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Helminth parasites of *Epinephelus morio* (Pisces: Serranidae) of the Yucatan Peninsula, southeastern Mexico

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Abstract. The present paper comprises a systematic survey of helminths from 202 red groupers, *Epinephelus morio* (Valenciennes) (Pisces: Serranidae), the most important commercial marine fish in the region, collected from ten localities off the Yucatan Peninsula in the Gulf of Mexico during 1994–1996; two more helminth species were recorded from *E. morio* earlier. Thirty species of helminths were found: Monogenea 1, Cestoda 3, Trematoda 17, Nematoda 8, Acanthocephala 1. Of them, 15 species were adults, whereas 15 species were larval stages parasitizing piscivorous elasmobranch and teleostean fishes, birds and marine mammals as adults. A new didymozoid trematode, *Allonematobothrium yucatanense* sp. n., is described from the fins of this host. Most findings represent new host– and geographical records. *Philometra margolisi*, a nematode parasitizing the gonads, is undoubtedly the most important parasite affecting the reproduction of the host, endangering *E. morio* in aquaculture. Larval anisakid nematodes (*Anisakis*, *Pseudoterranova*, *Hysterothylacium*) recorded from the red grouper in the region of the southern Gulf of Mexico are important from the viewpoint of public health.

The red grouper, *Epinephelus morio* (Valenciennes) (Serranidae, Perciformes) is a widely distributed species in the Gulf of Mexico and the most important fishery resource in the Yucatan Peninsula whose parasite fauna is insufficiently known. Until recently, the only data from Mexico were those given by Cuban and Russian researchers (Fajer et al. 1979, Zhukov 1983) off the Campeche coast, who recorded three species of helminth parasites (the gill monogenean *Haliotrema macrobaculum* Zhukov, 1983, a larval trypanorhynch cestode *Callitetrarhynchus* sp. and a larval anisakid nematode *Anisakis* sp.). Preliminary observations on the helminth parasites of *E. morio* from Yucatan, based on a small sample of fish examined in 1991 and 1992, were published by Moravec et al. (1995a,b), Vidal-Martínez et al. (1995) and Aguirre-Macedo and Bray (1997). Incidental data on the parasites of the red grouper have been provided by American authors from the northern Gulf of Mexico (e.g., Manter 1933, Deardorff and Overstreet 1981a,b,c) and from the Caribbean Sea (e.g., Nahhas and Cable 1964).

In 1994–1996, extensive investigations of the metazoan parasite fauna of *E. morio* were carried out by the research team of the Centre for Research and Advanced Studies of the Polytechnic Institute (CINVESTAV-IPN) in Mérida, Mexico. The results of the systematic evaluation of the helminth parasites collected are presented herein. Three new helminth species found during this research have already been formally described in separate papers (Moravec et al. 1995c, 1996, Vidal-Martínez et al. 1997).

MATERIALS AND METHODS

From November 1994 to June 1996, a total of 202 specimens of *Epinephelus morio* (Valenciennes), originating from ten localities in the Mexican States of Campeche, Yucatan and Quintana Roo, all in the region of the southern Gulf of Mexico (Fig. 1), were examined:

State of Campeche: Campeche: 13 fishes (body length 25–68 cm, weight 141–6350 g), III., IV., VII. 1995, III. 1996.

State of Yucatan: Celestun: 27 (22–47 cm, 140–1340 g), II., VII. 1995, V. 1996. Sisal: 23 (18–32 cm, 86–458 g), IV. 1995, III. 1996. Chelem: 25 (22–36 cm, 171–692 g), XII. 1995, IV. 1996. Chuburna: 7 (16–37 cm, 58–758 g), I. 1995, IV. 1996. Progreso: 38 (23–55 cm, 179–2145 g), VI., XI. 1995, V. 1996. Chicxulub: 4 (28–29 cm, 156–286 g), I. 1995. Telchac: 17 (25–76 cm, 225–4500 g). Rio Lagartos: 27 (23–38 cm, 170–1143 g), XI. 1994, V. 1995.

State of Quintana Roo: Chiquila: 21 (31–44 cm, 384–1295 g), III., IX. 1995.

Fish were obtained either by hook and line or purchased at ports of the artisanal fleet in Yucatan. Fresh fish were transported on ice to the Laboratory of Parasitology in Mérida, where they were examined for the presence of metazoan parasites within two days. Conventional helminthological methods were used for the preparation of the parasites for their subsequent study and identification. Trematodes, cestodes and acanthocephalans were stained in carmine and mounted in

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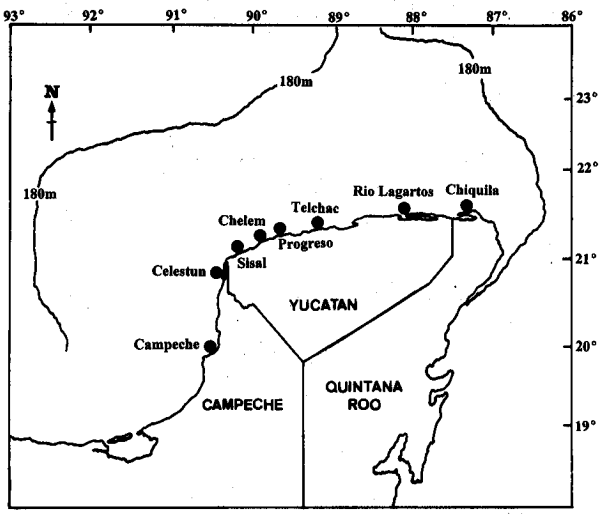

Fig. 1. Map of the study area, with indication of the sampling sites along the coast of the Peninsula of Yucatan, Mexico. Localities Chuburna and Chicxulub, situated near Chelem and Progreso, respectively, are not indicated.

Canada balsam. Nematodes were cleared with glycerine. Most monogeneans and some metacercariae were studied as mounts in ammonium-picrate.

Type and voucher specimens of the helminth species recorded have been deposited in the Helminthological Collection of the Institute of Biology, National Autonomous University of Mexico (UNAM), Mexico City; in the collection of the Parasitological Laboratory of the Centre for Research and Advanced Studies (CINVESTAV-IPN), Mérida Unit; and in the helminthological collection of the Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice. All measurements are given in millimetres.

REVIEW OF SPECIES

MONOGENEA

1. ***Pseudorhabdosynochus yucatanensis*** Vidal-Martínez, Aguirre-Macedo et Mendoza-Franco, 1997

Site: Gills.

Localities: Campeche (prevalence 85%, intensity 5–241 (mean 51)); Celestun (59%, 1–33 (12)); Sisal (78%, 1–54 (11)); Chelem (88%, 1–24 (6)); Chuburna (57%, 1–31 (10); Progreso (55%, 2–327 (52)); Chicxulub (in all 4 fishes examined, 1–5 (3)); Telchac (94%, 1–14 (7)); Rio Lagartos (88%, 2–158 (22)); Chiquila (38%, 1–12 (3)).

