Short Note

Diet and parasite communities of two lizard species, *Plica plica* and *Plica umbra* from Brazil and Ecuador

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Plica plica and *Plica umbra* from Brazil and Ecuador were examined for endoparasites. *Plica plica* harboured one species of Digenea, *Mesocoelium monas*, four species of Nematoda, *Oswaldocruzia vitti*, *Physalopteroides venancioi*, *Strongyluris oscari* and *Physaloptera retusa*; *P. umbra* harboured five species of Nematoda, *Oswaldocruzia bainae*, *Oswaldocruzia vitti*, *Physaloptera retusa*, *Strongyluris oscari* and *Piratuba digiticauda*. Three new host records are reported for *P. plica* and three for *P. umbra*. Both lizard species are ant specialists but do eat other types of prey. We speculate on sources of endoparasites based on the diets of these two arboreal tropical lizards.

Key words: helminth communities, Squamata, Tropiduridae

Plica plica Linnaeus, 1758 is known from northern South America (Brazil, Guyana, Peru, Surinam); *P. umbra* Linnaeus, 1758 occurs in Brazil, Guyana, Surinam, Ecuador, Peru and Venezuela (Avila-Pires, 1995). Both are myrmecophagous, scansorial, arboreal lizards (Vitt, 1991; Vitt et al., 1997). To our knowledge there is one report of helminths for these species (Bursey et al., 2005). The purpose of this report is to revise the helminth list for both species and to compare helminth infections within populations of these lizards from Brazil, Ecuador and Peru. Because the source of three of the endoparasites of these lizards are dietary, we present a summary of the diets of these two lizard species.

Twenty-five *P. plica* specimens (mean snout–vent length [SVL] = 107.1 mm ±36.2 SD, range 47–153 mm) from Brazil and 25 *P. umbra* (SVL = 84.1 mm ±6.0 SD, range 72–95 mm) from Brazil, plus two *P. umbra* from Ecuador (range 78–83 mm), were borrowed from the herpetology collection of the Sam Noble Oklahoma Museum of Natural History (OMNH), Norman, Oklahoma, USA and examined for helminths. Stomachs from these lizards had previously been removed and were not available for parasite examination. We employed Sorensen's index to compare the number of parasite species shared by *P. plica* and *P. umbra* (Brower et al., 1998). Collection localities are as follows: *P. plica*, Brazil, Acre state, *n*=7 (OMNH 37035-41), collected 1996; Amazonas state, *n*=2 (OMNH 37174-75), collected 1997; Pará state, *n*=6 (OMNH 36624-29), collected 1999; Rondônia state, *n*=10 (OMNH 37488-91, 37495-97, 37499-501), collected 1998; *P. umbra*, Brazil, Acre state, *n*=3 (OMNH 37042-44), collected 1996; Amazonas state, *n*=10 (OMNH 37176-181, 37738-39, 37741-42), collected 1997; Pará state, *n*=9 (OMNH 36615-23), collected 1995; Rondônia state, *n*=3 (37502-04), collected 1998; Ecuador, Sucumbios province, *n*=2 (OMNH 36395-96), collected 1994.

We also assembled data for 107 individual *P. plica* and 60 *P. umbra* from the above localities (same dates) that had contained prey in their stomachs. Stomachs of these lizards had been removed, opened, prey items spread on a petri dish, separated, counted, identified and measured for length and width. We calculated volumes of individual prey with the formula for an oblate spheroid:

$$V = \frac{4}{3}\pi\left(\frac{length}{2}\right)\left(\frac{width}{2}\right)^2$$

We also used the program BugRun, a 4th Dimension®-based analysis that produces dietary summaries, calculates mean prey size (length, width and volume) for each lizard, estimates stomach volume based on total prey volume and calculates niche breadth using the inverse of Simpson's diversity measure (Pianka, 1973, 1975, 1986; Simpson, 1949):

$$\beta = \frac{1}{\sum_{i=1}^{n} p_i^2}$$

where p is the proportional utilization of each prey type i. Niche breadth values (β) vary from 1 (exclusive use of a single prey type) to n (even use of all prey).

