



## Scavenging Behavior of the Bengal Monitor (*Varanus bengalensis*) in Jahangirnagar University Campus, Bangladesh

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### Authors' contributions

This research work was carried out in collaboration among all authors. Author KMMR designed the final research study, fieldwork, data processing, taken care of formatting and provided final change to this manuscript. Author MMHK and IIR helped to make the experimental design and interpretation of data. All authors read and approved the final manuscript.

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### ABSTRACT

The scavenging behavior of the Bengal Monitor (*Varanus bengalensis*) was studied at Jahangirnagar University campus, Bangladesh, from February 2010 to July 2010 by following focal sampling method. The behavioral patterns that were observed are scavenging, moving, resting, conflicting, and others (escaping, hiding etc.). The Bengal Monitor spent most of the time in scavenging (43.23%) during their active periods while least time (5.28%) was spent in others (escaping, hiding etc.) behavior. It spent 14.7% in moving, 21.3% resting and 15.5% conflict. During scavenging, the Bengal Monitor mainly fed on chicken feathers, eggshells, fish remains and the waste of vegetable matter. The highest scavenging activity was recorded in April (53.8%) and lowest (27.4%) in February. The scavenging behavior of this species varied in different months and seasons probably due to changing temperature and rainfall.

Keywords: Bengal monitor; scavenging; behavior.

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## 1. INTRODUCTION

Bengal Monitor (*Varanus bengalensis*) (Daudin, 1802) [1,2] or Common Indian Monitor, is a monitor lizard found widely distributed over South Asia [3,4,5,6,7,8]. This large lizard is mainly terrestrial [9] and grows to about 175 cm from the tip of the snout to the end of the tail [10]. Young monitors may be more *arboreal* [11] but adults mainly hunt on the ground preying mainly on arthropods but also taking small terrestrial vertebrates, ground birds, eggs and fish [12,13,14]. It is basically omnivorous [12,15] and often engaged in scavenging, hence playing a key role in cleaning the environment.

A scavenger is an organism that feeds on dead, decaying matter [16]. Scavenging, or necrophagy, is a carnivorous feeding behavior in which a predator consumes corpses or carrion that were not killed to be eaten by the predator or others of its species [17,18]. Scavenging behavior of the Bengal Monitor depends upon the habitat where dead and decaying food materials are available. Because of the availability of roadside restaurant and unplanned waste management system in Jahangirnagar University campus, the area has become a perfect place for scavengers like the Bengal Monitor. Therefore, this area was selected to evaluate the scavenging behavior of the Bengal Monitor, which is strongly linked with the local environmental condition and maintenance of the ecosystem.

### 1.1 Study Area

Jahangirnagar University is an area of outstanding scenic beauty and diverse aggregation of fauna and flora. The floral and faunal diversity of this campus is much higher than any other university campus of Bangladesh. The campus is situated two km north of Savar Upazilla centre in the district of Dhaka about 30 km north-west of Dhaka city. Geographically the campus is located from Latitude: 24°22'14''N to 23°46'31''N, Longitude: 90°11'22''E to 90°21'41''E and Altitude more or less 10.041m. The area is in the southern end of the Madhupur tract, which is known to have risen during Pleistocene period. For this reason, the area has a natural tendency for the growth of vegetation (trees, shrubs and herbs) and animal diversity in all direction. Location of Jahangirnagar University campus is shown in the (Fig. 1) (Kamal, S. 2007).

As an area, JU campus always regarded as a very good habitat for faunal diversity including Bengal Monitor. The students of this campus have a very good reputation for the conservation and management of Biodiversity. The university is fully residential and the campus remain open all over the year. Because of the availability of roadside restaurant and ecofriendly behavior of the students the study species Bengal Monitor, never fear to come garbage site for scavenging purposes. Except winter, they remain active throughout the year [19] and the diet (fresh and rotten) for scavenging also remain good in quantity.

## 2. MATERIALS AND METHODS

The scavenging behavior and others related behavior associated with the scavenging of the Bengal Monitor was recorded by focal sampling method in which data was recorded continuously during a certain period of time. Focal sampling means observing one individual for a specified amount of time and recording all instances of its behavior. Ideally, the choice of focal individuals is determined prior to the observation session. The availability of study species and scavenging sites, in the study area of Jahangirnagar University campus had allowed me to focus on specific scavenging behavioral patterns of the Bengal Monitor. The observation was done on a daily basis for six months (February to July 2010), mainly in mornings and evenings when the Bengal Monitor was relatively more active and more easily seen. The start of the scavenging activity was taken as the time when an animal came to any of the scavenging sites (garbage) for feeding (especially dead and decaying matter) and end of the activity was recorded when the animal left its scavenging site after completing the feeding. A total of 12 hours 23 minutes that means 44580 seconds had spent in the field to observe the scavenging and associated behavior of Bengal Monitor. The amount of time spent in scavenging behavioral patterns and other associated behavior during scavenging was calculated by summing the amount of time in each behavioral purpose, for each hour, each day and each month.