Comments: This species has already been figured and discussed by Vidal-Martínez et al. (1997).

CESTODA

2. ***Callitetrarhynchus*** sp. larvae Fig. 2A

Description: Body elongate, 10.47 long, maximum width 0.775. Two bothridia, 0.680 long and 0.381 wide, present. *Pars vaginalis* long, tentacle sheaths regularly sinous, somewhat enlarged anteriorly. Numerous gland cells surrounding tentacle sheaths from bulbs through most of *pars vaginalis*. Bulbs 0.816 long and 0.530 wide. Hooks on tentacles typical of genus (Campbell and Beveridge 1994).

Site: Blastocysts on surface of stomach and pyloric caeca.

Localities: Celestun (prevalence 4%, intensity 1); Chelem (8%, 1–2 (2)).

Comments: Plerocerci of the genus *Callitetrarhynchus* Pintner, 1931 are known from various teleosts, whereas adults are parasitic in sharks.

3. ***Tylocephalum*** sp. larvae Fig. 2B,C

Description: Body small, 0.816–1.061 long, maximum width at level of scolex, posterior part of body narrowed, relatively short. Body surface smooth. Scolex 0.258–0.340 long and 0.394–0.422 wide, with large, more or less triangular (in lateral view), invaginable *pars apicalis* 0.163–0.190 long and 0.163–0.204 wide. *Pars basalis* bearing four circular acetabula 0.122–0.150 in diameter.

Site: Pyloric caeca and surface of viscera.

Localities: Campeche (prevalence 23%, intensity 3–20 (mean 11)); Celestun (37%, 1–369 (56)); Sisal (13%, 2 (2)); Chelem (32%, 1–68 (13)); Chuburna (14%, 3 (3)); Progreso (47%, 1–273 (29)); Chicxulub (in 1 of 4 fishes examined, 3; Telchac (12%, 5–25 (15)); Rio Lagartos (26%, 3–81 (26)); Chiquila (10%, 3–6 (5)).

Comments: The structure of the scolex indicates that this larval type belongs to the genus *Tylocephalum* Linton, 1890. Although adult cestodes of this genus have been reported from cow-nosed rays (Rhinopteridae) in the North Atlantic (Euzet 1994), it is highly probable that, similar to the related genus *Tetragonocephalum* Shipley et Hornell, 1905, the range of hosts is wider, possibly including all Myliobatiformes. Members of the latter commonly occur in this region.

4. ***Eutetrarhynchus*** sp. larvae

Site: Surface of intestine.

Locality: Progreso.

Comments: Four specimens were found in 1 of 10 *E. morio* examined by V. Vidal-Martínez in August 1991. Although they are not a part of the newly collected material, they are included in this survey because they represent another unrecorded parasite species of *E. morio* in this region. In spite of their rather poor condition, these specimens can be assigned to the genus *Eutetrarhynchus* Pitner, 1913 *sensu lato* on the basis of their

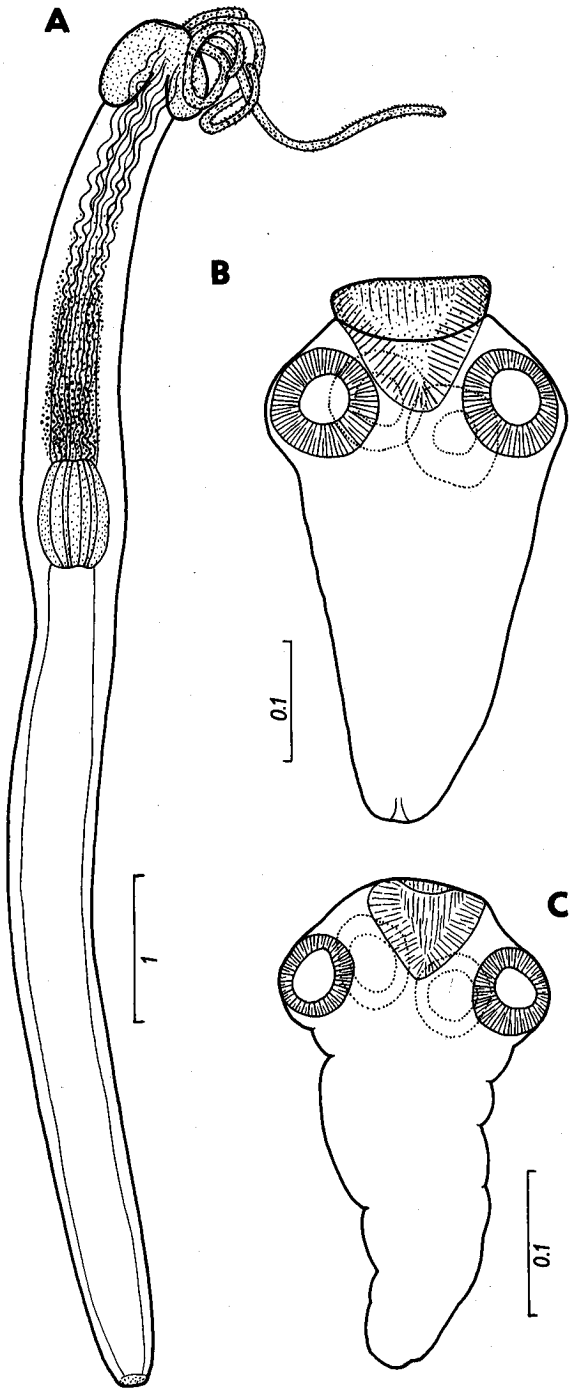

Fig. 2. Larval cestodes from *Epinephelus morio*. **A** – *Callitetrarhynchus* sp. larva, general view; **B**, **C** – *Tylocephalum* sp. larva (**B** – specimen with extruded *pars apicalis*, **C** – specimen with withdrawn *pars apicalis*).

tentacle armature. Adults of this genus are parasitic in elasmobranchs.

TREMATODA

5. ***Lepidapedon levenseni*** (Linton, 1900) Fig. 3B

Site: Pyloric caeca and intestine.

Localities: Celestun (prevalence 22%, intensity 1–32 (mean 6)); Sisal (35%, 1–4 (2)); Chelem (48%, 1–5 (3)); Progreso (58%, 1–29 (8)); Telchac (29%, 1–7 (4)); Rio Lagartos (11%, 1).

Comments: This species has already been reported from *E. morio* from three localities of this region by Aguirre-Macedo and Bray (1997). The morphology of specimens of the present material corresponds to the species redescription given by these authors.

6. ***Postporus epinepheli*** (Manter, 1947) Fig. 3D

Site: Intestine.

Localities: Celestun (prevalence 7%, intensity 1–2 (2)); Chelem (4%, 1); Progreso (11%, 2–12 (5)); Rio Lagartos (7%, 2 (2)).

