

# Diet and natural history notes of *Leptodactylus laticeps* (Anura: Leptodactylidae) in the Gran Chaco of Paraguay

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## Zusammenfassung

*Ernährung und Lebensweise von Leptodactylus laticeps (Anura: Leptodactylidae) im Gran Chaco Paraguays.*

Es werden Freilandbeobachtungen zur Lebensweise von *Leptodactylus laticeps* im Gran Chaco von Paraguay vorgestellt, die im Rahmen faunistischer Studien in der Regenzeit erfolgten. Neben Angaben zu Habitat, Abmessungen, Eiergröße und -zahl, liegt der Schwerpunkt dieses Artikels auf der Ernährungsökologie. Sowohl Magen-, als auch Darminhalte von 26 eröffneten subadulten (mittelgroßen) bis adulten *L. laticeps* aus der paraguayischen Oberen (Trockenen) und Unteren (Feuchten) Chaco-Region wurden getrennt voneinander analysiert. Insgesamt befanden sich unter den erkennbaren wirbellosen Beuteresten (in absteigender Anzahl) Termiten, Käfer (u. a. Curculionidae und Scarabaeoidea), Schaben, Tausendfüßer, Hautflügler (Ameisen und eine Wespe), Springschrecken, Spinnen (darunter eine ausgewachsene männliche Vogelspinne) und Wanzen; unter den erbeuteten Wirbeltieren befanden sich sechs Frösche (zumindest vier davon *Bufo granulosus*) und eine Maus. Die Ernährungsökologie der Art wird unter besonderer Berücksichtigung vertebrater und giftiger Beutetiere diskutiert.

Schlagwörter: Anura: Leptodactylidae: *Leptodactylus laticeps*; Paraguay: Gran Chaco; Ernährung; Lebensweise.

## Abstract

Field observations on the natural history of *Leptodactylus laticeps* made during faunistic studies in the rainy season in the Gran Chaco of Paraguay are presented. Besides information on the habitat, measurements, and egg size as well as egg number, this paper focuses on feeding ecology. Stomach and gut contents of 26 dissected sub-adult (medium-sized) to adult *L. laticeps* from the Paraguayan Upper (Dry) and Lower (Wet) Chaco region were analyzed separately. Among the recognizable invertebrate prey items were (in decreasing numbers) termites, beetles (e.g. Curculionidae and Scarabaeoidea), cockroaches, diplopods, hymenopterans (ants and one wasp), crickets/grasshoppers, spiders (among them one adult male tarantula), and bugs; among the vertebrates were six anurans (at least four of them *Bufo granulosus*) and one mouse. The feeding ecology of the species is discussed, with special reference to vertebrate and venomous prey.

Key Words: Anura: Leptodactylidae: *Leptodactylus laticeps*; Paraguay: Gran Chaco; diet; natural history.

## 1 Introduction

The red-spotted burrow frog, *Leptodactylus laticeps* BOULENGER, 1918, is a large-sized bufonoid leptodactylid with broad head and stout hindlegs, which is easily recognized by its characteristic dorsal colour pattern consisting of bright red-black spots on a whitish to yellowish background (Fig. 1). The snout-vent length may reach 115-125 mm in large specimens, with no size differences between sexes. However, males possess bilateral black thorny patches on the chest and bear a black thorn both at the outside of the first finger and at the base of the inner metacarpal tubercle.

*Leptodactylus laticeps* was recorded from the central and northern Chaco of Argentina to the Upper Chaco of Paraguay (CEI 1980, NORMAN 1994). Records from Bolivia (FROST 1985) still have to be confirmed (DE LA RIVA et al. 2000). Only scarce information about the natural history of the terrestrial and nocturnal frog is available

(VELLARD 1947, HEYER 1969, CEI 1980, NORMAN 1994, LAVILLA et al. 1995). It was reported to dwell in deep rodent holes in open landscape and to breed during the wet season by building foam nests. Additionally, warning and aggressive (fighting) behaviour is known, and the skin secretions can cause allergic reactions in humans, probably by the high content of histamine derivatives. With respect to the diet of the species, merely few statements like "it feeds preferably on the smaller frogs, *Leptodactylus bufonius*, abundant in its environment" (CEI 1980)," "coming out at night to hunt small frogs" (NORMAN 1994) or "les proies des adultes sont de petits Vertébrés (spécialement d'autres Anoures)" (LAVILLA et al. 1995) are available.