Lizards used for parasite examination had originally been fixed in 10% formalin and stored in 70% ethanol. The small intestine, large intestine and lungs were removed and searched for helminths using a dissecting microscope. Each nematode was cleared in glycerol on a glass slide and identified with a light microscope. Digeneans were regressively stained in hematoxylin, mounted in Canada balsam and examined as whole mounts. *Plica plica* was found to harbour one species of Digenea, *Mesocoelium monas* (Rudolphi, 1819) and four species of Nematoda, *Oswaldocruzia vitti* Bursey and Goldberg, 2004, *Physalopteroides venancioi* (Lent, Freitas and Proenca, 1946), *Strongyluris oscari* Travassos, 1923 and *Physaloptera retusa* Rudolphi, 1819; *P. umbra* was found to harbour five species of Nematoda, *Oswaldocruzia bainae* Ben Slimane and Durette-Desset, 1996,

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Table 1. Quantitative descriptions of parasite populations of *Plica plica* and *P. umbra* from Brazil, Ecuador and Peru. Data for Peru from Bursey et al. (2005).

	Plica plica				*Plica umbra*			
Collection locality	No.	Prevalence	Mean intensity	Range	No.	Prevalence	Mean intensity	Range
BRAZIL								
Acre								
Oswaldocruzia vitti	1	14 1/7	1	–	–	–	–	–
Physaloptera retusa	1	14 1/7	1	–	4	33 1/3	4	–
Physalopteroides venancioi	1	14 1/7	1	–		–	–	–
Strongyluris oscari	2	28 2/7	1	–	9	67 2/3	4.5±0.7	4–5
Amazonas								
Physaloptera retusa	4	50 1/2	4	–	6	10 1/10	6	–
Piratuba digiticauda	–	– 0/2	–	–	1	10 1/10	1	–
Strongyluris oscari	75	100 2/2	37.5±3.5	35–40	40	60 6/10	6.7±4.5	1–13
Pará								
Oswaldocruzia vitti	6	50 3/6	2.0±.7	1–4	4	18 2/9	2.0±1.4	1–3
Physaloptera retusa	4	33 2/6	1.3±0.6	1–2	5	18 2/9	2.5±0.7	2–3
Strongyluris oscari	12	67 4/6	3.0±1.8	1–5	4	18 2/9	2.0±1.4	1–3
Rondônia								
Mesocoelium monas	192	20 2/10	96.0±134.4	1–191	–	–	–	–
Oswaldocruzia vitti	9	60 6/10	1.5±0.84	1–3	3	66 2/3	1.5±0.7	1–2
Physaloptera retusa	7	30 3/10	2.3±2.3	1–5	6	66 2/3	1.5±0.7	2–4
Strongyluris oscari	238	60 6/10	39.7±38.5	3–98	–	–	–	–
ECUADOR								
Sucumbios								
Oswaldocruzia bainae	No hosts examined				3	50 1/2	3	–
Strongyluris oscari					1	50 1/2	1	–
Rhabdias sp.					1	50 1/2	1	–
PERU								
Madre de Dios								
Physaloptera retusa	29	67 6/9	4.8±4.4	1–12	217	64 9/14	24.2±30.0	1–94
Piratuba digiticauda	–	–	–	–	9	14 2/14	4.5±4.9	1–8
Strongyluris oscari	78	56 5/9	15.6±14.3	2–37	40	57 8/14	5.0±4.7	1–16
Hastospiculum sp. (larvae)	–	–	–	–	2	7 1/14	2	–

Oswaldocruzia vitti, *Physaloptera retusa*, *Strongyluris oscari* and *Piratuba digiticauda* Lent and Freitas, 1941.

