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Redescription of *Perezitrema bychowskyi* (Caballero & Caballero, 1975) (Trematoda: Macroderoididae), with remarks on the systematic status of *Perezitrema* Baruš & Moravec, 1996

František Moravec[1] & Guillermo Salgado-Maldonado[2]
[1]*Institute of Parasitology, Academy of Sciences of the Czech Republic, Branišovská 31, 37005 České Budějovice, Czech Republic*
[2]*Institute of Biology, National Autonomous University of Mexico, A.P. 70-153, 04510 México, D.F., Mexico*

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Abstract

A description is given of *Perezitrema bychowskyi* (Caballero & Caballero, 1975) based on newly collected specimens from the intestine of the tropical gar *Atractosteus tropicus* Gill in the Pantalos de Centla Biological Reserve, State of Tabasco, southeastern Mexico, collected in April 2001, and on a re-examination of the type-specimens. In contrast to the original description, the excretory vesicle of *P. bychowskyi* was found to be elongate saccular and the intestinal caeca join near the posterior extremity and open via a common median anus. These features, and the presence of a cirrus-sac, were found, using differential interference contrast optics in the type-specimens of *P. viguerasi* Baruš & Moravec, 1967, the type-species of the genus. This made possible a re-diagnosis of *Perezitrema* Baruš & Moravec, 1967. Although *P. bychowskyi* is very similar to *P. viguerasi* and their conspecificity cannot be excluded, the poor condition of the type-specimens of the latter does not enable their detailed comparison and, consequently, both are considered independent species for the time being. *P. lepisostei* (Watson, 1976) is considered a junior synonym of *P. bychowskyi*. *Perezitrema* is provisionally placed in the plagiorchioid family Macroderoididae, even though some of its morphological features are similar to those of the lepocreadioid families Enenteridae and Lepocreadiidae.

Introduction

In April 2001, during investigations into the metazoan parasites of tropical gars *Atractosteus tropicus* Gill carried out in the Pantanos de Centla Biological Reserve in the State of Tabasco, Mexico (Salgado-Maldonado et al., 2003; Moravec & Salgado-Maldonado, 2002), specimens of the trematode *Perezitrema bychowskyi* (Caballero & Caballero, 1975) were collected from the intestine of this host species. This material, as well as a re-examination of the type-specimens, made possible a detailed study (including scanning electron microscopy) and redescription of the morphology of this inadequately known species and a comparison with the type-specimens of *P. viguerasi* Baruš & Moravec, 1967, the type-species of the genus. The results obtained are presented herein.

Materials and methods

Tropical gars *Atractosteus tropicus* Gill were caught by professional fishermen in the Canal Nueva Esperanza (Nueva Esperanza Channel), Pantanos de Centla Biological Reserve, State of Tabasco. They were immediately examined for the presence of helminth parasites in the laboratory. The trematodes were washed in physiological saline and then fixed in 4% formaldehyde either slightly compressed by coverslip pressure or by the addition of hot fixative to a Petri dish containing these trematodes in a small amount of liquid. For light microscopy the trematodes were stained in carmine, dehydrated through an ethanol series and mounted in Canada balsam as permanent slides. Drawings were made with the aid of an Aristoplan microscope drawing attachment, using a differential interference contrast (DIC) optics. For scanning electron

microscopy (SEM), the trematodes were postfixed in 1% osmium tetroxide, dehydrated through an ethanol series and acetone, and then subjected to critical point drying. The specimens were coated with gold and examined using a JSM-6300 scanning electron microscope at an accelerating voltage of 15 kV. All measurements are given in micrometres unless otherwise stated. The specimens have been deposited in the National Helminthological Collection of the Institute of Biology, National Autonomous University of Mexico (UNAM), in Mexico City and in the Helminthological Collection of the Institute of Parasitology, Academy of Sciences of the Czech Republic (ASCR), České Budějovice.

