Ecological aspects of *Kentropyx calcarata* (Squamata: Teiidae) in a mangrove area in northeastern Brazil

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Resumen: *Kentropyx calcarata* se distribuye al este de los Andes desde el este de Venezuela y Guayanas hasta el centro-sur de Brasil, encontrándose en la selva amazónica, el bosque lluvioso atlántico y las regiones del Cerrado y la Caatinga. En este estudio se aportan datos sobre una población de *K. calcarata* en el estado de Piauí, nordeste de Brasil, en un ecosistema de manglares. La especie sólo fue hallada dentro del bosque de mangle y en la orilla del río. El 83% de los animales se encontró en el barro o en las raíces aéreas de *Rhizophora mangle*. Se observaron diversas conductas defensivas como correr sobre el agua, nadar y zambullirse. Con la marea baja, *K. calcarata* forrajeaba dentro de los agujeros de cangrejos en el barro. Dentro de un estómago diseccionado se hallaron pinzas de cangrejo (familia Grapsidae). Este es el primer registro de *K. calcarata* en un área de manglar y, por primera vez, se documenta el consumo de cangrejos para el género. Esta población parece haber desarrollado estrategias específicas para vivir en zonas de manglares, tales como su comportamiento defensivo y de alimentación. La dependencia de esta especie de las zonas boscosas de mangle conservadas alerta de la urgencia de desarrollar estrategias de conservación que puedan aliarse con la protección del medio ambiente y la prosperidad social de la comunidad local.

The South American lizards of the genus *Kentropyx* are the only teiids possessing phylloid keeled ventral scutes. Three species groups are recognised: striata group (*Kentropyx striata*), paulensis group (*Kentropyx paulensis*, *Kentropyx viridistriga*, *Kentropyx vanzoi*, *Kentropyx* sp.) and calcarata group (*Kentropyx calcarata*, *Kentropyx pelviceps*, *Kentropyx altamazonica*) (Gallagher *et al.*, 1986; Werneck *et al.*, 2009).

K. calcarata is the most widespread species of the genus, occurring in eastern Amazonia (in eastern Venezuela, Guyana, French Guiana, Suriname, and Bolivia), and in parts of the Atlantic Forest, and some forested environments within the Cerrado and Caatinga regions, in Brazil (Avila-Pires, 1995; Borges-Nojosa & Caramaschi, 2003; Sousa & Freire, 2008; Nogueira *et al.*, 2009). This terrestrial, heliothermic, wide-foraging species inhabits forested areas and forest edges, usually in riparian habitats (Vitt, 1991; Avila-Pires, 1995; Vitt *et al.*, 1997, 2000).

No ecological studies on the populations from northeastern Brazil have been published and existing information is restricted to dis-

tributional records and analyses of individuals in a taxonomic or biogeographical context (Gallaguer *et al.*, 1986; Borges-Nojosa & Caramaschi, 2003; Sousa & Freire, 2008; Nogueira *et al.*, 2009). Herein we provide ecological data regarding a population of *K. calcarata* inhabiting the mangroves of Parnaiba River Delta in the State of Piauí, northeastern Brazil.

Observations on the ecology of *K. calcarata* were made at the Delta do Parnaiba Environmental Protection Area (DPEPA), state of Piauí, northeastern Brazil (2º47'24.20"S / 41º50'40.91"W). The DPEPA covers 3138 km^2, comprising the entire littoral of Piauí state, and part of the littoral of Maranhão and Ceará States (Loebmann *et al.*, 2010). Climate in the area is tropical wet and dry (savanna) (Aw) with a pronounced dry season winter according to Köppen´s classification (Peel *et al.*, 2007). Temperatures are warm over the year, varying from 22 to 33ºC, with two pronounced seasons: rainy season is from January to May and dry season from June to December (Loebmann *et al.*, 2010).

The area consists mostly of mangrove forests with *Rhizophora mangle* (Rhizophoraceae), *Avicennia germinans* (Avicenniaceae), *Laguncularia racemosa* (Combretaceae), coastal dunes, rocky shores, sandy beaches, and some rice crops in the interior of the mangrove areas. Tidal variation in the area is classified as mesotidal (Davies, 1964), with a maximum range of 3.3 m (Loebmann *et al.*, 2010).

