

## ACTIVITY AND MICROHABITAT USE BY THE ENDEMIC WHIPTAIL LIZARD, *CNEMIDOPHORUS NATIVO* (TEIIDAE), IN A RESTINGA HABITAT (SETIBA) IN THE STATE OF ESPÍRITO SANTO, BRAZIL

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**ABSTRACT.** We studied activity and habitat use by the teiid lizard *Cnemidophorus natio* in Parque Estadual Paulo César Vinha (PEPCV), an area located near the southernmost limit of the species distribution – the Restinga of Setiba in the state of Espírito Santo, southeastern Brazil. Activity of *C. natio* was estimated by hourly transects from 07:00 to 18:00 h searching for lizards. Lizard activity was expressed by the frequency of active individuals in each hour interval. Microhabitat use by *C. natio* was measured along 20 one-hour transects of lizard search in different areas of PEPCV. For every lizard seen we recorded the microhabitat it was using at the moment of first sight. *Cnemidophorus natio* (N = 73) was active mainly from 07:00-14:00 h with a peak of activity from 09:00-11:00 h, when approximately 80% of the individuals were observed. The main microhabitats used by *C. natio* at PEPCV were bare sand and vegetation edges (nearly 70% of the individuals recorded). No significant difference was found in habitat use between adults and juveniles. We concluded that *Cnemidophorus natio* from Setiba has an activity concentrated in the morning, with activity decreasing when air temperature in the habitat is near the peak, and that its preferred microhabitats in the area are open sand or vegetation edges.

**KEYWORDS.** *Cnemidophorus natio*, Restinga, Activity, Microhabitat, Ecology.

### INTRODUCTION

Although the ecology of some of the species of the genus *Cnemidophorus* has been studied in different Brazilian biomes (Bergallo and Rocha, 1993, 1994; Vitt, 1995; Vitt *et al.*, 1997; Dias and Rocha, 2004; Mesquita and Colli, 2003; Mesquita *et al.*, 2006), studies usually focused on bisexual species, with the ecology of unisexual *Cnemidophorus* remaining relatively poorly known (Menezes *et al.*, 2000, 2004). Within *Cnemidophorus* (*sensu* Reeder *et al.*, 2002; Reeder and Cole, 2005), three lineages have unisexual representatives: some populations of the *Cnemidophorus lemniscatus* complex and *Cnemidophorus cryptus* from Amazonia (Ávila-Pires, 1995; Cole and Dessauer, 1993), and *Cnemidophorus natio* from the Atlantic Rainforest (Rocha *et al.*, 1997).

*Cnemidophorus natio* (Fig. 1) is endemic to restinga habitats (coastal sand dune habitats) along the eastern coast of Brazil, occurring from southern state of Espírito Santo northward to southern state of Bahia, (Rocha *et al.*, 1997, 1999; Vrcibradic *et al.*, 2002). For *Cnemidophorus natio*, the only unisexual species in the genus occurring south of the Amazon basin, information on activity and habitat use is re-

stricted for two populations, one from the species type-locality (municipality of Linhares, Espírito Santo) and one from the municipality of Prado, Bahia, Northeastern Brazil.

The coastal sand dune habitats of eastern Brazil (Restingas) to which *C. natio* is endemic are presently under intense degradation (Rocha *et al.*, 2003) and, as a result of the large loss of its habitat, the species was included in the Brazilian list of threatened animals (IBAMA, 2003). Acquisition of data on the ecology of *C. natio* may facilitate not only our understanding on how this parthenogenetic species copes with its environment (and to which extent its ecology may differ from bisexual species), but also can provide information needed for the establishment of management and conservation programs.

In this study we analyze the activity and habitat use by *C. natio* in an area located in the southernmost limit of the species distribution – the Restinga of Setiba in Espírito Santo. Specifically, we addressed the following questions: (i) Which is the activity pattern of *C. natio* at Setiba; (ii) how activity relates to air temperature in the habitat? (iii) Which are the preferred microhabitats used by the species in the area? (iv) Do adults and juveniles differ in microhabitat use?