During recent faunistic studies in the Upper Chaco of Paraguay (e.g. ZIEGLER et al. 2002) it was therefore my aim to find out more details about the natural history and in particular the feeding ecology of *Leptodactylus laticeps*.

## 2 Material and methods

Field studies took place in the Paraguayan summer and rainy season, from January to early February 2001, in the Upper (Dry) Chaco in the surroundings of Filadelfia (22°21'S 60°02'W) and Toledo (22°21'S 60°20'W). Collected specimens are deposited in the Staatliche Naturhistorische Sammlungen Dresden, Museum für Tierkunde (MTD; MTD D 43509-43526); for details see ZIEGLER et al. (2002). To enlarge the sample size, specimens of *Leptodactylus laticeps* deposited in the Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK) were included in this study; six of the latter specimens (ZFMK 37734, 37735, 38563, 38979, 38980, 52980) were collected in the vicinity of Filadelfia, two specimens (ZFMK 47297, 50352) originating (according to their labels) from San Bernardino near the Para-

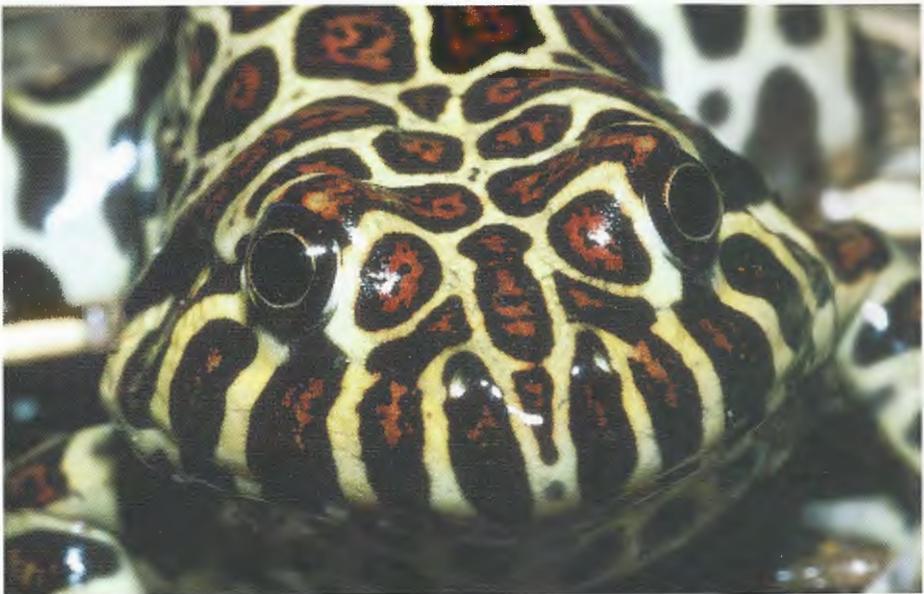


Fig. 1. The distinctive colour pattern of *Leptodactylus laticeps*.  
Das unverwechselbare Farbkleid von *L. laticeps*.

guayan capital Asunción, a locality bordering the eastern limits of the Lower (Wet) Chaco (see Fig. 2) and thus apparently representing one of the easternmost occurrences of the species.



Fig. 2. The location of Paraguay within South America (left), and localities of examined specimens of *Leptodactylus laticeps* (1: surroundings of Toledo; 2: surroundings of Filadelfia; 3: San Bernardino); the broken line indicates the border between the Upper (Dry) and Lower (Wet) Chaco in western Paraguay (according to NORMAN 1994).

Die Lage Paraguays innerhalb von Südamerika (links) mit den Fundorten der untersuchten Exemplare von *L. laticeps* (1: Umgebung von Toledo; 2: Umgebung von Filadelfia; 3: San Bernardino); die gestrichelte Linie zeigt die Grenze zwischen dem Oberen (Trockenen) und Unteren (Feuchten) Chaco in West-Paraguay an (nach NORMAN 1994).

