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Trematodes from Red Sea fishes: *Neohypocreadium aegyptense* n. sp. (Lepocreadiidae), *Fairfaxia cribbi* n. sp. and *Macvicaria chrysophrys* (Nagaty & Abdel-Aal, 1969) (Opecoelidae)

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Abstract

Specimens of the marine fishes *Chaetodon lineolatus* (Chaetodontidae), *Lethrinus nebulosus* (Lethrinidae) and *Acanthopagrus bifasciatus* (Sparidae) were caught in the Red Sea off the coast of Sharm El-Sheikh, South Sinai, Egypt. Fifteen (75%), four (16%) and fourteen (35%) fish, respectively, were found to harbour intestinal trematodes. *C. lineolatus* was parasitised by *Neohypocreadium aegyptense* n. sp. (Lepocreadiidae), *L. nebulosus* by *Fairfaxia cribbi* n. sp. (Opecoelidae) and *A. bifasciatus* by *Macvicaria chrysophrys* (Nagaty & Abdel-Aal, 1969) Bray, 1985 (Opecoelidae). *N. aegyptense* n. sp. is most similar to *N. chaetodoni* (Mahavi, 1972), but is smaller and differs in having acinous rather than digitate ovarian lobes, vitelline follicles extending anteriorly to midway between the ventral sucker and the intestinal bifurcation and an external seminal vesicle extending posteriorly to reach the anterior margin of the ovary. The generic diagnosis of *Neohypocreadium* is amended. *F. cribbi* n. sp. resembles *F. lethini* Cribb, 1990, but differs in having relatively smaller gonads, cirrus-sac and eggs, and larger suckers and pharynx. *M. chrysophrys*, collected from its type-host and locality, is redescribed. *Plagioporus saoudi* Ramadan, 1985 is considered its synonym.

Introduction

This is the second of two papers on the trematode fauna of Red Sea fishes (see Hassanine & Gibson, 2005). The present report deals with three digeneans, including two new species, from chaetodontid, lethrinid and sparid hosts. These worms were collected by the first author off the coast of the Red Sea at Sharm El-Sheikh, South Sinai, Egypt, and their study was completed during a visit to the Natural History Museum, London.

Materials and methods

During November of 2003, 20, 25 and 40 individuals of the fishes *Chaetodon lineolatus* (Chaetodontidae), *Lethrinus nebulosus* (Lethrinidae) and *Acanthopagrus bifasciatus* (Sparidae), respectively, were caught in the Red Sea off the coast of Sharm El-Sheikh, South Sinai, Egypt, and kept alive in aquaria. Fish identifications were based on Randall (1983) and modern names follow Froese & Pauly (2004). Standard parasitological techniques were used to examine the alimentary canal of the fish. Trematodes were removed from their host fishes under a dissecting microscope and observed live under a compound microscope. Some worms were fixed in alcohol-formalin-acetic acid (AFA) under a slight coverslip pressure and preserved in 75% ethyl alcohol. Whole-mounts were stained in alum carmine, cleared in terpineol and mounted in Canada balsam. Measurements are quoted as the range, with mean in parentheses, and are given in micrometres. The specimens are

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deposited in the Natural History Museum, London, and in the Helminthological Collection of the Red Sea Fishes, Marine Science Department, Faculty of Science, Suez Canal University, Ismailia, Egypt.

Family Lepocreadiidae Odhner, 1905
Subfamily Lepocreadiinae Odhner, 1905

Genus *Neohypocreadium* Machida & Uchida, 1987

Machida & Uchida (1987) erected *Neohypocreadium* for two new species, *N. longisaccatum* and *N. dorsoporum*, from the pyloric caeca and intestine of the chaetodontids *Chaetodon auriga* and *C. auripes* off southern Japan. The first was considered the type-species of the genus. They stated that *Neohypocreadium* was unique among genera of the family Lepocreadiidae in having dermal glands in the forebody, symmetrically arranged testes, an inter-testicular tri-lobed ovary, a pre-ovarian uterus, a dorsal genital pore and an excretory vesicle extending into the forebody. Based on the combination of these characters, they established for this genus the Neohypocreadiinae as a new subfamily within the Lepocreadiidae.