The following trematode specimens were examined in addition to the newly collected material:
Type-specimens (holotype and 9 paratypes) of *Neotropicotrema bychowskyi* Caballero & Caballero, 1975 from the National Helminthological Collection of the Institute of Biology, UNAM (Cat. Nos 786 and 888) from the intestine of *Atractosteus tropicus* from Campeche, Mexico.
Type-specimen (holotype) of *Allomacroderoides lepisostei* Watson, 1976 (deposited by Watson under the name *Paramacroderoides lepisostei*) from the US National Parasite Collection, Beltsville Agricultural Research Center, Beltsville, Maryland, USA (Cat No. USNPC 061329.00) from the intestine of *Atractosteus tropicus* from Nicaragua.
Type-specimens (holotype and 19 paratypes) of *Perezitrema viguerasi* Baruš & Moravec, 1967 from the Helminthological Collection of the Institute of Parasitology, ASCR (Cat. No. D - 12) from the intestine of *Lepisosteus tristoechus* from Zapata, Cuba.
Metacercariae (8 specimens) of *Perezitrema viguerasi* Baruš & Moravec, 1967 from the Helminthological Collection of the Institute of Parasitology, ASCR (Cat. No. D - 12) from the body-cavity of *Nandropsis tetracanthus* from Zapata, Cuba.

The scientific names of fishes are according to Froese & Pauly (2001).

***Perezitrema bychowskyi* (Caballero & Caballero, 1975)**

Syns *Neotropicotrema bychowskyi* Caballero & Caballero, 1975; *Allomacroderoides lepisostei* Watson, 1976

Description (Figures 1, 2)

(Based on 6 gravid specimens.) Body of unflattened specimens elongate, almost cylindrical, broadest at region of oral sucker; in slightly flattened specimens, maximum width may be at region of ventral sucker; body length 1.32-1.93 mm; maximum width 340-680. Body surface covered with numerous small triangular spines which are distinctly larger and denser on forebody than on hindbody; spines absent only from surface of oral sucker, region around genital pore and posterior half of ventral sucker. Numerous small tegumental papillae present on anterior margin of oral sucker, on ventral surface of forebody and outer surface of ventral sucker. Oral sucker terminal, very large, bell-shaped, 326-435 × 272-408, with distinct ventral groove; its anterior margin without any large lobes. Ventral sucker circular to oval, distinctly smaller than oral sucker, 82-190 × 95-204, pre-equatorial; its anterior half covered with minute spines; 8 distinct papilla-like outgrowths with broad bases and narrow distal ends present on its inner surface. Prepharynx very short or practically absent. Pharynx oval, muscular, 109-136 × 95-136. Oesophagus very short or absent. Intestinal bifurcation just posterior to pharynx; 2 simple, lateral caeca extend posteriorly to unite near posterior extremity of body to form cyclocoel which opens via distinct anus; body region around anal pore usually somewhat withdrawn.

Testes spherical to transversely oval, entire, equal or subequal in size, tandem or somewhat diagonal, close to each other, situated just anterior to posterior caecal union; anterior testis 122-190 × 150-272; posterior testis 109-204 × 136-231. Cirrus-sac well developed, 218-313 × 68-122, dorsal to ventral sucker, usually extending somewhat beyond latter posteriorly; it contains voluminous bipartite seminal vesicle, pars prostatica and short, smooth cirrus. Genital pore median, situated just anterior to ventral sucker.

Ovary spherical to oval, entire, 95-150 × 82-190, at short distance posterior to ventral sucker. Seminal receptacle present (but not observed in most specimens), just posterior to ovary. Uterus extends posteriorly into post-testicular space; uterine coils in pre-testicular field ventral, intercaecal; distal part of uterus forms metraterm which opens anteriorly into common genital atrium. Eggs numerous; fully-developed eggs operculate, yellow, 30-33 × 15-18. Vitellarium composed of numerous follicles, confined lateral fields, sometimes encroaching towards median line; fields extend