## MATERIAL AND METHODS

## Study Area

The study was carried out at Parque Estadual Paulo César Vinha (PEPCV), which comprises a protected area of 1500 hectares in the Restinga of Setiba, municipality of Guarapari, Espírito Santo, in coastal southeastern Brazil (20°33' to 20°38'S and 40°23' to 40°26'W, near sea level). "Restingas" are coastal sand dune habitats covered with herbaceous and shrubby vegetation, common along the Brazilian coast (Suguio and Tessler, 1984). Climate in the area is Tropical Aw (according to Köppen's system), with a wet summer and a dry winter. Mean annual temperature is 23.3°C with mean annual rainfall of 1307 mm and mean annual relative humidity of 80% (Fabris and César, 1996).

PEPCV comprises plant communities affected by the presence of lakes, topography, wind direction, distance from the sea and geological formation. For a detailed description of the local flora see Pereira



FIGURE 1. *Cnemidophorus nativo* from Parque Estadual Paulo César Vinha, municipality of Guarapari, state of Espírito Santo (specimen on its typical substrate, the sandy soil of restinga).

(1990). We sampled mainly areas corresponding to open *Clusia* and open Ericaceae formations (*sensu* Pereira, 1990; Fig. 2), where the species seems to be more abundant according to observations done by the senior author previous to this work. These are rela-

