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ECHINOCOCCUS VOGELI RAUSCH AND BERNSTEIN, 1972, FROM THE PACA, CUNICULUS PACA L. (RODENTIA: DASYPROCTIDAE), IN THE DEPARTAMENTO DE SANTA CRUZ, BOLIVIA

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ABSTRACT: Among approximately 2,000 mammals examined for helminths in various regions of Bolivia during 1983–1987, cysts of *Echinococcus vogeli* Rausch and Bernstein, 1972, were found in a single paca, *Cuniculus paca* L., collected at La Laguna, Departamento de Santa Cruz (lat. 16°36'W; long. 62°42'S). This record, the first from Bolivia, represents a considerable extension of the known geographic range of this species in South America. Upon analysis of the morphologic characteristics of the protoscoleces derived from the cysts, the sizes of rostellar hooks from the material from the paca were found to be well within the ranges reported in previous studies. Statistical analysis of frequency distributions of hook characteristics revealed some deviations from normality. These results indicate that parametric statistics should be applied with caution in analyses of inter- and intraspecific variation of morphologic characteristics of hooks of metacestodes of the genus *Echinococcus*.

Investigations during the last decade have shown that *Echinococcus vogeli* Rausch and Bernstein, 1972, has an extensive geographic range in Central America and South America. Records based mainly on the identification of the larval stage (metacestode) from wild rodents and from cases of polycystic hydatid disease in man have documented its occurrence in Panama, Colombia, Ecuador, Venezuela (Rausch and Bernstein, 1972; D'Alessandro et al., 1979; Rausch et al., 1981), and in Brazil (from Serra do Navio and Belem in the north and, based on cases of polycystic hydatid disease, from the State of Acre in the Amazonian region, and from Monte Azul Paulista in the State of Sao Paulo) (Rausch et al., 1984; Meneghelli, 1985; Meneghelli et al., 1986). The distribution of this cestode no doubt coincides with that of its natural hosts, the bush dog, *Speothos venaticus* (Lund), and rodents of the family Dasyproctidae. The paca, *Cuniculus paca* L., appears to be the most important intermediate host. Thus, *E. vogeli* may be expected to occur from about the level of the Isthmus of Tehuantepec, in southern Mexico, southward to Bolivia, Paraguay, and southern Brazil.

In the course of fieldwork in Bolivia during the years 1984–1987, we (S.L.G. and O.C.J.C.)

examined more than 2,000 mammals for helminths. These specimens, consisting mainly of rodents, were collected at several localities within all of the major habitat types represented in that country. Of rodents previously reported to serve as intermediate hosts of *E. vogeli*, 4 pacas, 7 agoutis (*Dasyprocta* spp.), and 158 spiny rats (*Proechimys* spp.) were examined. The larval stage of *Echinococcus* sp. was found in 2 pacas.

The present paper reports the first record of *Echinococcus vogeli* in Bolivia.

MATERIALS AND METHODS

All mammals were necropsied promptly after death, to avoid possible effects of autolytic changes on the helminths. The larval stage of *Echinococcus* sp. was found in the liver of 2 pacas, collected at La Laguna, 10 km N of San Ramon, Departamento de Santa Cruz, Bolivia (lat. 16°36'S; long. 62°42'W). Cysts of *Echinococcus* were removed intact from the hepatic tissue, injected with a small quantity of undiluted formalin, and preserved in a 10% formalin solution. In the laboratory, the cysts were transected, and brood capsules were stained in Semichon's acetic carmine. Protoscolices were separated and mounted in Canada balsam with sufficient pressure applied to the cover-glass to cause the rostellar hooks to lie flat. Rostellar hooks were measured by the method of Rausch et al. (1978), with the use of an oil immersion objective (1,000×). To assess normality and to determine the suitability of the data for parametric statistical tests, normal probability plots were constructed and examined for linearity; extent of skewness and kurtosis also were determined (Table I). Correlations were determined from a Pearson product moment correlation matrix (Table II). Levels of statistical significance were set at $P \leq 0.05$ prior to collection of data. Information concerning normality and correlations among morphological char-

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TABLE I. Summary of mensural data of hooks from protoscolices recovered from metacystodes of *Echinococcus vogeli* from the liver of a paca, *Cuniculus paca*, in the Departamento de Santa Cruz, Bolivia.