Specimens recently collected in the Dry Chaco (MTD D 43509-43526) were fixed in 50-60 % ethanol and later preserved in 70 % ethanol. Measurements are in millimetres and were taken with a calliper rule in the manner described in the following: snout-vent length: from tip of snout to end of urostyle; mouth width: between outer corners of mouth. The outer corners were used because it was not possible to open the mouths of all ZFMK specimens, due to different fixation as well as conservation periods (specimens were collected between 1982 and 1991). However, to estimate the inner mouth width it was measured in five well preserved specimens. After measuring the preserved specimens, eggs and contents of the gastro-intestinal tracts were removed and deposited separately with collection numbers. Egg numbers were estimated by comparing the amount of 100 separately counted eggs with the remaining egg mass (compare ZIEGLER 2002: 40). Egg size and coloration as well as contents of the gastro-intestinal tracts were determined in the ethanol preserved state. To enlarge the prey item data base, not only stomach contents but also gut contents were analyzed (for the reasons of separate analyses see detailed discussion in chapter 4). To avoid multiple counting of fragments of prey specimens, exclusively heads were counted when items were present in high numbers, for example in ants or termites. Bilateral structures, such as fore wings (elytra) of beetles were also considered. Presented percentages of prey item numbers found in the gastro-intestinal tracts, mean values as well as standard deviations were rounded. Systematics of prey taxa largely follows CHINERY (1987) and STORCH & WELSCH (1991). Abbreviations are as follows: mm: millimetres; M: mean; n<sup>G</sup>: gut prey item numbers; n<sup>S</sup>: stomach prey item numbers; R: range; SD: standard deviation; SVL: snout-vent length.

### 3 Results

#### 3.1 Observations in the Upper (Dry) Chaco

In the field, specimens of *Leptodactylus laticeps* were found in typical Dry Chaco semi-xerophile thorn forest environment in the surroundings of medium-sized to large (up to 50 m in length) water bodies (Fig. 3). The frogs were usually found active at night on sparsely vegetated thorn forest floor around water bodies. Although not as abundant as other syntopic anurans as, for example, *Bufo granulatus* SPIX, 1824, it was possible to detect up to ten medium-sized *L. laticeps* (Fig. 4) within one late January night in the surroundings of the pond depicted in Fig. 3. Observations of reproductive behaviour failed, probably due to the lack of rain fall in the respective observation nights. Only two specimens were discovered during the day, hidden under a pile of firewood in shrub woodland. These medium-sized frogs were found together with larger invertebrates, such as scorpions, spiders and scolopenders, as well as several vertebrates, among them toads (*Bufo granulatus*), microhylid and leptodactylid frogs (*Dermatonotus muelleri* [BOETTGER, 1885], and *Physalaemus biligonigerus* [COPE, 1861 "1860"]), lizards (*Homonota horrida* [BURMEISTER, 1861], and *Tropidurus spinulosus* [COPE, 1862]), as well as a large rat (*Graomys griseoflavus* [WATERHOUSE, 1837]). For a complete list of amphibians, reptiles and mammals which were recorded syntopically with *L. laticeps* in the Dry Chaco see ZIEGLER et al. (2002).

#### 3.2 Measurements, sex, and egg numbers/sizes

All 18 specimens of *Leptodactylus laticeps* collected in the Paraguayan Dry Chaco between 14 and 30 January 2001 (MTD D 43509-43526) were of medium size (sub-adult) with SVL of 55 to 81 mm (M = 70.3, SD = 6.6). In these specimens the (outer)

mouth widths ranged from 25.5 to 35 mm ( $M = 31.1$ ,  $SD = 2.9$ ). In addition, the actual (inner) mouth width was measured in five specimens ( $R = 21-25$  mm,  $M = 23.8$ ,  $SD = 1.6$ ).

The frogs in the ZFMK collection were two medium-sized specimens ( $SVL = 79$  and  $88$  mm), one female ( $SVL = 101$  mm) and five males ( $SVL = 94-103$  mm,  $M = 98.6$ ,  $SD = 4.2$ ). Their (outer) mouth widths were 37-41 mm ( $M = 38.6$ ,  $SD = 1.7$ ) in the five males, 33-37 mm in the two medium-sized specimens (ZFMK 37735, 52980), and 40 mm in the female (ZFMK 47297). The single adult female, which had been collected in San Bernardino in January 1987, contained about 2000 pale eggs with a maximum diameter of 2 mm.

