

Hemidactylus frenatus (Squamata: Gekkonidae): call frequency, movement and condition of tail in Costa Rica

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Abstract: Call frequency and movements of the gecko *Hemidactylus frenatus* were studied in Punta Morales, Costa Rica from April 1999 through May 2000. Call activity of *H. frenatus* was positively related to air temperature at night and throughout the year. Higher activity was at dusk, dawn, and during the hottest months. Call frequency was related with gecko abundance per month, although not during the night. More males and females had a regenerated tail compared to juveniles, the last ones could have it complete or regenerated. Females moved longer distances than males and juveniles. Adults were found higher on walls. Males and females were recaptured more times than juveniles, and the period of time between their recaptures was longer. Members of this population do not seem to be as aggressive to other geckos as mentioned in the literature. *Rev. Biol. Trop.* 54 (4): 1125-1130. Epub 2006 Dec. 15.

Key words: call frequency, gecko distribution, *Hemidactylus frenatus*, autotomy, temperature, seasonality.

Hemidactylus frenatus (Schlegel, 1836) is one of the 70 species of this genus. It has a world wide distribution (Church and Chun-Sim 1961, Hunsaker II 1966, Bustard 1970, Synder and Weathers 1976, Cheng and Lin 1977, 1978, Frankenberg 1982) and is reported in the new continent in Mexico, Panama and some places of the United States (Marcellini 1970, McCoy and Busack 1970, Poulin *et al.* 1995). In Costa Rica this species has been reported but there are no studies about its natural history or activity.

As mentioned somewhere else (Marcellini 1970), this nocturnal gecko is mostly associated to human edifications and is often found near artificial lights. For this and other species of geckos daily and seasonal activity have been studied, including data of number of individuals, call frequency, and movement range of captive animals. In *H. frenatus* the activity range varies daily and annually both in tropical and temperate areas (Bustard 1970, Marcellini 1971, 1974, Frankenberg and Werner 1981), probably being

correlated to luminosity, temperature, rain, and human activity (Marcellini 1970).

Several authors mention that *H. frenatus* is aggressive (Hunsaker II 1966, Marcellini 1970, McCoy and Busack 1970, Bolger and Case 1992, Petren *et al.* 1993, Case *et al.* 1994), and fights or encounters may result in persecutions, tail loss or scars resulting from bites (Marcellini 1970, Bolger and Case 1992). Besides its autotomic characteristic, the tail has an important role in the natural history of this species. Males and females use the tail during courtship, as part of an advertisement signal to other geckos, and when they localize a prey (Marcellini 1970).

Some authors mention that *H. frenatus* is territorial and has a social hierarchy, aspects closely related to movement and distribution of the individuals. Dominant adults can determine the distribution of young or other species of geckos that cohabit the same area (Hunsaker II 1966, Marcellini 1970, Lin and Cheng 1984, McCoid and Hensley 1993, Hanley *et*

al. 1998). This distribution and displacement of animals can be related to animal density, aggressiveness, dominance or tolerance among each other (Marcellini 1970).

Because there is no study that analyzes these characteristics of the natural history and ecology of *H. frenatus* in Costa Rica, and the aspects related to tail loss and movement range still need to be understood, the purpose of this study was to determine the period of higher calling activity during the night and along the year on a population of *H. frenatus* in Costa Rica, and if this is related to air temperature and animal abundance; determine the tail condition by sex and size of the animals; and finally analyze some aspects related to the displacement on the building where this population inhabit.

MATERIALS AND METHODS

The study was done in the Universidad Nacional Field Station in Punta Morales, Costa Rica. Call frequency at night was measured counting the number of calls during the first 15 min of each hour. Simultaneously, air and surface temperature (building wall) were also measured. Calling activity and number of individuals were related by counting the number of individuals immediately after measuring surface temperature. Geckos were captured and data were recorded: sex, snout-vent length (SVL), tail length (from the cloaca to the distal part of the tail), and tail condition as complete (a tail that had not been cut or regenerated) or regenerated (it had been cut or had a regeneration scar), in three different points: the base, in the middle or in the tip. Each gecko was marked by cutting phalanx. For each gecko observation (captures and recaptures), the exact place in the building where the gecko was found was logged. The position was measured as the horizontal distance from one extreme of the wall to the place where the gecko was, and the vertical distance from the base of the wall to the height on the gecko. The movement between two capture points was calculated as the minimum linear distance the gecko could have moved using the walls.