Comments: The specimens are in agreement with the redescription of this species provided by Aguirre-Macedo and Bray (1997), who recorded it from *E. morio* of this region.

7. ***Lecithochirium floridense*** (Manter, 1934) Fig. 3G

Site: Stomach.

Localities: Campeche (prevalence 20%, intensity 1–11 (mean 4)); Celestun (7%, 5–14 (10)); Sisal (17%, 1); Chelem (8%, 1); Progreso (32%, 1–6 (2)); Telchac (6%, 1); Rio Lagartos (33%, 1–5 (2)); Chiquila (53%, 1–10 (3)).

Comments: *L. floridense* is known to occur in a wide range of marine teleosts from Florida (Manter 1934, Overstreet 1969) and Cuba (Moravec and Baruš 1971). In Mexico it has been recorded from *E. morio* from the Yucatan Peninsula by Aguirre-Macedo and Bray (1997), who redescribed the species.

8. ***Helicometra torta*** Linton, 1910 Fig. 3A,H

Description: Body elongate, 4.39–5.30 long and 0.966–1.088 wide. Oral sucker subterminal, size 0.218–0.272 × 0.285–0.313; acetabulum 0.558–0.639 × 0.544–0.585, situated at anterior part of body. Size ratio of suckers 1 : 1.5–1.7. Prepharynx absent. Oval muscular pharynx measuring 0.136–0.177 × 0.177–0.204. Oesophagus very short. Caeca narrow, long, extending nearly to end of body. Testes median, tandem; anterior testis 0.299–0.367 × 0.354–0.381, posterior testis 0.313–0.367 × 0.299–0.408. Genital pore posterior to intestinal bifurcation. Cirrus sac 0.748–0.898 long and 0.163 wide. Ovary pretesticular, somewhat lobed, 0.204–0.245 × 0.245–0.367. Uterus coils spirally between ovary and acetabulum, containing eggs measuring 0.060–0.063 × 0.036; one egg pole provided with a filament about 0.150 long. Vitelline follicles beginning

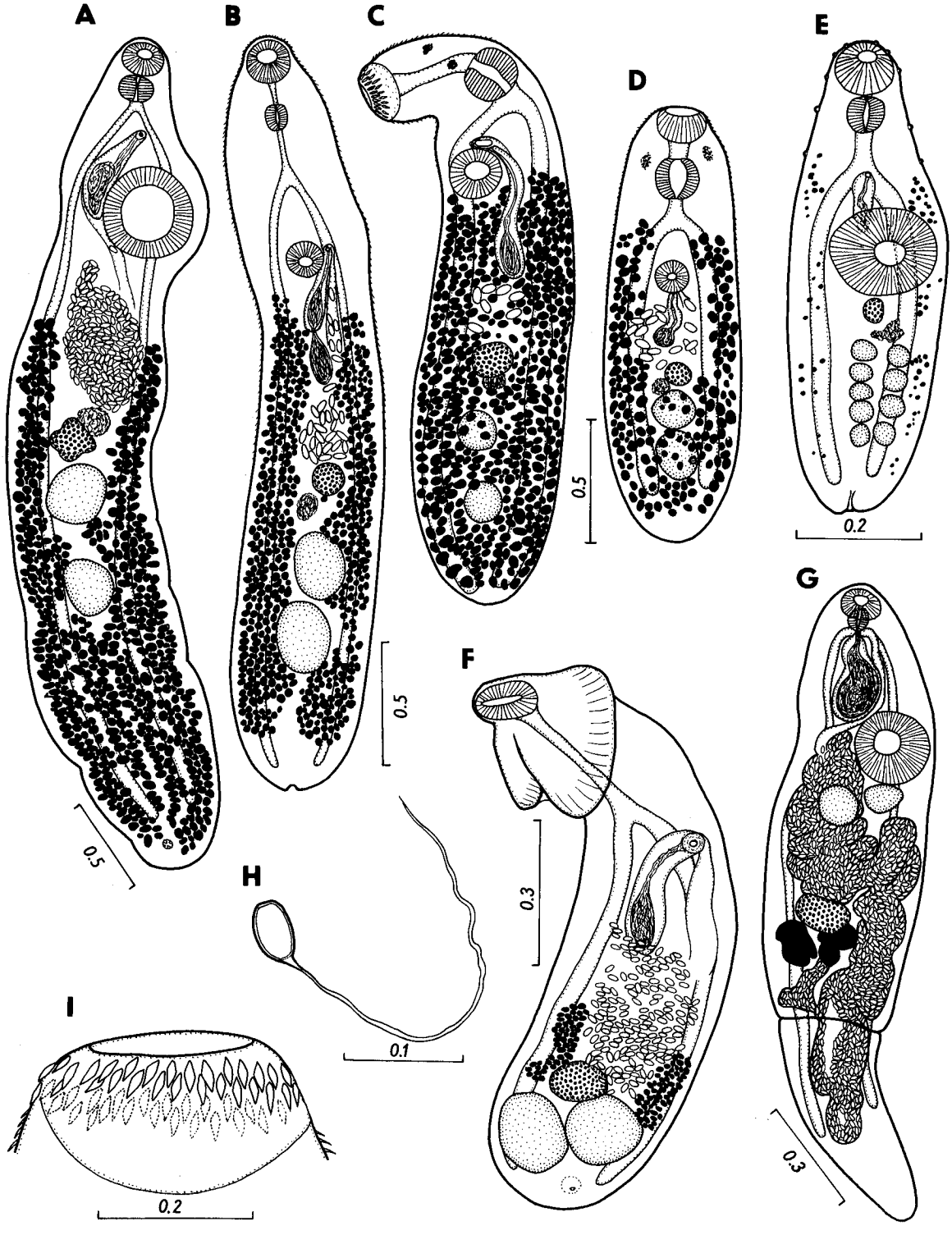

Fig. 3. Adult trematodes from the digestive tract of *Epinephelus morio*. **A**, **H** – *Helicometra torta* Linton, 1910 (**A** – general view, **H** – egg); **B** – *Lepidapedon levenseni* (Linton, 1900); **C**, **I** – *Stephanostomum dentatum* (Linton, 1910) (**C** – general view, **I** – oral sucker); **D** – *Postporus epinepheli* (Manter, 1947); **E** – *Helicometrina nimia* Linton, 1910; **F** – *Barisomum erubescens* Linton, 1910; **G** – *Lecithochirium floridense* (Manter, 1934).

about midway between acetabulum and ovary, extending almost entirely lateral to caeca to posterior end of body, filling most of posttesticular space.

Site: Intestine.

Localities: Rio Lagartos (prevalence 19%, intensity 1–2 (1)); Chiquila (14%, 1–6 (3)).

