Stebbins, R. C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin, Boston, Massachusetts. 336 pp.

Upton, S. J., and C. T. McAllister. 1990. The *Eimeria* (Apicomplexa: Eimeriidae) of Serpentes, with descriptions of three new species from colubrid snakes. Canadian Journal of Zoology 68: 855–864.

——, ——, **S. E. Trauth, and D. K. Bibb.** 1992. Description of two new species of coccidia (Apicomplexa: Eimeriorina) from flat-headed snakes, *Tantilla gracilis* (Serpentes: Colubridae) and reclassification of misnomer species within the genera *Isospora* and *Sarcocystis* from snakes. Transactions of the American Microscopical Society 111: 50–60.

J. Helminthol. Soc. Wash.
63(1), 1996, pp. 130–135

Research Note

Host-Induced and Geographical Variation in *Levinseniella cruzi* Travassos, 1920 (Digenea: Microphallidae)

SERGIO R. MARTORELLI AND VERONICA A. IVANOV

Centro de Estudios Parasitológicos y de Vectores (CEPAVE-CONICET-UNLP), Calle 2 No. 584, La Plata 1900, Bs. As. Argentina. e-mail: postmaster@cepave.edu.ar

ABSTRACT: Morphological variation in *Levinseniella cruzi* (Digenea: Microphallidae) among the hosts from 3 localities, *Rollandia rolland chilensis* (Podicipedidae), *Himantopus melanurus* (Recurvirostridae), and *Vanellus chilensis lampronotus* (Charadriidae), was analyzed through an ANOVA test and with cluster analysis. A great variation in body shape and size of parasites is noted. Male pocket length and number, sucker diameter, pharynx and genital papillae length, and ratio of suckers appear to be the most constant features and, therefore, valuable for systematic purposes. The morphological variation is discussed in relation to host species and geographical distribution. A new host for *L. cruzi* is reported.

KEY WORDS: Digenea, Microphallidae, Aquatic birds, host-induced variations.

Levinseniella cruzi was previously reported by Martorelli (1988) from the ceca of 2 birds from Buenos Aires Province: the white tufted grebe, *Rollandia rolland chilensis* Lesson, 1828 (Podicipedidae) and the South American stilt, *Himantopus melanurus* Vieillot, 1817 (Recurvirostridae). We analyzed the morphological variation of *L. cruzi* among avian hosts from various geographic localities.

Definitive hosts were collected from 3 localities related with lentic freshwater environments in Buenos Aires Province (Argentine): Chascomús, a typical "pampa lagoon" which drains in Río Salado system (35°36'S, 58°00'W); Mar Chiquita, a large lagoon by the sea in contact with the Atlantic Ocean (37°46'S, 57°27'W) and Los Talas, artificial and small lagoons related to the Río de La Plata system (34°52'S, 57°00'W).

Six specimens of each species of bird included in this study were examined: *R. r. chilensis* from Los Talas, *R. r. chilensis* from Chascomús, and *H. melanurus* and *Vanellus chilensis lampronotus* Wagler, 1827 (Charadriidae) from Mar Chiquita.

Voucher specimens of this parasite from different hosts and localities were deposited in the Museo de la Plata, La Plata, Buenos Aires, Argentina, Helminth Coll. no. 3303 a, b; 3304 a, b, c; 3305 a, b, and in USNPC 84905–84908.

All the digeneans measured were recovered alive from the bird's cecum, fixed in Bouin Hollande pressured with a cover glass, stained in Langeron alcoholic carmine, dehydrated in ethanol, cleared in creosote, and mounted in natural Canada balsam. All dimensions were given in millimeters. The morphological variation was studied taking into consideration the measurements shown in Table 1.

One-way analysis of variance (ANOVA) and Tukey's multiple range test were used to appraise differences in these morphological dimensions among 3 groups of specimens: 1) parasites from *R. r. chilensis*, 2) parasites from *H. melanurus*, and 3) parasites from *V. ch. lampronotus* (referred to as groups 1, 2, and 3 hereafter).