The activities associated with scavenging patterns displayed by the Bengal Monitor were recorded in five different categories, viz., scavenging, foraging, resting/basking, conflicting, and escaping, which are defined below -

1. **Scavenging:** A special type of feeding behavior showed by an animal in which the animal feeds on dead and decaying matter.
2. **Foraging:** When an individual visits different potential food sources in search of food.
3. **Resting/basking:** When an individual becomes inactive and does not move much. Basking, on the other hand, is basically sun-bathing (especially during the cold season) to heat-up the body, which is often done during the resting.
4. **Conflicting:** When an individual competes or engage in clash with another individuals of the same or different species for food, mate or territory.
5. **Others:** When an individual shows different types of minor behavior that are

not defined above, such as escaping, hiding etc.

The proportion of time spent in different activities or behavior was calculated by the following equation:

$$T_f = (nf \times 100) \div N \text{ (Gupta and Kumar, 1994; Feeroz, 1999)}$$

Where,

- T<sub>f</sub> = Time spent on a particular behavior as percentage (%) of total active period;
- nf = Amount of time spent for showing a particular behavior;
- N = Total amount of time spent for all behavior.

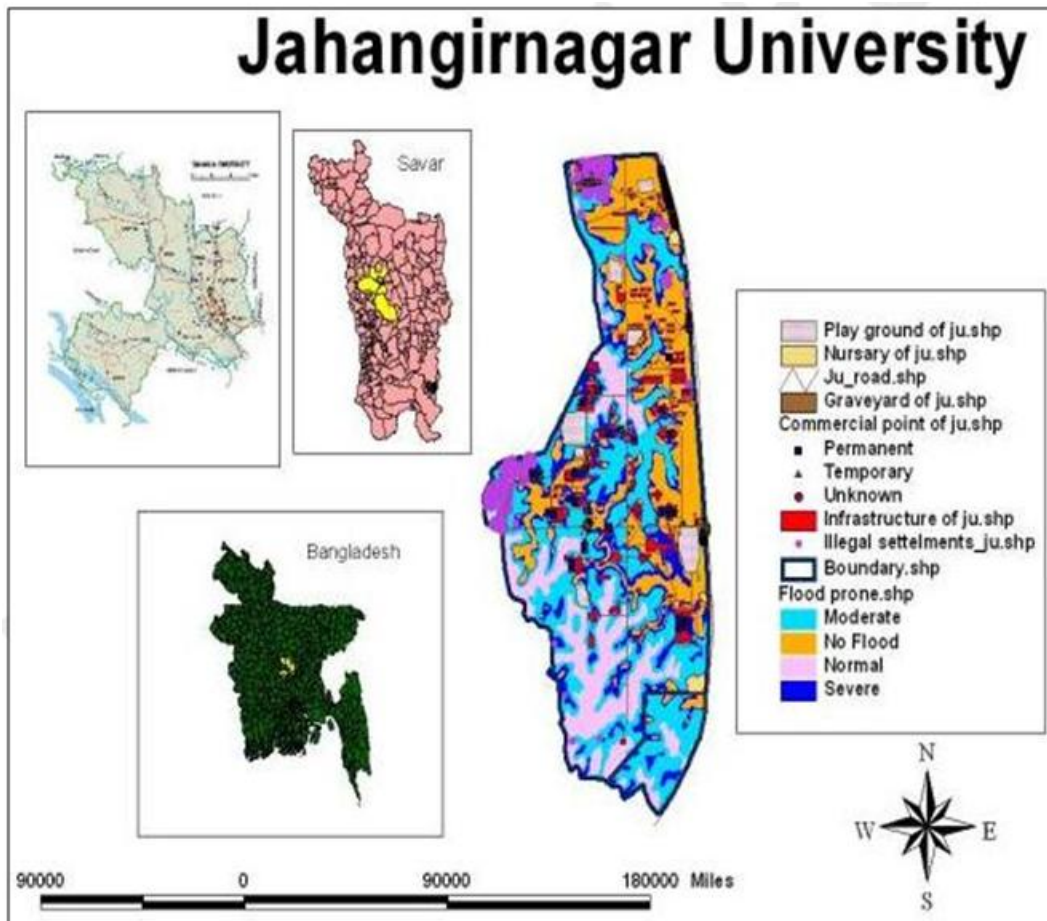


Fig. 1. Location map of Jahangirnagar University campus

### 3. RESULTS AND DISCUSSION

#### 3.1 Diet of Bengal Monitor

Diet of Bengal monitor includes different types of food items that can be fresh or decomposing. A total of ten different food groups were identified during field observation of which three were insects, one crustacean, and also vertebrates and fruits (Table 1). It normally hunts in bushy areas and along the edge of water bodies, but scavenges in homesteads and roadsides where the kitchen litters are disposed. It moved along the selected areas of feeding in search of food. Sometimes it digs the soil with the help of forelimbs and jaws to capture the prey. Prey is engulfed from head to tail in most cases, after killing by frequent jerking.

