Helminth parasites and diet of *Leptodactylus petersii* (Steindachner, 1864) (Anura: Leptodactylidae) from Amapá state, Eastern Amazon, Brazil

A. E. OLIVEIRA-SOUZA¹, M. M. SALVIANO SANTANA¹, T. DOS SANTOS REIS², C. E. COSTA-CAMPOS¹, C. ALBUQUERQUE DE MIRANDA³, F. T. V. MELO¹

¹Laboratório de Herpetologia, Departamento de Ciências Biológicas e da Saúde, Universidade Federal do Amapá, Campus Marco Zero do Equador, 68903-419, Macapá, Amapá, Brazil; ²Laboratório de Zoologia, Departamento de Ciências Biológicas e da Saúde, Universidade Federal do Amapá, Campus Marco Zero do Equador, 68903-419, Macapá, Amapá, Brazil; ³Laboratório de Biologia Celular e Helmintologia “Profa Dra Reinalda Marisa Lanfredi” Instituto de Ciências Biológicas - Universidade Federal do Pará, Av. Augusto Corrêa 01 – Guamá Zipcode: 66075-110 – Belém, Pará, Brazil Fone: +55 (91) 3201-7890

Article info
Received April 10, 2020
Accepted May 20, 2020

Summary
*Leptodactylus petersii* is a species of anuran found in both terrestrial and aquatic habitats and occurs from South America to southern North America and the West Indies. Studies involving the fauna of anuran parasites offer complementary information related to ecology. Thus, since there are few studies on the natural history of this species, this research aims to analyze the diet and the presence of endoparasitic helminths of *Leptodactylus petersii* from the state of Amapá, Brazil. We found 10 different taxonomic categories of prey in stomach contents, with the categories Hymenoptera (Formicidae) with 32.26 % (n = 12) being the most representative. Among the 12 individuals of *L. petersii* that were analyzed for helminth parasites, 83.3 % were infected with at least one species of helminths allocated to Phylum Nematoda. Our results report a new occurrence site for *Rhabdias breviensis*, originally described for *Leptodactylus petersii* in the state of Pará, as well as the second report of *Ortleppascaris* sp. in Brazil.

Keywords: Leptodactylidae; diet; nematodes, Amazon

Introduction
Studies about the parasite fauna of anurans may offer complementary information related to the ecology, behavior and feeding habits of the host, revealing the trophic interactions between the host and the environment, especially when considering that the life cycle of many parasite species are strictly linked to the food web interactions (Marcogliese, 2004; Dobson et al., 2008). Thus, information about feeding habits and parasite infection are important aspects of interactions between the anuran and the environment. *Leptodactylus petersii* (Steindachner, 1864) is an anuran species found in many habitats, both terrestrial and aquatic, and occurs from South America to the south of North America and in Ocidental Indias (Lima et al., 2006). *L. petersii* is allocated in the species group *Leptodactylus melanotus* and is characterized by having snout vent length varying between 32 to 40 mm for males and between 35 to 45 mm for females, being of nocturnal habits and dwelling in forests and flooded pastures, occurring in the Amazon and in the Guiana shield region (De Sá et al., 2014).

As there are scarce studies about the natural history of this species, this research aims to present and describe the endoparasite helminth composition and the diet of *Leptodactylus petersii* from the state of Amapá, Brazil.

Material and Methods

Study area and sampling
The specimens of *Leptodactylus petersii* were manually collected in floodplain areas, located in the state of Amapá. These areas are found mainly in river margins determined by the tides, char-
characterized for having a nutrient rich soil, however, they are fragile environments with origins linked to sediments deposition. These environments are used in plant extraction and, in the state of Amapá, the widest floodplain forests occur along with the amazonic waterfront (Amapá, 2002). From September 2017 until June 2018, 87 L. petersii individuals were collected through active and acoustic search (Heyer et al., 1994).