Moreover, in order to compare the specimens of *L. cruzi* from different hosts and their localities

Table 1. Measurements of specimens of *Levinseniella cruzi* from different hosts. All measurements are given in mm.

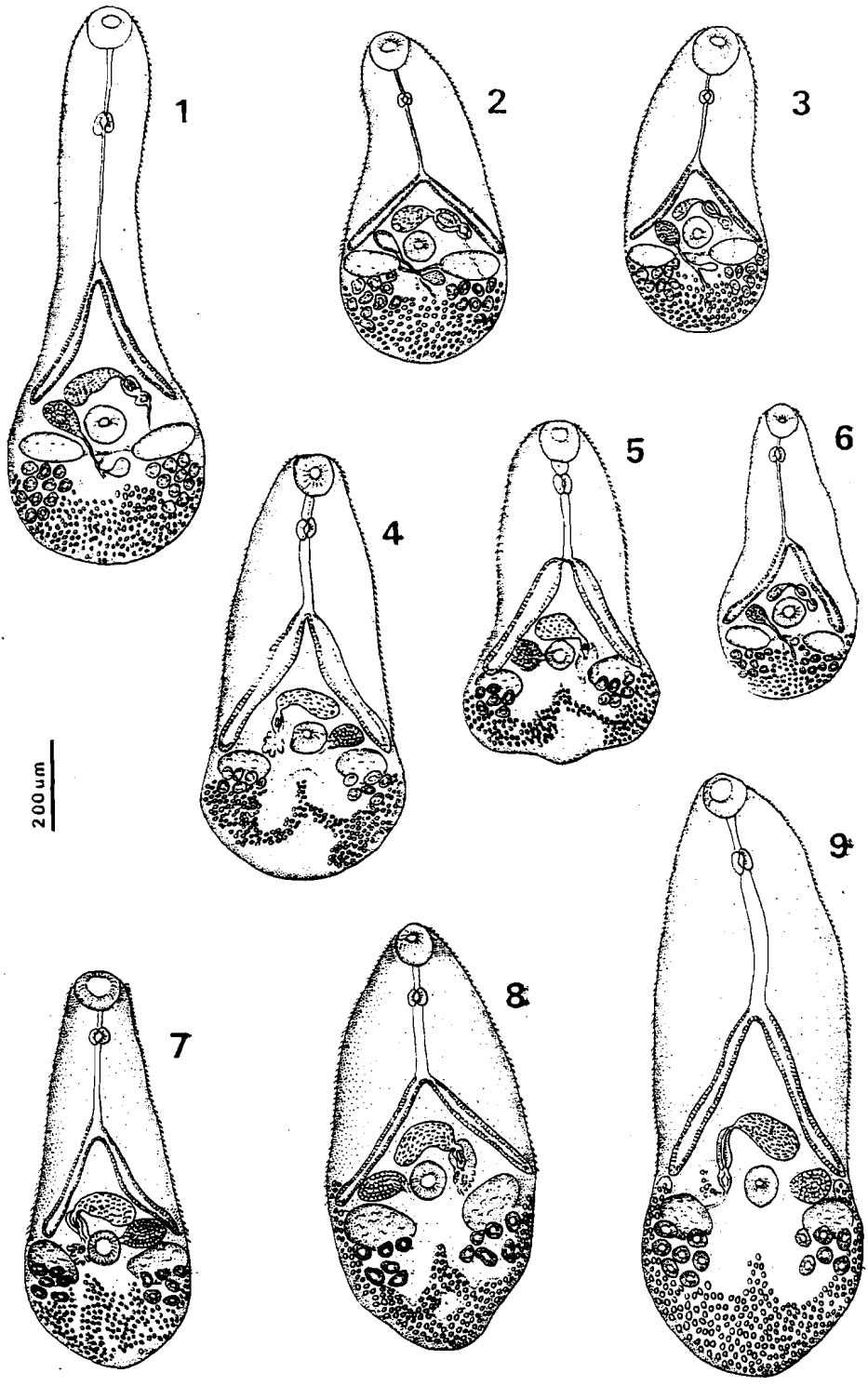
	Body length	Body width	Body length / Body width	Oral sucker	Ventral sucker	Oral sucker / Ventral sucker	Pharynx length	Esophagus length	Body length / Forebody	Pre-pharynx length	Intestinal ceca length
R. r. chilensis											
Mean	0.803	0.354	2.24	0.085	0.066	1.292	0.041	0.094	3.801	0.104	0.241
Maximum	1.319	0.459	2.95	0.102	0.079	1.593	0.048	0.199	5.841	0.179	0.329
Minimum	0.512	0.239	1.66	0.066	0.059	0.881	0.031	0.028	2.709	0.039	0.168
SD	0.245	0.069	0.36	0.011	0.006	0.208	0.003	0.044	1.017	0.034	0.053
N	20	20	20	19	20	19	19	17	17	16	14
H. melanurus											
Mean	0.702	0.285	2.52	0.078	0.061	1.321	0.038	0.139	2.719	0.041	0.25
Maximum	1.014	0.468	2.94	0.108	0.078	1.818	0.048	0.168	3.346	0.072	0.357
Minimum	0.592	0.208	2.05	0.059	0.044	1.108	0.024	0.084	2.141	0.028	0.179
SD	0.114	0.072	0.28	0.013	0.011	0.179	0.007	0.029	0.407	0.012	0.058
N	14	14	14	14	13	13	14	11	11	12	10
V. ch. lampronotus											
Mean	0.902	0.429	2.12	0.088	0.069	1.271	0.043	0.159	3.175	0.041	0.317
Maximum	1.329	0.539	2.81	0.109	0.088	1.492	0.052	0.286	4.527	0.072	0.403
Minimum	0.649	0.304	1.51	0.064	0.057	1.016	0.032	0.084	2.645	0.019	0.209
SD	0.159	0.063	0.32	0.012	0.008	0.125	0.006	0.044	0.461	0.013	0.059
N	25	25	25	24	24	24	22	22	22	20	20