RESULTS

Daily patterns for air and surface temperature were very similar, having a higher peak at dusk and dawn ($F=42.730$, $p<0.001$, $df=13.210$; Fig. 1). These peaks coincided with the ones for gecko calling activity ($F=13.748$, $p<0.001$, $df=13.143$; Fig. 1). Calling production was seasonally related to air temperature, when the mean temperature was higher geckos called more often ($F=4.991$, $p=0.027$, $df=1.143$; Fig. 2). Air and surface temperatures were lower in February 2000, followed by higher temperature in March, April, and May ($F=32.673$, $p<0.001$, $df=12.210$; Fig. 2). Calling activity was low in April, but increased in May of both years. In September and December 1999 it rained, the temperatures were lower, and there was a decrease in calling activity (Fig. 2).

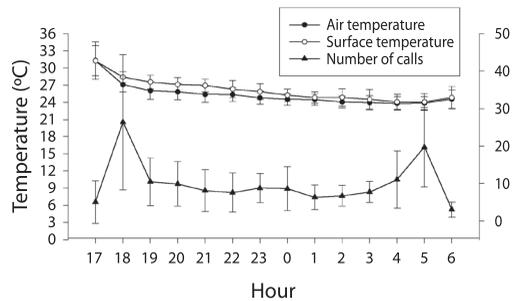


Fig. 1. Air temperature, surface temperature and number of calls of *H. frenatus* (average and standard deviation) per hour.

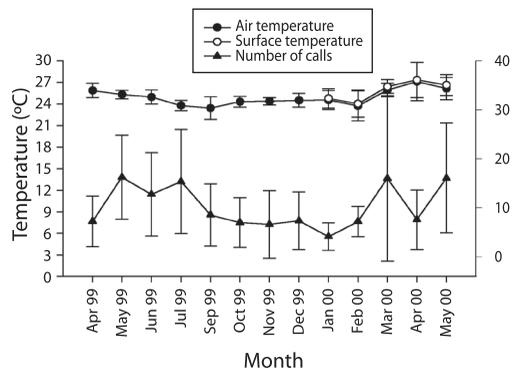


Fig. 2. Air temperature, surface temperature and number of calls of *H. frenatus* (average and standard deviation) per month.

Considering gecko abundance in relation to calling production (general linear model, Lindsey 1999), both factors were positive related ($t= 7.960$, $p<0.001$, $df= 1$). Geckos called more at dusk than at midnight ($t= -7.330$, $p<0.001$, $df= 1$). Months with higher number of geckos had higher calling activity. Numbers of calls were higher in March ($t= 4.380$, $p<0.001$, $df= 3$) and May ($t= 3.360$, $p<0.001$, $df= 3$), and also the number of geckos for both months (March: $t= 2.460$, $p= 0.014$, $df= 3$; May: $t= 2.800$, $p= 0.005$, $df= 3$). Gecko abundance was not different between dusk and midnight ($t= -1.700$, $p= 0.089$, $df= 1$), but it varied between months. It was lower in April and February ($t= 1.410$, $p= 0.160$, $df= 3$). The decrease of calling activity seen at midnight was not related to a decrease in gecko abundance. April had more geckos at midnight (contrary to February, March, and May) and fewer calls. However, the decrease in calls per month was related to low gecko abundance.

