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Yungasicola travassosi gen. n., sp. n. (Digenea: Dicrocoeliidae: Eurytrematinae) from Two Species of Grass Mice of the Genus *Akodon* Meyen (Rodentia: Muridae) from the Yungas of Bolivia

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ABSTRACT: A new species and genus of digenetic trematode of the family Dicrocoeliidae is described from 2 species of grass mice, *Akodon fumeus* and *Akodon mimus*, both collected from an isolated area in the eastern part of the Andes mountains or Yungas of Bolivia. This species differs from all known dicrocoeliids in the unique disposition of the vitelline fields, the much less extensive uterus through the body of the worm (extending posteriad only just past the midline), and cecal branches that are generally conspicuous and lined with a thick layer of glandular epithelial tissue.

KEY WORDS: Digenea, Dicrocoeliidae, Eurytrematinae, new species, *Yungasicola travassosi* sp. n., Mammalia, Muridae, *Akodon*, Yungas, Departamento de La Paz, Río Aceromarca, Bolivia

Species included in the family Dicrocoeliidae Odhner, 1910, are digenetic trematodes with a cosmopolitan distribution, occurring in the bile ducts, gall bladders, intestines, and pancreatic ducts of terrestrial vertebrates (Yamaguti, 1971). The life cycles of many species of these trematodes are well known and include a mammalian definitive host with a pulmonate mollusc first intermediate host. Second intermediate hosts may include various species of arthropods (Olsen, 1974). The classification of the Dicrocoeliidae has been controversial (see Travassos, 1944; Yamaguti, 1971) but has been stabilized somewhat by Panin (1981, 1984). Several species of dicrocoeliids have been reported from South American mammals (Travassos, 1944; Travassos et al., 1969 and references therein). However, in spite of extensive studies by Travassos and other workers, no record of the presence of a dicrocoeliid trematode from mammals of Bolivia has been made previously.

While conducting a large-scale study on the diversity of mammals and their parasites from throughout Bolivia (Gardner and Campbell, 1992; Anderson, 1997), we examined several hundred individuals representing ~10 species of grass mice of the genus *Akodon*. From a single localized area in the Andes, we found a previously unknown species of digenetic trematode in the gall bladders of 2 sympatric/syntopic species of mice, including both the soft grass mouse *Akodon mimus* (Thomas, 1901) and the smoky grass mouse or ratón fumoso *Akodon fumeus* Thomas, 1902.

Rodents of the genus *Akodon* Meyen (Muridae: Akodontini) occupy suitable habitats at altitudes from sea level to >5000 m throughout South America. Of the >45 species of *Akodon* described from this continent, the Colombian grass mouse *Akodon affinis* (J. A. Allen, 1912) has the northern most distribution and is known only from the western cordillera of Colombia (Eisenberg, 1989). The southernmost species is the ratón hocico bayo or orange-nosed mouse *Akodon xanthorhinus* (Waterhouse, 1837) in the Tierra del Fuego of Argentina (Redford and Eisenberg, 1992). Twelve species of *Akodon* are currently known from Bolivia, with 2 described endemic species, including the dark lowland grass mouse *Akodon dayi* Osgood, 1916, and the Siberia grass mouse *Akodon siberiae* Myers and Patton, 1989 (see Anderson, 1997). Ancestors of the tribe Akodontini (family Muridae) are thought to have arrived in South America via the Panamanian Land Bridge as late as 2.5 million years ago (Marshall and Sempere, 1993).

Despite extensive knowledge of ecology and distribution of these mammals throughout South America, relatively little is known of their parasite faunas. Here we report on a distinctive new species of trematode, which also requires the establishment of a new genus.