Parasite collection and identification
Among 87 individuals, 12 were sent to the laboratory of Zoology of the Federal University of Amapá, where their weight and length were measured with a caliper (Mitutoyo®) and scales. The frogs were euthanized, and all their organs were dissected and analyzed for collection of gastrointestinal contents and endoparasites. The helminths found were killed with 70 % alcohol preheated at 85°C and preserved in the same solution at room temperature. All helminths collected were cleared in Aman Lactophenol and mounted in temporary microscope slides. The identification of the helminths was performed using taxonomic keys proposed by Anderson, (2000) and Vicente et al., (1991) and species original description articles.

Diet composition analysis
The remaining 75 collected specimens went through the stomach flushing technique, which consists in stomach washing with the purpose of analyzing the diet items consummed by the individuals (Solé et al., 2005), and were later returned to nature. Regarding the diet, the stomach contents were analyzed under stereomicroscope and the identification of the preys in the samples was done with the aid of the identification key proposed by Rafael et al., (2012) and the volume was measured through the ellipsoid formula (Magnusson et al., 2003), where \( V \) represents prey volume, \( l \) = item length and \( w \) = item width.

\[
V = \frac{4}{3} \pi \left( \frac{l}{2} \right) \left( \frac{w}{2} \right)^2
\]

The Importance Value Index (IVI) was also measured, through the equation below (Where IVI = Importance Value Index; \( F\% \) = occurrence frequency; \( N\% \) = numerical frequency; \( V\% \) = volumetric frequency of each prey category in the diet):

\[
IVI = \left( \frac{F\% + N\% + V\%}{3} \right)
\]

The level of specificity of the diet was analyzed using the Levins Index (Pianka, 1986), where results from 0-0.50 show diet specificity and values from 0.51-1.00 show generalist feeding habits. Where \( B \) =Levins index (trophic niche breadth); \( i \) = prey category; \( n \) = number of categories; \( p_i \) = numerical or volumetric proportion of the category of prey \( i \) in the diet.

\[
B = \frac{1}{\sum_{i=1}^{n} p_i^2}
\]

The correlations between body variables and largest prey volume from each individual were done through simple linear regression according to Zar (1999). We used 0.05 as the significance threshold.

| Prey item | N | N (%) | F | F (%) | V | V (%) | IVI |
|-----------|---|-------|---|-------|---|-------|-----|
| Phylum Arthropoda | | | | | | | |
| Class Arachnida | | | | | | | |
| Acari | 8 | 22.86 | 7 | 22.58 | 0.78 | 0.41 | 15.28 |
| Diptera | 1 | 2.86 | 1 | 3.23 | 0.36 | 0.19 | 2.09 |
| Collembola | 1 | 2.86 | 1 | 3.23 | 0.03 | 0.02 | 2.03 |
| Coleoptera | 7 | 20.00 | 6 | 19.35 | 52.52 | 27.55 | 22.30 |
| Hymenoptera | 1 | 2.86 | 1 | 3.23 | 8.57 | 4.50 | 3.53 |
| Formicidae | 12 | 34.29 | 10 | 32.26 | 9.36 | 4.91 | 23.82 |
| Coleoptera larvae | 1 | 2.86 | 1 | 3.23 | 40.92 | 21.47 | 9.18 |
| Diptera larvae | 2 | 5.71 | 2 | 6.45 | 16.28 | 8.54 | 6.90 |
| Orthoptera | 1 | 2.86 | 1 | 3.23 | 7.31 | 3.83 | 3.31 |
| Class Malacostraca | | | | | | | |
| Isopoda | 1 | 2.86 | 1 | 3.23 | 54.5 | 28.59 | 11.56 |
| Total | 35 | 100 | 31 | 100 | 190.63 | 100 | 100 |

Table 1. Number of items found in the diet (N%), occurrence (F%), volume (V%) and Importance Value Index (IVI) in the diet of Leptodactylus petersii.
Results

We collected 87 individuals (36 adults and 51 juveniles), with the 36 adults showing SVL of 17.56 – 46.85 mm (33.77 ± 6.53 mm) and weighting 0.5 – 11.00g (4.23 ± 2.55g), while the 51 juvenile individuals had SVL of 13.38 – 26.5 mm (16.37 ± 2.30 mm) and weighted 0.2 – 1.6 g (0.48 ± 0.22 g).

