SOME BEHAVIOURAL ASPECTS ON THE *Hemidactylus* SPECIES OF BANGLADESH

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Abstract

Hemidactylus is a taxonomically complex genus and little is known about its feeding and breeding behavior in Bangladesh. Most of the species of this genus have a preference to live within human habitations, and play an important role in ecosystem, controlling insect pest population. Their breeding strategy is almost similar with each other and associated with their body structure. Review of literature found that there is a relationship between life history pattern and their reproductive biology. They lay two eggs per clutch usually and the highest egg number (12) has been recorded for *H. frenatus*. Strong significant positive correlation (r = 0.91) was found for preclaocal-femoral pores and egg number. Besides, significant negative correlation was found for average female body size and egg number (r = 0.96). Previous work and observation records showed that feeding habit is almost similar among all species of *Hemidactylus* and dipteran insects were the mostly consumed food item.

Key words: *Hemidactylus*; Feeding; Breeding ecology; Life history.

INTRODUCTION

One of the most diverse lizard genus *Hemidactylus* (Oken 1817) comprises of 144 species (Uetz *et al.* 2016), widely distributed in the warmer parts in the tropics and subtropics of Asia, Africa, and the Pacific as well as in Mediterranean Europe, and northern South America (Bauer *et al.* 2010, Carranza and Arnold 2012). According to Global Biodiversity Information Facility (www.gbif.org), 32221 geo-referenced records of *Hemidactylus* genus have been so far recorded till 13th October 2018. The adaptive life history and reproductive behavior of this genus have facilitated its wide distribution with high species diversity in different corners of the world. About 28 species have been reported from the Indian subcontinent and 13 of them are endemic to this region (Bansal and Karanth 2010). Of these, Bangladesh harbors six species of this genus under the family Gekkonidae (Chakma 2009). The geo-referenced records of the species of Bangladesh according to GBIF are: 13,187 for *H. frenatus*, 933 for *H. garnotii*, 866 for *H. platyurus*, 677 for *H. brookii*, 292 for *H. bowringii*, and 235 for *H. flaviviridis*. *Hemidactylus* genus in Bangladesh had been assessed by the IUCN Bangladesh (2015) and all of them are considered as least concern. The studies of Chakma (2009), Hasan *et al.* (2014) and IUCN BD (2015) suggest that most of the species of *Hemidactylus* are found in the northeastern and southeastern part of Bangladesh whereas *H. frenatus* is widely distributed and *H. flaviviridis* is found throughout the country except the Sundarbans. A new distribution record of *H. bowringii* in the northwestern Bangladesh has been reported by Rabbe *et al.* (2017).

Taxonomically the species of *Hemidactylus* is difficult to identify and chromosomal studies have been done for the same species in several times to eradicate ambiguity (Carranza and Arnold 2006). However, the study of Carranza and Arnold (2006) suggest that differences of external features like size of body, tail structure, ratio of the head, body and limbs, color variation in dorsal and ventral sides exist in different species. Furthermore, bulks of studies have been done on different aspects of the species around the world but no extensive work has been done on this genus in Bangladesh. Reptile population including lizard is facing different types of threats and their population is gradually declining. Six types of factors, such as habitat loss and degradation, invasive species, diseases, pollutants and agrochemicals, unsustainable use, and global climate change are causing the decline of reptile population (Gibbons *et al.* 2000). Some species of reptiles can also be a threat to others and it is likely for the species which can adapt themselves easily both in urban areas and human habitations. The work of Vanderduys and Kutt