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Materials and Methods

From 1984 through 2000, individuals of several species of *Akodon* were collected and examined for parasites throughout Bolivia. In 1992, rodents harboring digeneans in their gall bladders were found in 2 geographically close localities, most mice being collected at or near our campsite at the Río Aceromarca and fewer at a slightly lower elevation on the Río Unduavi. These 2 localities are situated at the bottoms of canyons in the eastern mountains of the Andes. The area is known as the Yungas, an ecological transition zone that includes habitats ranging from high altitude puna to low altitude tropical forest. The Yungas extends the length of Bolivia and runs north to south from Peru to Argentina (Unzueta, 1975). In this area, the altitude of the land decreases rapidly west to east, typically changing from a maximum of >5000 to 1500 m and lower over a distance of ~150 km. This unique geological/ecological zone is characterized by first-order streams that have cut deep gorges, with the lowest elevations along streams and rivers having temperate conditions, and ''puna'' or tundra-like habitat directly above (3500–4500 m). At the Río Aceromarca collecting locality, the lowest elevation from which we collected specimens was ~2800 m. At this altitude characteristic vegetation includes tree ferns, *Begonia* sp., and alder trees (genus *Alnus).*

All rodents were collected by use of Sherman live traps baited with a mixture of oatmeal, vanilla, tuna, and sardines or snap traps baited with peanut butter. Traps were placed in suitable habitats each evening and checked at first daylight the following morning. Details of each rodent collected (i.e., exact type of habitat from which each animal was taken) were recorded in the field collection catalog book (the NK book) and in the rodent trapping data book, which are maintained in the Museum of Southwestern Biology (MSB) of the University of New Mexico, Albuquerque, New Mexico 87131 (http://www.unm.edu/~museum/). Additional details of trapping localities can also be found in field notes of the expedition that are correlated with specimens maintained at the MSB and the Harold W. Manter Laboratory of Parasitology (HWML). All rodent collections were made in accordance with the terms of a cooperative agreement established among the National Museum of Natural History, La Paz, the University of New Mexico, Albuquerque, the University of California, Davis, and the Harold W. Manter Laboratory of Parasitology, University of Nebraska, Lincoln.

Trematodes were found in the gall bladders and bile ducts of individual rodents during routine necropsy. Most worms were relaxed and killed in distilled water and fixed in either hot or cold 10% aqueous vol/vol formalin. Some specimens were preserved in vials filled with 95% aqueous vol/vol EtOH, or placed in cryotubes, frozen in liquid nitrogen, and stored at −85°C in an ultralow temperature freezer in the HWML.

Whole mounts were stained with Ehrlich's acid hematoxylin or Semichon's acetic carmine, dehydrated in ethanol, cleared in xylene, terpineol, or methyl benzoate, and mounted on glass slides in Canada balsam. All measurements are given in micrometers, with the range followed by the mean, standard deviation, and sample size *n* in parentheses. Drawings were made with the aid of a drawing tube. Abbreviations used: Colección Nacional de Helmintos, Instituto de Biología, UNAM, México D. F., Mexico (CNHE); U.S. National Parasite Collection, Beltsville, Maryland, U.S.A. (USNPC).

Results

Class Cercomeridea Brooks, O'Grady, and Glen, 1985
Order Plagiorchiformes La Rue, 1957
Family Dicrocoeliidae Looss, 1899
Subfamily Eurytrematinae Panin, 1981
Yungasicola gen. n.

Description

Dicrocoeliidae, Eurytrematinae. Body broad, diamond-shaped, broadest in equatorial region with anterior and posterior ends attenuated. Tegument unspined. Oral sucker subterminal. Acetabulum pre-equatorial. No prepharynx. Esophagus short. Intestinal ceca terminating near posterior end of body. Each cecal branch conspicuous, terminating in extreme posterior part of body with 1 or both ceca expanded either fully or partially, depending on the state of each specimen at time of death. Ceca usually lined with 1 layer of relatively thick mucus-producing epithelial cells (by evidence of numerous mucus-containing vacuoles in each cell). Testes symmetrical, pre-equatorial, intercecal, immediately postacetabular. Cirrus sac relatively short, containing sinuous seminal vesicle, secretory cells, and unarmed cirrus. Genital pore median, at level of esophagus. Ovary equatorial, submedian, posteromedial to left or right testis. Seminal receptacle postovarian. Laurer's canal present, not observed to terminate on surface of body. Vitellaria mostly extracecal, with some follicles medial to ceca, restricted to forebody, and extending from level of testes anteriad to cecal bifurcation. Uterus occupying most of intercecal field. Metraterm short, opening separately into genital pore. Excretory vesicle tubular, bifurcating slightly posterior to uterus. Eggs relatively small.