Out of the 87 *Leptodactylus petersii*, 64 (73.6 %) had empty stomachs and only 23 (26.4 %) had at least one diet item in their gastrointestinal content. These consumed 10 different taxonomic categories of preys, but Hymenoptera (Formicidae) and Acari had the highest frequency in the diet of *L. petersii*, representing 32.26 % (n=12) and 22.58 % (n=8), respectively of prey items. Though, when it comes to volume, Isopoda (28.59 %) contributed with the highest volume in the diet, followed by Coleoptera (27.55 %). The Importance Value Index (IVI) shows that the most representative category was Hymenoptera (Formicidae) with 23.82 % (Table 1).

The niche width value was 0.39.

We did not find significant correlation between SVL and prey volume (r=0.2402, p=0.2695) and between mandible width and prey volume (r=0.2443, p=0.2613), however, the correlation between the weight of the animal and volume of the largest prey consumed was significant (r=0.4322, p=0.0394).

Among the 12 *L. petersii* individuals that were analyzed for helminths parasites, 83.3 % were infected by at least one helminth species of Nematoda, no other groups of parasites were found. In total, 12 nematodes of three taxa were found, with prevalence and abundance of female Cosmocercidae gen. sp. (7 out 12; 58.3 % of prevalence) collected from the large and small intestines, followed by *Rhabdias breviensis* (4 out of 12; 33.3 %) from the lungs and one host was infected by *Ortheppascari* sp. larvae found encysted in the liver tissue.

Discussion

The individuals consumed some preys like the ones found in the work by Teles et al., (2018), where the diet of *Leptodactylus macrostemum* was analyzed and had the categories Coleoptera and Hymenoptera (Formicidae) as the most frequent items. The diet of these specimens showed similarities with various works involving the diet of Leptodactylids, such as the work by Piatti & Souza (2011), which showed the Orders Coleoptera and Hymenoptera as the most frequent for *Leptodactylus podicipinus* individuals from a rice field in the wetlands.

In this study, we observed differences in relation to previous studies, for instance, the one by Ceron et al., (2018), which also analyzed the diet of *Leptodactylus podicipinus*, belonging to the same *Leptodactylus melanontus* species group, where the prey category with the highest IVI was Coleoptera; however, the *L. petersii* individuals analyzed in this study had Hymenoptera (Formicidae) as the most representative item.

Regarding the niche width value (0.39), it can be related to the availability of ants in the environment, as those have a great biomass in the tropical forests (Holdobler & Wilson, 1990), becoming then, the most consumed item by the individuals. The majority of Leptodactylidae species have generalist habits and are sit and wait foragers, feeding of large and soft body preys, but that is not the case with *L. petersii*, that fed mainly of ants and mites. Records of ants in the diet of species from of the Genus *Leptodactylus* are also found in the work by Ferreira et al., (2007), about the diet of *L. natalenses*. These differences between diets of species of Leptodactylids can be attributed to the availability of preys, reflecting a generalist behavior in this species. Therefore, there is no feeding pattern for this group, as opposing to the observed in Dendrobatids, which showed preference for a determined type of prey (Toft, 1980; Grant et al., 2006).

We did not observe significant correlation between SVL and volume and mandible width and volume, presenting that both variables do not influence in the volume of the prey, which may be related to the type of prey consumed and, this type of influence may be much more common in frogs that feed of larger preys than in those that consume smaller preys, such as ants and mites, which is also observed in the work by Camera et al., (2014), where the authors also did not find significant correlation between SVL of *L. mystaceus* and prey volume. The correlation between weight of animal and volume showed different results, as it was significant.

In our study we found only nematodes and an incredibly low parasite species richness (three species), and the reduced parasite species richness among *Leptodactylus* spp. was also observed by Goldberg et al., (2009), that found only two species of nematodes when they surveyed parasites from 31 specimens of *L. petersii* (C. podicipinus with 52 % of prevalence and Physaloptera larvae 23 % of prevalence) collected in Tocantins state, Brazil and also Bursey et al. (2001) that reported only Cosmocerca brasiensi infecting *L. petersii* from Peru.