Having a regenerated tail was more common in adults (83 % of males and 69 % of females) than in juveniles (45 %) ($\chi^2 = 33.312$, $p<0.001$, $df= 2$). More males had a tail regenerated at the base than males with a complete tail. ($\chi^2 = 8.765$, $p= 0.033$, $df= 3$). Females could

have it complete or regenerated at any point ($\chi^2 = 5.405$, $p= 0.144$, $df= 3$), and juveniles with complete tails were more common than juveniles with a tail regenerated at any point ($\chi^2 = 43.380$, $p<0.001$, $df= 3$; Table 1). If we include the factor of gecko size, individuals of different sizes had different conditions ($F= 3.544$, $p= 0.002$, $df= 6.339$; Table 1). Males with the tail regenerated in the middle had a higher average size than males with complete tails (LSD, $p<0.001$). Females of any size could have complete or regenerated tails at any point (LSD, $p<0.05$). Juveniles with the tail regenerated in the base had a larger average length than the ones with complete tails (LSD, $p<0.001$).

In the building, the distance geckos moved varied per sex ($F=4.481$, $p= 0.014$, $df=2.77$; Table 2). Females moved farther than males (LSD, $p= 0.019$) and than juveniles (LSD, $p= 0.017$), but the last two moved similar distances (LSD, $p<0.05$). Although females moved longer distances than males and juveniles (Table 2), adults of both sexes and also juveniles have been captured close to each other.

The height where geckos were located also varied per sex ($F=9.873$, $p<0.001$, $df=2.154$; Table 2). Juveniles were at lower heights than males (LSD, $p= 0.001$) and females

TABLE 1
Percentage and size (SVL, mean±S.D.) of males, females and juveniles of *H. frenatus* with complete tails (C), regenerated in the tip (RT), in the middle (RM) and in the base (RB)

	% Geckos				Gecko size (cm)			
	C	RT	RM	RB	C	RT	RM	RB
Males	16.8	29.4	20.2	33.6	5.17±0.61	5.56±0.41	5.67±0.44	5.45±0.52
Females	30.7	17.6	25.5	26.1	4.78±0.39	4.84±0.4	4.91±0.36	4.8±0.47
Juveniles	55.7	22.8	7.6	13.9	2.41±0.52	2.73±0.52	2.66±0.5	3.2±0.59

TABLE 2
Movement, height perch and captures time of males, females and juveniles of *H. frenatus*

	Males		Females		Juveniles	
Displacement between recaptures	6.3±6.2	N= 27	8.3±9.3	N= 37	2.8±2.9	N= 12
Height between recaptures (m)	2.3±0.9	N= 27	2.5±0.9	N= 37	1.8±1.1	N= 12
Days between recaptures	29.6±25.4	N= 55	34.4±29.4	N= 76	18.5±12.8	N= 22

(LSD, $p < 0.001$), but adults of both sexes were at similar heights (LSD, $p = 0.624$).

The distances geckos displaced among recaptures were not correlated to the time between captures in males ($r = 0.006$, $p = 0.963$, $N = 55$), females ($r = -0.03$, $p = 0.775$, $N = 76$) or juveniles ($r = 0.330$, $p = 0.134$, $N = 22$). Otherwise, the time between recaptures did vary per sex ($F = 3.168$, $p = 0.040$, $df = 2.150$; Table 2). It was longer in females than in juveniles (LSD, $p = 0.013$), but did not differ between males and females (LSD, $p = 0.302$). It tended to be higher in males than in juveniles (LSD, $p = 0.096$).

DISCUSSION

The relation between temperature and gecko activity (Fig. 1), represented as a higher temperature and higher activity at dusk and dawn, also occurs in other species of geckos, for example *Thecadactylus*, *Gehyra*, *Ptenopus*, and *Hemidactylus turcicus* (Frankenberg 1982). Seasonally, months with higher temperatures had more geckos and higher calling activity, pattern also found by Marcellini (1970). It is suggested that the temperature during the day could determine the degree of gecko activity at night, where higher temperatures during the day are related to higher activity at night. Gecko shelters have high temperatures during the day, which can increase gecko body temperature and accelerate digestion process, causing more animals to forage at night (Marcellini 1970).

Although temperature and number of calls is related, another factor, such as gecko abundance, is also involved to calling activity of this species. The relationship between abundance and calling activity could explain why in April the number of geckos and calls were low although temperature was high (Fig. 2).