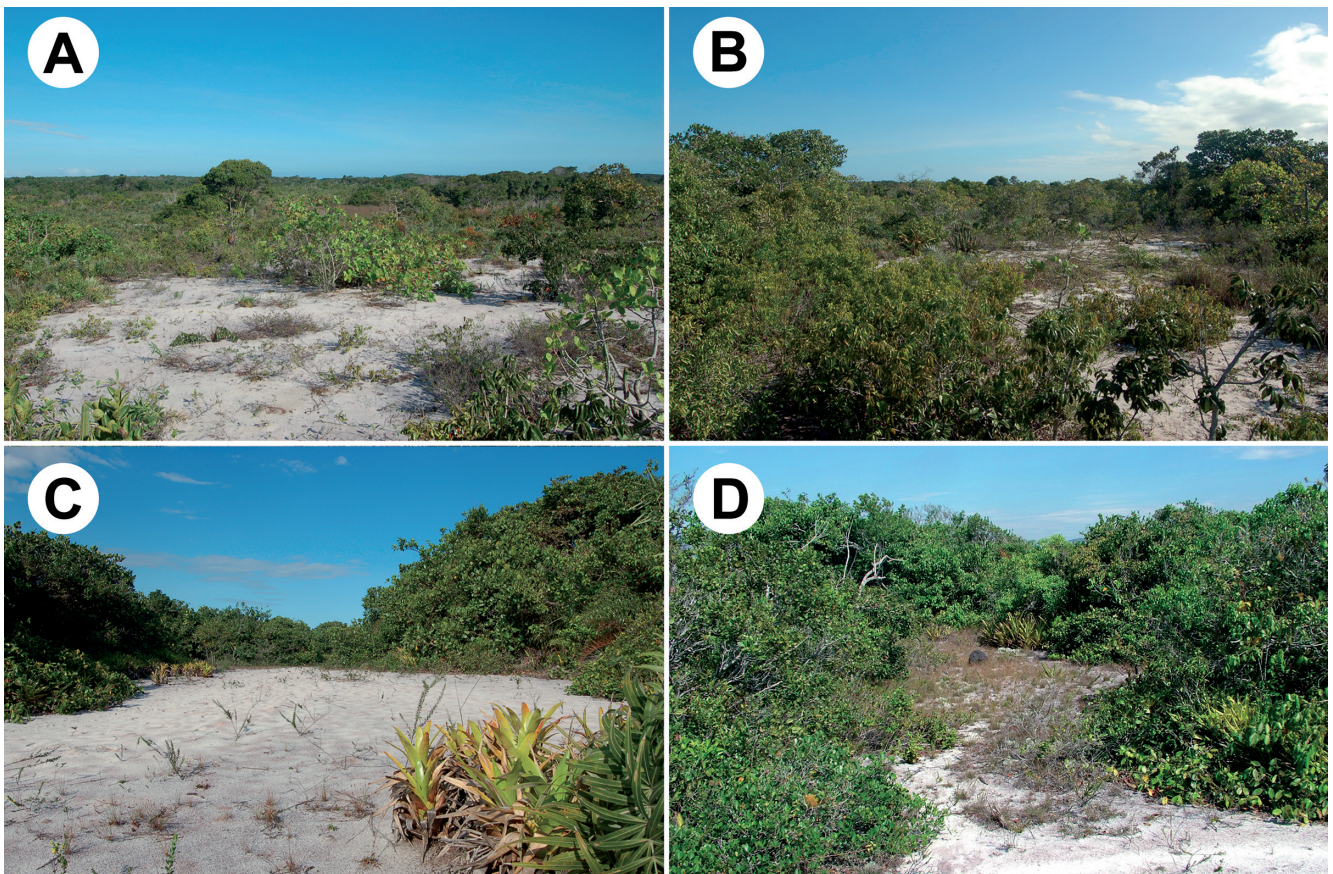


FIGURE 2. Habitats used by *Cnemidophorus nativo* at Parque Estadual Paulo César Vinha, state of Espírito Santo: (A, B) open Ericaceae formation, and (C, D) open *Clusia* formation.

tively open sandy soil habitats characterized by the discontinuity of the vegetation, which is organized in small and large shrubs, forming mosaic-like vegetation structures. In this habitat bromeliads usually occur in high densities, and in the study area particularly the bromeliads *Vriesea procera* and *Aechmea nudicaulis* are common in the open *Clusia* formation, usually surrounding shrubs.

### Activity and Microhabitat

To estimate the activity of *Cnemidophorus natio* at PEPCV one observer performed hourly transects from 07:00 to 18:00 h during five days in January 2006 looking for lizards. In no occasion during previous visits to the area lizards were seen active before 07:00 h. Each transect lasted from 25 to 30 minutes along a previously defined trail approximately 500 m long. During each transect the observer moved slowly, in a walking pace, recording the number of active individuals. Activity was estimated by the frequencies of active individuals along each hour interval. Activity transects were made solely in the open *Clusia* formation (Fig. 2C, D). We chose the open *Clusia* formation simply because the species seemed to be more abundant there during previous visits to the area. Although we might be masking a potential difference of activity pattern among habitats, specially the portion nearer the shore, where the species is also relatively abundant and the degree of insulation is higher than in the *Clusia* formation in early morning, we think that sampling the habitat where the species is more abundant, like the *Clusia* formation, should give us

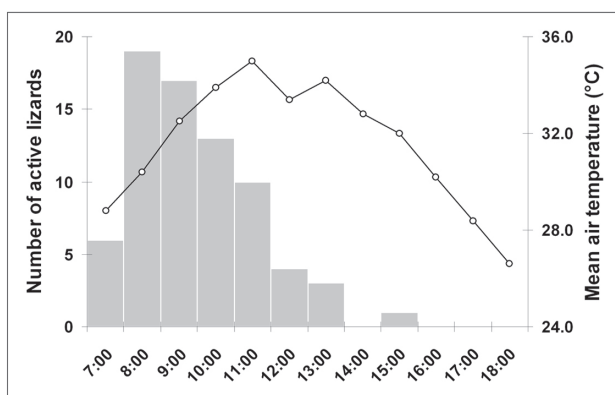


FIGURE 3. Frequency of active individuals of *Cnemidophorus natio* (bars) and mean air temperatures (line and dots) along each hourly interval of the day at Parque Estadual Paulo César Vinha, state of Espírito Santo.