Taxonomic Summary

TYPE AND ONLY SPECIES: *Yungasicola travassosi* sp. n. from *Akodon fumeus* and *Akodon mimus.*

TYPE HOST: *Akodon fumeus* Thomas, 1902 (smoky grass mouse)

TYPE LOCALITY: Bolivia, Departamento de

La Paz, Río Aceromarca, 16°19′S, 67°53′W, elevation 2,990 m.

ETYMOLOGY: The genus is named after the Yungas of Bolivia, comprising the beautiful and rugged eastern side of the Andes Mountains and as yet the only area in which these trematodes are known to occur. The root ending is derived from Latin *colo*: to inhabit or *incola* an inhabitant; gender neuter.

Remarks

Yungasicola gen. n. bears some similarities to *Canaania* Travassos, 1944, and *Prosolecithus* Yamaguti, 1971, but can be distinguished from them by the combination of several morphological traits such as the limited posterior extent of the gravid uterus, the oral sucker being larger than the ventral sucker (ratio of oral sucker/acetabulum close to 1 : 1), the well-developed and relatively turgid intestinal ceca (much more turgid in most specimens of *Yungasicola* than in *Prosolecithus*), the distribution of the vitellaria from the posterior edge of the testes anteriorly to just posterior to the cecal bifurcation (in *Prosolecithus*, the vitellaria are entirely pretesticular), and the location of the testes and ovary in the pre-equatorial zone.

Yungasicola travassosi sp. n. (Figs. 1–4)

Description

All measurements and statistics are based on the study of 35 specimens unless otherwise stated. With characteristics of the genus. Body broad, wide in middle portion and narrowing at both ends, 1,970–3,330 (2,710 ± 381, $n = 19$) long by 716–1,450 (981 ± 178) wide. Tegument unspined. Oral sucker rounded, 217–344 (272 ± 34.7, $n = 30$) long by 198–366 (276 ± 39.8, $n = 30$) wide. Acetabulum slightly smaller than oral sucker, rounded, situated anterior to midbody, 192–341 (258 ± 40.9) long by 183–344 (263 ± 39.9) wide. Oral sucker/acetabulum ratio 1 : 0.78–1 : 1.25 (1 : 1.05) long by 1 : 0.83–1 : 1.15 (1 : 1.05) wide. Pharynx rounded, 96–164 (130 ± 21.6) long by 76–146 (112 ± 18.2) wide. Esophagus short, 31–74 (53 ± 14, $n = 11$) long. Intestinal bifurcation in anterior 1/4 of body. Ceca terminating near posterior extremity of body. Internal wall usually lined with thick layer of epithelial tissue. Each cecum strongly developed, particularly in middle and posterior region, with irregularly expanded or turgid appearance, varying among and within individuals.

MALE REPRODUCTIVE SYSTEM: With 2 rounded to oval testes, symmetrical or very slightly oblique, situated immediately posterior to acetabulum. Right testis 96–214 (154 ± 27.8) long by 108–186 (135 ± 21) wide; left testis 112–229 (159 ± 29.9) long by 96–189 (135 ± 21.7) wide. Cirrus sac short, located between anterior border of acetabulum and cecal bifurcation, 105–285 (190 ± 48.1) long by 22–71 (51 ± 13.2) wide. Internal seminal vesicle straight or coiled, merging with straight muscular ejaculatory duct to form an unarmed cirrus. Everted cirrus 225–375 (310 ± 18, $n = 6$) long. Few glandular cells within cirrus sac. Genital pore median, at level of posterior edge of pharynx.