Comments: The present specimens agree with the existing descriptions of this species (Manter 1933, Aguirre-Macedo and Bray 1997), but they are larger. *H. torta* is known from *Epinephelus morio*, *E. striatus* and *E. adscensionis* from Florida, USA. One specimen of this species was found by Aguirre-Macedo and Bray (1997) in *E. morio* from the Yucatan Peninsula (Rio Lagartos), Mexico.

9. ***Helicometrina nimia*** Linton, 1910 Fig. 3E

Description: Body oval, 0.870–0.992 long, maximum width 0.286. Anterior end of body with several tegumental papillae. Oral sucker subterminal, 0.090–0.111 × 0.105–0.117. Acetabulum near middle of body, 0.165–0.174 × 0.156–0.195. Pharynx 0.060–0.063 × 0.066–0.069. Oesophagus 0.060–0.105 long. Caeca extending posteriorly nearly to end of body. Testes almost spherical, 0.033–0.048 × 0.027–0.051, 9 in number, forming two longitudinal intercaecal rows in hindbody; 5 testes in right row and 4 in left row. Small oval ovary median, between acetabulum and testes, 0.033–0.036 × 0.045–0.051. Genital pore at level of intestinal bifurcation, cirrus sac median, 0.102–0.120 long and 0.027–0.039 wide. Vitellaria weakly developed, extending from level of oesophagus to ends of caeca. Eggs not present.

Site: Intestine.

Locality: Campeche (prevalence 15%, intensity 1 (mean 1)).

Comments: The two available specimens are immature and their species identification is based mainly on the number of testes and the situation of the genital pore.

H. nimia is known as a parasite of many species of marine fishes (including *Epinephelus analogus*) in the Gulf of Mexico, the Caribbean Sea and the Pacific Ocean (Yamaguti 1971). Its rare occurrence in *E. morio* and the fact that only immature specimens were found suggest that this host species acquires infection accidentally by feeding either on the prey fishes serving as its common definitive hosts or on shrimps serving as second intermediate hosts (Manter 1933).

10. ***Barisomum erubescens*** Linton, 1910 Fig. 3F

Description: Body smooth, 1.54 long, with head collar 0.381 long and 0.381 wide; maximum width of hindbody 0.422. Oral sucker almost terminal, measuring 0.694 × 0.449, followed by oesophagus 0.367 long. Caeca extending to posterior extremity. Testes almost spherical, 0.775 × 0.857 and 0.694 × 0.925, one on each side at posterior extremity. Genital pore near left margin, at about one third of body length. Cirrus sac curved, 0.394 long and 0.082 wide. Ovary oval, submedian, pretesticular, size 0.775 × 0.585. Uterus forming loops between ovary and posterior end of cirrus sac; metraterm well developed. Filamented eggs measuring 0.027–0.030 × 0.012–0.015. Vitelline follicles pretesticular, in two lateral groups.

Site: Intestine.

Locality: Progreso (prevalence 3%, intensity 1).

Comments: Only one specimen of *B. erubescens* was found. It differs from the original species description in having unlobed testes, which may be due to its generally small body measurements.

This species is known to occur in some marine fishes (*Angelichthys*, *Pomacanthus*, *Scarus*) in Florida, USA, and Cuba (Yamaguti 1971).

11. ***Allonematobothrium yucatanense*** sp. n. Fig. 4

Description (4 complete specimens and several body fragments; measurements of holotype in parentheses): Body slender, very long, 24–46 (42) long and 0.150–0.258 (0.231) in maximum width; breadth of worms relatively constant. Posterior end of body rounded. Mouth aperture terminal, opening into small, atrophied oral sucker, 0.033–0.054 × 0.033–0.054 (0.039 × 0.036). Pharynx funnel-shaped, with glandular appearance similar to that of oral sucker. Oesophagus long, very narrow, measuring 0.060–0.105 (0.105), difficult to discern. Oesophagus bifurcating posteriorly to form two narrow, atrophied caeca, extending posteriorly to some distance anterior to end of body, being obscured by uterus for most of their length. Ventral, weakly defined acetabulum present, 0.021 × 0.015–0.024 (0.021 × 0.015) in diameter, situated 0.180–0.246 (0.246) from anterior extremity. Complete excretory vesicle not observed. Excretory pore not found; posterior end of stem relatively broad, spirally coiled. Tubular testes paired, parallel, very long; 10.88–29.92 (24.48) long, representing about one half of body length or more; originating at some distance posterior to acetabulum and terminating a short distance anterior to posterior end of ovary. Ovary single, tubular, more or less intertesticular, 3.26–7.01 (7.01) long. Genital junction in second half of body, 15.40–34.82 (32.01) from anterior extremity. Ootype surrounded by Mehlis' gland. Small seminal receptacle present. Uterus first descending, forming only one loop. Distal region of uterus gradually narrowing to form slender metraterm. Uterus containing numerous small, oval eggs, measuring 0.027–0.036 × 0.015–0.018 (0.030–0.033 × 0.015). Vitellarium single, tubular, unbranched, extending from genital junction to level close to posterior extremity.

Type host: *Epinephelus morio* (Valenciennes).

Site: Fins.

Type locality: Telchac, Yucatan, Mexico (holotype collected on 30 January 1996); prevalence 41%, intensity 1–6 (mean 3)).