a better idea of the activity pattern of the species in the area as a whole. The open Ericaceae formation (Fig. 2A, B), where the species is also abundant, is similar to the *Clusia* formation regarding sun exposure and microhabitat availability and we expect activity there to be similar to that of the habitat sampled. *Cnemidophorus* species are usually absent or rare in excessively shaded environments, and *C. natio* is no exception. During microhabitat transects (described below) few individuals were found inside areas with high canopy, and never more than 4 m into the forest, so we decided not to do activity transects in forested areas. Air temperature (to the nearest 0,2°C) was recorded at each hourly interval (prior to starting each transect) with a thermometer placed 25 cm above the ground and with a shaded bulb.

To estimate microhabitat use by *C. natio* observers walked 20 one-hour transects looking for lizards in different areas of the Park. Transects were performed from January to April 2006. For every lizard seen one attempt was made to capture by hand. For each lizard captured we recorded the microhabitat it was using at the moment of first sight and measured its snout-vent length (SVL) with a steel ruler (to the nearest millimeter). For analytical purposes, we considered individuals having SVL of 49 mm, or larger, as adults, and individuals smaller than 49 mm as juveniles. Juvenile and adult sizes are based on a study on reproductive ecology (Menezes *et al.*, 2004) which reported the minimum reproductive size of *C. natio* at Prado, Bahia, as 48.8 mm SVL. We also recorded the degree of exposure to direct solar radiation by each lizard using the following categories: (1) on sun (lizard completely exposed to direct solar radiation);

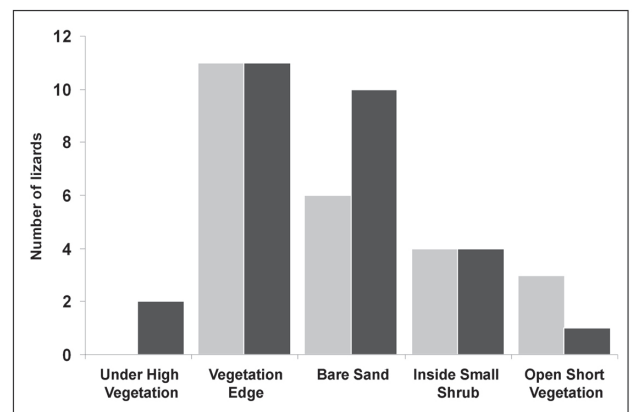


FIGURE 4. Microhabitat categories used by *Cnemidophorus natio* at Parque Estadual Paulo César Vinha, state of Espírito Santo. Lighter bars represent juveniles (< 49 mm SVL) and darker bars represent adults (≥ 49 mm).



(2) on filtered sun (parts of the body were on sun and parts on shade due to the vegetation); (3) on shade; (4) obligatory shade (no sun was available – cloudy period and the lizard had no option to move into or out of the shade). To avoid recapturing the same individual and to keep the independence of our data, each captured lizard received a temporary mark (nail polish mark on the dorsum) and was subsequently released at the exact place of capture, without further harming. Microhabitat sampling was made at different areas of the park to avoid recapturing of the same individuals and thus to prevent data pseudoreplication (transects were at least 1 km apart from each other). Six transects were made in the open *Clusia* formation, six in the open Ericaceae formation, six inside forest areas, and two in the manmade trails opened for access to the beach (transects in these trails commonly crossed more than one phytophysiology).

Microhabitat categories used by lizards during the present study were: (1) bare sand; (2) open short vegetation (vegetation height do not reach one meter above ground; e.g. grasses); (3) under high vegetation (under a shrub with diameter larger than 2 m or inside high canopy forest; vegetation height usually above 2 m); (4) vegetation edge (the lizard was observed inside vegetation less than 1 m from shrub edge); (5) inside small shrub (shrub diameter less than 2 m; shrub height usually under 2 m).