Toman (1989) established *Pseudohypocreadium* as a new lepocreadiid genus for *P. chaetodoni* Toman, 1989 from the intestine of three species of *Chaetodon*, *C. lunula, C. auriga* and *C. zanzibarensis*, off the Seychelles, Indian Ocean. He referred the genus to the subfamily Lepocreadiinae and stated that it is closely similar to *Hypocreadium* Ozaki, 1936, but differs in having a dorsal genital pore, a different body shape, a different ovarian shape and a peculiar anatomical structure of the metraterm. Later, Toman (1992) observed that *Pseudohypocreadium* was a synonym of *Neohypocreadium* and synonymised *P. chaetodoni* (the type and the only species of *Pseudohypocreadium*) with *N. longisaccatum*.

Bray et al. (1994) redescribed *N. dorsoporum* from 11 fish species (*Chaetodon aureofasciatus*, *C. auriga*, *C. flavirostris, C. kleinii, C. lineolatus, C. melannotus, C. pelewensis, C. ulietensis, C. vagabundus, Heniochus chrysostomus* and *Parachaetodon ocellatus*) off Heron Island, southern Great Barrier Reef, Queensland, Australia. They also examined the type-specimen of *Preptetos chaetodoni* Mahavi, 1972, and stated that in this species the genital pore is dorsal. Accordingly, they transferred it to *Neohypocreadium* as a new combination. This species was originally collected from *Chaetodon pictus* (now *C. vagabundus*) in the Bay of Bengal off India. In addition, these authors did not accept the Neohypocreadiinae as a valid subfamily and stated that the status of many of the subfamilies erected in the Lepocreadiidae is controversial and a detailed phylogenetic study was needed to assess their value. More recently, in a revision of the Lepocreadiidae, Bray (2005) considered the Neohypocreadiinae a synonym of the Lepocreadiinae.

Accordingly, three species of *Neohypocreadium* are currently recognised, i.e. *N. longisaccatum* Machida & Uchida, 1987 (type-species), *N. dorsoporum* Machida & Uchida, 1987 and *N. chaetodoni* (Mahavi, 1972) Bray, Cribb & Barker, 1993.

***Neohypocreadium aegyptense* n. sp.**

Type-host: Chaetodon lineolatus Cuvier (Chaetodontidae).
Site: Pyloric caeca and intestine.
Type-locality: Red Sea, off Sharm El-Sheikh, South Sinai, Egypt.
Prevalence: 15/20 fishes examined, 75%.
Type-material: Holotype and paratypes are deposited in the Natural History Museum, London, Reg. Nos 2004.11.30.11 and 2004.11.30.12–13; other paratypes are in the Helminthological Collection of the Red Sea Fishes, Marine Science Department, Faculty of Science, Suez Canal University, Ismailia, Egypt.

Description (Figure 1)

[Based on 12 fully-gravid specimens.] Body elongate-oval, dorso-ventrally flattened, 1,156–2,004 × 362–867 (1,580 × 615). Forebody 351–620 (486) in length, representing 26–33 (1 specimen 21) (30)% of total body length. Tegument spinous throughout. Numerous gland-cells scattered in parenchyma of forebody. Oral sucker small, terminal, globular, 54–110 × 70–130 (82 × 100). Ventral sucker globular, 95–174 (125) × 87–246 (135 × 167), embedded in parenchyma in middle of second quarter of body. Sucker-width ratio 1:1.3–1.5 (1:1.4).