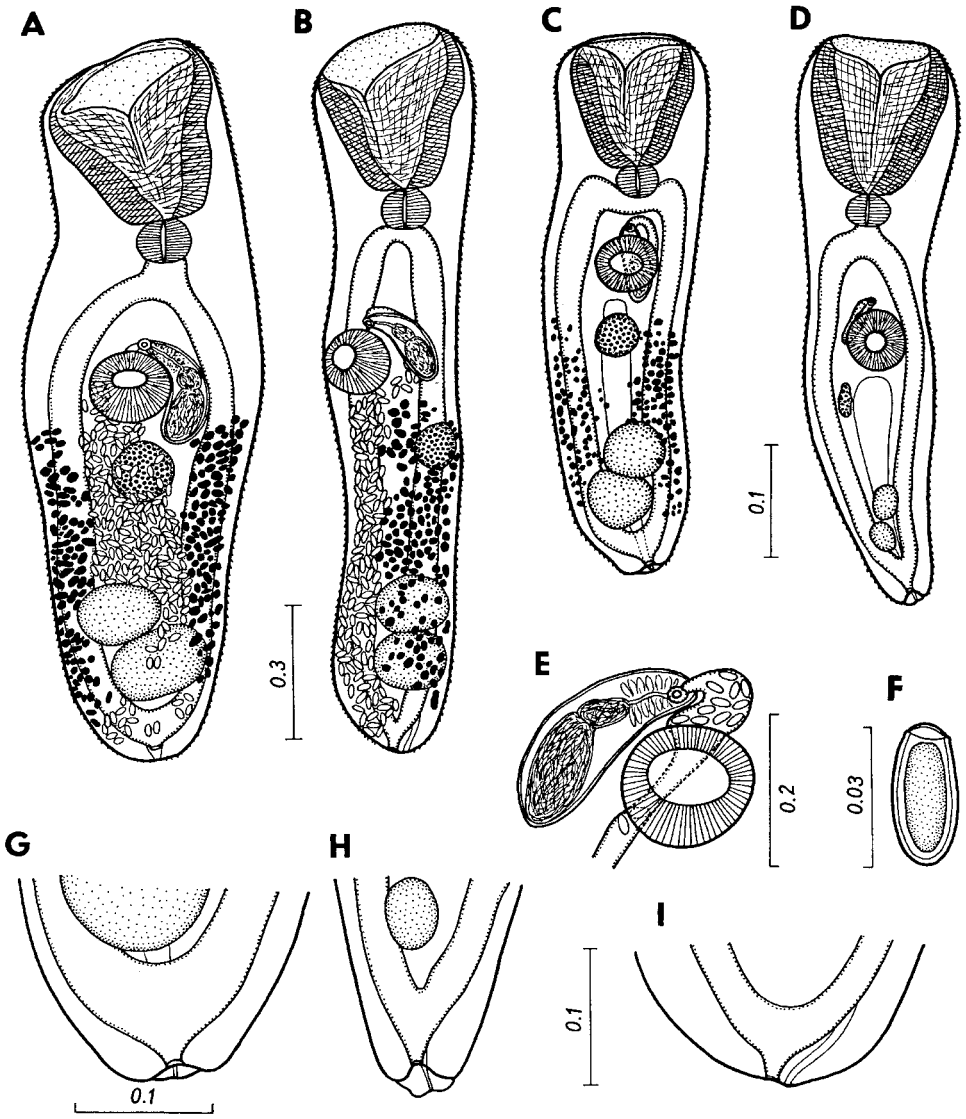

Figure 1. Perezitrema bychowskyi (Caballero & Caballero, 1975) from *Atractosteus tropicus*, Mexico. A, gravid specimen (flattened), ventral view; B, gravid specimen (non-flattened), ventrolateral view; C, non-ovigerous specimen (flattened), ventral view; D, juvenile specimen (unflattened), ventral view; E, region of ventral sucker; F, egg; G-I, posterior end of body in three different specimens (G, specimen C; H, specimen D; I, specimen B). Scale-bars in mm.

from level of posterior margin of ventral sucker to about posterior margin of posterior testis.

Excretory vesicle elongate saccular, dorsal to intestine and gonads, reaches anteriorly almost to level of ovary, excretory pore dorsal to anus, usually at different level (more posteriorly); uroproct absent.