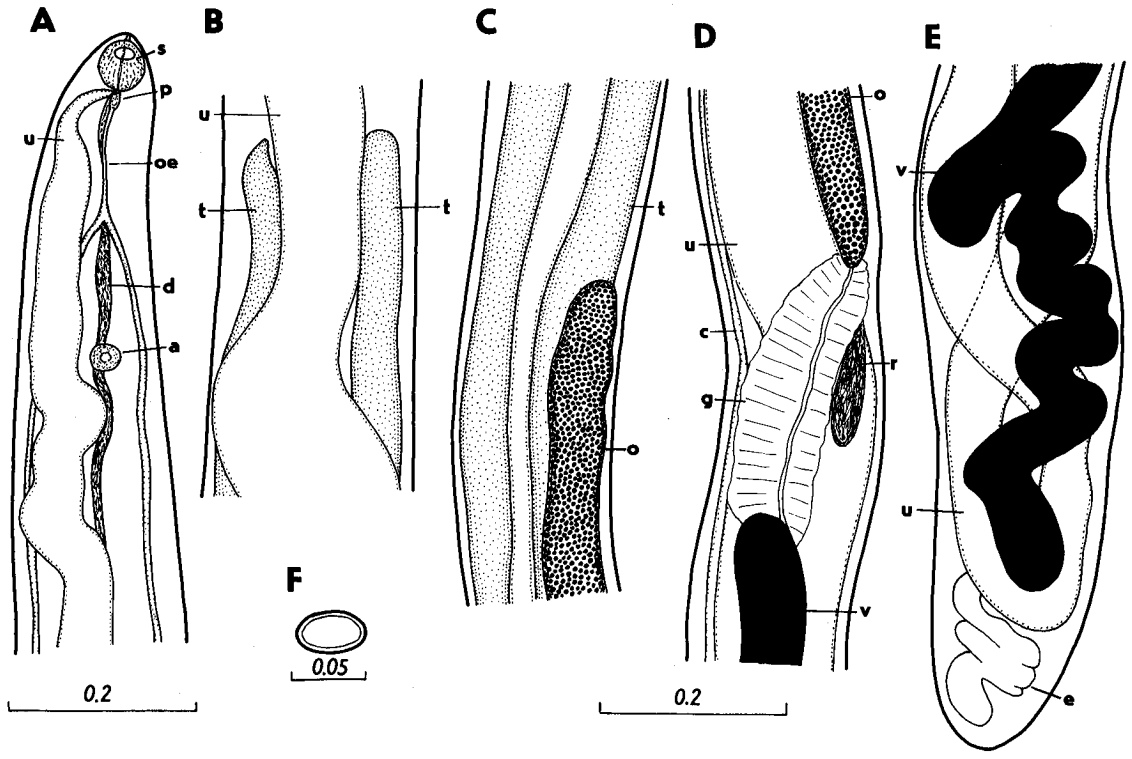

Fig. 4. *Allonematobothrium yucatanense* sp. n. from fins of *Epinephelus morio*. **A** – anterior end of body; **B** – region of anterior ends of testes; **C** – region of anterior end of ovary; **D** – region of genital junction; **E** – posterior end of body; **F** – egg. **Abbreviations**: a – acetabulum, c – caecum, d – vas deferens, e – posterior end of steam of excretory vesicle, g – Mehlis gland, o – ovary, oe – oesophagus, p – pharynx, r – seminal receptacle, s – oral sucker, t – testis, u – uterus, v – vitellarium.

Other localities: Campeche (8%, 1); Celestun (22%, 1–3 (2)); Sisal (39%, 1–3 (1)); Chelem (40%, 1–6 (2)); Chuburna (14%, 4 (4)); Progreso (3%, 1–3 (2)); Chiquila (29%, 1–3 (2)).

Deposition of types: Institute of Biology, National Autonomous University of Mexico, Mexico City (holotype, Cat. No. CNHE-3151); Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice (paratypes – Cat. No. D-376).

Comments: The new species is morphologically very similar to *A. epinepheli* Yamaguti, 1965, described from *Epinephelus quernus* from Hawaii, differing from it mainly in much smaller body size (body length 24–46 mm vs. 70–365 mm), larger eggs (0.027–0.036 × 0.015–0.018 mm vs. 0.020–0.024 × 0.008–0.010 mm) and geographical distribution. The new species can be distinguished from two congeneric species by the size of eggs, *A. ghanense* Fischthal et Thomas, 1968 (0.015–0.020 × 0.010–0.013 mm) from *Epinephelus aeneus* from Ghana and *A. apharei* Yamaguti, 1970 (0.016–0.019 × 0.008–0.010 mm) from *Aphareus rutilans* from Hawaii.

In contrast to the original generic diagnosis given by Yamaguti (1965), the testes of *A. yucatanense* are terminating posteriorly at short distance anterior to the genital junction (those in the type species *A. epinepheli* terminate in the region of the genital junction). In our opinion, this difference is not of a generic importance and, therefore, we suggest to modify the generic diagnosis of *Allonematobothrium* in that "the testes are paired, long, parallel, situated at middle part of body".

12. ***Stephanostomum dentatum*** (Linton, 1900) Fig. 3C,I

Site: Intestine.

Locality: Rio Lagartos (prevalence 4%, intensity 1 (mean 1)).

Comments: This species has been reported from a wide range of teleost fishes in the North Atlantic and northern Gulf of Mexico as well as in the North Pacific. It has already been reported and redescribed from *E. morio* in Yucatan (Telchac) by Aguirre-Macedo and Bray (1997). The only recorded specimen of the present material is somewhat larger (body length 3.10 mm) and its oral sucker is armed with 51 spines arranged in a double row.

13. ***Stephanostomum*** sp. metacercariae Fig. 5G,I

Description: Body 3.81–4.96 long, maximum width at posterior part of body 1.16–1.74. Tegument densely covered with spines, especially at its anterior half. Two eye-spots present. Oral sucker 0.231–0.313 × 0.340–

0.422, with double row of 35–37 spines 0.060–0.081 long. Acetabulum preequatorial, 0.422–0.503 × 0.462 –0.490. Prepharynx 0.571–0.639 long. Pharynx 0.204 –0.272 × 0.258–0.326. Oesophagus 0.109–0.190 long. Caeca broad, extending to posterior extremity. Developing testes median, tandem, 0.122–0.204 in diameter. Ovary pretesticular, 0.068–0.082 in diameter. Developing cirrus sac posterior to acetabulum.

Site: Encysted in tissues of head and near swimbladder.

Localities: Campeche (prevalence 8%, intensity 1); Sisal (9%, 1–3 (mean 2)); Progreso (3%, 5).

Comments: In contrast to *Stephanostomum dentatum*, these metacercariae are distinctly larger and their oral sucker bears only 35–37 spines. It can be supposed that the adults of this species are parasitic in predatory fishes.

14. ***Bucephalus*** sp. metacercariae Fig. 5A

Description: Body length 0.394, maximum width 0.136. Tegument with fine spines. Rhynchus sucker-like, 0.081 in diameter, with seven tentacular appendages. Mouth opening 0.105 from posterior extremity. Pharynx 0.030 in diameter, intestine saccular, oriented anteriorly. Cirrus sac about 0.060 long, near posterior end of body.

Site: Encysted in fins.

Locality: Campeche (prevalence 8%, intensity 1).

Comments: Adults are apparently parasitic in some predatory fishes.

15. ***Rhipidocotyle*** sp. metacercariae Fig. 5H

Description: Body elongate, 2.58 long, maximum width 0.313. Anterior part of body with fine spines. Rhynchus 0.218 long and 0.258 wide, with pentagonal cap-like expansion. Mouth 0.694 from posterior end of body. Pharynx 0.051 in diameter, intestine short. Testes spherical, 0.150–0.163 in diameter, diagonal, situated between mouth and posterior extremity. Ovary oval, submedian, pretesticular, 0.122 × 0.068. Developing cirrus sac near posterior end of body. Several vitelline follicles extending from 1.12 from anterior extremity to level of ovary.

Site: Encysted in fins.

Locality: Rio Lagartos (prevalence 4%, intensity 1).

Comments: Adults of this species are apparently some predatory fishes.

16. ***Dollfustrema*** sp. metacercariae Fig. 5B

Description: Length of body 0.394–0.558, maximum width 0.150–0.163. Rhynchus sucker-like, measuring 0.093–0.099 × 0.129–0.147, armed with a large number of very fine and rather long spines arranged in double row. Body surface covered by minute spines. Mouth 0.099–0.135 from posterior extremity. Pharynx 0.048–0.057 × 0.051–0.057; sac-like intestine fairly large. Anlagen of testes posterior to mouth opening. Developing cirrus sac at posterior end of body.