In other hand, some authors reported a higher parasite diversity when studying the parasite community of Leptodactylids, for instance Goldberg et al., (2002) studying the parasite fauna of *Leptodactylus melanontus* (same species group for *L. petersii*) found 11 different species of parasites and the studies performed by Campião et al., (2012, 2014, 2016) Hamann et al., (2012), González & Hamann, (2006), González & Hamann, (2016), Teles et al., (2014) found an average of 12 species of helminths infecting different *Leptodactylus* spp. hosts.

According to Campião et al., (2015) the main determinants of parasite richness are related to the anurans body size. However, if we compare the body size and parasite richness of hosts studied by those authors, it’s possible to observe that they all belong to small
moderate body size, indicating that other factors might be influencing in the parasite richness of Leptodactylus spp. from those studies. For example, another important determinant of parasite richness is the host habitat (Bush et al., 1990; Campião et al., 2016), and this might be related to the differences found in studies performed in Amazon Region (present study, Bursey et al., 2001 and Goldberg et al., 2009) and in other regions, considering that fragmentation and habitat differences can be a factor influencing the parasitic community (Gibb & Hochuli, 2002; Hamann et al., 2006). We also observed females of Cosmocercidae gen. sp. as the adults, 2006). We also observed females of Cosmocercidae gen. sp. as the contamination and habitat differences can be a factor influencing the parasitic community and this might be related to the differences found in studies performed in Amazon Region (present study, Bursey et al., 2001 and Goldberg et al., 2009). Although the life cycle of these nematodes is yet to be known, the presence of these larvae in anurans suggests that the infection route for these helminths is through the ingestion of the prey, which indicates that the anurans participate as potential intermediate/paratenic hosts. The parasites recorded for L. petersii up until this moment are Cosmocerca podicipinus, Physaloptera sp. in Tocantins (Goldberg et al., 2009), Rhabdias breviensis from the Breves municipality, Pará (Nascimento et al., 2013), and Cosmocerca brasilienise in the reserve of Cuzco, in the Peruvian Amazon (Bursey et al., 2001). Thus, our results report a new occurrence location for Rhabdias breviensis, as well as the second report of larvae of Ortleppascaris sp. in Brazil, raising the hypothesis that these anurans are acting as intermediate/paratenic hosts in the life cycle of these parasites.

Conflict of Interest
The authors declare that they have no conflict of interest.

Acknowledgements
We thank Instituto Chico Mendes de Conservação da Biodiversidade (SISBIO/ICMBio # 48102-2), for issued permits. We are also grateful to Universidade Federal do Amapá and Universidade Federal do Pará for their support. This work was supported by PPG-BAIP/UFPA the National Council for Scientific and Technological Development (CNPq) (grant number 431809/2018-6 Universal); CNPq Research grant productivity to MELO, F. T. V. (Process Nº 304955/2018-3)

References
AMAPA – INSTITUTO DE PESQUISAS CIENTÍFICAS E TECNOLÓGICAS DO ESTADO DO AMAPÁ (2002): Macrodiagnóstico do estado do Amapá: primeira aproximação do zoneamento ecológico econômico [Macrodiagnosis of the state of Amapá: first approach to ecological economic zoning]. Macapá, Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá, Zoneamento Ecológico Econômico, 140 pp. (In Portuguese)

ANDERSON, R.C. (2000): Nematode Parasites of Vertebrates, their Development and Transmission. 2nd Edition, Wallingford, UK, CABI Publishing, 650 pp.

ANDERSON, R.C., CHABAUD, A.G., WILLMOTT, S. (2009): Keys to the Nematode Parasites of Vertebrates: Archival Volume. London, CAB International, 463 pp.