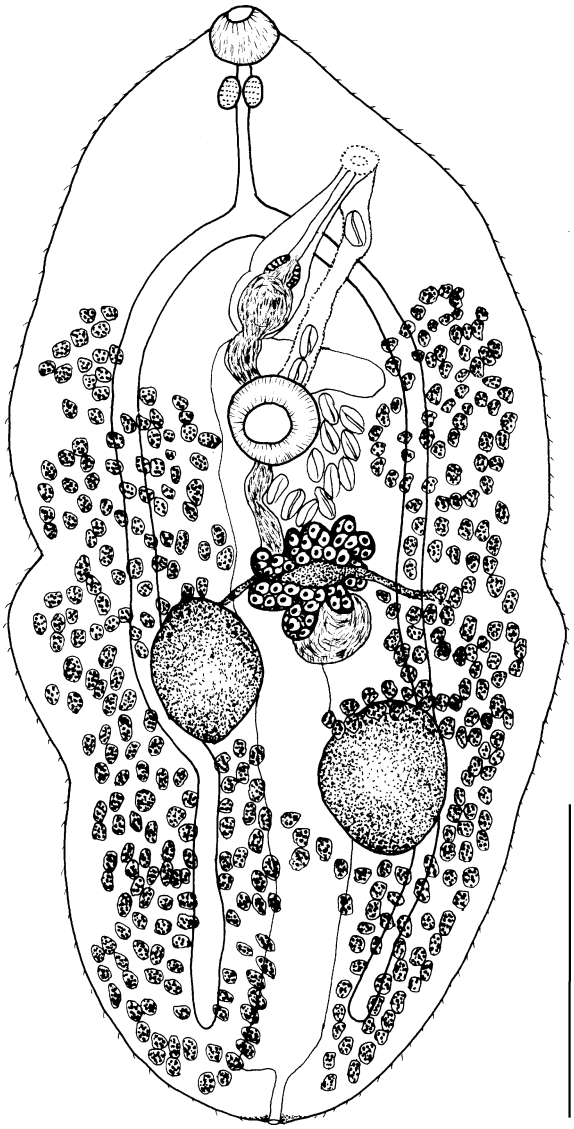

Figure 1. Neohypocreadium aegyptense n. sp. from *Chaetodon lineolatus*, Red Sea. *Scale-bar:* 500 μm.

Prepharynx short, 12–16 (14) in length, usually inconspicuous. Pharynx small, globular, 38–60 × 40–76 (49 × 58). Oesophagus moderately long, 96–140 (118) in length. Intestinal bifurcation midway between suckers. Caeca narrow, terminating blindly near posterior extremity.

Testes 2, round to oval, situated diagonally in middle of hindbody, well separated; anterior (dextral) testis 135–302 × 90–279 (219 × 185); posterior (sinistral) testis 149–258 × 84–232 (204 × 158). External seminal vesicle long, broad, tubular, extending between cirrus-sac and ovary. Cirrus-sac well developed, claviform, extends diagonally from short distance anterior to ventral sucker to genital pore, 260–441 × 65–107 (351 × 86), contains globular seminal vesicle, vesicular pars prostatica and relatively long ejaculatory duct. Genital pore dorso-sinistral at mid-oesophageal level.

Ovary multi-lobed, acinous, median, midway between ventral sucker and posterior testis. Seminal receptacle round, relatively large, overlapping ovary dorsally. Laurer's canal present. Uterus short, pre-ovarian, inter-caecal, confined to left side, modified terminally into distinct metraterm. Eggs oval, operculate, with thin shells which readily collapse and are variable in size, 50–66 × 30–42 (57 × 37). Vitelline follicles moderately large, circum-caecal, extend from midway between intestinal bifurcation and ventral sucker to posterior extremity; at level of ovary, transverse vitelline collecting ducts arise from vitelline follicles on each side, open into small saccular vitelline reservoir situated ventrally to ovary.

Excretory vesicle I-shaped, long, broad, passes between testes to reach ventral sucker, where it curves to left around anterior margin of sucker; excretory pore postero-terminal.

Discussion

As indicated above, three species of *Neohypocreadium* are currently recognised. In the type-species, *longisaccatum*, the cirrus-sac extends posteriorly into the hindbody to reach the anterior border of left testis, the external seminal vesicle is shorter than the cirrus-sac and the genital pore is antero-sinistral to the intestinal bifurcation. In *N. dorsoporum*, the cirrus-sac does not reach as far as the anterior border of the ventral sucker, the external seminal vesicle is longer than the cirrus-sac and the genital pore is sinistral to the pharynx. Bray et al. (1994) differentiated *N. chaetodoni* from *N. dorsoporum* by the obliquely arranged testes (versus symmetrical), the pre-testicular ovary (versus inter-testicular), the genital pore which situated at the level of the intestinal bifurcation (versus of at the level of the pharynx), and by its larger body size. *N aegyptense* n. sp. is most similar to *N. chaetodoni*, but differs in having the following characters:

– The worms are smaller (1.15–2.0 mm versus 1.5–2.64 mm; the specimens of *N chaetodonti* in the Collection of the Natural History Museum, London, donated by Prof. R. Madhavi, measure 2.1–3.1 mm).
– The vitelline follicles extend anteriorly to midway between the ventral sucker and the intestinal bifurcation, versus to the level of the oesophagus (examination of the NMH specimens from *N. chaetodonti* indicates that there is some variation and overlap in this feature in one or two specimens).
– The external seminal vesicle extends posteriorly to reach the anterior border of the ovary, versus to midway between the ventral sucker and the ovary.
– The ovary is multilobate with an acinous (bunch of grapes) appearance, verses about three, sometimes branched, subdigitate lobes (the lobes are more elongate in the NHM specimens than figured by Madhavi (1972)).