## RESULTS

*Cnemidophorus natio* (N = 73) was active mainly from 07:00-14:00 h, (Fig. 3). The activity peak occurred from 09:00-11:00 h, a period when approximately 80% of the individuals were observed. The peak of lizard activity was not concomitant with that of the peak of air temperature in the habitat (Fig. 3); when lizard activity was already considerably reduced, air temperature was still rising (Fig. 3). During all but one transect-day, weather condition was sunny; in only one occasion the day became cloudy along the day. In this last occasion cloudy condition occurred after *C. natio* was already active (it started after 12:00 h) in a period when the species activity was already decreasing. Thus we could not test for effects of cloudy conditions on *C. natio* activity.

During transects for microhabitat use we captured 52 *C. natio* individuals, 28 adults and 24 juveniles (mean SVL = 51.4 mm; range 34.0-74.0 mm SVL). Since there was no difference among juveniles and adults in microhabitat use (Wilcoxon test,  $z = 0.816$ ;

$p = 0.414$ ), data from all individuals were pooled to describe patterns of microhabitat use (although represented separately in Fig. 4) and sun exposure. Most lizards were active on vegetation edges (42%) and on open sand (25%; Fig. 4).

Regarding the degree of body exposure to sun, approximately 40% of the lizards were under filtered sun, 31% in obligatory shade, 23% under direct solar radiation, and 6% in shade. When disturbed, the lizards tended to flee from the observer and retreat into the nearest vegetation, promptly ceasing its movements. If the observer stayed motionless for a short period, the lizard quickly resumed activity, usually coming out to open ground again. On one occasion one of us (PLVP) observed one individual on the top of a bromeliad, about 30 cm above the ground. Because this observation was not made during microhabitat transects, this record was not included in the frequencies of microhabitat use. On several occasions lizards were found foraging among bromeliads on vegetation edge, or around small shrubs. In these cases the record was considered as “on vegetation edge” or “within small shrub”, depending on its position.

## DISCUSSION

Our data indicate that *Cnemidophorus natio* is an entirely diurnal species which is active mainly in the morning, ceasing activity in early afternoon. A similar trend in activity was found for the population of *C. natio* in the Linhares region (also in Espírito Santo), where most activity was from 08:30-15:00 h (Bergallo and Rocha, 1993) and in Prado region, Bahia, where activity was mainly from 08:00-13:00 h (Menezes *et al.*, 2000). The main microhabitat used by *C. natio* at PEPCV was bare sand and vegetation edge (nearly 70% of the individuals recorded). This trend was similar to that found for *C. natio* in Linhares (Bergallo and Rocha, 1993) where most lizards were on bare sand (about 75%) and on vegetation edges (about 25%; Bergallo and Rocha, 1993).

Studies on species of *Cnemidophorus* in other biomes showed similar results found by us for *C. natio* in Setiba restinga. Several species from Amazonian savanna habitats (the unisexual *Cnemidophorus cryptus*, and the bisexual *C. gramivagus* and *C. lemniscatus*), from Cerrado areas of central Brazil (*C. parvica*), and from restinga habitats of eastern Brazil (*C. abaetensis* and *C. littoralis*) apparently restrict their activity periods to morning and early afternoon

(Teixeira-Filho *et al.*, 1995; Dias and Rocha, 2004; Mesquita and Colli, 2003). *Cnemidophorus mumbuca*, a recently described species from the Cerrado, seems to have a broader range of activity (08:00-17:30 h), but most activity is concentrated from 10:00 to 14:00 h, which is similar to most *Cnemidophorus* species (Colli *et al.*, 2003; Mesquita *et al.*, 2006). The widespread *C. ocellifer* (an entity which actually may include more than one species treated under the same name; Rodrigues 1987; Rocha *et al.*, 1997, 2000; Colli *et al.*, 2003) seems to have a comparatively more variable and extended activity period in some areas within its range. *Cnemidophorus ocellifer* may be active until mid-to-late afternoon in some Cerrado (Mesquita and Colli, 2003) and restinga areas (Dias and Rocha, 2004), or may follow the general trend of activity of the other species, being active mainly during the morning in some Caatinga sites (e.g. Vitt, 1995).