Character	n	Min	Max	Mean	Range	S	S ²	Skewness g ₁	Kurtosis g ₂
Large hooks									
Total length	100	37	44	39.83	7	1.49	1.22	0.69	0.64
Handle length	100	13	18	15.50	5	0.79	0.89	0.47	1.19*
Guard width	100	10	16	12.90	6	1.60	1.26	0.006	-0.54
Blade length	100	20	33	24.29	13	2.23	1.49	1.64*	10.53*
Small hooks									
Total length	100	2.7	35	32.59	4	1.25	1.12	0.37	-0.58
Handle length	100	13	19	16.34	6	1.36	1.16	0.08	0.64
Guard length	100	8	13	10.33	5	1.03	1.02	-0.28	0.22
Blade length	100	13	23	16.39	10	1.97	1.40	1.04*	3.99*

* Indicates statistically significant deviation from a normal distribution (i.e., $H_0: g_1 = 0$) ($P \leq 0.05$).

acters of the hooks from the protoscolices has been included to facilitate future comparisons. All measurements are given below in μm , unless otherwise stated.

RESULTS

In the first paca 3 cysts were present in the liver. They were subspherical in shape and about 15–20 mm in greater diameter. The comparatively large brood capsules were rather few and scattered on the surface of the germinal layer. The cysts from the second paca were sterile, and the cestode therefore was not identifiable.

Based on form, proportions, and dimensions of the rostellar hooks, we identified the larval cestode as *E. vogeli* (see comparative measurements, Table III). Some brood capsules contained hooks that were not yet fully developed.

Lengths of hooks reported previously (Rausch et al., 1978) were as follows: large hooks ($n = 313$), 39.1–45.6 ($\bar{x} = 41$); small hooks ($n = 283$), 30.4–36.9 ($\bar{x} = 33$). For the present material, lengths of large hooks judged to be fully developed ($n = 100$) ranged from 37 to 44 ($\bar{x} = 40$); those of small hooks ($n = 100$), 2.7 to 35 ($\bar{x} = 32.6$) (Figs. 1, 2). These dimensions were well within the range previously reported for *E. vogeli* by Rausch et al. (1978).

In proportions and dimensions, the hooks from the Bolivian material differed from those of the larval *E. oligarthrus* (Diesing, 1863). Large hooks of *E. oligarthrus* ranged from 29.1 to 37.9 ($\bar{x} = 32$); small hooks, 22.6 to 29.5 ($\bar{x} = 25.9$) (Rausch et al., 1978).

Dimensions of hooks from the Bolivian material exhibited relatively few correlations (Table III). Statistically significant correlations were evident between lengths of large hooks and width of guard of large hooks, and lengths of large hooks and length of blade of small hooks. A significant negative correlation was evident between length of handle and width of guard of large hooks. Length of blade of small hooks was found to be positively correlated with both guard width of large hooks and length of small hooks, and negatively correlated with length of handle.

The observed frequency distributions obtained from measurements of material from Bolivia are summarized in Table I. Only those values significantly different from a normal distribution ($P \leq 0.05$) are discussed. The frequency distribution of measurements of length of handle of large hooks is slightly leptokurtic, whereas the distribution of length of blade of large hooks is significantly skewed toward the larger values and is leptokurtic (Table I). The

TABLE II. Summary of lengths of hooks from protoscolices of 2 species of *Echinococcus* from natural infections of *Cuniculus paca* in South America.

Species	Large hooks			Small hooks			Source of material
	n	Range	Mean	n	Range	Mean	
<i>E. vogeli</i>	100	37–44	39.83	100	27–35	32.59	Liver of paca, Dept. Santa Cruz, Bolivia
<i>E. vogeli</i>	313	39.1–45.6	41.08	283	30.4–36.9	32.98	Liver of paca (Rausch et al., 1978)
<i>E. oligarthrus</i>	50	30.4–33.9	32.00	50	24.3–28.7	25.90	Muscle of paca (Rausch et al., 1978)

TABLE III. Pearson product moment correlations among characters of hooks from protoscolices of *Echinococcus vogeli* from *Cuniculus paca* in the department of Santa Cruz, Bolivia. For all measurements $n = 100$.