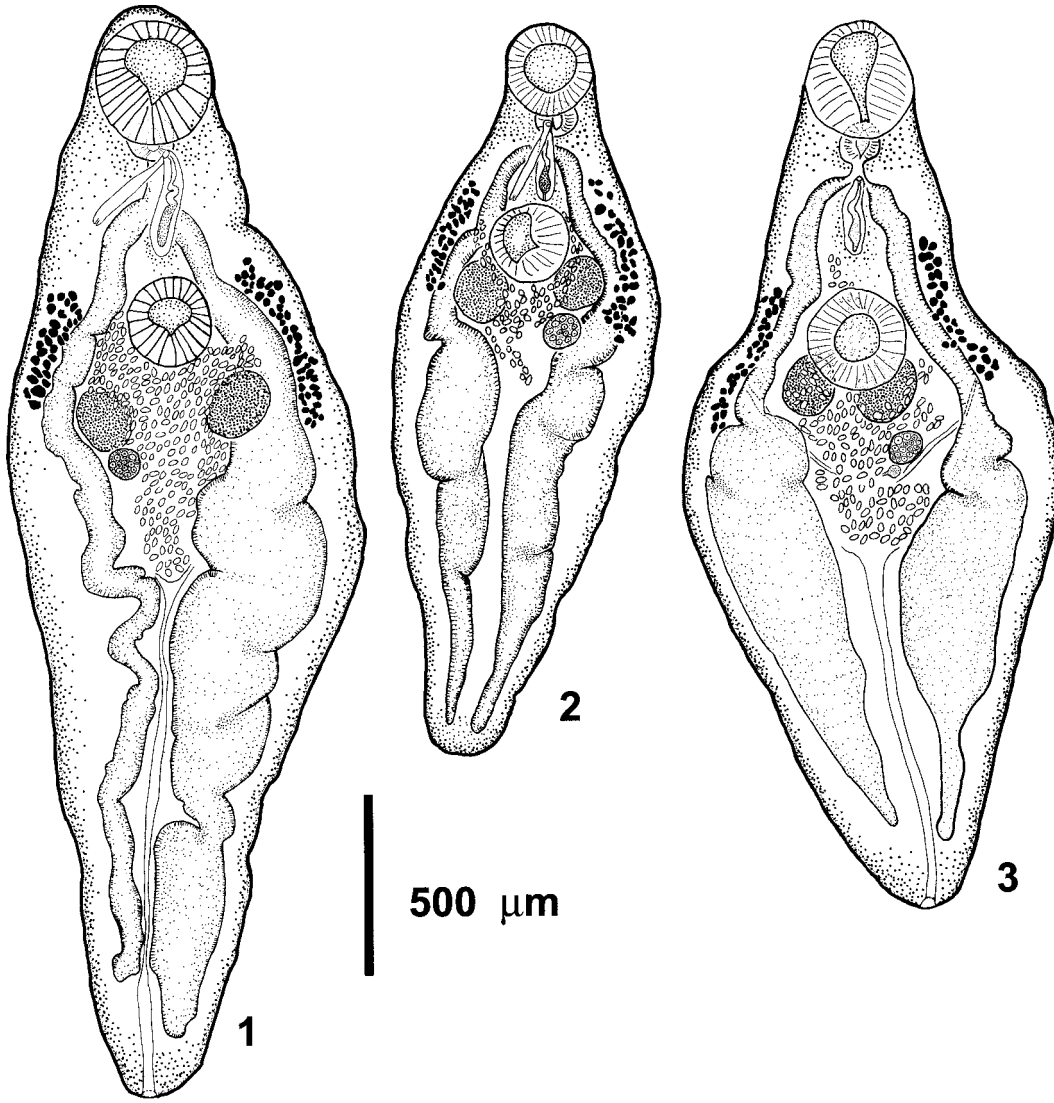
FEMALE REPRODUCTIVE SYSTEM: Typical of dicrocoeliids. Ovary rounded, 56–136 (95 ± 21.7) long by 62–132 (95 ± 21) wide, located posterior to left or right testis. Oviduct leading to ootype where ducts from seminal receptacle and vitellaria join. Laurer's canal present, directed dorsad, external opening not observed. Seminal receptacle small, postovarian, 19–37 (30 ± 6.9, $n = 7$) in diameter. Vitellaria consisting of small follicles clumped together, forming 2 mostly extracecal lateral fields, some follicles present in cecal area. Distribution of vitellaria restricted to area between ovario-testicular zone posteriad to cecal bifurcation. Vitelline reservoir formed by junction of left and right vitelline collecting ducts, opening to ootype via short common duct. Uterus occupying most of ovario-testicular area, with some loops extending posteriad relative to ovary, then ascending and forming numerous loops to reach metraterm. Metraterm short, opening to common genital pore. Eggs yellow to light brown, not operculate, 19–31 (26 ± 2.8, $n = 92$) long by 12–20 (16.3 ± 2, $n = 92$) wide. Excretory vesicle Y-shaped, bifurcating almost at level of ovary. Excretory pore terminal.