To search for the lizards we used visual active search by terrestrial transects and boat surveys along the margins of the mangrove forest. Visual observations were made exclusively in the mangrove forests and in the rice crop fields. Visual search was performed by the same two researchers (IJR and TP), in two periods of the day: 8:00 – 12:00 h and 14:00 – 17:00 h. Field work occurred in September and December 2007 and February and April 2008, totalizing 16 days of observations, and 224 hour-man sampling effort.

When a lizard was seen data was taken on its habitat, microhabitat and defensive strategy when capture was attempted. One voucher specimen was sacrificed with a Tiopental injection, fixed in 10% formalin and preserved in 70% alcohol. The specimen was deposited in the Coleção Herpetológica da Universidade Federal do Ceará (CHUFC L4236). At the laboratory, its stomach was removed, dissected and its contents analyzed on a Petri-dish under a stereomicroscope. All required legal permits were obtained prior to fieldwork.

K. calcarata apparently is not very common in the area; only 30 individuals were seen during fieldwork. The species was only observed in mangrove forest areas and in the margin of the river (exposed to sunlight). In the rice crop fields the species did not occur. Microhabitats used varied between mud, roots of mangroves (heights 0-2 m), crab holes on the ground, vegetation on the ground, and fallen tree trunks. The 83% of lizards were seen either in the mud or on mangrove roots of *R. mangle* (Figure 1). Individuals were very agile in climbing the *R. mangle* roots foraging for food (Figure 2). Some lizards crossed small puddles of water by running. During low tide, individuals foraged inside crab holes in the mud. As the tide raised, individuals stopped foraging and began to seek refuge in the canopy.

K. calcarata displayed a wide variety of defensive strategies. The first line of defense was to flee and seek refuge by climbing on to *R. mangle* roots upon the first sight of predator. After being chased by the researchers, one lizard climbed a tree at a height of 3 m. As we tried to reach it, the lizard jumped into the water and swam with its body partially sub-

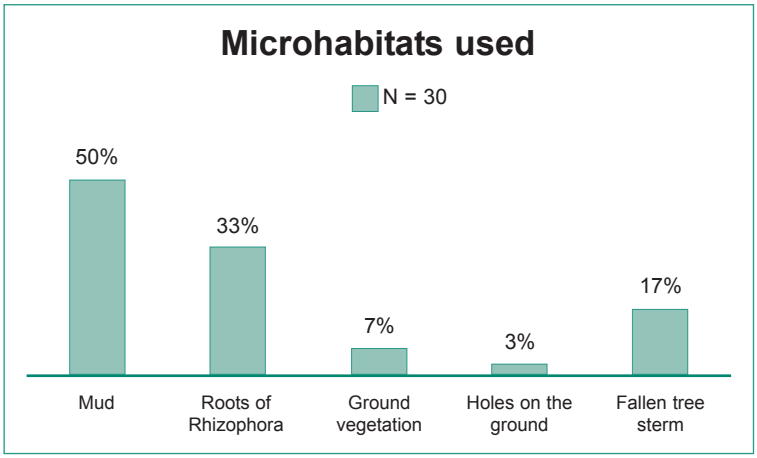

Figure 1. Microhabitats used by *K. calcarata* in the mangrove ecosystem.
Figura 1. Microhabitas usados por *K. calcarata* en el ecosistema de manglar.

mersed, making an ondulatory movement using body and tail. We continued to pursue the lizard trying to catch it in the water, after which the lizard dove and spent almost 60 s under the water surface, appearing in another *R. mangle* root, from where it escaped.

One adult male (SVL 89 mm, TL 160 mm) was collected and its stomach content analyzed. We found only claws and legs of a crab of the Grapsidae family. The voucher was deposited at the Coleção Carcinológica do Laboratório de Invertebrados Marinhos da UFC (n° 329; Figure 2).