Host: Tropical gar *Atractosteus tropicus* Gill (Lepisosteidae, Lepisosteiformes).
Site: Intestine.
Locality: Canal Nueva Esperanza (18°23′779″N, 92°34′784″W), Pantalos de Centla, State of Tabasco, Mexico (26 April 2001).
Infection: Prevalence 14% (3 of 21 hosts examined); intensity 1-4 specimens.

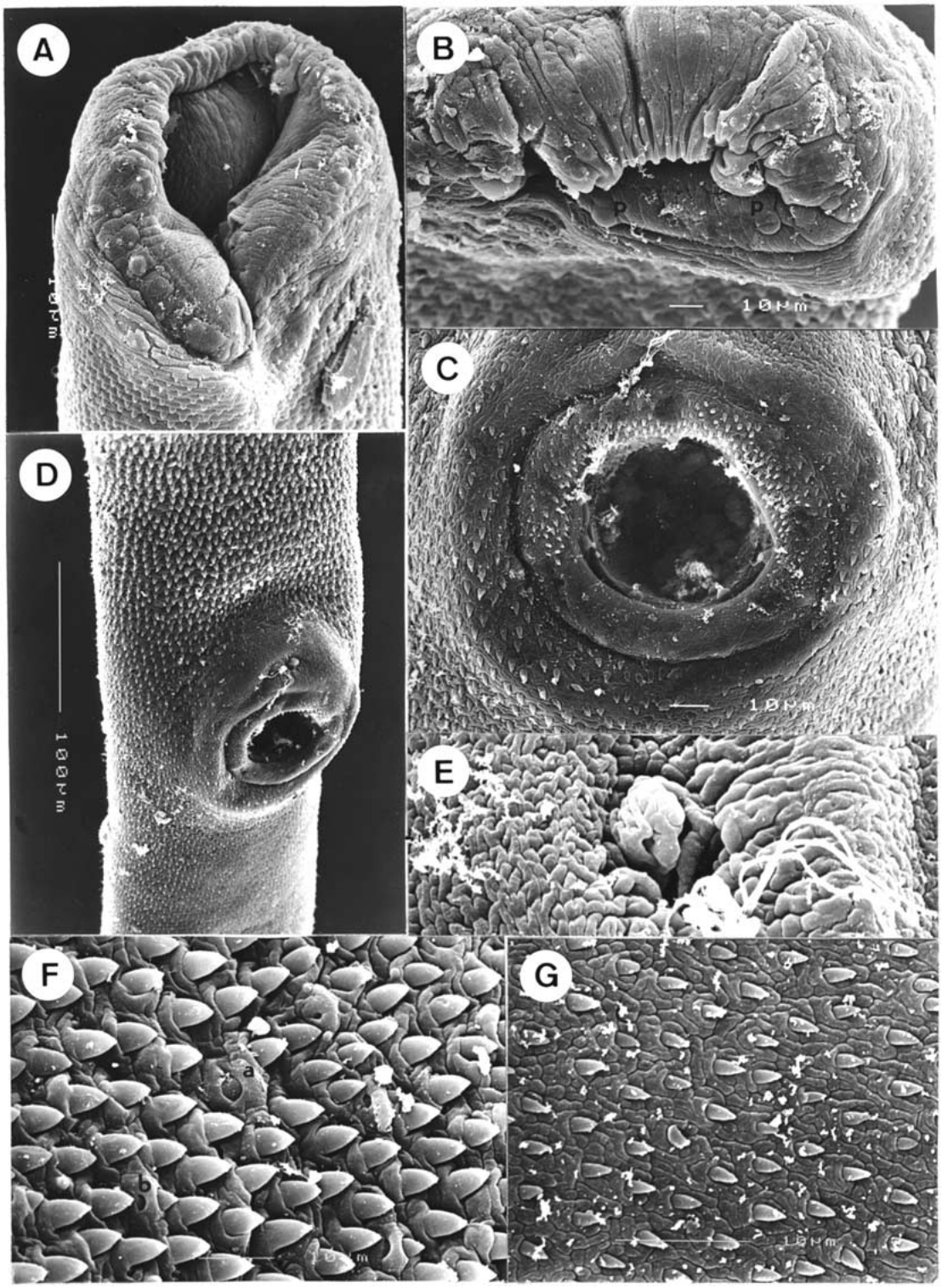

Figure 2. Perezitrema bychowskyi (Caballero & Caballero, 1975) from *Atractosteus tropicus*, Mexico, SEM micrographs. A, oral sucker, ventro-apical view; B, margin of oral sucker, apical view; C, ventral sucker, ventral view (note spines on its anterior half and papilla-like outgrowths on inner surface); D, region around ventral sucker; E, genital pore; F, tegumental spines on forebody; G, tegumental spines on hindbody. *Abbreviations*: a, larger tegumental papilla; b, smaller tegumental papilla; p, papilla on oral sucker.

Re-examination of specimens of *Perezitrema viguerasi* Baruš & Moravec, 1967

A re-examination of the type-specimens of *P. viguerasi* with the use of DIC optics showed that some morphological features of these trematodes were, because of a poor condition of specimens, inaccurately or erroneously described.

In the original description, two blindly ending caeca were reported, but the structure of the posterior end of the body is mostly obscure because of the presence of numerous eggs; however, in one non-ovigerous and one gravid specimen (Figure 3B,D), it is possible to observe that the caeca are united and that they open via a common anus. This is also visible in conspecific metacercariae (Figure 3F,G).

The excretory vesicle was reported as Y-shaped, bifurcating just posterior to the posterior testis; however, in fact, the posterior region of the intestinal tract was mistaken for the excretory vesicle, probably because the former overlaps the termination of the latter. The re-examination of this specimen shows (Figure 3C,D) that the excretory vesicle is saccular in this species, which is better visible in the conspecific metacercaria (Figure 3E).

Only the presence of a seminal vesicle was originally reported for *P. viguerasi*, but the re-examination showed the presence of a cirrus-sac containing a voluminous, bipartite seminal vesicle in some specimens; a short, smooth, extruded cirrus was observed occasionally.