Taxonomic summary

TYPE HOST: *Akodon fumeus* Thomas, 1902 (smoky grass mouse)

TYPE LOCALITY: Bolivia: Departamento de La Paz, Río Aceromarca, 16°19′S, 67°53′W, elevation 2,990 m.

SYMBIOTYPES (see Frey et al., 1992): Holosymbiotype: *Akodon fumeus* Thomas, 1902. Female, MSB catalog no. 68518; Division of Bi-



Figures 1–3. 1. *Yungasicola travassosi* gen. n., sp. n. Holotype, ventral view (HWML16400). 2. Paratype (CNHE4283) of *Yungasicola travassosi* gen. n., sp. n., ventral view. 3. Paratype (HWML16404) of *Yungasicola travassosi* gen. n., sp. n., ventral view.

ological Materials, New Mexico Cryovoucher no. NK25800. Collected on 3 August 1992.

PARASYMBIOTYPES (FROM TYPE LOCALITY): *Akodon fumeus*, MSB no. 68505, NK25795; MSB no. 68506, NK25796; MSB no. 68507, NK25797; MSB no. 68514, NK25798; MSB no. 68517, NK25799; MSB no. 68511, NK25803; MSB no. 68513, NK25807; MSB no. 68510, NK25820. Colección Boliviana de Fauna (CBF) catalog numbers: CBF2564, NK25769; CBF2569, NK25763; CBF2568, NK25766. *Akodon mimus* (Thomas 1901), American Museum of Natural History (AM) catalog numbers: AM264833, NK25804; AM264842, NK25767; AM264831, NK25773. Collected from 2 to 7 August 1992.

PARASYMBIOTYPES (from other locality) (from which additional paratypes were collected): Bolivia: Departamento de La Paz, Río Unduavi, 16°