BURSEY, C.R., GOLDBERG, S.R., PARMELEE, J.R. (2001): Gastrointestinal helminths of 51 species of anurans from Reserva Cuzco Amazónico, Peru. Comp. Parasitol., 68: 21 – 35. DOI: 10.1654/4132

BUSH, A.O., AHO, J.M., KENNEDY, C.R. (1990): Ecological versus phylogenetic determinants of helminth parasite community richness. Evol. Ecol., 4: 1 – 20. DOI: 10.1007/BF02270711

BUSH, A.O., LAFFERTT, K.D., LOTZ, J.M., SHOSTAK, A.W. (1997): Parastology meets ecology on its own terms: Margolis et al. revisited. J. Parasitol., 83: 575 – 583. DOI: 10.2307/3284227.

CAMERA, B., KRINSKI, D., CALVO, I. (2014): Diet of the Neotropical frog Leptodactylus mystaceus (Anura: Leptodactylidae). Herpetol. Notes, 7: 31 – 36

CAMPIÃO, K.M, MORAIS, D.H., DIAS, O.T., TOLEDO, AGUIAR, A., TOLEDO, G., TAVARES, L.E.R., SILVA, R.J. (2014): Checklist of Helminth parasites of Amphibians from South America. Zootaxa, 3843: 1 – 93. DOI: 10.11646/zootaxa.3843.1.1

CAMPIÃO, K.M, RIBAS, A.C.A, MORAIS, D.H., SILVA, R.J.T. (2015): How many parasites species a frog might have? determinants of parasite diversity in South American anurans. Plos One, 10(10): e0140577. DOI: 10.1371/journal.pone.0140577

CAMPIÃO, K.M, SILVA, I.C.O., DALAZEN, G.T., PAINA, F., TAVARES, L.E.R. (2016): Helminth Parasites of 11 Anuran Species from the Pantanal Wetland, Brazil. Comp. Parasitol., 83: 92 – 100. DOI: 10.1654/1525-2647-83.1.92

CAMPIÃO, K.M, SILVA, R.J.; FERREIRA, V.L. (2012): Helminth parasite communities of allopatric populations of the frog Leptodactylus podicipinus from Pantanal, Brazil. J. Helminthol., 88: 1 – 7. DOI: 10.1017/S0017563512000557

CERON, K., MOROTI, M.T., BENÍCIO, R.A., BALBOA, Z.P., MARÇOLA, Y., PEREIRA, L.B., SANTANA, D.J. (2018): Diet and first re-
port of batrachophagy in Leptodactylus podicipinus (Anura: Leptodactylidae). Neotrop. Biodivers., 4: 70 – 74. DOI: 10.1080/23766808.2018.1467173

De Sá, R.O., Grant, T., Camargo, A., Heyer, W.R., Ponssa, M.L., Stanley, E. (2014): Systematics of the Neotropical Genus Leptodactylus Fitzinger, 1826 (Anura: Leptodactylidae): Phylogeny, the Relevance of Non-molecular Evidence, and Species Accounts. S. Am. J. Herpetol., 9: 1 – 128. DOI: 10.2994/SAJH-D-13-00022.1

Dobson, A., Lafferty, K.D., Kuris, A.M., Hechinger, R.F., Jetz, W. (2008): Homage to Linnaeus: how many parasites? How many hosts? Proc. Natl. Acad. Sci. U.S.A., 105 (2008): 11482 – 11489. DOI: 10.1073/pnas.0803232105

Ferreira, R.B., Dantas, R.B., Teixeira, R.L. (2007): Reproduction and ontogenetic diet shifts in Leptodactylus natalensis (Anura, Leptodactylidae) from southeastern Brazil. Bol. Mus. Biol. Mello Leitão, 22: 45 – 55

Gibb, H.; Hochuli, D.F. Habitat fragmentation in an urban environment: large and small fragments support different arthropod assemblages. Biol. Conserv., v. 106, n. 1, p. 91-100, 2002. DOI: 10.1016/S0006-3207(01)00232-4

Goldberg, S.R., Bursey, C.R., Salgado-Maldonado, G., Baez, R., Caneda, C. (2002): Helminth parasites of six species of anurans from Los Tuxtlas and Catemaco Lake, Veracruz, Mexico. South. Nat., 47, 293 – 329. DOI: 10.2307/3672917