### 3.3 Stomach and gut contents

Of the 26 dissected specimens of *Leptodactylus laticeps* six stomachs (23.1 %) and three guts (11.5 %) were empty. Only a single gastro-intestinal tract (3.9 %) was completely empty. Of the remaining 20 stomachs and 23 guts with contents, 15 and 13 %, respectively, contained merely a pale to dark "paste" consisting of mud, tiny and therefore unrecognizable or largely digested prey fragments and apparently parts of the shed and eaten skin. In addition, stones, leaves, seed capsules, small branches and pieces of wood (up to 19 mm long), as well as further small plant material were found in eight (40 %) of the stomachs and in seven (30.4 %) of the guts with contents. Stones and plant fragments most probably were picked up passively by the frogs, because all stomachs and five guts also contained animal prey. Thus, of 26 specimens of *L. laticeps* dissected, merely 17 stomachs (65.4 %) and 18 guts (69.2 %) contained recognizable animal prey items. Worm-like endoparasites occasionally found in the gastro-intestinal tracts were not taken into account as prey.

Recognizable prey items accounted for a total of 235 specimens ( $n^S = 62$ ;  $n^G = 173$ ). Each stomach with contents held one to 20 prey items ( $M = 3.6$ ,  $SD = 5.1$ ), and each gut one to 34 prey items ( $M = 9.7$ ,  $SD = 11.5$ ). Among them were (in systematical order) two spiders (Araneae), seven diplopods (Diplopoda), 12 cockroaches (Blattodea), 172 termites (Isoptera), four crickets/grasshoppers (Saltatoria), two bugs (Heteroptera), 16 beetles (Coleoptera), most of them with strong fore wings, among others Curculionidae and Scarabaeoidea (Lamellicornia), seven hymenopterans (Hymenoptera), among them six ants (Formicidae) and one wasp, six undetermined insects (Insecta), among them two larvae, six anurans (Anura), at least four of them being *Bufo granulatus*, and one rodent (Rodentia). Percentages of prey items are presented in Figs. 5 and 6.

Reconstruction of prey sizes was not possible in all cases. Sporadic data are presented in the following (in systematical order): Of the two spider remains, one represented a large tarantula. The chelicerae of the male tarantula measured 14 mm, its fangs were 10 mm long. Two of the diplopods were 20 mm long, the widths of two other specimens were at least 3.5 mm. One of the smallest cockroaches was about 10 mm long, at least half of them were relatively large, with sizes up to 45 mm. The head widths of termites usually measured 1 to 3 mm, but soldiers had head lengths of up to 10 mm. Fragments of crickets/grasshoppers indicated at least one half of them having been relatively large. Both bugs measured merely 2 mm. 14 beetles were 10-30 mm long ( $M = 14.8$ ,  $SD = 5.5$ ). The largest beetle had mandibles of more than 3 mm lengths. Among hymenopterans, the single wasp measured 15 mm, and three ants 11 to 15 mm. The head width of another ant measured 3 mm. The two insect larvae were 11 and 26 mm long. Four of the anurans were identified, among other characters by their size, cephalic crests and small parotoid glands, as *Bufo granulatus*, with SVL



Fig. 3. Habitat of *Leptodactylus laticeps* at Toledo in the Dry Chaco during the rainy season (23 January 2001).

Habitat von *L. laticeps* in Toledo im Trocken Chaco zur Regenzeit (23. Januar 2001).

of 28.5-34 mm ( $M = 30.7$ ,  $SD = 2.9$ ). Of the two other, largely digested anurans, one leg length measured 16 mm. The remains of the single rodent, a small mouse, consisted of parts of fur and of the lower jaw, with an incisor tooth about 6 mm long and a first cheek tooth of about 1.2 mm length. A comparison of recorded as well as estimated maximum sizes (lengths) of prey taxa is shown in Fig. 7.