Helminth species, intensity, mean intensity (Bush et al., 1997) and range are given in Table I. Similar data for *P. plica* and *P. umbra* collected in Peru (Bursey et al., 2005) are also given in Table I. *Mesocoelium monas*, *O. vitti* and *P. venancioi* are new host records for *P. plica*. *Oswaldocruzia bainae*, *O. vitti* and *P. digiticauda* are new host records for *P. umbra*. Selected helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA: *P. plica* (all from Brazil): *Mesocoelium monas* (USNPC 101387), *Oswaldocruzia vitti* (USNPC 101388), *Physaloptera retusa* (USNPC 101389), *Physalopteroides venancioi* (USNPC 101390), *Strongyluris oscari* (USNPC 101391); *P. umbra* (all from Brazil): *Oswaldocruzia vitti* (USNPC 101393); *Physaloptera retusa* (USNPC 101394), *Piratuba digiticauda* (USNPC 101395), *Strongyluris oscari*, (USNPC 101396), *Oswaldocruzia bainae* (USNPC 101392); *Strongyluris oscari* (from Ecuador) (USNPC 101397); *Rhabdias* sp. (from Ecuador) (USNPC 101398).

The number of hosts collected in specific localities is often too small to make meaningful comparisons within those localities. The stomachs were missing in the Brazilian and Ecuadorian samples, thus we suspect the counts for *Physaloptera retusa* are much too low. We would expect the counts for this species to be more like that reported for the Peruvian sample (Table I).

If we compare helminth lists for the two species, we have *Mesocoelium monas*, *Oswaldocruzia vitti*, *Physaloptera retusa*, *Physalopteroides venancioi* and *Strongyluris oscari* in *P. plica* and *Hastospiculum* sp. (larvae), *Oswaldocruzia bainae*, *Oswaldocruzia vitti*, *Physaloptera retusa*, *Piratuba digiticauda*, *Rhabdias* sp. and *Strongyluris oscari* in *P. umbra* (note that the *Rhabdias* sp. was a partial specimen, and species identification was not possible). Sorensen's index (Brower et al., 1998) was 0.5 for the helminth species infecting *P. plica*

Table 2. Diets of *P. plica* and *P. umbra* from all localities sampled. No.: number of prey; volume: volume of each prey type in pooled stomachs of each lizard species; freq: number of individual lizards that contained each type of prey. Hymenopterans includes all non-ant hymenopterans.

	Plica plica (*n*=107)					*Plica umbra* (*n*=60)				
Prey type	No.	% No.	Volume	% Vol.	Freq.	No.	% No.	Volume	% Vol.	Freq.
Orthopterans	22	0.75	3908.57	2.56	20	5	0.2	24.71	0.14	2
Blattarians	14	0.48	4959.87	3.25	9	1	0.04	25.62	0.15	1
Odonates	1	0.03	33.28	0.02	1	–	–	–	–	–
Hemipterans	35	1.2	3475.75	2.28	27	2	0.08	99.47	0.58	2
Homopterans	6	0.21	1815.22	1.19	6	–	–	–	–	–
Coleopterans	201	6.88	16742.24	10.96	60	15	0.59	203.46	1.18	8
Dipterans	5	0.17	101.2	0.07	5	–	–	–	–	–
Lepidopterans	–	–	–	–	–	1	0.04	6.89	0.04	1
Trichopterans	1	0.03	0.67	0	1	–	–	–	–	–
Psocopterans	1	0.03	0.21	0	1	1	0.04	0.32	0	1
Springtails	–	–	–	–	–	1	0.04	0.01	0	1
Termites	104	3.56	13168.12	8.62	10	30	1.18	1419.83	8.27	3
Ants	2116	72.42	80332.36	52.6	103	2470	97.32	15106.25	87.95	58
Hymenopterans	296	10.13	13441.78	8.8	40	5	0.2	191.58	1.12	5
Dermapterans	1	0.03	40.86	0.03	1	–	–	–	–	–
Insect larvae	44	1.51	8427.4	5.52	27	2	0.08	17.03	0.1	2
Insect pupae	1	0.03	127.62	0.08	1	–	–	–	–	–
Spiders	10	0.34	2213.2	1.45	8	1	0.04	9.1	0.05	1
Mites	30	1.03	2.48	0	3	1	0.04	0.1	0	1
Pseudoscorpions	3	0.1	5.14	0	3	–	–	–	–	–
Harvesters	2	0.07	87.39	0.06	2	–	–	–	–	–
Millipedes	19	0.65	2250.24	1.47	19	1	0.04	14.3	0.08	1
Centipedes	4	0.14	110.94	0.07	3	–	–	–	–	–
Isopods	–	–	–	–	–	1	0.04	56.37	0.33	1
Earthworms	1	0.03	69.13	0.05	1	1	0.04	1.55	0.01	1
Molluscs	4	0.14	49.57	0.03	4	–	–	–	–	–
Lizards	1	0.03	1357.41	0.89	1	–	–	–	–	–
Totals	2922	100	152720.65	100	–	2538	100	17176.59	100	–
Niche breadths		1.85		3.23			1.06		1.28	