Goldberg, S.R., Bursey, C.R., Aquino-Shuster, A.L. (1991): Gastric nematodes of the Paraguayan caiman, Caiman yacare (Alligatoridae). J. Parasitol., 77(6): 1009 – 1011. DOI: 10.2307/3282758

Goldberg, S.R., Bursey, R.C., Caldwell, J.P., Shepardo, D.B. (2009): Gastrointestinal helminths of six sympatric species of Leptodactylus from Tocantins State, Brazil. Comp. Parasitol., 76: 258 – 267. DOI: 10.1654/4368.1

González, C.E., Hamann, M.I. (2006): Helminthos parasitos de Leptodactylus bufonius Bouleangher, 1894 (Anura: Leptodactylidae) de Corrientes, Argentina. Rev. Esp. Herp., 20: 39 – 46.

González, C.E., Hamann, M.I. (2007): Nematode parasites of two species of Chaunus (Anura: Bufonidae) from Corrientes, Argentina. Zootaxa, 1393: 27 – 34. DOI: 10.11646/zootaxa.1393.1.3

González, C.E., Hamann, M.I. (2016): Nematode Parasites of Leptodactylus elenae and Leptodactylus podicipinus (Anura: Leptodactylidae) from Corrientes, Argentina. Comp. Parasitol., 83(1): 117 – 121. DOI: 10.1654/1525-2647-83.1.117

Grant, T., Frost, D.R., Caldwell, J.P., Gagliardo, R.O.N., HadDAO, C.F.B., KOK, PJ., Wheeler, W.C. (2006): Phylogenetic systematics of dart-poison frogs and their relatives (Amphibia: Athesphatanura: Dendrobatidae). Bull. Am. Mus. Nat. Hist., 299: 1 – 262. DOI: 10.5531/sd.sp.14

Hamann, M.I., González, C.E., Kehr, A.I. (2006): Helminth community structure of the oven frog Leptodactylus latinasus (Anura, Leptodactylidae) from Corrientes, Argentina. Acta Parasitol., 51:294 – 299. DOI: 10.2478/s11686-006-0045-1

Hamann, M.I., Kehr, A.I., González, C.E. (2012): Community structure of helminth parasites of Leptodactylus bufonius (Anura: Leptodactylidae) from northeastern Argentina. Zool. Stud., 51(8): 1454 – 1463

Heyer, W.R., Donnelly, M.A., Mcdiarmid, R.W., Hayek, L.A.C., Foster, M.S. (1994): Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians. Biological Diversity Handbook Series. Washington, Smithsonian Institution Press, 384 pp.

HoldoBlner, B., Wilson, E.O. (1990): The Ants. Cambridge, Belknap Press of Harvard University Press, 732 pp.

Leivas, P.T., Leivas, F.W.T., Câmpio, K.M. (2018): Diet and parasites of the anuran Physalaemus cuvieri Fitzinger, 1826 (Anura: Leuviuridae) from an Atlantic Forest fragment. Herpetol. Notes, 11: 109 – 113

LimA, A.P., Magnusson, W.E., Menin, M., Ermann, L., Rodrigues, D.J., Keller, C., Ho, W. (2006): Guia de sapos da Reserva Adolpho Ducke, Amazônia Central [Frog guidebook of AdolpAmu Ducke Reserve, Central Amazon]. Manaus, Attempa Design Editorial, 168 pp. (In Portuguese)

Magnusson, W.E., LimA, A.P., SilvA, W.A., Araujo, M.C. (2003): Use of geometric forms to estimate volume of invertebrates in ecological studies of dietary overlap. Copo, 2002: 13 – 19. DOI: 10.1643/0045-8511(2003)003(0013:UOGFTE)2.0.CO:2

MarchGuesse, D.J. (2004): Parasites: Small Players with Crucial Roles in the Ecological Theater. EcoHealth, 2: 151 – 164. DOI: 10.1007/s10393-004-0028-3

MoraVeC, F., Kaiser, H. (1995): Helminth parasites from West Indian frogs, with descriptions of two new species. Caribb. J. Sci., 31: 252 – 268

NASAcmen, L.C.S., GonçAlves, E.C., Melo, F.T.V., GiseE, E.G., furtado, A.P., santos, J.N. (2013): Description of Rhabdias breviensis n. sp. (Rhabditoidea: Rhabdiasidae) in two Neotropical frog species. Syst. Parasitol., 86: 69 – 75. DOI: 10.1007/s11230-013-9432-9

PAnka, E.R. (1986): Ecology and natural history of desert lizards. New Jersey, Princeton University Press, 222 pp.