#### 3.2 Scavenging Behavioral Patterns

The proportion of time spent in different activity categories is one of the important aspects of ecology of the Bengal Monitor. It had spent considerable amount of time in different activities including scavenging. Scavenging, or necrophagy, is a carnivorous feeding in which a predator consumes corpses or carrion that were not killed to be eaten by the predator or others of its species. Scavengers play an important role in the ecosystem by contributing to the decomposition of dead animal remains. Decomposers complete this process, by consuming the remains left by scavengers.

The total amount of time spent by Bengal Monitor for feeding of dead, decaying and waste materials from garbage sites are considered as scavenging behavior of that species in the present study.

For study, the scavenging behavioral patterns and other associated behavior showed during scavenging by Bengal Monitor in the study area, data were collected between February 2010 and July 2010. A total of 12 hours 23 minutes that means 44580 seconds observations were recorded from six months study period.

#### 3.3 Activity Period

This is the entire time period showed by the Bengal Monitor for scavenging. The start of the scavenging activity period was taken as the time when Bengal Monitor come to the scavenging sites (Garbage) for feeding purposes (feed specially dead and decaying materials) and end

of the activity period was recorded when the individual animal left their scavenging sites after completed the feeding. The scavenging behavior of Bengal Monitor not limited within only scavenging activity but also the combined action of some other behavioral activities i.e. moving, resting/basking, conflicting, and others (escaping, hiding etc.). During the study period, Bengal Monitor started its scavenging activities at some times after dawn and continues it up to the evening, but more frequently from 6.30 am to 10.30 am and from 3.00 pm to 4.30 pm. The entire behavioral patterns had varied with the seasonal variation. Environmental condition such as heavy rain, dense fog, too hot or too cold etc. also affect the behavior importantly. Since the study species is a cold blooded animals for that their activity patterns during winter were somewhat remain absent. However, sometimes they came outside for basking at the time of bright sunshine.

#### 3.4 Time Budget

The Bengal Monitor spent the highest (43%) proportion of time in scavenging. During showing the scavenging behavior, the other types of behavior that are related to scavenging also showed by the Bengal Monitor. The associated behavior that was seen during scavenging activity includes moving, resting, conflicting and others (escaping, hiding etc). Among the associated behavior during the scavenging, the Bengal Monitor spent the highest (21%) proportion of time in resting and it had spent 16% and 15% time in conflicting and moving respectively. During scavenging, it had spent less proportion of time (5%) in others behavioral activity (Fig. 2, Table 2).

#### 3.5 Monthly Scavenging and Other Behavioral Patterns

The monthly scavenging behavior and other associated activities varied across the different months. During the study period, Bengal Monitor had spent most of its time in scavenging (43.2%) at garbage sites. The highest scavenging was recorded in April (53.8%) and the lowest in February (27.4%). The highest time spent in moving was recorded in June (19%) and lowest in July (12%). For resting, the Bengal Monitor spent highest time in February (40.6%) and lowest in April (8.3%). The conflicting was the highest in both April and July (20% in each month) and lowest in March (9.4%). The others type of behavior (escaping, hiding etc.) was the

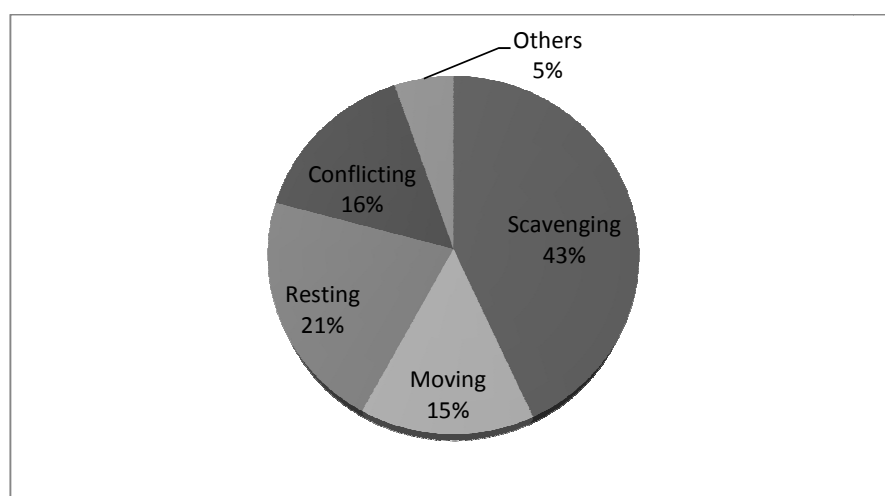
highest in June (10.2%) and the lowest in May (2.3%). A complete view of time spent in different activities in different month is shown in the (Fig. 3).