Genus *Perezitrema* Baruš & Moravec, 1967

Syns *Neotropicotrema* Caballero & Caballero, 1975; *Allomacroderoides* Watson, 1976

Diagnosis: Body elongate, cylindrical, spinose. Oral sucker very large, bell-shaped. Ventral sucker much smaller than oral sucker, in middle of body. Prepharynx short; pharynx globular. Oesophagus short; two caeca unite near posterior extremity of body to form cyclocoel which opens via single anus. Testes entire, directly tandem, close to posterior extremity. Cirrus-sac well developed, dorsal to ventral sucker, contains bipartite seminal vesicle, pars prostatica and smooth cirrus. Genital pore median, just anterior to ventral sucker. Ovary entire, median or submedian, posterior to ventral sucker, far anterior to anterior testis. Uterus reaches posterior end of body. Eggs small, numerous. Vitelline follicles form lateral fields extending from posterior margin of ventral sucker to posterior margin of posterior testis. Excretory vesicle saccular; excretory pore dorsal to anus. Intestinal parasites of freshwater and brackish-water fishes. Type-species: *P. viguerasi* Baruš & Moravec, 1967.

Discussion

Perezitrema was established by Baruš & Moravec (1967) for *P. viguerasi* Baruš & Moravec, 1967, a species described from the intestine of the Cuban gar *Lepisosteus tristoechus* (Bloch & Schneider) in Cuba. They assigned it to the family Acanthostomidae Poche, 1926, mainly because of the very large, bell-shaped oral sucker, an allegedly Y-shaped excretory vesicle and the apparent absence of a cirrus-sac. Later, similar worms were described as *Neotropicotrema bychowskyi* from the intestine of the tropical gar *Atractosteus tropicus* Gill in Campeche, Mexico by Caballero & Caballero (1975), but, because they had a well-developed cirrus-sac and a posteriorly united caeca (cyclocoel), the authors created a new genus to accommodate this new species and mentioned that it did not belong to the Acanthostomidae. The same trematode was later recorded by Osorio-Sarabia et al. (1987) from the same host species in the nearby Mexican state of Tabasco.