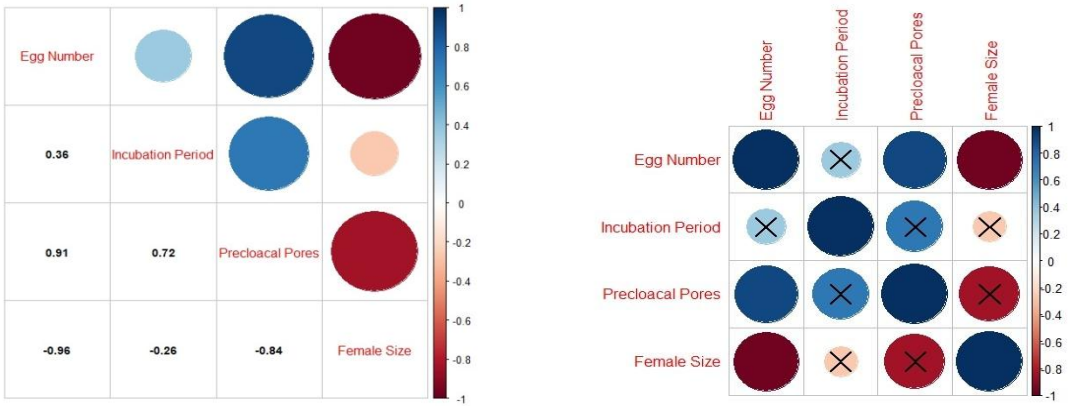
(2012) on Asian house gecko (*Hemidactylus frenatus*) suggests that the species can invade mother habitats, eradicate native species and carry diseases. So, it is important to know the breeding biology of the species along with different types of surviving strategies, restriction of their distribution and their protection from different kinds of threats. The reproduction of lizards is associated with season, environmental factors and natural selection (Al-Amri 2012). The climatic condition and anthropogenic factors provide suitable habitats for the reproduction of all species of lizard of Bangladesh. Unfortunately, no reproductive work has been reported so far from Bangladesh. In Bangladesh, research on feeding mechanism and feeding behavior of the species of this genus is scanty. Information from direct observation show that *Hemidactylus* spp. consume large number of harmful insects. No study on the evaluation of this genus in terms of controlling pest population and diseases carrying insect has been done so far. An attempt was taken to review some behavioural studies of *Hemidactylus* genus in Bangladesh.

MATERIAL AND METHODS

Data were collected from previously observed records and secondary sources such as extensive review of literatures and published articles from different sources. The data of breeding biology of *Hemidactylus* were collected from Church (1962), Sanyal and Prasad (1967), Mitchell and Zug (1988), and Al-amri (2012). Breeding data were noted as egg number, incubation period, precloacal pores and female size. We also collected information on habits, habitats and life history patterns of *Hemidactylus* which includes direct observation, morphometric studies, gut analysis and sampling (Zug *et al.* 2007, Naher *et al.* 2013, Tkaczenko *et al.* 2014, Hasan *et al.* 2014). The data were analyzed employing statistical package R-3.5.1 and Pearson correlation coefficient of different parameters was calculated.

RESULTS AND DISCUSSION

The species of *Hemidactylus* genus are characterized by having medium body size, sexual dimorphism, and more or less similar breeding strategy among them (Table 1). *H. garnotii* is a parthenogenetic species and data for the reproduction of *H. bowringii* was insufficient. So, data were analyzed excluding this two species. Among the six relationships, four (egg number and precloacal pores, egg number and female size, precloacal pores and female size, and precloacal pores and incubation period) are strongly related and the rest two relationship (incubation period and egg number, and incubation period and female size) are weak (Fig. 1a).



a **b**

Fig. 1. **a**. Correlation value in between different parameters. **b**. Significance of Correlation (p-value) in between different parameters and statistical analysis set at p>0.5 level of significant.

Significant strong correlation was found between precloacal pores and egg number (r = 0.91) and female body size and egg number (r = 0.96) (Fig. 1a and b). The other correlations (incubation period and egg number, incubation period and precloacal pores, incubation period and female size, and precloacal pores and female size) were not significant in *Hemidactylus* (Fig. 1b).

Life History and Reproduction

H. flaviviridis is the largest species with 90 mm snout vent length (SVL) and others SVL ranges from 34 to 66 mm (Zug *et al.* 2007, Hasan *et al.* 2014). The average SVL of the male of six species of *Hemidactylus* is 56.12 mm and female is 53.86 mm (Table 1). So, the average body size of male is larger than female. The largest and the smallest tail length are observed in *H. flaviviridis* and *H. bowringii* with a measurement of 92 mm and 50 mm, respectively and the average tail length of the six species of *Hemidactylus* is 69.5 mm (Hasan *et al.* 2014).