**Table 1. Major diet (fresh and rotten) of the Bengal Monitor**

Sl. no.	Prey group	Food types	Part eaten	Frequency	Proportion (%)
1.	Gryllidae (crickets)	Insect	Whole body parts	8	11
2.	Acrididae (grasshoppers)	Insect	Whole body parts	7	10
3.	Mole crickets	Insect	Whole body parts	5	7
4.	Freshwater crabs	Crustaceans	Whole body parts	1	1
5.	Fish	Vertebrates	Unused parts of fish	18	26
6.	Aves	Vertebrates	Eggs	2	3
7.	Chicken	Vertebrates	Chicken meat, bone and egg shells	16	23
8.	Mammalia (house mouse)	Vertebrates	Whole body parts	2	3
9.	Vegetables	Vegetables	Waste vegetable matters	6	9
10.	Fruit	Fruits	Waste part	5	7

**Table 2. Frequencies of different activities of the Bengal Monitor**

Month	Net scavenging	Moving	Resting	Conflicting	Others	Total
February	1860	891	2755	794	480	6780
March	3642	1170	1590	690	288	7380
April	3870	990	600	1440	300	7200
May	3300	1110	1680	1530	180	7800
June	3060	1440	1440	900	780	7620
July	3540	930	1440	1560	330	7800
Total	19272	6531	9505	6914	2358	44580
%	43.2	14.7	21.3	15.5	5.3	



**Fig. 2. Proportion of time spent in different activities by the Bengal Monitor**

### 3.6 Time Spent in Net Scavenging

Overall, the Bengal Monitor spent most of time (43.2%) in net scavenging at the selected scavenging sites during the six-month study periods from February 2010 to July 2010. The scavenging behavior is varied from month to

month depends on changed environmental or climatic condition. The Bengal Monitor spent the highest amount of time (53.8%) in scavenging in the month of April and the lowest (27.4%) in February. The overall scavenging behavior showed by the Bengal Monitor in different month represented in the (Fig. 4, Table 3).

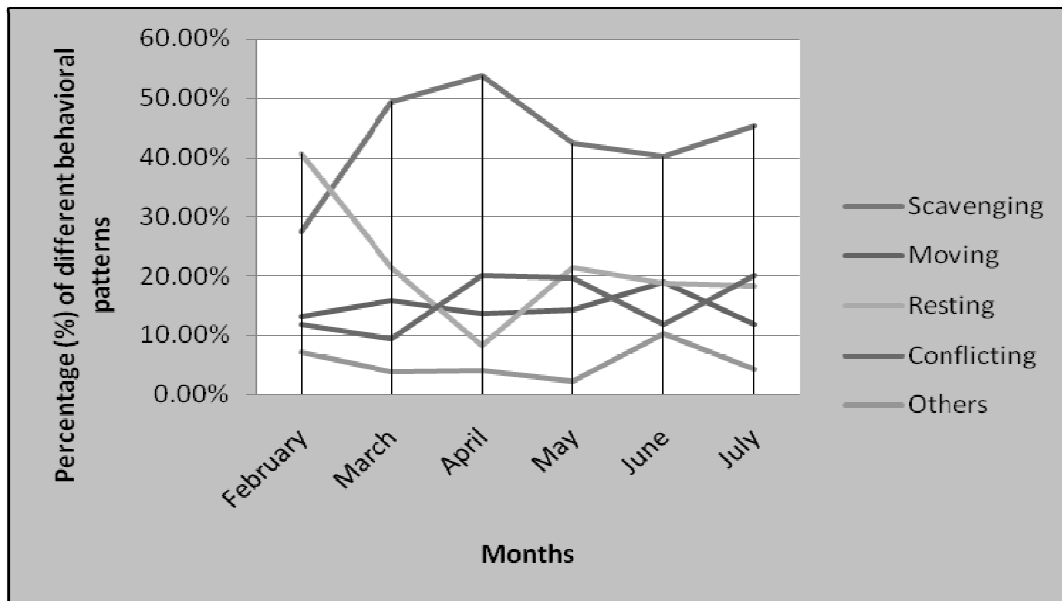


Fig. 3. Variation of activity patterns of the Bengal Monitor across different months