In 1976, Watson, apparently being unfamiliar with the paper of Caballero & Caballero (1975), described an additional new genus and species, *Allomacroderoides lepisostei*, from *A. tropicus* from Nicaragua. The general morphology was similar to that of *N. bychowskyi*, but the excretory vesicle was described as saccular and the caeca as ending blindly near the posterior extremity of the body; the author assigned this species to the Plagiorchiidae Lühe, 1901.

Brooks (1980), when revising the acanthostomes, considered *Perezitrema, Neotropicotrema* and *Allomacroderoides* to belong to the Plagiorchiidae and synonymised both of the last named genera with *Perezitrema*.

This study shows that the specimens of the present material are morphologically and biometrically more or less identical with those described as *N. bychowskyi*; Caballero & Caballero (1975) only overlooked the anus which, in the specimens observed in ventral view, lies directly over the termination of the excretory vesicle, so that it is difficult to distinguish it from the excretory pore. The excretory vesicle was described as Y-shaped, but it was not illustrated and, apparently, its shape was only presumed. It is

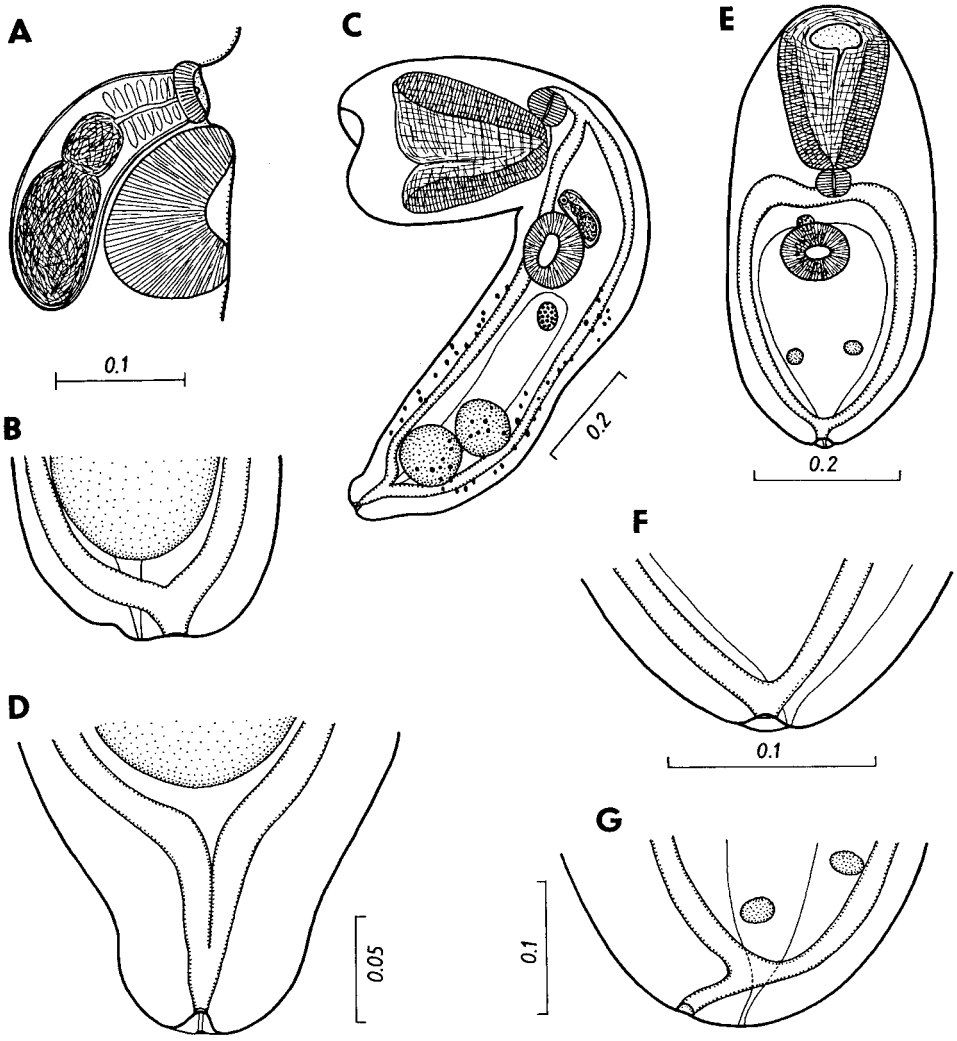

Figure 3. Perezitrema viguerasi Baruš & Moravec, 1967 from Cuba. A-D, type-specimens from *Lepisosteus tristoechus*: A, region of cirrus-sac and ventral sucker in gravid specimen, lateral view; B, posterior end of gravid specimen, subventral view; C, non-ovigerous specimen, ventral view; D, posterior end of non-ovigerous specimen C, ventral view. E-G, metacercariae from *Nandropsis tetracanthus*: E, general view; F, posterior end of specimen E, ventral view; G, posterior end of another specimen, subventral view. Scale-bars in mm.

necessary to remark that the excretory vesicle is very difficult to observe in this species, especially in adult trematodes, where it is overlapped by uterine coils containing eggs and by gonads. Of the ten re-examined type-specimens of *N. bychowskyi*, the shape (saccular) of the excretory vesicle was clearly visible in only one paratype, whereas in all of the remaining specimens, including the holotype, it was indistinct. Since the specimens of the present material are morphologically identical with the type-specimens of *Pereztrema bychowskyi*, they originated from the same host species in the same geographical region, we consider them to belong to this species.