The higher percentage of adults compared to juveniles having the tail regenerated at any point (Table 1) is also common in other species. In *H. garnotii* and *H. turcicus*, 54 % and 65 % of adults, respectively, had tails in regeneration, compared with 10 % and 31 % in juveniles (Marcellini 1970). It is not known the reason for

tail breakage at the base, the middle, or the tip. Greer (1989) says that tail loss in geckonids is mainly at the base (the first five non autotomic vertebrae are followed by vertebrae that are autotomic), although it can also be broken at different parts. Tail loss can occur because of fights between individuals or predator attacks. This loss allows the survival of the gecko at the cost of losing the tail (Marcellini 1970, Greer 1989).

It is possible that males are not as aggressive as mentioned in previous literature, because they would move farther apart or to another building to avoid contact with the aggressive males, (a same gecko was never captured in a different building), and as a consequence there would be males that could disappear during the study, but it did not happen. The movement of males reported by Marcellini (1970) is similar to those found here, but females in this study seem to move farther away. Brattstrom (1974) and Wilson (1975) say that an increase in density could produce an increase of aggressive interactions between animals. Although there are persecutions and aggressions between individuals (Marcellini 1970, pers. obs.), there is a possibility that this species has a social hierarchy system.

Marcellini (1970) also found that males and females remain in higher places, and that higher locations have better thermoregulation properties and provide more shelter for rain and wind. The temperature is also a little bit higher and because the presence of artificial lights, insects are more abundant. Because juveniles remained in lower places, they could not have much contact with adults. The occurrence of fights between adults and juveniles were therefore reduced, lowering instances of tail loss in juveniles. Adults also eat juveniles of the same species (Bolger and Case 1992, pers. obs., McCoid and Hensley 1993), therefore, being in lower places can avoid cannibalism. Fights between juveniles had not been reported in literature and in this study was not observed. This could also explain the lower tail regeneration proportion in juveniles as compared to adults.

Geckos do not necessarily move longer distances apart when the time passed is longer

(Table 2), suggesting that they remain within certain ranges. Males and females had longer periods of time without being re-observed (Table 2), probably because they remained in places with difficult access, as the roof. Because juveniles were in lower parts of the building, it was possible that they did not move to the roof, where adults could stay for a certain period, reason to have a longer time between adult recaptures. It has been reported that *H. frenatus* is aggressive with individuals of the same species and others (Church and Chun-Sim 1961, Hunsaker II 1966, Marcellini 1970, McCoy and Busack 1970, Bolger and Case 1992, Petren *et al.* 1993, Case *et al.* 1994, Schmidt *et al.* 1996), and that is dominant over other species that live in the same habitat, sometimes forcing them to re-locate (such as *H. garnotii*, *Lepidodactylus lugubris* and *Leiopisma metallica*). They pursue and bite other geckos, eat their young, and prevent other species from reaching the refuges and feeding places. Marcellini (1970), Bolger and Case (1992), and Case *et al.* (1994) say that within the species, males tolerate other individuals of the same sex less, but they tolerate females and juveniles, while females tolerate individuals of both sexes and juveniles.

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RESUMEN

Estudié la frecuencia de canto y el desplazamiento de la lagartija *Hemidactylus frenatus* en Punta Morales, Costa Rica. La frecuencia de canto se correlaciona positivamente con la temperatura ambiental durante la noche y con la temperatura a lo largo del año. La mayor actividad fue al

anochecer, al amanecer y durante los meses más calurosos. La abundancia mensual de lagartijas se relacionó con la frecuencia de canto, no así la abundancia por noche. Las colas regeneradas son más frecuentes en hembras y machos que en las lagartijas jóvenes. Las hembras se desplazaron mayores distancias que machos y jóvenes. Los adultos se encontraban más alto en las paredes de los edificios. Los machos y hembras se recapturaron más veces que los jóvenes, y el tiempo entre recapturas fue mayor. Esta población no parece ser tan agresiva como se menciona en la literatura.

Palabras clave: frecuencia de canto, distribución, temperatura, estacionalidad, *Hemidactylus frenatus*, autotomía.

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