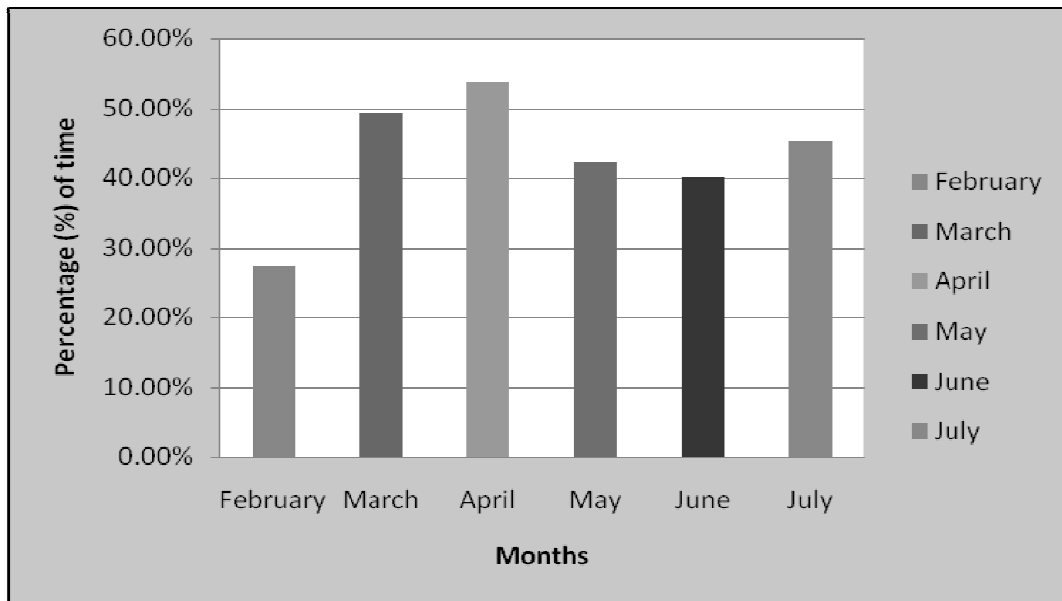


Fig. 4. Monthly variations in scavenging behavior of the Bengal Monitor

### 3.7 Associated Behavior Related to Scavenging

During the study period in the scavenging sites, the Bengal Monitor showed not only the scavenging behavior but also some behavioral activities that were often associated with the scavenging. These were categorized as moving (ordinary), resting, conflicting, and others.

#### 3.7.1 Moving

Movement or moving is the activity that covered significant amount of time during scavenging behavioral patterns. Bengal Monitor spent an important (14.7%) proportion of active time in moving. Maximum moving activity were recorded in June (19%) and the lowest was in July (12%). Moving activity in different month varied importantly. The monthly variations in overall

moving activity is shown in the (Fig. 5). The movement of Bengal Monitor also affected by the seasonal temperature variation and availability of food found in the scavenging sites.

#### 3.7.2 Resting

The Bengal Monitor when spent their time by remain inactive or standing motionlessly as recognized resting. Basking is type of behavior related to resting showed by Monitor lizard during heavy cold or winter to protect itself from cold weather.

During study period, the Bengal Monitor spent variable amount of time in resting. In this study, the resting is another type of behavior or activity that has close relationship with the scavenging behavior.

Table 3. Monthly variations in scavenging behavioral patterns

Month	Net scavenging		Moving		Resting		Conflicting		Others	
	Obs	%	Obs	%	Obs	%	Obs	%	Obs	%
February	1860	27.4	891	13.2	2755	40.6	794	11.7	480	7.8
March	3642	49.3	1170	16	1590	21.5	690	9.6	288	3.9
April	3870	53.7	990	13.8	600	8.3	1440	20.0	300	4.2
May	3300	42.3	1110	14.2	1680	21.5	1530	19.6	180	2.0
June	3060	40.2	1440	19	1440	19	900	11.8	780	10.2
July	3540	45.4	930	12	1440	18.5	1560	20.0	330	4.2

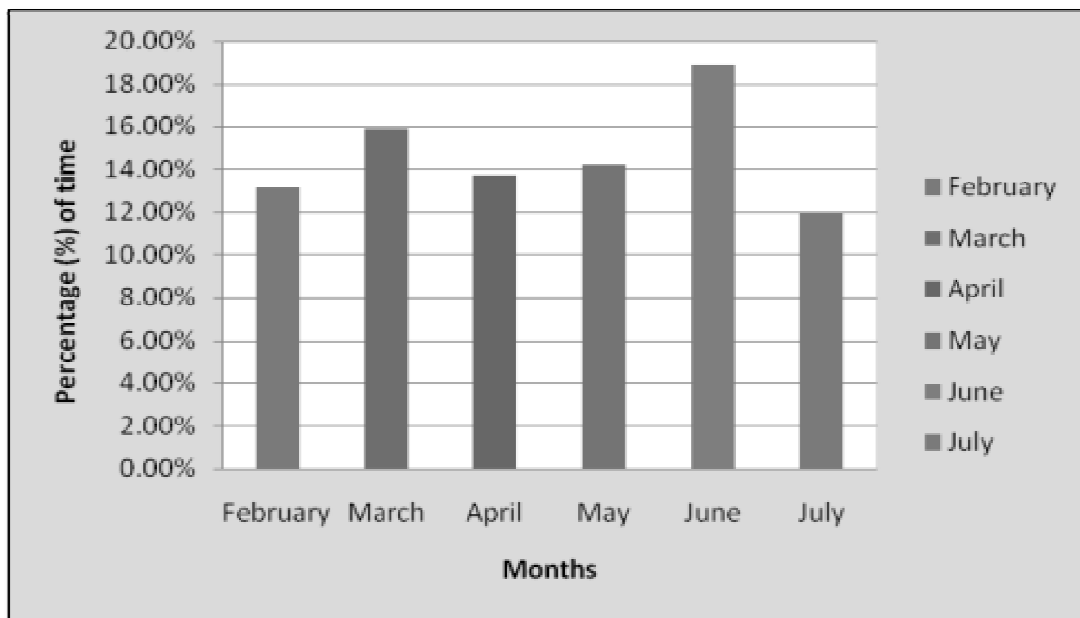


Fig. 5. Monthly variations in moving activity

Bengal Monitor spent an average of 21.3% time in resting during the entire study period. Resting period of Bengal Monitors also varied in different month and season. The highest (40.6%) proportion of time spent in resting in February and the lowest (8.3%) in April (Fig. 6).