Table 1. Some important characteristics (morphological and reproductive) according to different authors.

Species Name		***H. bowringii***	***H. brookii***	***H. flaviviridis***	***H. frenatus***	***H. garnotii***	***H. platyurus***
SVL (mm)	Adult	34-51	45-65	90	42-59	49-66	47-58
	Male	34.5-49	50.2-65	68-80.8	47.8-58.6	_	49.2-58.1
	Female	35.6-50.7	45.06-61.7	71.1-79.3	42.5-49.1	56.5	47.5-50.7
Tail length (mm)		50	70	92	70	70	65
Sexual orientation		Sexually dimorphic	Sexually dimorphic	Sexually dimorphic	Sexually dimorphic	Partheno-genetic	Not sexually dimorphic
Precloacal-femoral pores		18-27	11-16	5-7	28-36	0	36-40
Egg Number		_	8*	4	12	6	10*
Incubation period (days)		35	39	36-39	42	_	90
References		Zug *et al.* 2007, Islam 2009, Hasan *et al.* 2014	Mitchell and Zug 1988, Zug *et al.* 2007, Chakma 2009, Hasan *et al.* 2014	Sanyal and Prasad 1967, Al-amri2012, Hasan *et al.* 2014	Yamamoto and Ota 2006, Zug *et al.* 2007, Chakma 2009, Hasan *et al.* 2014	Walter and Meshaka 1994, Zug *et al.* 2007, Hasan *et al.* 2014	Church 1962, Zug *et al.* 2007, Hasan *et al.* 2014

* *eggs counted from oviduct*

All the studied species of this genus have precloacal-femoral pores except *H. garnotii* (Zug *et al.* 2007) probably because all of them are females and reproduce through parthenogenesis. The highest precloacal femoral pores (average = 38) has been recorded for *H. platyurus* and 10 eggs have been counted from oviduct whereas *H. flaviviridis* possesses the lowest number of precloacal femoral pores (average = 6) and produces the lowest number of eggs among the six species (Table 1). Relationship of pores and egg number is positive (Fig. 1a) which means that the presence of more pores in females attracts more males to copulate and the increased probability of laying more number of eggs.

It was reported that four species are sexually dimorphic (viz. *H. frenatus*, *H. flaviviridis*, *H. bowringii*, and *H. brookii*), *H. garnotii* parthenogenetic and *H. platyurus* not dimorphic (Zug *et al.* 2007, Hasan *et al.* 2014). Zug *et al.* (2007) considered some morphological characteristics to express sexual dimorphism and some of these were: snout-vent length, crus length, fore-arm length, head length, jaw width, snout-eye length, snout-fore limb length, trunk length etc. Sexual dimorphism is absent in *H.*

platyurus as the measurement and proportions of different morphological characters showed least variability between males and females (Zug *et al.* 2007).

All species of Bangladesh are oviparous and lay two eggs in first clutch (Chakma and Islam 2009). The highest number of clutch and egg has been reported for *H. frenatus* by Yamamoto and Ota (2006). The analysis shows that correlation between female body size and egg number is negative (Fig. 1a). This means that the number of egg laying decreases with the increase of female body size. Usually it is expected that when female body size increases the potentiality of laying eggs would also increase. The source of collecting egg number data was different like counting from oviduct and counting from laid eggs. Positive relationship may be expected if data can be collected from similar source, but the previous researches on reproduction are not sufficient. There is a positive relationship between incubation period and egg number (Fig. 1a) which means when the egg number increases incubation period also increases. Six types of correlation between different parameters of breeding in *Hemidactylus* were analyzed and among them only two correlations are found significant (Fig. 1b). Data of incubation period of *H. garnotii* and egg number of *H. bowringii* have not been found.