Although *K. calcarata* is found in several habitats throughout its range, until now the species was never mentioned occupying mangrove ecosystems (Avila-Pires, 1995; Nogueira, 2006; Sousa & Freire, 2008). The canopy formed by the preserved mangrove forest creates a shadow environment, providing an adequate habitat for *K. calcarata*. The species was found mostly in these mangrove forests and in the edge of river banks. In the rice crops inside the mangroves, where the forest was cut down, the species was not found, suggesting its dependence of forested environments and its relative low tolerance to open areas (Martins, 1991; Vitt, 1991; Avila-Pires, 1995; Vitt *et al.*, 1999).

In the mangroves, *K. calcarata* used a wide range of microhabitats as observed in other ecological studies for the species (Vitt, 1991; Vitt *et al.*, 1997, 2000). The ability to climb mangrove trees, swim and run across small puddles (see Luke, 1986) make this species very adapted to this particular environment. Tidal variation throughout the day makes foraging microhabitats available only for some periods and forces individuals to seek refuge in the arboreal substrate. Such arboreal habit, especially in flooded areas, has been reported for *K. striata* in the Amazon Rain Forest (Vitt & Carvalho, 1992).

The rectangular fringed toes of *K. calcarata* are cited as an adaptation to locomotion across water and to explore the arboreal substrate (Luke, 1986), which seems compatible with the ecology of the populations of *K. calcarata* in the mangrove habitat, and has been documented in *K. altamazonica* and *K. striata* (Vitt & Carvalho, 1992; Vitt *et al.*, 2001). Unfortunately we were not able to collect enough specimens to compare and verify if there are morphological adaptations in the mangrove populations of *K. calcarata*, such as more developed toe fringed when compared to other populations of forested areas.

Figure 1. Adult male of *K. calcarata* (a); mangrove ecosystem, showing aerial roots of *R. mangle* (b); *K. calcarata* foraging on *R. mangle* root (c); crab of the Grapsidae family, found inside the stomach of *K. calcarata* (d).
Figura 1. Adulto de *K. calcarata* (a); ecosistema de manglar, mostrando las raíces aéreas de *R. mangle* (b); *K. calcarata* buscando alimento sobre una raíz de *R. mangle* (c); cangrejo de la familia Grapsidae, hallado en el estómago de *K. calcarata* (d).

K. calcarata shows impressive swimming capacity, diving and under-water resistance to escape from predation. Those behaviors have been documented in other lizards, especially in the semi-aquatic species *Crocodilurus amazonicus*, *Uranoscodon superciliaries*, *Dracaena guianensis* (Howland *et al.*, 1990; Martins, 2005; Mesquita *et al.*, 2006) and in the genus *Kentropyx* (Vitt, 1991; Vitt *et al.*, 2001). Swimming and diving performances are effective means of escaping from predators or foraging for food (Pianka & Vitt, 2003). In the case of *K. calcarata* we did not see any foraging behavior on water and it seems like this behavior is only used for defensive and locomotive purposes.

The ability to spend time under water for long periods has been reported in the families Agamidae, Diplodactylidae, Iguanidae, Lanthanotidae, Scincidae, Varanidae (Hare & Miller, 2009), Gymnophthalmidae and Teiidae (Pianka & Vitt, 2003), appearing independently in several lineages of lizards (Hare & Miller, 2009), with the utilization of freshwater habitats and resources evolving numerous times within lizards (Bauer & Jackman, 2008).

The diet reported for *K. calcarata* in other ecological studies demonstrates the preference for arthropods, especially Orthoptera and Arachinidae (Martins, 1991; Vitt, 1991; Vitt *et al*., 1997; Teixeira, 2001). Crab predation in this individual of *K. calcarata* arises different questions: are crabs the major source of food for this population? Was this predation an isolated event? In the stomach content of this particular individual we were only able to find crab parts of one species of the Grapsidae family. Since only one individual had its stomach analyzed we cannot conclude if this was an isolated case or if it is common in this particular population. However, the foraging behavior observed, such as the exploration of crab holes in the mud may indicate a specialized behavior appropriate for crab predation on mangroves. To our knowledge crab predation among the genus *Kentropyx* has never been reported. This particular prey is more common in semi-aquatic lizards such as *C. amazonicus* and *D. guianensis* (Martins, 2005; Mesquita *et al*., 2006), and in the Varanidae family which has species well adapted to feeding on crabs, such as *Varanus mertensis* and *Varanus dumerilii* (Losos & Greene, 1988; Mayes *et al*., 2005; Cota *et al*., 2008).