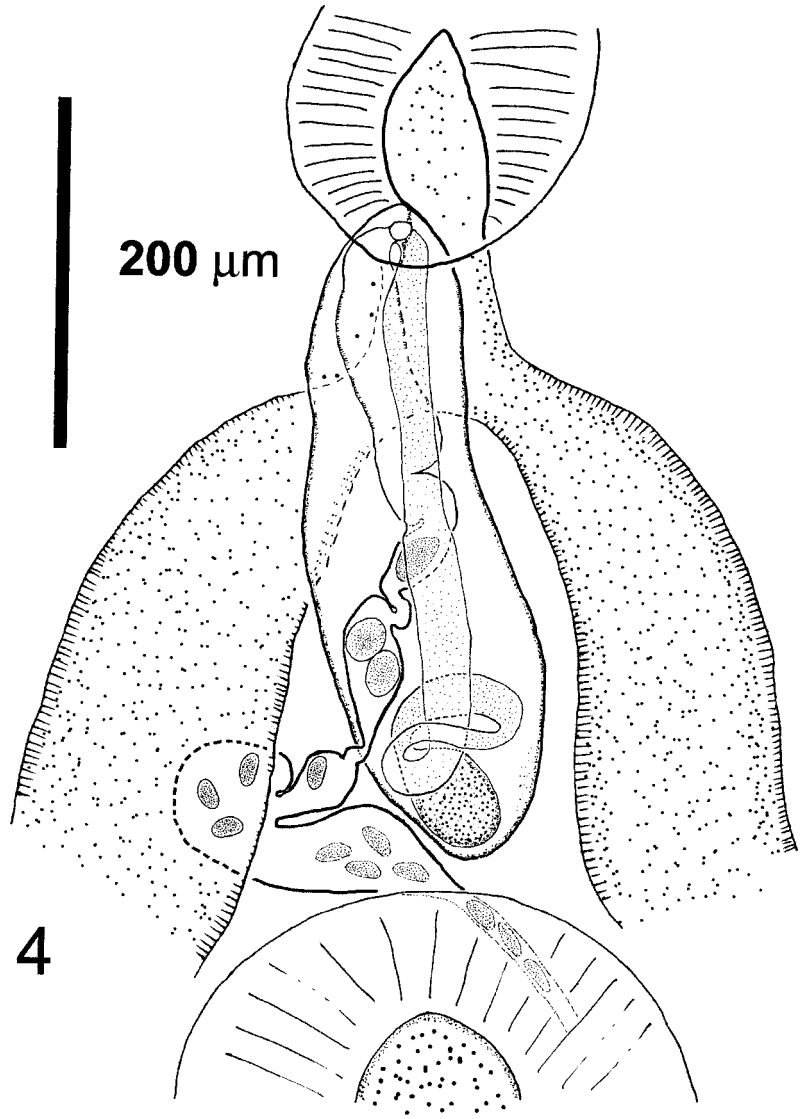


Figure 4. Detail of the terminal genital ducts (ventral view) of a paratype CNHE2414.

18′S, 67°51′W, elevation 2,500 m. *Akodon fumeus*, MSB no. 68526, NK25910. Collected 7 August 1992.

SITE OF INFECTION: Gall bladder and bile ducts.

SPECIMENS DEPOSITED: 1 holotype, HWML 16400 and 10 paratypes, HWML16401–16407; 6 paratypes, CNHE 4214–4215; 6 paratypes, USNPC91839–91843.

ETYMOLOGY: This species is named in honor of the Brazilian helminthologist Lauro Travassos, in recognition of his contribution to the study of the diversity and taxonomy of the Dicrocoeliidae.

Remarks and Discussion

Yungasicola travassosi is superficially similar to the 2 known species of the genus *Prosolecithus*. However, our new species differs from *Prosolecithus pellucidus* Pojmanska, 1957, described from the Eurasian shrew *Sorex araneus* Linnaeus, 1758, in western Poland (Pojmanska, 1957), and *Prosolecithus danubica* Tkach and Bray, 1995 from *S. araneus* and the southern

water shrew *Neomys anomalus* Cabrera, 1907 from Ukraine (Tkach and Bray, 1995) in having much different relative sizes of the oral sucker versus the acetabulum and in having a uterus that is much less extensive posteriad. Tkach and Bray (1995) also showed (p. 137) that species of *Prosolecithus* are morphologically and ecologically similar (i.e., in topography of suckers and reproductive system and in occurring in the bile ducts of small mammals) to some species of the genus *Zonorchis* Travassos, 1944, and also to the only species of the monotypic genus *Canaania* (*Canaania obesa* Travassos, 1944). The primary differences between species that make up these 2 genera are the greater extent of the uterus through the body and the shorter vitelline fields in species of *Zonorchis* relative to *Canaania.* The distribution and length of the vitelline fields in *C. obesa,* as well as the host groups and geographical distribution, were considered by Tkach and Bray (1995) as sufficient reason to separate species in both genera. *Canaania obesa* was described from the bile ducts of a grass mouse, *Akodon arviculoides* (Lund, 1841) (syn. of *Bolomys lasiurus* [Lund, 1841]) in Brazil, whereas species of *Prosolecithus* occur in the bile ducts and gall bladder of shrews from central Europe. Further, Tkach and Bray (1995) stated (p. 137): ''We suggest that the complete modern and historical isolation renders impossible the existence of a genus, one representative of which is living in Brazil and two are from central Europe.'' We have taken this statement and our morphological comparison into consideration to justify the establishment of a new genus.

Yungasicola travassosi sp. n. differs from *C. obesa* by having a more restricted distribution of vitelline fields, as well as fewer uterine loops. In *Y. travassosi,* the vitelline fields extend from the posterior edge of the testes anteriad to just behind the cecal bifurcation, whereas in *C. obesa,* the vitelline fields are distributed along most of the extension of the ceca, into the posterior extremity of the body. The uterine loops of *Y. travassosi* rarely reach the posterior part of the ovary, whereas in *C. obesa* the uterine loops extend well posterior to the ovary; the loops of the uterus of *Y. travassosi* in the pre-acetabular region are less well-developed than those of *C. obesa*. *Yungasicola travassosi* also differs from *C. obesa* by having a ratio of oral sucker/acetabulum length and width close to 1 : 1 (1 : 1.05), whereas *C. obesa* has an acetabulum usually 2–3 times larger than the oral sucker (1 : 2.17–1 : 3.07).