### **3.7.3 Conflicting**

When an animal compete or clash with another individuals of same or different species for different purposes like feeding, mating, managing habitat etc. is generally known as conflicting behavior.

During scavenging, the Bengal Monitor shows this type of behavioral activity more significantly than other type of behavioral activity. In this study, conflicting generally occurs with the scavengers like crow, dog, Asian pied starling etc. The conflicting activity showed by the Bengal Monitor at the scavenging sites only for dead decaying food materials for that reasons it is considered as an associated scavenging behavior.

In this study, the Bengal Monitor spent moderate (15.5%) proportion of time in conflicting. The highest proportion was in both April and July (20%), and the lowest in March (9.4%) (Fig. 7).

### **3.7.4 Other behaviors**

During the study period, the Bengal Monitor spent little bit of time by showing other types of behavior which includes escaping, hiding etc besides the scavenging, moving, resting and conflicting behavior.

Least (5.3%) proportion of time was spent in others (escaping, hiding, etc.) category of behavior. Activities under others category varied across the different months. The highest proportion was in June (10.24%) and the lowers in May (2.30%) (Fig. 8).

Bengal Monitors are almost carnivorous and they consume almost anything that is smaller than themselves and that they can easily overpower [20]. They are known to scavenge carcasses of previously felled animals. Their documented observed prey species list is considerable, containing roughly 200 species [21]. Common prey include annelids, insects, amphibians, smaller reptiles, birds, small mammals, and eggs. Cannibalism of eggs, hatchlings, and even adults has been noted, although predation on

adults is rare [22,23]. As with most varanids, they swallow prey whole but are also capable of ripping and tearing flesh from larger animals and carcasses [21,24]. My study site was limited to garbage side of the roadside restaurant of JU campus for focusing particularly scavenging activity that's why may be I couldn't find a vast list of prey species as like of Affenberg.

The waste materials, particularly the kitchen remains, are exposed to an outdoor environment are subject not only to the process of decomposition, but also to scavenging by animals like the Bengal Monitor. The scavenging behavior of fauna can vary considerably with region and season, temperature, rainfall affecting the rate of decomposition O'Brien et al. [25]. This study has found similar results where all the different activities, including the scavenging, of the Bengal Monitor varied across the different months. The active period of the Bengal Monitor varied in different months in corresponding to seasonal changes. During the summer i.e., from May to August, the day range is longer than the other months and during winter, the day range is shorter. In the equator, days and nights are each 12 hours long throughout the year, but at latitude of 20 degree there is a difference of about three hours between the longest and shortest day of year. Bangladesh is at about 24 degrees north latitude and there is a difference between the longest and shortest day. The Bengal Monitors gets longer active period during the summer and monsoon seasons than in winter.

The scavenging behavior of by the Bengal Monitor was affected by various kinds of factors other than the seasonal change. During this study, it was found that in peak of winter (December-January) the Bengal Monitor was seen rarely and rarely visited the scavenging sites, but occasionally came out during the midday for basking. In this study, the Bengal Monitor began to show scavenging activity, and all other activities, mainly from February when the day length began to increase and the overall temperature also began to rise. Therefore, it is concluded that there is a direct relationship between scavenging and temperature. Logos and Greene (1998) stated that seasonal and geographical variation of the temperature have some effect in the diet of the monitor lizard species [26], which generally agrees with the findings of this study. Majupuria, T. C [27], stated that all monitors are predators and act scavenger eating any animals food. They don't chew or crush their food as other lizards do. The



scavenging activity is also fluctuated by the rainfall variation. During heavy rain periods the *Varanus* generally has shown least scavenging patterns than sunny days. Vernet, R. and M. Lemire [28], however, mentioned that the activity

of lizards depends more on prey availability than climate. Monitors lives in holes and in midday they steed out of their cells in search of food, which consist of smaller reptiles and insects [29].