The morphology of *Allomacroderoides lepisostei* is also identical with that of *P. bychowskyi*. Walton (1976) correctly described the excretory vesicle as saccular, but he failed to observe the cyclocoel and the anus near the posterior extremity, which are rather indistinct in gravid specimens; both these features were found in the re-examined holotype of *A. lepisostei*. The two papillae reported by Walton (1976) on the oral sucker belong to a group of tegumental papillae and were also observed in specimens of the present material (Figure 2B). Since the host species of both these forms is identical and they occur in neighbouring

regions, we consider *A. lepisostei* a junior synonym of *P. bychowskyi*.

A re-examination of the type-specimens of *P. viguerasi* has confirmed that the main taxonomic features of this species, including the presence of the cirrus-sac, the form of the terminal portion of the intestine and the saccular excretory vesicle, are identical with those of *P. bychowskyi* and, consequently, that they both belong to the same genus. New data on the morphology of *P. viguerasi*, the type species of *Perezitrema*, enabled us to re-define the genus (see above).

The morphology of *P. bychowskyi* is very similar to that of *P. viguerasi* and some biometrical data (e.g. the size of both suckers, pharynx, cirrus-sac, gonads, eggs, body width and extent of vitelline follicles) are practically identical in both species; but the body of *P. viguerasi* is more elongate and longer (1.86-2.74 mm), tegumental spines on the forebody are indistinct, the intestinal bifurcation is far anterior to the ventral sucker and the oesophagus is rather long. However, it seems that the specimens of *P. viguerasi* were in a poor condition prior to their fixation, probably dead and macerated; therefore, it may well be that the morphological differences found are only due to changes after the death of the worms. Even though it cannot be excluded that these forms are conspecific, until new, well-preserved specimens from Cuban gars are available for a comparison, we consider them to be valid species.

The morphology of both *P. viguerasi* and *P. bychowskyi*, particularly the presence of the cirrus-sac and the saccular excretory vesicle, shows clearly that *Perezitrema* does not belong to the Acanthostomidae, where it was originally placed by Baruš & Moravec (1967). Yamaguti (1971) assigned this genus to the family Opisthorchiidae Looss, 1899, subfamily Aphallinae Yamaguti, 1958. According to Watson (1976) and Brooks (1980), this genus belongs to the Plagiorchiidae.