	Male pocket number	Male pocket length	Egg length	Body length / Egg length	Ovary length	Right testis	Left testis	Seminal vesicle length	Genital papillae length	Genital papillae width
R. r. chilensis										
Mean	7.2	0.016	0.019	40.71	0.074	0.102	0.089	0.089	0.023	0.018
Maximum	10	0.023	0.024	73.33	0.091	0.114	0.104	0.108	0.024	0.019
Minimum	6	0.011	0.018	23.33	0.048	0.081	0.082	0.066	0.023	0.016
SD	1.4	0.003	0.001	13.89	0.013	0.011	0.008	0.012	0.0005	0.002
N	12	9	20	20	8	6	4	10	2	2
H. melanurus										
Mean	6.8	0.016	0.019	35.51	0.077	0.061	0.054	0.086	0.023	0.018
Maximum	8	0.016	0.021	49.78	0.108	0.069	0.054	0.088	0.035	0.019
Minimum	6	0.016	0.018	30.39	0.052	0.053	0.054	0.083	0.012	0.016
SD	0.8	0	0.001	6.005	0.017	0.008	0	0.002	0.009	0.002
N	8	1	14	14	5	2	1	3	2	2
V. ch. lampronotus										
Mean	7.8	0.018	0.019	47.22	0.081	0.107	0.102	0.141	0.031	0.021
Maximum	10	0.035	0.024	78.24	0.093	0.121	0.109	0.152	0.039	0.024
Minimum	6	0.01	0.017	31.57	0.075	0.099	0.087	0.131	0.026	0.018
SD	1.3	0.007	0.002	11.22	0.007	0.009	0.007	0.006	0.004	0.002
N	17	13	23	23	10	8	8	3	5	7

SD = Standard deviation, *N* = number of parasites.