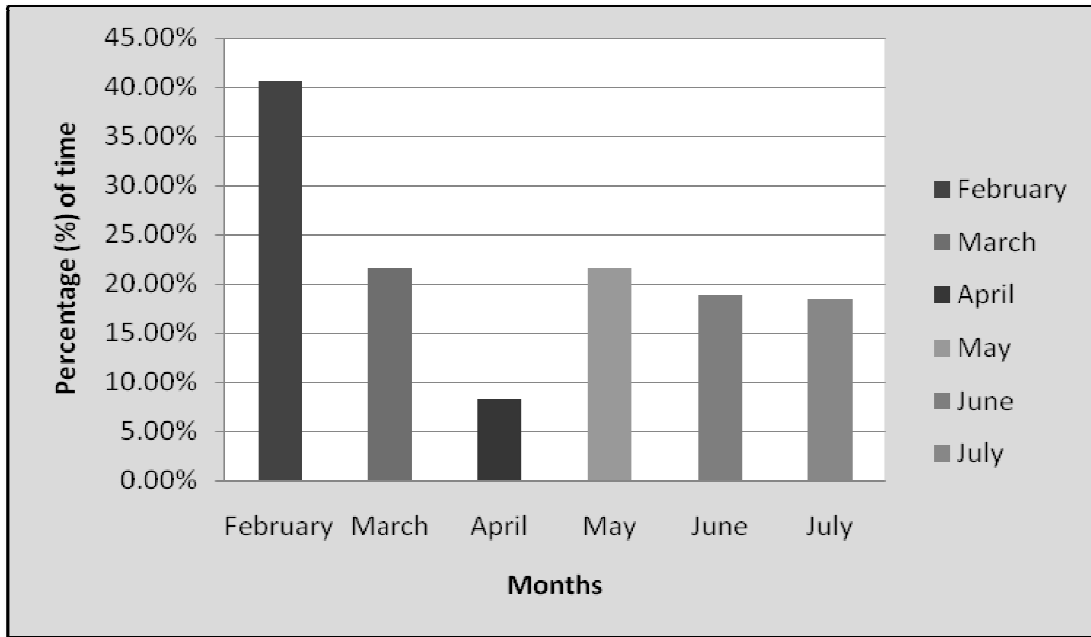


Fig. 6. Monthly variations in resting activity

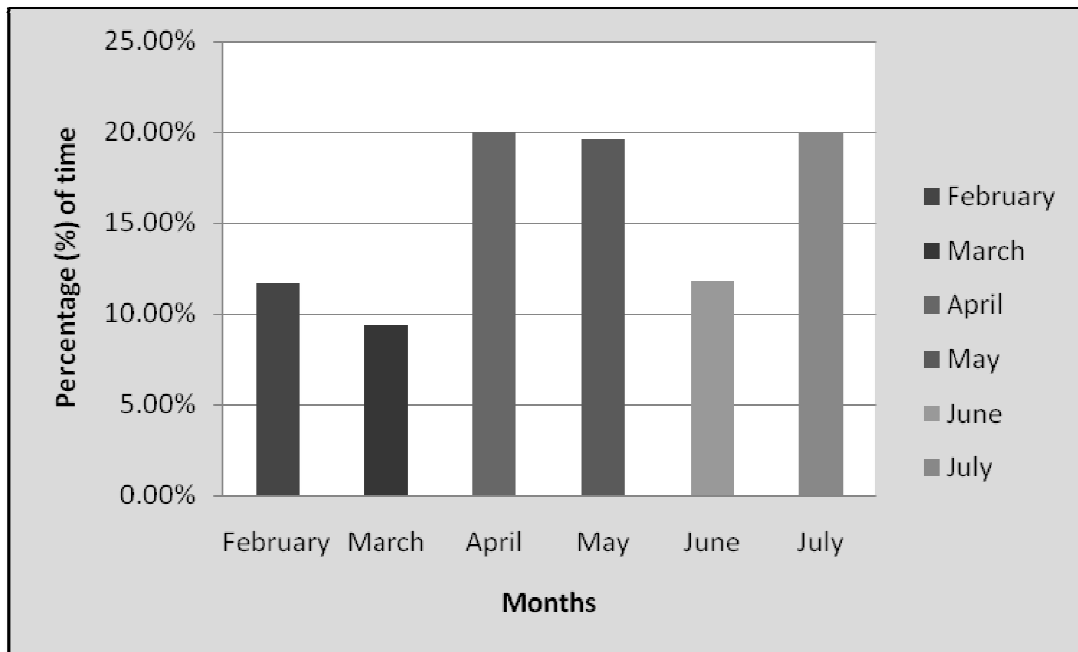
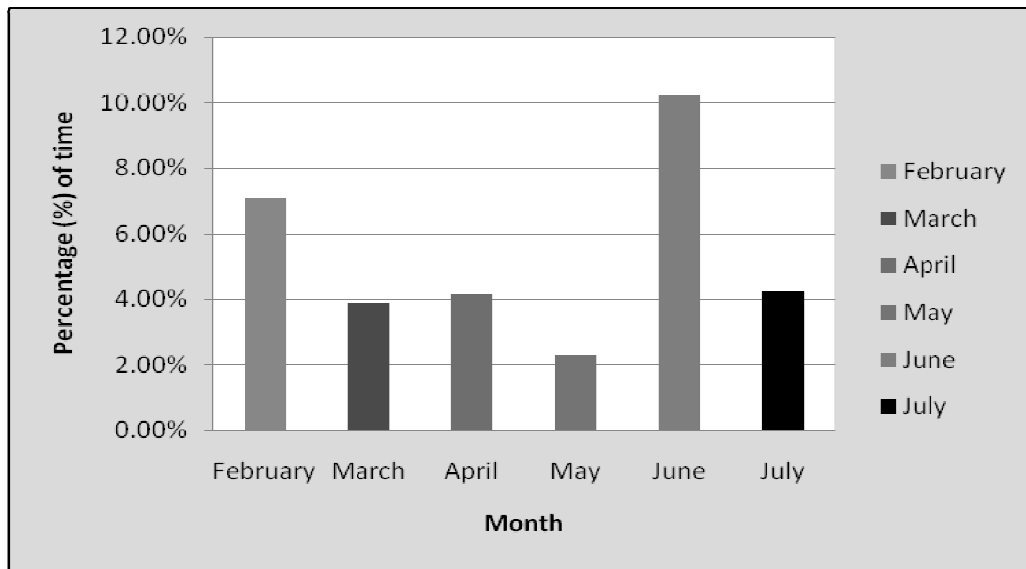