Piatti, L., Souza, F.L. (2011) Diet and resource partitioning among anurans in irrigated rice fields in Pantanal, Brazil. Braz. J. Biol., 71: 653 – 661. DOI: 10.1590/S1519-69842011000400009

Price, P.W. (1990): Host populations as resources defining parasite community organization. In: Esch, G.W., Bush, A.O., AhO J.M. (Eds) Parasite communities: patterns and processes. Springer, Dordrecht, pp. 21 – 40

PelzaC, J.A., Melo, G.A.R., carvalho, C.J.B., Casari, S.A., ConstanTino, R. (2012): Insetos do Brasil: Diversidade e Taxonomia [Insects of Brazil: Diversity and Taxonomy]. Ribeirão Preto, Holos, 795 pp. (In Portuguese)

Silva, J.P., Melo, F.T.V., Silva, L.C.N., GonçAlves, E.C., GiseE, E.G., furtado, A.P., santos, J.N. (2013); Morphological and Molecular Characterization of Orleppascaris sp. Larvae. Parasites of the Cane Toad Rhinella marina from Eastern Amazonia. J. Parasitol., 99:118 – 123. DOI: 10.1645/GE-3203.1

Sole, M., Beckmann, O., Pelz, B., Kvet, A., Engels, W. (2005): Stomach-flushing for diet analysis in anurans: an improved
protocol evaluated in a case study in Araucaria forests, southern Brazil. *Stud. Neotrop. Fauna Environ.*, 40: 23 – 28. DOI: 10.1080/01650520400025704

Sprunt, J.F.A. (1978): Ascaridoid nematodes of amphibians and reptiles: *Gedoelstascaris* n. g. and *Ortleppascaris* n. g. *J. Helminthol.*, 52: 261 – 282. DOI: S0022149X00005460

Teles, D.A., Cabral, M.E.S., Araujo-Filho, J.A., Dias, D.Q., Avila, R.W., Almeida, W.O. (2014): Helminths of *Leptodactylus vastus* (Anura: Leptodactylidae) in an area of Caatinga, Brazil. *Herpetol. Notes*, 7: 355 – 356

Teles, D.A., Rodrigues, J.K., Teixeira, A.M., Araujo-Filho, J.A., Sousa, J.G.G., Ribeiro, S.C. (2018): Diet of *Leptodactylus macrosternum* (Miranda-Ribeiro 1926) (Anura: Leptodactylidae) in the Caatinga domain, Northeastern Brazil, Neotropical Region. *Herpetol. Notes*, 11: 223 – 226

Toft, C.A. (1980): Feeding ecology of thirteen syntopic species of anurans in a seasonal tropical environment. *Oecologia*, 45: 131 – 141. DOI: 10.1007/BF00346717

Vicente, J.J., Rodrigues, H.O., Gomes, D.C., Pinto, R.M. (1991): Nematóides do Brasil. Parte II: nematóides de anfíbios [Brazilian Nematodes. Part II: Nematodes of Amphibians]. *Rev. Bras. Zool.*, 7: 549 – 626. DOI: 10.1590/S0101-817519900000400015 (In Portuguese)

Waddle, A.R., KinSELLA, J.M., Ross, J.P., Rojas-Flores, E., Percival, H.F., Forrester, D.J. (2009): Nematodes collected by gastric lavage from live American alligators, *Alligator mississippiensis*, in Florida. *J. Parasitol.*, 95: 1237 – 1238. DOI: 10.1645/GE-1989.1.

Zar, J.H. (1999): *Biostatistical analysis*. 3rd Edition, Upper saddle river, New Jersey, Prentice Hall, 662 pp.