Among the vertebrate prey, a single anuran was found in the stomachs of six medium-sized specimens of *Leptodactylus laticeps* with SVL of 66-77 mm ( $M = 73.2$ ,  $SD = 3.9$ ). Only in two cases the anuran prey was the only content of the stomach, in the four other stomachs also plant fragments or seed capsules, as well as specimens or parts of cockroaches, termites, and / or beetles were found. The remains of the single mouse were found in the gut of the largest male (ZFMK 38979), together with plant fragments, as well as several diplopods, cockroaches, termites, crickets/grasshoppers, beetles, and ants.



Fig. 4. Medium-sized specimen of *Leptodactylus laticeps* from Toledo. Mittelgroßes Exemplar von *L. laticeps* aus Toledo. All photos: T. ZIEGLER.

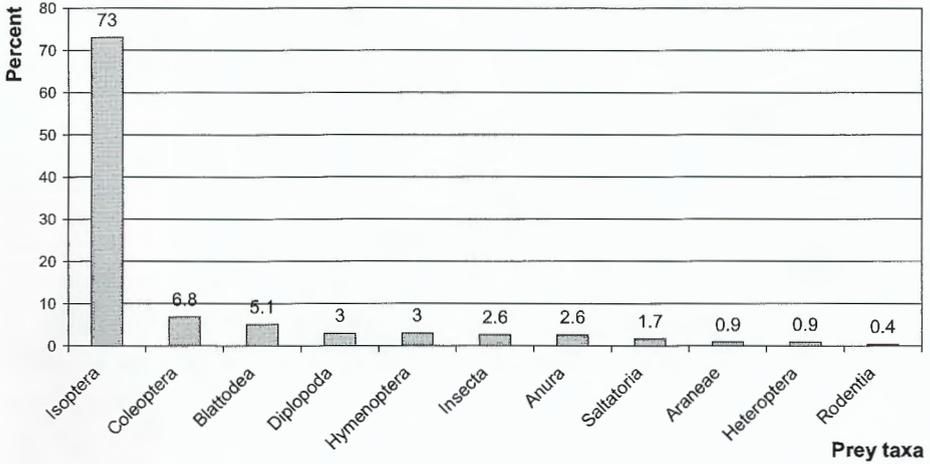


Fig. 5. Percentage of prey items found in the gastro-intestinal tracts of 26 examined specimens of *Leptodactylus laticeps*.  
 Prozentualer Anteil der in den Magen-Darm-Trakten der 26 untersuchten Exemplare von *L. laticeps* gefundenen Beutetiere.

The large, gravid female specimen had only a large cockroach of about 40 mm length in its gastro-intestinal tract (stomach), probably due to the large amount of eggs, which filled the body cavity.

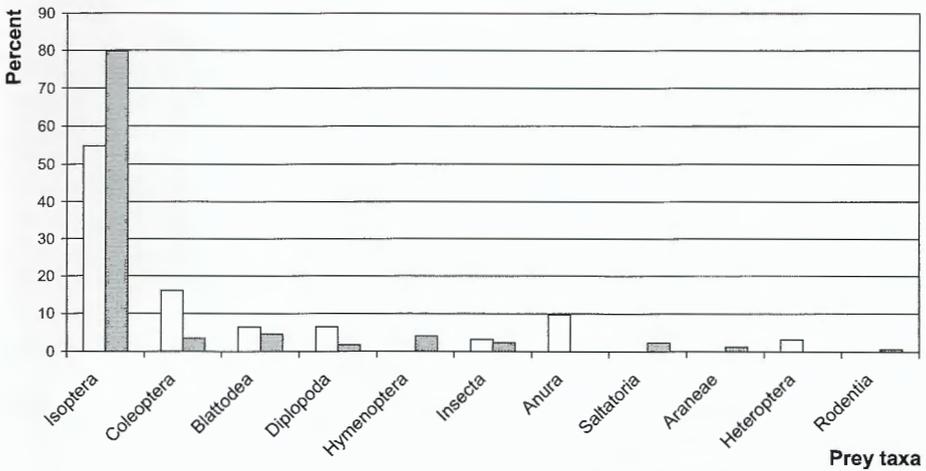


Fig. 6. Percentage of prey items found in the stomachs (white columns) and in the guts (grey columns) of 26 examined specimens of *Leptodactylus laticeps*.  
 Prozentualer Anteil der in den Mägen (weiße Säulen) und Darm-Trakten (graue Säulen) der 26 untersuchten Exemplare von *L. laticeps* gefundenen Beutetiere.