Ecology and Feeding Behavior

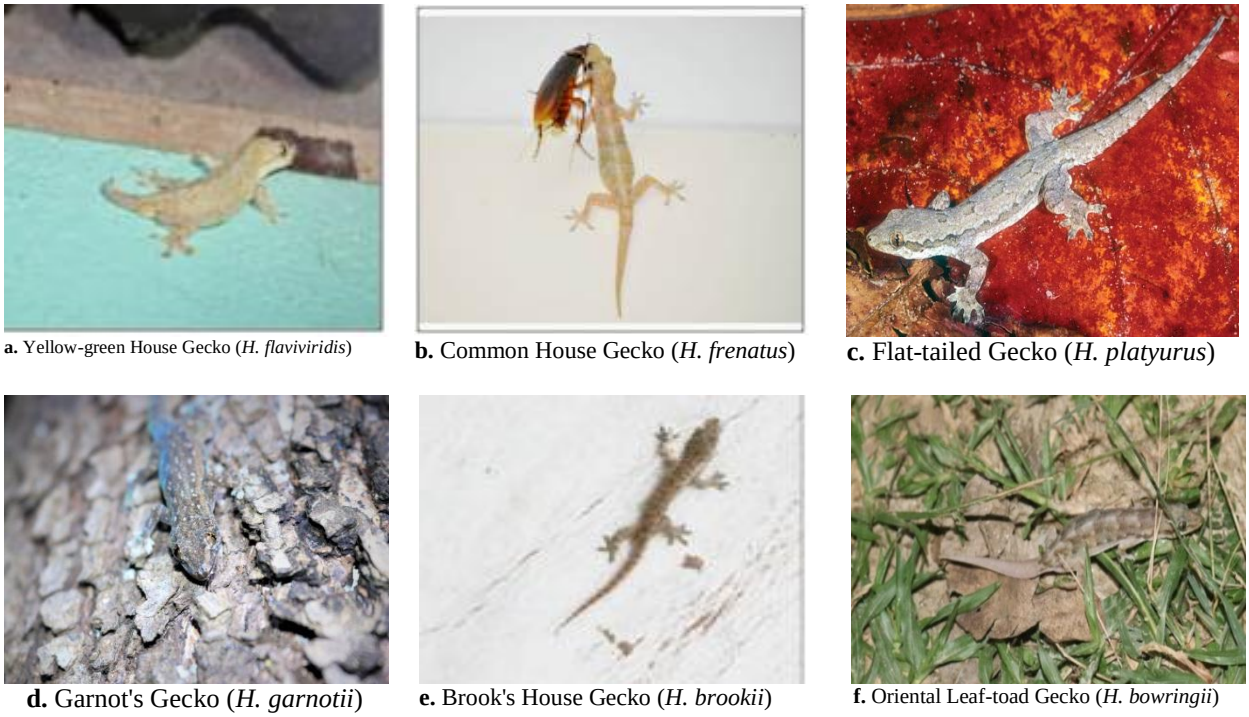
Habitat preference in *Hemidactylus* is not very diverse being saxicolous, arboreal or semi-arboreal and a preference to inhabit human habitation (Table 2). Chakma (2009), Islam (2009) and Hasan *et al.* (2014) found that all six species of *Hemidactylus* prefer human habitation and except *H. brookii* all are arboreal or semi-arboreal. Hasan *et al.* (2014) suggest that all are commensalistic and nocturnal in habit.

Table 2. Currently recognized species of *Hemidactylus* genus and their habit and food preferences.

Species Name		***H. bowringii***	***H. brookii***	***H. flaviviridis***	***H. frenatus***	***H. garnotii***	***H. platyurus***
Authority		Gray 1845	Gray 1845	Ruppell 1835	Dumeril and Bibron 1836	Dumeril and Bibron 1836	Schneider 1792
English Name		Oriental Leaf-toad Gecko	Brook's House Gecko	Yellow-green House Gecko	Common House Gecko	Garnot's Gecko	Flat-tailed Gecko
Local Name		Choto Tiktiki	Chiti Tiktiki	Goda Tiktiki	Mosrin Tiktiki	Dola Tiktiki	Chepta-leji Tiktiki
Habitat	Saxicolous		√		√		√
	Arboreal/ semi-arboreal	√		√	√	√	√
	Human habitation	√	√	√	√	√	√
Habit	Activeness	Nocturnal	Nocturnal	Nocturnal	Nocturnal	Nocturnal	Nocturnal
	Feed on	Insects	Hy, O, C, I, A	O, I, A, L	L, C, A, D, Hy, O, He, Z	Insects	D, H, L
References		Zug *et al.* 2007, Islam 2009, IUCN BD 2015	Zug *et al.* 2007, Chakma 2009, Hasan *et al.* 2014, IUCN BD 2015	Chakma 2009, Hasan *et al.* 2014, IUCN BD 2015	Tyler 1961, Zug *et al.* 2007, Chakma 2009, Hoskin 2011, Naher *et al.* 2013, Hasan *et al.* 2014	Zug *et al.* 2007, Chakma 2009, Hasan *et al.* 2014, IUCN BD 2015	Zug *et al.* 2007, Chakma 2009, Hasan *et al.* 2014, Tkaczenko *et al.* 2014, IUCN BD 2015