Site: Encysted in fins.

Localities: Campeche (prevalence 69%, intensity 6–760 (mean 121)); Celestun (19%, 1–7 (2)); Sisal (52%, 2–41 (12)); Chelem (88%, 1–32 (10)); Chuburna (71%, 12–61 (25)); Progreso (13%, 3–130 (40)); Telchac (41%, 1–6 (3)); Rio Lagartos (41%, 1–14 (5)); Chiquila (19%, 1–32 (10)).

Comments: This type of metacercariae is tentatively assigned to the genus *Dollfustrema* Eckmann, 1934, considered by some authors a synonym of *Prosorhynchus* Odhner, 1905. This identification is mainly based on the fact that the rhynchus is provided with a crown of spines larger than those on the body surface. The spines of these metacercariae appear to be arranged in a double crown, whereas a triple crown of spines is reported in the generic diagnosis (however, the drawing of its type species *D. vaneyi* (Tseng, 1930) (see Yamaguti 1971) shows only two rows of spines). It is possible that the arrangement of these spines in metacercariae may slightly differ from that in conspecific adult trematodes.

Adults of several *Dollfustrema* species are parasitic in marine fishes of this region (Yamaguti 1971), but the species identification of metacercariae is impossible. The present material shows that *Dollfustrema* sp. metacercariae belong to the most frequent parasites of *Epinephelus morio* in the Yucatan Peninsula.

17. ***Cardiocephalus*** sp. metacercariae Fig. 6

Description: Body oval, 1.52–2.08 long, maximum width at middle 1.02–1.52. Short anterior part of body (0.272 long and 0.272–0.381 wide) bearing oral sucker separated by transverse tegumental fold from rest of body. Middle part of body long and wide, with broad longitudinal lateral fields of darker tissue on each side. Posterior part of body 0.408–0.449 long and 0.462 –0.721 wide. Oral sucker subterminal, measuring 0.136–0.150 × 0.190–0.204. Acetabulum situated approximately at middle of body, 0.190–0.245 × 0.204–0.260. Two well developed pseudosuckers present. Pharynx measuring 0.068 in diameter. Oesophagus 0.272–0.340 long, bifurcating at level of pseudosuckers into two caeca ending near caudal end of body. Large, transverse holdfast situated at end of middle part of body, measuring 0.367–0.476 × 1.006–1.088. Posterior part of body provided with anlagen of sexual glands and subterminal excretory pore.

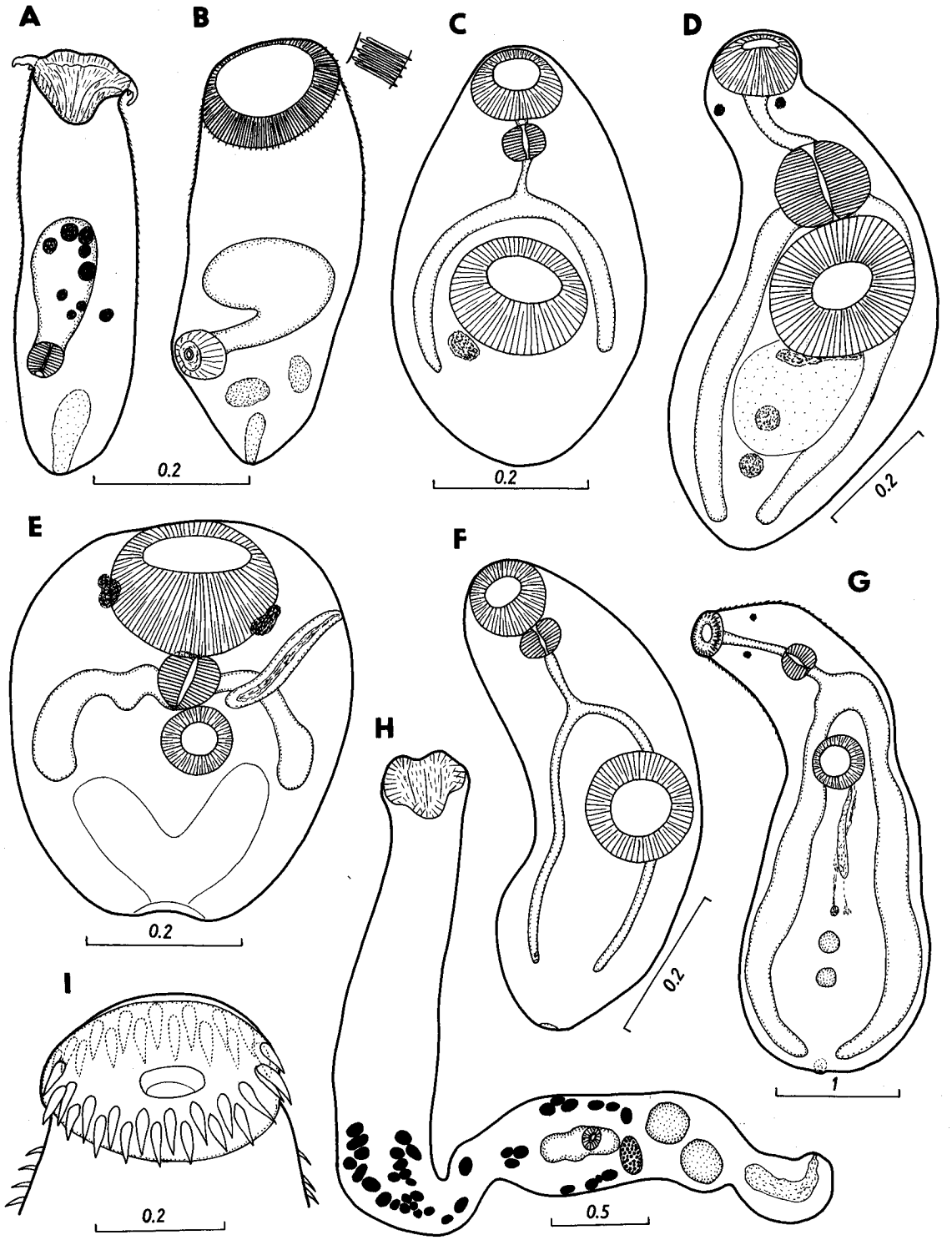

Fig. 5. Metacercariae from *Epinephelus morio*. **A** – *Bucephalus* sp.; **B** – *Dollfustrema* sp. (with detail of arrangement of oral spines); **C** – Metacercaria Type 1; **D** – Metacercaria Type 4; **E** – Metacercaria Type 2; **F** – Metacercaria Type 3; **G**, **I** – *Stephanostomum* sp. (**G** – total view, **I** – oral sucker); **H** – *Rhipidocotyle* sp.