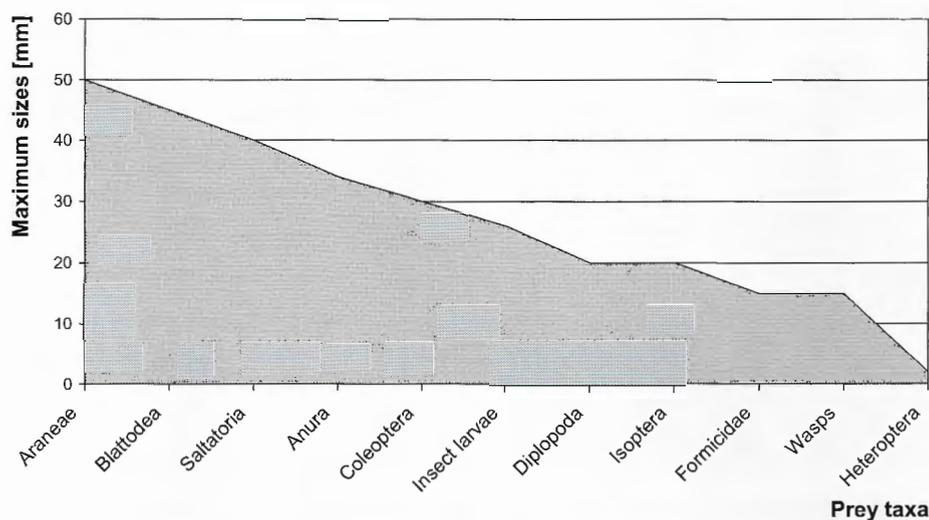


Fig. 7. Maximum sizes (lengths) of prey taxa found in the gastro-intestinal tracts of 26 examined specimens of *Leptodactylus laticeps*. Maximum sizes were measured in diplopods, cockroaches, bugs, beetles, hymenopterans, insect larvae, and anurans and estimated in spiders, termites, and crickets/grasshoppers. The single rodent is not included, because no appropriate size reconstruction was possible.

Maximale Größen (Längen) der in den Magen-Darm-Trakten der 26 untersuchten Exemplare von *L. laticeps* gefundenen Beutetaxa. Die Maximal-Größen wurden für Tausendfüßer, Schaben, Wanzen, Käfer, Hautflügler, Insektenlarven und Anuren gemessen sowie für Spinnen, Termiten und Springschrecken rekonstruiert. Der einzelne Nager ist nicht enthalten, da keine angemessene Größenrekonstruktion möglich war.

The most frequent prey items were termites. They were found in the gastro-intestinal tracts of 34.6 % of the frogs ( $n = 9$ ), mainly in medium-sized specimens. Only one adult frog (the largest male) had three termites in its gut among other prey. Termite numbers ranged from 1-18 ( $M = 8.5$ ,  $SD = 7.1$ ) in four stomachs and from 3-33 ( $M = 17.3$ ,  $SD = 12.1$ ) in seven guts. Also beetles were found in 34.6 % of the frogs ( $n = 9$ ), seven of them medium-sized and two frogs being adult males. Each one or two beetles were found in seven stomachs and four guts. Concerning the third major prey taxon, cockroaches were found in the gastro-intestinal tracts of 42.3 % of the specimens ( $n = 11$ ). In four stomachs a single cockroach was found, seven guts contained remains of 1-2 specimens.

#### 4 Discussion

Results of the gastro-intestinal tract dissections of the 26 medium-sized to adult specimens of *Leptodactylus laticeps* from the Paraguayan Gran Chaco did in general not contradict a preference for small anuran prey, as stated by CEI (1980), NORMAN (1994), and LAVILLA et al. (1995). However, the observed prey spectrum in the species is far more diverse.