As a forest adapted species, *K. calcarata* was only seen in areas with mangrove forests. No individuals were found in degraded areas or deforested mangroves with higher sun incidence. The deforestation of the mangroves for coal production and rice crops in this region is intense and common, despite the fact that it is within a protected area (DPEPA). The lack of law enforcement and sustainable economic activities in the region make it difficult to preserve this ecosystem that is home to several endangered species such as the Caatinga Howler monkey (*Alouatta ululata*) and the manatee (*Trichechus manatus manatus*).

In conclusion this paper presents the discovery of a new population of *K. calcarata* in the mangroves of northeastern Brazil, with behavioral data showing ecological adaptations to this particular environment. Future research is needed to confirm the preliminary results obtained in this study.

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References

Avila-Pires, T.C.S. 1995. Lizards of Brazilian Amazonia (Reptilia: Squamata). *Zoologische Verhandeligen (Leiden)*, 299: 1-706.

Bauer, A.M. & Jackman, T. 2008. Global diversity of lizards in freshwater (Reptilia: Lacertilia). *Hydrobiologia*, 595: 581-586.

Borges-Nojosa, D.M. & Caramaschi, U. 2003. Composição e análise comparativa da diversidade das afinidades biogeográficas dos lagartos e anfisbenídeos (Squamata) dos brejos nordestinos. 463-512. *In*: Leal, I.R., Tabarelli, M. & Silva, J.M.C. (eds.), *Ecologia e Conservação da Caatinga*. Recife, UFPE. Brazil.

Cota, M., Chan-Ard, T., Mekchai, S. & Laoteaw, S. 2008. Geographic distribution, instinctive feeding behavior and report of nocturnal activity of *Varanus dumerilii* in Thailand. *Biowak*, 2: 152-158.

Davies, J.L. 1964. A morphogenic approach to world's shorelines. *Zeitschrift fur Geomorphologie*, 8: 127-142.

Gallagher, D.S., Dixon, J.R. & Schmidly, D.J. 1986. Geographic variation in the *Kentropyx calcarata* species group (Sauria: Teiidae): a possible example of morphological character displacement. *Journal of Herpetology*, 20: 179-189.

Hare, K.M. & Miller, K.A. 2009. What dives beneath: diving as a measure of performance in lizards. *Herpetologica*, 65: 227-236.

Howland, J.M., Vitt, L.J. & Lopez, P.T. 1990. Life on the edge: the ecology and life history of the tropidurine igua-