and *P. umbra*. If we compare by country of collection, Sorensen's index was 0.5 for hosts from Brazil and 0.7 for hosts from Peru (data insufficient for Ecuador).

Diets of both lizard species are summarized in Table II. Both lizards feed primarily on ants, both numerically and volumetrically, but both occasionally eat other insects, invertebrates and some vertebrates. Little geographic variation exists in the composition of their diets. Even though these diet summaries include more lizards than those for which we have parasite data, they do provide insight into the many potential sources of endoparasites for these two lizard species. Species of *Hastospiculum* and *Piratuba* require an insect vector for infection, species of *Oswaldocruzia*, *Rhabdias* and *Strongyluris* are monoxenous (no intermediate host utilized), species of *Physaloptera* and *Physalopteroides* are heteroxenous and utilize primarily orthopterans as intermediate hosts (Anderson, 2000), while species of *Meoscoelium* have a single molluscan host and infection occurs with the ingestion of an infected snail or vegetation supporting cysts (Thomas, 1965). Currently *O. bainae* has been reported from lizards collected in Ecuador and Panama (Ben Slimane & Durette-Desset, 1996; Bursey et al., 2003); *O. vitti* has been reported from lizards in Brazil, Ecuador and Peru (Bursey & Goldberg, 2004; Bursey et al., 2005; Goldberg et al., 2006). *Mesocoelium monas*, *P. retusa*, *P. venancioi* and *P. digiticauda* infect a variety of hosts but are known from Brazilian lizards (see host lists in Bursey et al., 2005, 2007). To our knowledge, *Rhabdias anolis* from *Anolis frenatus* collected in Panama is the only rhabditid species reported to infect South American lizards. In the western hemisphere, species of *Hastospiculum* infect snakes (Baker, 1987); whether the infection reported here represents an accidental infection or shows that lizards may serve as paratenic hosts requires more study.

Further helminthological surveys will be necessary to determine if there is a physiological or ecological basis for the differences reported in helminth communities for populations of these two lizards. Nevertheless, some of the species-level differences may result from differences in frequencies of major prey categories eaten by each lizard species. The question remains as to whether differences within host populations are due primarily to distribution patterns of the helminths themselves, or whether physiological or ecological factors prevent infection in perceived hosts – why should *P. plica* and *P. umbra* not host similar populations of helminths?.

Acknowledgements. We thank S. Kark, T. Doleck and S. Goldsberry for assistance with dissections, Teresa Cristina S. Avila-Pires, Pete Zani and Shawn Sartorius for help in the field in Brazil and Pete Zani in Ecuador. Permits to conduct research and collect specimens in Brazil were issued by the Conselho Nacional de Desenvolvimento Cientifico e Tecnológico (CNPq. Portaria MCT no. 170, de 28/09/94) and the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA. no. 073/94-DIFAS), respectively under a research convenio between the Oklahoma Museum of Natural History and the Museu Paraense E. Goeldi. The Estación Biológica de Cuyabeno in Ecuador was made available by the Universidad Católica and permits to collect specimens in Ecuador were issued by the Ministry of Agriculture and Livestock of the Republic of Ecuador. All animals were treated in accordance with federal, state and university regulations (Animal Care Assurance 73-R-100, approved 8 November 1994). Field studies leading to this research were supported by NSF grants DEB-9200779 and DEB-9505518 to LJV and J.P. Caldwell.

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Accepted: 1 April 2009