Site: Brain.

Localities: Celestun (prevalence 15%, intensity 1–6 (mean 3)), Chelem (12%, 1), Chuburna (14%, 1), Progreso (13%, 1–6 (2), Chiquila (10%, 1).

Comments: This identification is based on the key to the genera of metacercariae of the Strigeidae provided by Sudarikov (1971) and on the site of infection (brain) in the fish host. Unfortunately, the morphology of

metacercariae of species belonging to *Cardiocephalus* Szidat, 1928 and to *Cardiocephaloides* Sudarikov, 1959 is not known and, therefore, it cannot be excluded that the metacercariae of the present material belong to the latter genus. Both genera are closely related and differ from each other in features found in adults; nevertheless, the posterior part of body of these metacercariae is well constricted from the forebody, which is typical of *Cardiocephalus* (see Yamaguti 1971).

Adult trematodes of both genera are intestinal parasites of aquatic birds, mainly of the family Laridae. Of a few American species of *Cardiocephalus*, for example *C. medioconiger* Dubois et Vigueras, 1949 was described from *Larus argentatus smithsonianus* from Cuba, whereas the only species of *Cardiocephaloides*, *C. brandesii* (Szidat, 1928) occurs in *Larus* spp. and some other birds in Panama, Mexico, Cuba, USA, Brazil and Argentina (Yamaguti 1971). According to Hunter and Vernberg (1960), metacercariae of *C. brandesii* were found in the ventricles of the brain of fishes, *Mugil cephalus* and *Menidia menidia*; their identification was proved experimentally.

18. **Metacercaria** Type 1 Fig. 5C

Description: Body ovoid, smooth, 0.354–0.381 long, maximum width 0.177–0.249. Oral sucker subterminal, 0.054–0.066 × 0.063–0.084. Acetabulum in middle of body, measuring 0.078–0.105 × 0.108–0.129. Prepharynx 0.003–0.012 long. Pharynx 0.027–0.030 × 0.027–0.045. Length of oesophagus 0.030–0.042. Caeca short, extending posteriorly to posterior margin of acetabulum.

Site: Encysted in fins.

Locality: Campeche (prevalence 8%, intensity 64).

19. **Metacercaria** Type 2 Fig. 5E

Description: Body short, oval, smooth, 0.394–0.462 long and 0.313–0.367 wide. Two eye-spots present at level of oral sucker. Oral sucker large, size 0.126–0.132 × 0.150–0.165. Acetabulum small (0.063 × 0.066), at middle of body. Pharynx 0.045–0.051 × 0.048–0.051. Caeca short, slightly exceeding acetabulum. Genital pore lateral, at level of eye-spots, developing cirrus sac oriented to acetabulum. Excretory vesicle V-shaped, prominent excretory pore terminal.

Site: Encysted on anterior part of intestine.

Locality: Celestun (prevalence 4%, intensity 4).

20. **Metacercaria** Type 3 Fig. 5F

Description: Body elongate-oval, smooth, 0.449 long and 0.163 wide. Oral sucker 0.066 × 0.072. Acetabulum larger, 0.102 × 0.099, at middle of body. Pharynx 0.036 in diameter. Oesophagus 0.051 long. Caeca narrow, ending a short distance from body end.

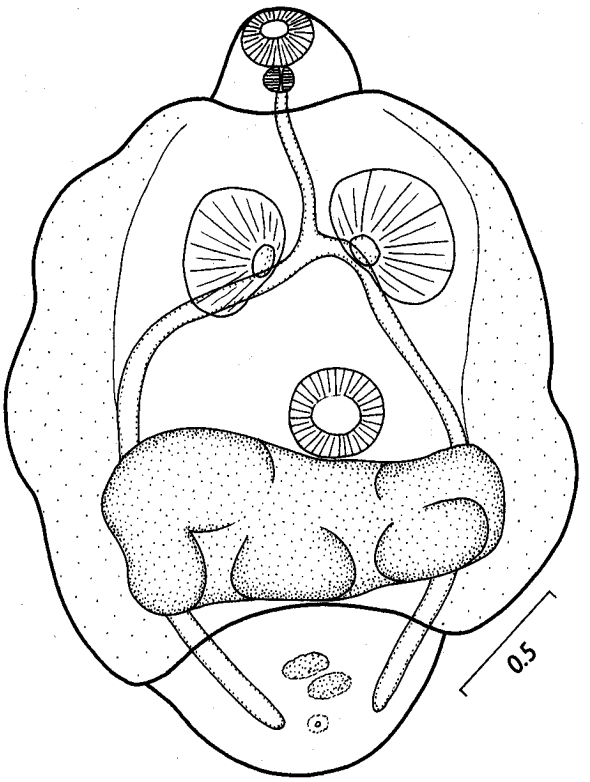

Fig. 6. Metacercaria of *Cardiocephalus* sp. from the brain of *Epinephelus morio*.

Site: Encysted in fins.

Locality: Campeche (prevalence 8%, intensity 30).

21. **Metacercaria** Type 4 Fig. 5D

Description: Anterior part of body narrower than posterior part. Body smooth, 0.857–0.898 long, maximum width 0.367–0.422. Two eye-spots present below oral sucker. Oral sucker 0.111–0.120 × 0.153–0.159. Acetabulum large, size 0.218–0.225 × 0.285–0.290. Prepharynx 0.120–0.180 long. Pharynx larger than oral sucker, measuring 0.135–0.144 × 0.141–0.180. Oesophagus absent. Caeca extending posteriorly to end of body. Developing testes spherical, median, tandem.

Site: Encysted on gills.

Locality: Campeche (prevalence 15%, intensity 4–6 (mean 5)).

NEMATODA

22. ***Paracapillaria epinepheli*** Moravec, Mendoza-Franco et Vargas-Vázquez, 1996

Site: Stomach.

Localities: Campeche (prevalence 23%, intensity 1–18 (mean 10)); Celestun (7%, 1 (1)); Sisal (22%, 1–4 (2));

Chelem (20%, 1–2 (1)); Chuburna (29%, 1–2 (2)); Progreso (5%, 1–4 (3)); Telchac (24%, 1–3 (2)); Rio Lagartos (26%, 1–3 (2)).

Comments: This species has been described by Moravec et al. (1996).

23. ***Philometra margolisi*** Moravec, Vidal-Martínez et Aguirre-Macedo, 1995

Site: Gonads.

Localities: Campeche (prevalence 62%, intensity 1-25 (mean 8)); Celestun (41%, 1-47 (16)); Sisal (39%, 1–32 (10)); Chelem (88%, 1–84 (11)); Chuburna (86%, 5–10 (7)); Progreso (79%, 1–36 (12)); Chicxulub (75%, 4–10 (7)); Telchac (53%, 3–10 (5)); Rio Lagartos (37%, 1–17 (8));, Chiquila (53%, 2–41 (10).