Notes: A= Araneae, C= Coleoptera, D= Diptera, H= Homoptera, He= Hemiptera, Hy= Hymenoptera, I= Isoptera, L= Lepidoptera, O= Orthoptera, Z= Zygoptera

The species of *Hemidactylus* have been seen in different habitats like on walls on which they could easily capture prey (Fig. 2a and b). They sometimes show very good camouflage with nature in their habitats (Fig. 2d, camouflage with tree and 2f, camouflage with grass).



a. Yellow-green House Gecko (*H. flaviviridis*) **b.** Common House Gecko (*H. frenatus*) **c.** Flat-tailed Gecko (*H. platyurus*)

d. Garnot's Gecko (*H. garnotii*) **e.** Brook's House Gecko (*H. brookii*) **f.** Oriental Leaf-toad Gecko (*H. bowringii*)

Fig. 2. The species of the *Hemidactylus* genus are presented here from Bangladesh. Photo credit: Md. Fazle Rabbe (**a,d,e,f**); M. Firoj Jaman (**b**); Internet (**c**).

The review of previous records shows that five species of *Hemidactylus* are found in different parts of Bangladesh. Among them, *H. bowringii* has been reported from northwestern region only and *H. garnotii* from southwestern region only and the other three species are found in all three studied regions of Bangladesh (Table 3). *H. brookii*, *H. flaviviridis* and *H. frenatus* are found in all kinds of habitats, such as roadside, human habitation, wall, tree, etc. *H. bowringii* was also found in grassland and *H. garnotii* was only found in tree (Table 3).

The majority of geckos are insectivores and few are herbivores and carnivores (Daniel 2002). Tyler studied the feeding behavior of *H. frenatus* in 1961 and recently the feeding ecology of this species studied by Naher *et al.* (2013) through gut analysis. *H. frenatus* used to eat dipterans (Tyler 1961) and coleopterans (Naher *et al*. 2013) mostly as their food. The feeding ecology and habitat of *H. platyurus* and *H. frenatus* was studied by Tkaczenko *et al.* (2014) through behavioral observation and insect sampling revealing preference of insects of the order of Araneae, Coleoptera, Diptera, Homoptera, Hymenoptera, Lepidoptera, and Orthoptera. It reflects similarity with the behavior of *H. brookii* and *H. flaviviridis* studied by Chakma 2009 (Table 2). Our observation suggests that *Hemidactylus* species have a preference for dipterans especially for mosquitoes which is a harmful insect for human. We have also observed the consumption of cockroaches by *H. flaviviridis* and grasshopper by *H. garnotii*. All six species are found eating various groups of insects (Table 3). The preying method of all species is found more or less similar. Initial movement towards prey was strikingly rapid. After that, when *Hemidactylus* got near to the prey, it took some time and then suddenly grab the object. Parves and Alam (2015) reported about predation of congeneric *H. frenatus* by *H. flaviviridis*.

Table 3. Diversity of species of *Hemidactylus* genus and their habitat and food preferences.