Fig. 7. Monthly variation in conflicting activity



**Fig. 8. Monthly variation in others (escaping, hiding, etc.) activities**

The movement of the Varanid species depends on their body size [12,30]. The size of activity areas has also been shown to vary among varanid species [31]. For example, *V. rosenbergi* have a mean home range of 7.8 ha [32] and *V. bengalensis* have a home range of between 4.4 - 5.3 ha [30]. The Bengal monitor lives in JU campus also use almost similar home range in different purposes. Seasonal inactivity has been reported for several varanids including *V. gouldii* and *V. panoptes* (Christian et al. Christian and Weavers), *V. glebopalma* and *V. rosenbergi* [32,33,34,35,36]. *Varanus rosenbergi* displays lower movement activity during seasonally low ambient temperatures [32]. The moving activity of Bengal Monitor also affected very much by the monthly rainfall and temperature changes [37]. The monitor lizard was inactive in the study site during winter because of low temperature that's why summer period was chosen for recording behavioral activity of the study species. And During this study lowest moving activity was seen in the month of July this was happen mainly because of late rainy seasons that means in July rainfall was greater in the month of July than other month of the study periods.

The resting behavior is often used synonymously with the basking behavior. Like other reptiles, most varanids behaviorally adjust their core body temperature during activity [38]. Large varanids such as adult *V. komodoensis*, which possess a high thermal inertia, rely to a lesser extent on behavioural modification of core body temperature [30]. Varanids bask in sunlight to

elevate core body temperature to within a narrow preferred temperature range [35,36,39]. The entire study shows that the temperature influences resting/basking behavior. In the study site, the lowest temperature always remains in the month of January and the study species was very inactive during that period. This was probably because the Bengal Monitor is cold-blooded animals and they remain inactive in the whole winter seasons. Other than winter during study period, highest resting behavior was recorded in the month of February because temperature in the month of February remains a little bit of cold that hampered the activity of Monitor Lizard species and they took lower rest in the month of April because during April temperature was so suitable for their different activities.

In the study period, Bengal Monitor showed a very interesting type of behavior during scavenging called conflicting behavior. In the wild, Bengal monitors are almost completely solitary. Much of the daytime is spent in constant movement, searching for food. Bengal monitor are more likely to interact with one another during the peak breeding season, when males compete for mates [21]. However, in this study Conflicting behavior occurred for the competition of food. The actual conflict generally happens with the house crow and domestic dogs. Asian pied starlings also do conflict with Bengal Monitor for dead and decaying feeding materials in the study area.

The Bengal Monitor during scavenging showed another behavior type called others behavior which is sum of the combination of insignificant behavior types i.e. escaping, hiding etc. The escaping and hiding capacity of the Bengal Monitor is greatly influenced by the intelligence level of the species. Varanid lizards are considered to be intelligent, with some species showing a capacity to even count [32].

Throughout the year, the Bengal Monitor together with other scavengers plays a great role in removing the waste materials from university campus and keeps the environment clean. But these environmental friends are losing their number at an alarming rate from Jahangirnagar University campus due to various reasons. We should take proper initiatives to save Bengal Monitor in our campus and throughout the country.

#### 4. CONCLUSION

In Jahangirnagar University Campus not only the common and well-known scavenger like House crow, Asian pied starling and Dog but also Bengal monitors are playing their role as a scavenger. Bengal Monitor spend considerable amount of time in scavenging during their active period. As a scavenger, they are playing great role to keep the campus environment safe and clean. Though Bengal Monitor is regarded as a least concern species [40,41] in terms of conservation status according to IUCN but by considering their role as a scavenger, we should conserve this environmental friendly species.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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