With the inclusion of *N. chaetodoni* and *N. aegyptense* in *Neohypocreadium*, its diagnosis should be amended as follows.

***Neohypocreadium* Machida & Uchida, 1987**
Body round or elongate. Tegument spined. Dermal glands developed in forebody. Oral sucker terminal or subterminal. Prepharynx very short or practically absent. Pharynx moderately well developed. Oesophagus short. Intestinal bifurcation in forebody; caeca terminate blindly near posterior extremity. Ventral sucker larger than oral sucker, in anterior half of body. Testes two symmetrical or diagonal, in posterior half of body. External seminal vesicle present. Cirrus-sac elongate or claviform, enclosing internal seminal vesicle, pars prostatica and relatively long ejaculatory duct. Genital pore dorsal, antero-sinistral to intestinal bifurcation. Ovary lobed, median, pre- or intertesticular. Seminal receptacle and Laurer's canal present. Uterus pre-ovarian, inter-caecal. Vitellarium follicular, extending most or entire length of caeca, usually confluent posterior to gonads. Excretory vesicle I-shaped, reaches into forebody. Intestinal parasites of marine teleosts (mainly chaetodontids), Indo-West Pacific Region. Type-species: *N. longisaccatum* Machida & Uchida, 1987.

Family Opecoelidae Ozaki, 1925
Subfamily Plagioporinae Manter, 1947

Genus *Fairfaxia* Cribb, 1990

Cribb (1990) erected *Fairfaxia* for *F. lethrini* Cribb, 1990 from the intestine of the lethrinid fish *Lethrinus chrysostomus* [now *L. miniatus*] off the southern Great Barrier Reef, Australia. He referred the genus to the family Opecoelidae and subfamily Plagioporinae, and differentiated it from 34 genera known at that time in this subfamily by a combination of characters: the large size of the ventral sucker in relation to body size, the restricted post-testicular zone, the small globular cirrus-sac, the median genital pore, the vitelline follicles being interrupted at the level of the ventral sucker, and the short excretory vesicle. To date, *Fairfaxia* is known only from its type-species.

***Fairfaxia cribbi* n. sp.**

Type-host: Lethrinus nebulosus Forsskål (Lethrinidae).
Site: Intestine.
Type-locality: Red Sea, off Sharm El-Sheikh, South Sinai, Egypt.
Prevalence: 4/25 fishes examined; 16%.
Type-material: Holotype and paratypes are deposited in the Natural History Museum, London, Reg. No. 2004.11.30.14–15, and in the Helminthological Collection of the Red Sea Fishes, Marine Science Department, Faculty of Science, Suez Canal University, Ismailia, Egypt.
Other material examined: Three paratype specimens of *F. lethrini* from the Natural History Museum, London, Reg. No. 1987.4.8.1–3

Description (Figure 2)

[Based on 15 fully-gravid specimens.] Body small, fusiform, 675–887 × 260–349 (809 × 305). Forebody 265–381 (323) long, representing 40–44 (42)% of total body length. Tegument unspined. Oral sucker well developed, subterminal, usually slightly longer than wide, 140–177 × 115–181 (159 × 148). Ventral sucker large, oval to round, situated close to middle of body, occupying almost full body width, 204–260 × 215–325 (232 × 270).