Region	Place	Species	Habitat	Preys on
Northwestern Bangladesh	Rangpur, Thakurgaon	*H. bowringii*	Grassland (*Cynodon dactylon*), Tree (*Mangifera indica*), Wall	Spider, Ant
	Nilphamari, Thakurgaon, Rangpur	*H. brookii*	Human Habitation, Tree (*Eucalyptus* sp. *Artocarpus heterophyllus*, *Carica papaya*, *Swietenia mahagoni*)	Mosquito, Cricket
	Dinajpur, Nilphamari, Rajshahi, Thakurgaon, Rangpur	*H. frenatus*	Human Habitation, Tree (*Mangifera indica*), Wall	-
	Dinajpur, Nilphamari, Rajshahi, Thakurgaon, Rangpur	*H. flaviviridis*	Human Habitation, Tree (*Mangifera indica*, *Averrhoa carambola*), Wall, Roadside	Moth, Housefly, Bug
Central Bangladesh (Dhaka)	Ramna, National Botanical Garden	*H. brookii*	Wall, Tree (*Swietenia mahagoni*, *Albizzia procera*)	Mosquito, Ant
	Ramna, DU campus, National Botanical Garden	*H. flaviviridis*	Wall, Human Habitation	Cockroach, Mosquito
	Ramna, DU campus, National Botanical Garden	*H. frenatus*	Wall, Human Habitation	-
Southeastern Bangladesh	Chittangong, Noakhali	*H. brookii*	Tree (*Soneratia apetala*, *Phoenix sylvestris*, *Zizyphus jujuba*), Wall	Mosquito, Ant
	Noakhali	*H. garnotii*	Tree (*Soneratia apetala*)	Grasshopper
	Widely distributed in Bangladesh	*H. frenatus*	Tree (*Phoenix sylvestris*, *Zizyphus jujuba*), Wall	Beetle, Ant, Moth
	Widely distributed in Bangladesh	*H. flaviviridis*	Tree (*Phoenix sylvestris*), Wall	-

Chromosomal Variation

Karyotypic analysis has been done for only about 11% of house gecko species using conventional cytogenetic methods (Patawang and Tanomtong 2015). The chromosome number in house geckos varies from 40 to 46 and *H. garnotii* (3n=70) reported as triploid parthenogenetic (Patawang and Tanomtong 2015). Kluge and Eckardt (1969) and later Patawang and Tanomtong (2015) found 40 chromosomes in *H. frenatus*, *H. brookii* and *H. flaviviridis*. Both *H. bowringii* and *H. platyurus* have 46 chromosomes (Nakamura 1931, Kluge and Eckardt 1969, Darevsky *et al.* 1984, Patawang and Tanomtong 2015) and the variation in chromosomal morphology is shown in Table 4.

Table 4. Chromosome characteristics of the genus *Hemidactylus.*

Species Name		*H. bowringii*	*H. brookii*	*H. flaviviridis*	*H. frenatus*	*H. garnotii**	*H. platyurus*
Chromosome	Morphology	46 R	4 V and 36 R	40 R	40 R	6 X, 18 V, 46 R	44 T and 2 A
	Chromosome no. (2n)	46	40	40	40	70	46
	Bi-armed	0	4	-	0	6	0
	Uni-armed	46	36	-	40	64	46
References		Nakamura 1931, Kluge and Eckardt 1969, Darevsky *et al.* 1984	Bhatnagar 1962, Kluge and Eckardt 1969, De Smet 1981, 5= Darevsky *et al.* 1984	Kluge and Eckardt 1969, Darevsky *et al.* 1984	Patawang and Tanomtong 2015	Kluge and Eckardt 1969, Darevsky *et al.* 1984	Patawang and Tanomtong 2015

*3N; A= Acrocentric, R= Rods graded to dots, T= Telocentric, V= V-shaped, X= X-shaped

Hemidactylus is an important genus of reptile group because of its insectivorous habit. But a thorough study on the feeding and breeding ecology of the species of this genus has not been done yet in Bangladesh. So, comprehensive studies on behavioral ecology are therefore recommended through this review. In Bangladesh, the studies on the ecology and chromosomal variation are not sufficient that could provide adequate information. The previous studies show that most of the species have more or less similar chromosome morphology. Karyological analysis should be done using modern techniques as most of the work in this field had been done before 1990s. All the six *Hemidactylus* species are protected by Bangladesh Wildlife (Conservation and Security) Act, 2012 and included in Schedule II. So, to protect lizard, wildlife laws should be implemented. To eradicate myth and local prejudice about lizards, awareness creation and conservation education among local people should be increased.

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