Characters	Large hook length	Large hook handle length	Large hook guard width	Large hook blade length	Small hook length	Small hook handle length	Small hook guard width	Small hook blade length
Large hook length	1.0	—	—	—	—	—	—	—
Large hook handle length	0.199*	1.0	—	—	—	—	—	—
Large hook guard width	0.087	0.081	1.0	—	—	—	—	—
Large hook blade length	0.697*	-0.443*	0.032	1.0	—	—	—	—
Small hook total length	0.327*	0.086	0.091	0.155	1.0	—	—	—
Small hook handle length	0.169	0.049	-0.107	0.070	0.397*	1.0	—	—
Small hook guard width	0.046	0.050	0.192	0.003	0.168	0.186	1.0	—
Small hook blade length	0.074	-0.004	0.279*	0.018	0.410*	-0.476	-0.056	1.0

* Indicates significant correlation between characters at $P \leq 0.05$.

frequency distribution of length of blade of small hooks is also positively skewed and leptokurtic (Table I).

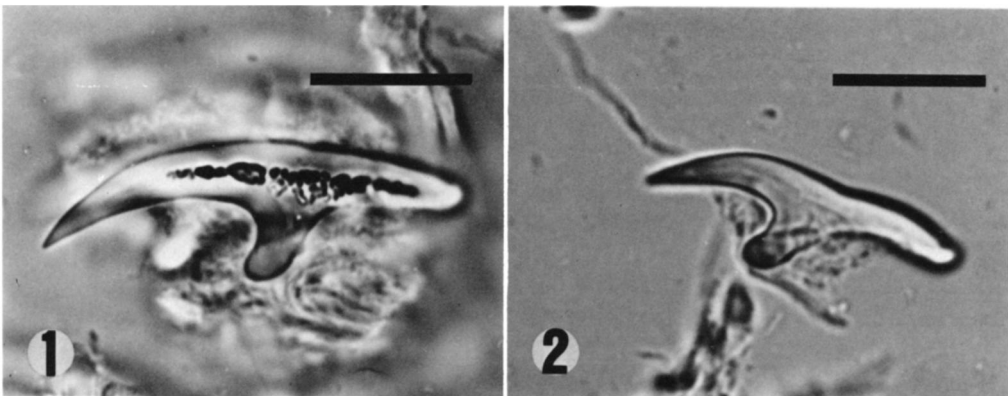
DISCUSSION

The deviations from normality evident in the frequency distributions of those characters mentioned above require that some transformations may be necessary before parametric statistical tests can be applied for comparative purposes. Some hooks that were measured may not have been fully developed, possibly causing the observed deviations. Multivariate statistical analyses (less susceptible to deviations from normality than univariate tests) may allow more complete comparisons of geographic and host-induced variation within and among species of *Echinococcus* in the neotropics.

The northeastern lowlands of the Departamento de Santa Cruz consist of palm-nut savanna interspersed with rather dense gallery forest

(Hershkovitz, 1969; Unzueta, 1975). At the locality where the pacas were collected, the vegetation was a mixture of primary and secondary growth, semitropical deciduous forest. Some areas were heavily grazed by cattle. The northeastern part of the Departamento de Santa Cruz is recognized as a zone of faunistic and floristic transition where the southern elements of the Chaco thorn forest intergrade with the more humid tropical and subtropical deciduous forests of the Amazon basin (Unzueta, 1975; Mercado, 1985).

Most people in the region subsist in part by hunting with use of dogs, and some domestic cats are kept (Dickerman, pers. comm.). The paca is a preferred food resource, and the viscera of the rodents are usually discarded where they are readily available to dogs. Living conditions and close association with the dogs would seem to favor infection of man by *E. vogeli*, as in Colombia and other countries (D'Alessandro et al., 1979). The lack of any records of human cases of polycystic hydatid disease in Bolivia might be



FIGURES 1, 2. 1. Large hook from protoscolex of *E. vogeli*. Scale bar = 16 μm . 2. Small hook from protoscolex of *E. vogeli*. Scale bar = 16 μm .

attributable to the limited availability of diagnostic services.

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