Figures 1–9. *Levinseniella cruzi*. 1, 2. Specimens of *L. cruzi* from *R. r. chilensis* in Chascomús (ventral view). 3. Specimens of *L. cruzi* from *R. r. chilensis* in Los Talas (ventral view). 4–6. Specimens of *L. cruzi* from *H. melanurus* in Mar Chiquita (Fig. 4: dorsal view, Figs. 5 and 6: ventral view). 7–9: Specimens of *L. cruzi* from *V. ch. lampronotus* in Mar Chiquita (Figs. 7 and 9: dorsal view, Fig. 8: ventral view).

Figure 10. Similarity dendrogram of specimens of *L. cruzi* from different hosts and localities. 1 = parasites from *R. r. chilensis* in Chascomús, 2 = parasites from *R. r. chilensis* in Los Talas, 3 = parasites from *H. melanurus* in Mar Chiquita, 4 = parasites from *V. ch. lampronotus* in Mar Chiquita.


1
2
3
4
5
6
200 um
7
8
9

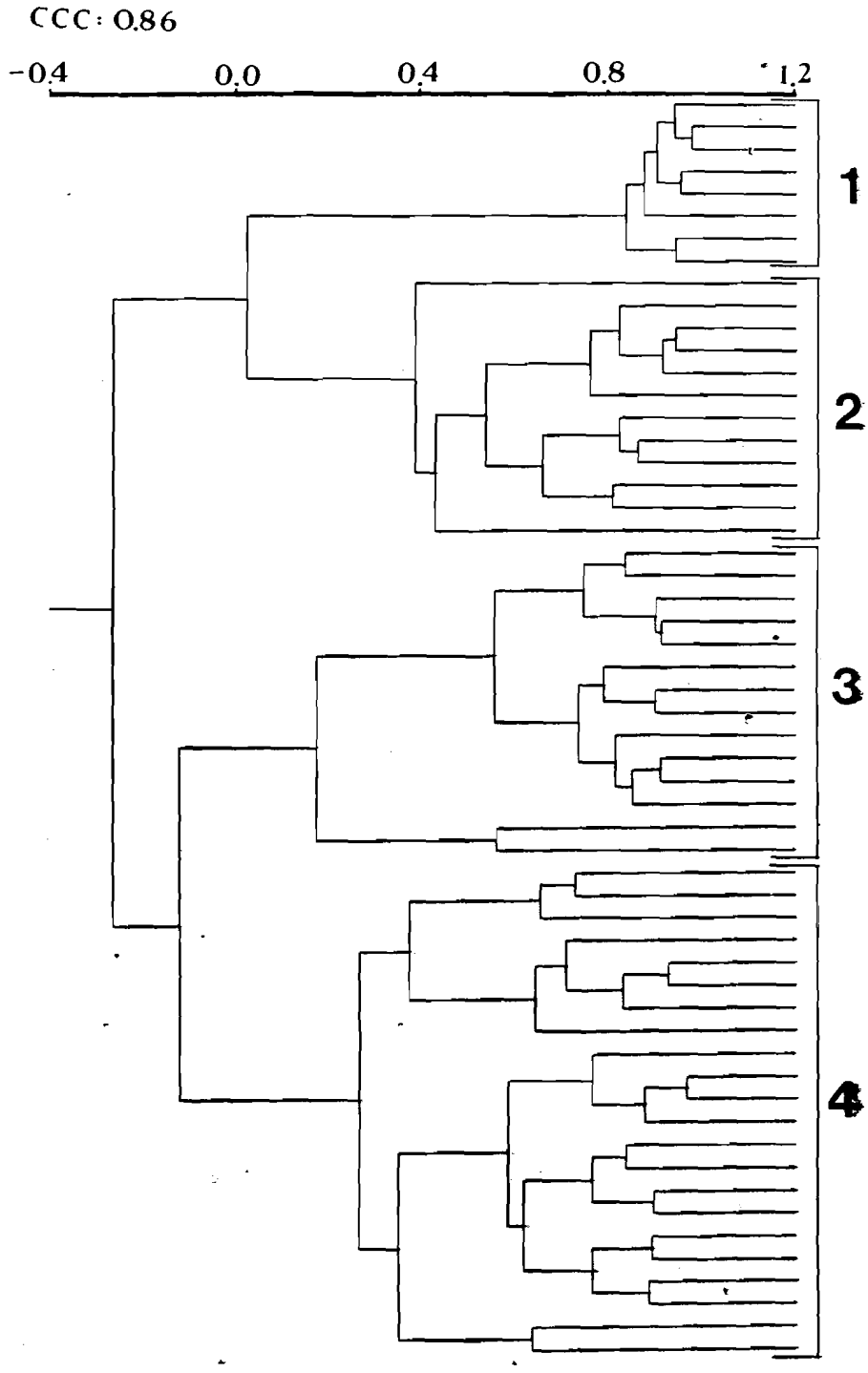

CCC: 0.86
-0.4
0.0
0.4
0.8
1.2
1
2
3
4

Table 2. Summary of one-way analysis of variance (ANOVA).

Source of variation	df	MS	*F* ratio	Significance level
Body length (Bl)	56	0.0359	5.149	0.008
Body width (Bw)	56	0.0048	19.924	0.000
Bl/Bw	56	0.113	6.311	0.003
Oral sucker (Os)	54	1.4×10^{-4}	2.96	0.063
Ventral sucker (Vs)	54	6.8×10^{-5}	4.765	0.012
Os/Vs	53	0.0305	0.350	0.706
Prepharynx length	45	0.0005	40.40	0.000
Pharynx length	52	3.7×10^{-5}	2.615	0.082
Esophagus length	47	0.0018	11.08	0.000
Intestinal ceca length	41	0.0034	8.43	0.000
Right testis diameter	13	0.0082	3.999	0.044
Left testis diameter	11	6.4×10^{-5}	29.22	0.000
Ovary diameter	20	1.7×10^{-4}	0.487	0.621
Seminal vesicle length	13	1.2×10^{-4}	25.63	0.000
Genital papillae length	6	6.2×10^{-5}	1.112	0.388
Genital papillae width	6	5.8×10^{-6}	3.797	0.099