Of a total of 235 recognizable prey specimens, merely seven were vertebrates. However, although vertebrate prey represents only 3 % of the total amount of prey

items, a comparison of body masses between vertebrate and invertebrate prey items (which was not possible due to the partly strong digestion of the specimens) would be in favour of the former. In addition, vertebrate prey items were found in seven (27 %) of the 26 dissected frogs, thus emphasizing the importance of vertebrates in their diet. The facts that CEI (1980) emphasized the importance of *Leptodactylus bufonius* as prey and that *Bufo granulosis* was eaten in the Dry Chaco (this study), suggest that common anurans substantially provide for prey. Apparently *B. granulosis* replaces the rarer *L. bufonius* in the study site.

Incidentally, the higher prey item amount in the guts (average 9.7 versus 3.6 in the stomachs) is put down to an accumulation of prey fragments that are hard to digest to not digestible. For this reason, and because gut contents usually do not contain easily digestible prey, and therefore have limited value in comparison with more diverse stomach contents, stomach and gut content data were presented separately. Therefore, the high percentages of termite prey items presented in Figs. 5 and 6 must be carefully interpreted. In addition, as already stated above, in Figs. 5 and 6 only percentages of prey item numbers are presented and not their respective masses. To visualize this in a direct comparison: six (relatively large) anuran prey items were found in six stomachs (23.1 %), but the much more smaller termites were only in four stomachs (15.4 %) with an average number of 8.5 either.

Apart from the field observations, also some of the prey taxa, for example cockroaches or the common lesser toads, confirmed *Leptodactylus laticeps* hunting at night on the ground of shrub woodland in the vicinity of water.

As the stomachs of both adult specimens from San Bernardino contained each a single cockroach, one of the most frequent prey found in the dissected specimens, I could not find significant differences in feeding ecology between specimens from the Upper and Lower Chaco region. In addition, I could not find major differences between the prey caught by medium-sized frogs and by large adults. *Leptodactylus laticeps* seems to be an opportunistic predator, which equally feeds on small invertebrates as termites as well as on larger animals, as adult tarantulas, anurans, and mice, provided that they can be overpowered and fit its mouth. Among invertebrate prey items, beside millipedes and spiders, insects were most abundant (at least six taxa) with termites, beetles and cockroaches in decreasing numbers being the most numerous prey items found in the gastro-intestinal tracts.

It is interesting to note that not only prey items of significantly different sizes, but also several potentially dangerous or venomous animals were caught, for example the large beetle with its strong mandibles, the wasp and the large tarantula with fangs of 10 mm, that was swallowed by an adult male of 94 mm SVL, anyhow. Anatomical or histological studies for example on the mucous membranes, could show whether special adaptations enable the species to ingest such potentially dangerous and / or venomous prey.

For comparison, preying on venomous arthropods, such as scorpions, is known for several amphibians of the genera *Bufo*, *Plethodontohyla*, *Pyxicephalus*, and *Scaphiopus* (POLIS et al. 1981, LOURENÇO et al. 1997) and even from another representative of the genus, *Leptodactylus pentadactylus* (LAURENTI, 1768), as described in LOURENÇO & CUELLAR (1995). Although scorpion feeding was neither observed in the field nor were respective items among the recognizable remains in the dissected specimens of *Leptodactylus laticeps*, preying on scorpions cannot be excluded from the data at hand, especially as the species is known to occur syntopically with several scorpion species (ZIEGLER & LOURENÇO 2002).

## Acknowledgements

I am indebted to the "Ludwig-Reichenbach-Gesellschaft e. V. (Förderverein der Staatlichen Naturhistorischen Sammlungen Dresden)" for substantially financing the first excursion of the Museum für Tierkunde Dresden to the Paraguayan Gran Chaco. Special thanks to JAKOB UNGER (Filadelfia/Winnipeg) and his family for their support while conducting field studies. Professor Dr. WOLFGANG BÖHME (ZFMK) as well as Dr. UWE FRITZ, Dr. EDGAR LEHR and Dr. MATTHIAS STÖCK (MTD) kindly loaned material under their care and thus made stomach content analyses possible. Last but not least I wish to thank MICHAEL FRANZEN (Neuching) and Dr. JÖRN KÖHLER (ZFMK) for commenting on the manuscript.

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Manuscript received: 16. September 2002

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