nid lizard *Uranoscodon superciliosum*. *Canadian Journal of Zoology*, 68: 1366-1373.
Loebmann, D., Mai, A.C.G. & Lee, T. 2010. The invasion of five alien species in the Delta do Parnaíba Environmental Protection Area, Northeastern Brazil. *International Journal of Tropical Biology and Conservation*, 58: 909-923.
Losos, J.B. & Greene, H.W. 1988. Ecological and evolutionary implications of diet in monitor lizards. *Biological Journal of the Linnean Society*, 35: 379-407.
Luke, C. 1986. Convergent evolution of lizard toe fringes. *Biological Journal of Linnean Society*, 27: 1-16.
Martins, M. 1991. The lizards of Balbina, Central Amazonia, Brazil: a qualitative analysis of resource utilization. *Studies on Neotropical Fauna and Environment*, 26: 179-190.
Martins, M. 2005. Life in the water: ecology of the jacarerana lizard, *Crocodilurus amazonicus*. *Herpetological Journal*, 16: 171-177.
Mayes,P.J., Thompson, G.G. & Withers, P.C. 2005. Diet and foraging behavior of the semi-aquatic *Varanus mertensi* (Reptilia: Varanidae). *Wildlife Research*, 32: 67-74.
Mesquita, D.O., Colli, G.R., Costa, G.C., França, F.G.R., Garda, A. & Peres Jr, A.K. 2006. At the water´s edge: ecology of semiaquatic Teiids in Brazilian Amazon. *Journal of Herpetology*, 40: 221-29.
Nogueira. C. 2006. Diversidade e Padrões de Distribuição da fauna de lagartos do Cerrado. Unpublished Ph.D. Thesis. Universidade de São Paulo. Brazil.
Nogueira, C., Colli, G.R. & Martins, M. 2009. Local richness and distribution of the lizard fauna in natural habitat mosaics of the Brazilian Cerrado. *Austral Ecology*, 34: 83-96.
Peel, M.C., Finlayson, B.L. & McMachon, T.A. 2007. Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences Discussions*, 4: 439-473.
Pianka, E.R. & Vitt, L.J. 2003. *Lizards: Windows to the Evolution of Diversity*. University of California Press, Los Angeles, California, USA.
Sousa, P.A.G. & Freire, E.M.X. 2008. *Kentropyx calcarata*: Geographic Distribution. *Herpetological Review*, 39: 238.
Teixeira, R.L. 2001. Comunidade de lagartos da Restinga de Guriri, São Mateus - ES, sudeste do Brasil. *Atlântica*, 23: 77-84.
Vitt, L.J. 1991. Ecology and life history of the wide-foraging lizard *Kentropyx calcarata* (Teiidae) in Amazonian Brazil. *Canadian Journal of Zoology*, 69: 791-799.
Vitt, L.J. & Carvalho, C.M. 1992. Life in the trees: the ecology and life history of *Kentropyx striatus* (Teiidae) in the lavrado area of northern Brazil, with comments on the life histories of tropical teiid lizards. *Canadian Journal of Zoology*, 70: 1995-2006.
Vitt, L.J., Zani, P.A. & Lima, C.M. 1997. Heliotherms in tropical rain forest: the ecology of *Kentropyx calcarata* (Teiidae) and *Mabuya nigropunctata* (Scincidae) in the Curuá-Una of Brazil. *Journal of Tropical Ecology*, 13: 199-220.
Vitt, L.J., Zani, P.A. & Espósito, M.C. 1999. Historical ecology of Amazonian lizards: Implications for community ecology. *Oikos*, 87: 286–294.
Vitt, L.J., Sartorius, S.S., Avila-Pires, T.C., Espósito, M.C. & Miles, D.B. 2000. Niche segregation among sympatric Amazonian teiid lizards. *Oecologia*, 122: 410–420.
Vitt, L.J., Sartorius, S.S., Avila-Pires, T.C.S. & Espósito, M.C. 2001. Life at the river's edge: ecology of *Kentropyx altamazonica* in Brazilian Amazonia. *Canadian Journal of Zoology*, 79: 1855–1865.
Werneck, F.P., Giugliano, L.G., Collevatti, R.G. & Colli, G.R. 2009. Phylogeny, biogeography and evolution of clutch size in South American lizards of the genus *Kentropyx* (Squamata: Teiidae). *Molecular Ecology*, 18: 262-278.

Comportamiento carroñero en *Malpolon monspessulanus*

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La culebra bastarda (*Malpolon monspessulanus*) probablemente es uno de los colúbridos más abundantes en la Península Ibérica. Su gran tamaño provoca desenlaces fatales en los habituales encuentros con el hombre, ya que sigue sufriendo los temores atávicos y desinformación habitual en la relación de los ofidios con el ser humano. A pesar de esto parece estar aumentando su presencia en la comunidad de colúbridos mediterráneos en la Península Ibérica por ser una especie altamente adaptable a los ambientes antrópicos (cultivos, construcciones, basureros, etc.) (Segura *et al.*, 2007). Se beneficia de su dieta generalista, ya que el número de especies presa sobre las que depreda supera la treintena (Pleguezuelos, 2003).

El 29 de mayo de 2011, durante un recorrido en coche por un camino rural que comu-