Yamaguti (1958) erected the tribe Eurytrematini to include 8 genera of dicrocoeliids: *Eurytrema* Looss, 1907; *Canaania* Travassos, 1944; *Concinnum* Bhalerao, 1936; *Conspicuum* Bhalerao, 1936; *Dictyonograptus* Travassos, 1920; *Platymosoides* Yamaguti, 1971; *Platynosomum* Looss, 1907; and *Zonorchis* Travassos, 1944. Later, Panin (1981) raised the tribe Eurytrematini to the rank of subfamily (Eurytrematinae), and Panin (1984) also used the subfamily name in his book.

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Literature Cited

Anderson, S. 1997. Mammals of Bolivia, taxonomy and distribution. Bulletin of the American Museum of Natural History 231:1–652.

Eisenberg, J. F. 1989. Mammals of the Neotropics: The Northern Neotropics. Vol. 1. The University of Chicago Press, Chicago, Illinois, U.S.A. 449 pp.

Frey, J. K., D. W. Duszynski, W. L. Gannon, T. L. Yates, and S. L. Gardner. 1992. Designation and curation of type host specimens (symbiotypes) for new parasite species. Journal of Parasitology 78: 930–932.

Gardner, S. L., and M. L. Campbell. 1992. Parasites as probes for biodiversity. Journal of Parasitology 78:506–600.

Marshall, L. G., and T. Sempere. 1993. Evolution of the Neotropical Cenozoic land mammal fauna in its geochronologic, stratigraphic and tectonic context. Pages 329–392 *in* P. Goldblatt, ed. Biological Relationships between Africa and South America. Yale University Press, New Haven, Connecticut, U.S.A.

Olsen, O. W. 1974. Animal Parasites, Their Life Cycles and Ecology. Dover Publications, Inc. New York, New York, U.S.A. 562 pp.

Panin, V. 1981. Principles of the taxonomy and the system of trematodes of the family Dicrocoeliidae Odhner, 1911. Pages 123–133 *in* Parazity Komponenty Vodnykh i Nazemnykh Biotsenozov Kazakhstana. Nauka, Alma-Ata, USSR. (In Russian.)

———**.** 1984. Trematody Dikrotseliidy Mirovoi Fauny. Nauka, Kazakshkaya SSR, Alma-Ata, USSR, 248 pp. (In Russian.)

Pojmanska, T. 1957. Parasozity wewnetrzne (Cestoda, Trematoda) drobnych ssakow polynch z okolic Turwi kolo Poznania. Acta Parasitologica Polonica 5:117–161. (In Polish.)

Redford, K. H., and J. F. Eisenberg. 1992. Mammals of the Neotropics: the Southern Cone. Vol. 2: Chile, Argentina, Uruguay, Paraguay. The University of Chicago Press, Chicago, Illinois, U.S.A. 430 pp.

Tkach, V. V., and R. A. Bray. 1995. *Prosolecithus danubica* n. sp. (Digenea: Dicrocoeliidae), a new digenean from shrews on islands of the Danube delta. Parasite 2:133–140.

Travassos, L. 1944. Revisão da Família Dicrocoeliidae Odhner, 1910. Monografias do Instituto Oswaldo Cruz, No. 2. Imprensa Nacional, Rio de Janeiro, Brazil. 357 pp.

———**, J. F. Teixeira de Freitas, and A. Kohn.** 1969. Trematódeos do Brasil. Memórias do Instituto Oswaldo Cruz 67:1–881.

Unzueta, O. Q. 1975. Mapa Ecológico de Bolivia: memoria explicativa. Ministerio de Asuntos Campesinos y Agropecuarios, División de Suelos, Riegos e Ingeniera, La Paz, Bolivia. 309 pp.

Yamaguti, S. 1958. Systema Helminthum. Vol. 1. The Digenetic Trematodes of Vertebrates. Parts 1 and 2. Interscience Publishers, Inc., New York, U.S.A. 974 pp.

———. 1971. Synopsis of Digenetic Trematodes of Vertebrates. Vols. 1–2. Keigaku Publishing Co., Tokyo, Japan, 1074 pp.

Obituary Notice

ROY C. ANDERSON

1925–2001

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Appointed to Editorial Board, 1983-2001