The shape of the excretory vesicle, the spinose tegument and the general morphology of *Perezitrema* indicate that this genus might belong either to the plagiorchioid family Macroderoididae McMullen, 1937 or to the lepocreadioid families Lepocreadiidae Odhner, 1905 or Enenteridae Yamaguti, 1958; unfortunately, according to Yamaguti (1971, 1975), both these groups differ principally in larval characters. However, Gibson (1996) mentioned that the plasticity in cercarial morphology in lepocreadioids casts doubt upon the use of this feature as a phylogenetic indicator. The latter author wrote that in adult morphology the macroderoidids are 'very similar to some lepocreadioid groups, but can be distinguished in the majority of instances (except *Pristicola* Cable, 1952) by the posterior extent of the uterus'.

In the presence of tegumental spines and a well-developed cirrus-sac containing a bipartite seminal vesicle, in the posterior extent of the uterus and in having the metacercariae parasitic in fishes, *Perezitrema* resembles the Macroderoididae; moreover, the morphologically similar species *Macroderoides spinifer* Pearse, 1924 occurs in North American *Lepisosteus* spp. [*L. platostomus* Rafinesque and *L. osseus* (Linnaeus)]; however, in contrast to *Perezitrema*, all the genera listed in this family include species with two blindly ending caeca. The presence of blind caeca is a character mentioned by Gibson (1996) in the diagnoses of both the Plagiorchioidea Lühe, 1901 and the Macroderoididae.

In contrast to *Perezitrema*, species of the lepocreadidoid families often possess eye-spots, the uterine field is normally pre-ovarian and their metacercariae (in known cases) are usually parasitic in aquatic invertebrates; moreover, species of the Lepocreadiidae possess an external seminal vesicle (Gibson, 1996). On the other hand, some forms of these families possess an anus, a large, funnel-shaped oral sucker and their ventral sucker may have papilliform appendages, thus resembling *Perezitrema*. In many important features, *Perezitrema* seems to resemble members of the Enenteridae, which includes parasites of marine, mostly herbivorous fishes, differing from them mainly in the extent of the uterus. Yamaguti (1971) considered it a subfamily within the Opecoelidae Ozaki, 1925 and its members were diagnosed as having a smooth body surface (see also Skryabin & Koval, 1965). However, recent studies by Brooks et al. (2000), Bray & Cribb (2001) and Cribb et al. (2001) have shown affinities of the Enenteridae with the Lepocreadiidae and the diagnosis of the former given by Bray & Cribb (2001) clearly states that the tegument of its members is spinous. Unfortunately, the life-cycles of enenterids have not yet been studied.

The life-cycles of *Perezitrema* spp. are unknown, but encysted metacercariae of both species were found in naturally infected cichlids: Moravec & Baruš, 1971) found the metacercariae of *P. viguerasi* in *Nandropsis tetracanthus* (Valenciennes) in Cuba, whereas those of *P. bychowskyi* were reported from *Hypsophrys nicaraguensis* (Günther) in Nicaragua (Watson, 1976) and from *Cichlasoma geddesi* (Regan), *C. octofascia-*

tum (Regan), *C. pearsei* (Hubbs), *C. urophthalmus* (Günther), *Parachromis managuensis* (Günther), *Petenia splendida* Günther, *Thorichthys helleri* (Steindachner), *T. meeki* (Brind), *Vieja bifasciata* (Steindachner), *V. fenestrata* (Günther) and *V. synspila* (Hubbs) in southern Mexico (Vidal-Martínez et al., 2001). In utilising small fishes as the second intermediate host, the life-cycles of *Perezitrema* spp. appear to resemble those of *Macroderoides* spp. (see Yamaguti, 1975).

It is apparent from the above discussion that the assignment of *Perezitrema* to a family remains problematical, mainly because of the unsatisfactory situation in the delimitation of some higher taxa of trematodes and the lack of knowledge of the development of *Perezitrema* spp. Nevertheless, for the time being, until more necessary data are obtained, we suggest including *Perezitrema* within the Macroderoididae, even though the presence of the cyclocoel and anus is not in accordance with the current diagnosis of this family. Nevertheless, it does appear that the posterior regions of the digestive tract can vary considerably within some families.

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