Male pockets number	34	1.6351	1.677	0.202
Male pockets length	20	4.1×10^{-5}	0.355	0.705
Bl/Forebody length	47	0.5153	8.094	0.001
Egg length (El)	54	2.1×10^{-6}	1.120	0.333
Bl/El	54	134.39	4.654	0.013

df = degrees of freedom, MS = mean square.

taking into consideration all the measurements at the same time (Table 1), a cluster analysis was applied. In order to obtain a matrix with a low number of missing data, measurements such as testes and ovary diameter, male pockets, genital papillae, and seminal vesicle length were excluded from the analysis because such characters could not be measured in specimens where the eggs overlapped them. The product–moment correlation coefficient (r) was applied and the resulting dendrogram was constructed using the UPGMA method. The distortion caused by this method was measured by calculating the cophenetic correlation coefficient (CCC) (Rohlf, 1970).

Table 3. Significant differences between groups (Tukey's multiple range test).

Source of variation	*R. r. chilensis*–*H. melanurus*	*R. r. chilensis*–*V. ch. lampronotus*	*H. melanurus*–*V. ch. lampronotus*
Body length (Bl)			•
Body width (Bw)	•	•	•
Bl/Bw			•
Ventral sucker			•
Prepharynx length	•	•	
Esophagus length	•	•	
Intestinal caeca length		•	•
Right testis diameter	•		•
Left testis diameter	•		•
Seminal vesicle length		•	•
Bl/Forebody length	•	•	
Bl/Egg length			•

We found *L. cruzi* in the cecum of the southern lapwing *V. ch. lampronotus* from Mar Chiquita as well as in *R. r. chilensis* and *H. melanurus* as previously reported by Martorelli (1988). In Figures 1–9, specimens of *L. cruzi* in different hosts are shown at the same magnification.