Comments: This species was described by Moravec et al. (1995b).

24. ***Philometra salgadoi*** Vidal-Martínez, Aguirre-Macedo et Moravec, 1995

Site: Occular cavity.

Localities: Celestun (prevalence 26%, intensity 1–6 (1)); Sisal (35%, 1–11 (3)); Chelem (56%, 1–7 (3)); Chuburna (14%, 3 (3)); Progreso (26%, 1–11 (3)); Chicxulub (100%, 1–3 (2)); Telchac (53%, 1–3 (2)); Rio Lagartos (41%, 1–12 (4)); Chiquila (24%, 1–6 (3)).

Comments: This species was described by Vidal-Martínez et al. (1995).

25. ***Ascarophis mexicana*** Moravec, Salgado-Maldonado et Vivas-Rodríguez, 1995

Site: Stomach.

Localities: Campeche (prevalence 23%, intensity 1–6 (3)); Celestun (11%, 1–2 (2)); Sisal (30%, 1–8 (3)); Chelem (8%, 1 (1)); Chuburna (57%, 1–8 (3)); Progreso (3%, 2 (2)); Telchac (12%, 1 (1)); Rio Lagartos (11%, 1–2 (2)).

Comments: This species was described by Moravec et al. (1995c).

26. ***Hysterothylacium eurycheilum*** (Olsen, 1952)

Site: Intestine.

Locality: Rio Lagartos (2 specimens found in 1 of 7 fishes examined in 1992).

Comments: This species has been reported by Moravec et al. (1995a). It has not been recorded from *E. morio* since.

27. ***Hysterothylacium*** sp. larvae

Site: Encapsulated on anterior part of digestive tract.

Localities: Celestun (prevalence 7%, intensity 1 (1)); Sisal (4%, 1 (1)); Progreso (3%, 2–6 (4)); Telchac (6%, 1 (1)); Rio Lagartos (4%, 1 (1)); Chiquila (5%, 2 (2)).

Comments: The morphology of these larvae suggests that they may be conspecific with *H. eurycheilum* (see above). A larva of this type has already been reported from *E. morio* from Rio Lagartos by Moravec et al. (1995a).

28. ***Anisakis typica*** (Diesing, 1861) larvae

Site: Encapsulated on viscera.

Localities: Campeche (prevalence 1%, intensity 1 (mean 1)); Chelem (4%, 1 (1)); Chiquila (5%, 1 (1)).

Comments: This species has already been dealt with by Moravec et al. (1995a).

29. ***Pseudoterranova decipiens*** (Krabbe, 1878) larvae

Site: Encapsulated on viscera.

Localities: Celestun (prevalence 41%, intensity 1–17 (7)); Sisal (4%, 2 (2)); Chelem (20%, 1–18 (6); Chuburna (29%, 1–2 (2)); Progreso (34%, 1–14 (5)); Chiquila (5%, 2 (2)).

Comments: Hosts of the adult nematodes are marine mammals (mostly pinnipeds), whereas larvae are found in marine fishes. Similar to *Anisakis* larvae, *Pseudoterranova* larvae from fishes may cause a parasitic disease in man (Moravec 1994).

ACANTHOCEPHALA

30. ***Gorgorhynchus clavatus*** (Van Cleave, 1940)

Site: Intestinal lumen (adults) and surface of viscera (juveniles).

Localities: Celestun (prevalence 26%, intensity 1–12 (mean 4)); Sisal (39%, 1–7 (3)); Chelem (44%, 1–4 (3)); Chuburna (43%, 1–4 (2)); Progreso (16%, 1–4 (2)); Telchac (18%, 1–23 (8)); Rio Lagartos (4%, 1 (1)).

Comments: This species has already been dealt with by Moravec et al. (1995a).

In addition to helminths, two species of parasitic crustaceans (Copepoda), *Hatschekia serrana* Pearse, 1952 and *Lernanthropus* sp., were found as common gill parasites of the red grouper.

DISCUSSION

This survey shows that the helminth fauna of the red grouper (*Epinephelus morio*) is unusually rich in species in coastal waters of the Yucatan Peninsula, Mexico, being represented by a total of 30 parasite species. The data obtained from the ten investigated

localities, all on the coast of the Gulf of Mexico, did not indicate any substantial differences in the species composition of helminths, especially if, for example, differences in the size of fish samples, the body size of fish or the seasons when samples were taken are considered. Unfortunately, no *E. morio* were obtained off the Caribbean coast of the Yucatan Peninsula, where, in contrast to the Gulf of Mexico, this fish species is rare.

Of the 30 helminth species (Monogenea 1, Cestoda 3, Trematoda 17, Nematoda 8, Acanthocephala 1) recorded from the red grouper, only one half (15) represent adult parasites, whereas the second half (15) is formed by larval stages. The helminth materials from *E. morio* of this region led to the discovery of 6 new species (1 monogenean, 1 trematode and 4 nematodes) and, for many species, the present findings represent new host- or geographical records.

A high number of helminth species parasitizing the red grouper as larvae shows an important role of this fish species for the life-cycles and transmission of many helminth parasites of piscivorous elasmobranch and teleostean fishes (*Tylocephalum*, *Callitetrarhynchus*, *Eutetrarhynchus*, *Stephanostomum*, *Bucephalus*, *Rhipidocotyle*, *Dollfustrema*, *Hysterothylacium*), fish-eating birds (*Cardiocephalus*) and marine mammals (*Anisakis*, *Pseudoterranova*). Unfortunately, the morphology of many larval stages does not enable their specific or even generic identification. Nevertheless, the data show that *E. morio* plays a role not only as the definitive host of helminths but, especially smaller-sized fishes, act frequently as intermediate- or paratenic hosts.

The most frequent site of infection of adult helminths, particularly trematodes, is the host's digestive tract (stomach, intestine, pyloric caeca), but also gills (*Pseudorhabdosynochus yucatanensis*), fins (*Allonematobothrium yucatanense*), orbits (*Philometra salgadoi*) and gonads (*Philometra margolisi*). Larval stages occur, mostly encysted or encapsulated, in the gills, fins, brain and in the abdominal cavity (on mesentery and viscera surface).

Of the helminth species recorded, the most pathogenic and the most important from the viewpoint of fish health and fish reproduction seem to be the nematode *P. margolisi*, causing a serious damage to the gonads of infected fish (own unpublished data), affecting thus negatively the reproduction of this most important commercial fish species in the Yucatan Peninsula. *Philometra margolisi*, as well as the related nematode *P. salgadoi* and the monogenean *P. yucatanensis*, represent a potential problem for *E. morio* in aquaculture. Larval anisakids (*Anisakis typica*, *Pseudoterranova decipiens*, *Hysterothylacium* sp.) recorded from the red grouper of this region are known as the agents of serious parasitic diseases in humans and are, therefore, important from the viewpoint of public health.

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