Our results suggest that the reduction of the activity by *Cnemidophorus nativo* in Setiba coincides with the peak of air temperature in the area. Some authors have suggested that certain ground temperatures are needed for whiptail lizards of the genus *Aspidoscelis* (which also tend to have relatively short period of activity) to start, maintain, and cease activity (e.g. Milstead, 1957, Hardy, 1962, Kay *et al.*, 1973, Punzo, 2001). This can be the case of *C. nativo* ceasing activity in the afternoon. *Aspidoscelis* is apparently closely related to *Cnemidophorus* (Reeder *et al.*, 2002, Reeder and Cole 2005). However, Winne and Keck (2004) tested this hypothesis in laboratory condition with two species (*Aspidoscelis inornata* and *A. gularis*) and concluded that temperature alone was not the sole factor influencing activity. In fact certain soil temperatures were needed by lizards to start activity, but maintaining and ceasing of activity could be controlled by other mechanisms. Dehydration (Porter *et al.*, 1973; Bowker, 1993) and satiation (Perez-Mellado, 1992; Metcalfe and Steele, 2001) may also cause alteration in activity pattern in some species. Winne and Keck (2004) also suggested that endogenous factors might be involved. We still do not know which factors are important in activity control in *C. nativo*, but environmental temperatures may play an important role.

In general, microhabitat use by *Cnemidophorus nativo* from Setiba was similar to those of other species of the genus *Cnemidophorus* (including both unisexual and bisexual species), in which most individuals were active on bare sand or in shrub edges (Bergallo and Rocha, 1993; Teixeira-Filho *et al.*, 1995; Mes-

quita and Colli, 2003). Even in distinct environments, subject to very different environmental conditions, the places where these lizards are expected to be found along a given habitat vary little, reinforcing the idea that habitat preference is relatively phylogenetically conservative (Pianka and Vitt, 2003; Vitt *et al.*, 2003) and is not expected to vary among uni and bisexual species. An exception to this trend seems to be *C. abaetensis* and *C. ocellifer* populations from Salvador, Bahia, which were not found active on bare sand or in portions of the habitat where no leaf litter was available, although many portions of the species habitat in that area was composed by bare sand (Dias and Rocha, 2004). This contrasts with *C. nativo* from Setiba, which was more commonly found on sand, even when individuals were among shrubs or in vegetation edges with leaf litter available on the ground (PLVP, pers. obs.).

We conclude that *Cnemidophorus nativo* from Setiba has an activity concentrated in the morning, decreasing activity when air temperature is reaching its peak, and that its preferred microhabitats in the area are open sand and vegetation edges.

#### RESUMO

Nós estudamos a atividade e o uso do habitat pelo lagarto *Cnemidophorus nativo* (Teiidae) no Parque Estadual Paulo César Vinha (PEPCV), área próxima ao limite sul da distribuição da espécie e localizada na Restinga de Setiba no Estado do Espírito Santo. A atividade foi estimada por transectos horários entre 07:00 e 18:00 h à procura por lagartos e foi demonstrada pela frequência de indivíduos ativos a cada intervalo horário. O uso do microhabitat foi estimado através de 20 transectos de uma hora de duração à procura por lagartos. Cada lagarto avistado teve o seu microhabitat anotado. A atividade de *Cnemidophorus nativo* (N = 73) foi registrada principalmente entre as 07:00 e 14:00 h com pico de atividade entre 09:00 e 11:00 h, quando cerca de 80% dos indivíduos foram vistos. Os principais microhabitats utilizados foram areia nua e bordas de vegetação (somando cerca de 70% das observações). Não foi encontrada diferença significativa no uso do habitat entre adultos e jovens. Concluímos que, em Setiba, *Cnemidophorus nativo* possui atividade concentrada na parte da manhã, diminuindo a atividade quando a temperatura do ar atinge o seu auge. Os habitats preferidos pela espécie na área são a areia nua e bordas da vegetação.

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