Osteodystrophy in Captive Green Iguanas.* Ohio state university, Colombus. 1-18 pp.

Mattison, C. 1992. *The Care of Reptiles and Amphibians in Captivity.* Anmol publications. 58-59.

Mattison, C. 2004. *Lizards of the World.* Cassell illustrated, a member of octopus publishing group, 53-54.

Pianka, E. & E.J Vitt. 2003. *Lizards: Windows to the Evolution of Diversity.* Library of Congress cataloguing in publication data, 156.

Susan, D. 1994. Growth of Juvenile Green Iguanas. Nutrition support service, *Pembroke*, 1-4.

Troyer, K. 1984. Diet Selection and Digestion in *Iguana iguana*: the importance of age and nutrients requirements. *Journal on Oecologia*, 61(2), 201-207.

Registered with the Registrar Office of Newspapers for India
(Ministry of Information and Broadcasting)
Registration No. TNENG/2007/19859
(*vide* letter dated 28.05.2007 of the Registrar of Newspapers for India)

Cobra, the bi-annual journal of the Chennai Snake Park Trust, invites articles and notes on reptiles and amphibians, their ecology, biology, natural history, conservation or other aspects. These may be of scientific or popular interest. Black and white photographs are also welcome.

Authors are advised to consult a recent issue of Cobra to check for stylistic requirements of the journal and then submit their manuscripts through e-mail to cspt1972@gmail.com

Annual subscription for 2 issues of ***COBRA*** commencing from the date of subscription including postage.

Individual – Rs. 75/-
Institution – Rs. 150/-

by MO/DD in favour of
"Chennai Snake Park Trust"
Payable at Chennai.

Chennai Snake Park Trust
Rajbhavan Post, Chennai – 600 022. India.
Phone: 91-044-22353623
E-mail: cspt1972@gmail.com
Website: chennaisnakepark.org

Printer	:	**N. Arunachalam**, Students Offset Services Shop No. 3, Apex Chambers, 20, Thiagaraya Road, Pondy Bazar, Chennai - 600 017.
Publisher	:	**R. Rajarathinam** on behalf of Chennai Snake Park Trust. Published by Chennai Snake Park Trust, Rajbhavan Post, Chennai - 600 022
Editor	:	**Dr. M. Arumugam**