A summary of the ANOVA for the 3 groups is presented in Table 2. In Table 3, the contrasts among the groups of parasites for mean measurements are shown.

As noted in Figure 10, the results of the cluster analysis of *L. cruzi* specimens show the 2 largest clusters separated at a low value of correlation ($r = -0.27$). One of them contains specimens from *H. melanurus* and *V. ch. lampronotus* from Mar Chiquita, and the other specimens from *R. r. chilensis* from Chascomús and Los Talas. This result might suggest the presence of geographical variation, as Kennedy (1980a) found for *Hematoloechus* sp.

The former cluster is divided into 2 groups ($r = -0.12$): 1 contains specimens from *H. melanurus* and the other those from *V. ch. lampron-*

otus, which indicates host-induced variation (Blankespoor, 1974; Kennedy, 1980b).

The latter cluster is formed on one hand by specimens from *R. r. chilensis* in Chascomús and on the other by specimens from this host in Los Talas (r = 0.02).

The great variation in body size and shape of specimens in *L. cruzi* was one of the most notable features. Parasites from *R. r. chilensis* are usually pear-shaped with the forebody clearly prolonged in some specimens. Those from *H. melanurus* have a pear-shaped body but are smaller in size. Pear-shaped, oval, and tongue-shaped specimens could be seen parasitizing *V. ch. lampronotus* (Figs. 1–9).

The most important taxonomic features of *L. cruzi* include terminal genitalia and the position of vitelline glands (Deblock, 1971). We suggest that male pocket length and number, oral sucker and ovary diameter, pharynx and genital papillae length, and the oral sucker/ventral sucker ratio are less subject to variation and, therefore, valuable for systematic purposes.

Finally, the report of a new definitive host for *L. cruzi* confirms the low specificity for this group of parasites. As far as we know, *L. cruzi* has been reported from a mamalian host, *Scapteromys aquaticus* (Cricetidae), by Sutton and Lunaschi (1994), and avian hosts of 4 different families: *Annas bahamensis* (Anatidae) by Travassos (1920), *R. r. chilensis* (Podicipedidae) and *H. melanurus* (Recurvirostridae) by Martorelli (1988), and *V. ch. lampronotus* (Charadriidae) in this study.

Literature Cited

Blankespoor, H. D. 1974. Host-induced variation in *Plagiorchis noblei* Park, 1936 (Plagiorchiidae: Trematoda). The American Midland Naturalist 92:415–434.

Deblock, S. 1971. Contribution a l'etude des Microphallidae Travassos, 1920 XXIV. Tentative de phylogenie et de taxonomie. Bulletin du Muséum National d'Histoire Naturelle. Zoologie 7:358–467.

Kennedy, M. J. 1980a. Geographical variations in some representatives of *Haematoloechus* Looss, 1899 (Trematoda: Haematoloechidae) from Canada and the United States. Canadian Journal of Zoology 58:1151–1167.

———. 1980b. Host-induced variations in *Haematoloechus buttensis* (Trematoda: Haematoloechidae). Canadian Journal of Zoology 58:427–442.

Martorelli, S. R. 1988. El ciclo biológico de *Levinseniella cruzi* Travassos, 1920 (Digenea, Microphallidae) parásita de los ciegos cólicos de *Rollandia rolland chilensis* (Aves, Podicipedidae) e *Himantopus melanurus* (Aves, Recurvirostridae). Iheringia 68:49–62.

Rohlf, F. J. 1970. Adaptive hierarchical clustering schemes. Systematic Zoology 19:58–82.

Sutton, C. A., and L. I. Lunaschi. 1994. Estudio sobre digeneos parásitos de roedores Cricetidae y Muridae, de la provincia de Buenos Aires, Argentina. Neotrópica 40:61–72.

Travassos, L. 1920. Contribucao para o conhecimento de fauna helminthologica brasileira. IX Sobre as especies da subfamilia Microphalina Ward, 1901. Archivos. Escola Superior de Agricultura e Medicina Veterinaria. 4:85–91.