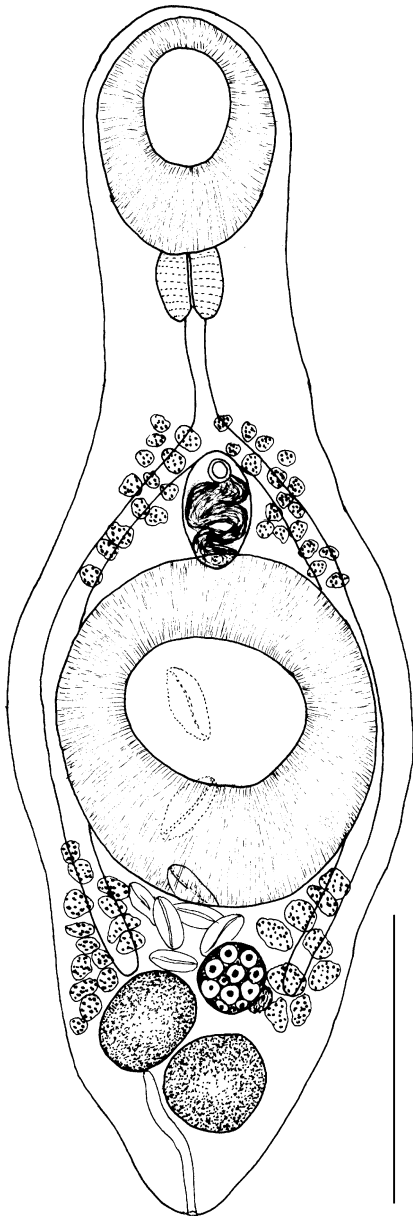

Figure 2. Fairfaxia cribbi n. sp. from *Lethrinus nebulosus*, Red Sea. *Scale-bar:* 200 μm.

Sucker-width ratio 1:1.71–2.12 (1:1.84); sucker-length ratio 1:1.36–1.80 (1.51).

Prepharynx virtually absent. Pharynx well developed, slightly longer than wide, 44–60 × 38–51 (52 × 45). Oesophagus relatively long, 47–60 (54). Intestinal bifurcation midway between pharynx and ventral sucker. Caeca narrow, terminate blindly close to anterior border of testes.

Testes 2, round to oval, contiguous or almost so, situated obliquely in middle of hindbody, subequal, 60–96 × 60–97 (78 × 74). Cirrus-sac small, globular, medial, between intestinal bifurcation and ventral sucker, 60–87 × 42–77 (74 × 60). Seminal vesicle tubular, highly coiled, fills most of cirrus-sac. Genital pore median, just posterior to intestinal bifurcation.

Ovary round, submedian, between ventral sucker and posterior testis, 38–60 × 34–60 (49 × 47). Seminal receptacle and Laurer's canal present. Uterus short, inter-caecal between ovary, anterior testis and ventral sucker, then passes directly anteriorly to genital pore. Eggs oval, moderately large, operculate, 53–61 × 22–40 (57 × 32). Vitelline follicles moderately large, circum-caecal, extend from level of intestinal bifurcation to level of anterior testis, with large interruption at level of ventral sucker; lateral fields almost confluent dorsally in forebody.

Excretory vesicle I-shaped, reaches to anterior testis; excretory pore terminal.

Discussion

Morphologically, the above description agrees in many respects, such as overall size and general body-shape, and with the description of *F. lethrini* by Cribb (1990), but clearly differs in some features and measurements. Differences include:

- The suckers are larger in relation to the size of the worm (mean body-length/sucker ratios: oral 5.01 and ventral 3.49 versus 7.2 and 4.97) than in *F. lethrini*.
- The testes are oblique versus tandem (but slightly oblique in some paratypes of *F. lethrini* in the NHM Collection); they are also smaller, mean 78 × 74 versus 106 × 104 and 108 × 103 μm for the anterior and posterior testes of *F. lethrini*. In fact the gonads and cirrrus-sac tend to be larger in *F. lethrini*.
- The pharynx is larger, mean 52 × 45 versus 37 × 40 μm in *F. lethrini*.
- The eggs are smaller, 53–61 × 22–40 (57 × 32) versus 68–71 × 42–49 (70 × 45) μm in *F. lethrini* (measurements of the eggs of 2 paratypes of *F. lethrini* with eggs in the NHM collection are slightly smaller – 62–66 μm).

In view of these differences and the great geographical difference in the records (NW Indian Ocean versus SW Pacific), we consider the present material to be new. We name it for Dr Tom Cribb, the founder of the genus.

Genus *Macvicaria* Gibson & Bray, 1982

Plagioporus Stafford, 1904 used to be a large opecoelid genus which included intestinal trematodes from both freshwater and marine fishes. Gibson & Bray (1982) erected *Macvicaria* to include those marine species of *Plagioporus* in which the genital pore is ventro-lateral and the excretory vesicle extends anteriorly to at least the level of the anterior testes. Accordingly, they transferred *Plagioporus alacris* (Looss, 1901) and *P. soleae* (Dujardin, 1845) to *Macvicaria*. The first was designated as the type-species of the genus. Although Shimazu & Nagasawa (1985) expressed some doubt about the validity of *Macvicaria*, it has been accepted as valid by recent authors, such as Bartoli et al. (1989), Zdzitowiecki (1990), Zdzitowiecki & Cielecka (1997) and Cribb (2005).

Subsequently, 14 species of *Plagioporus* have been transferred by several authors to *Macvicaria*: *P. sillagonis* Yamaguti, 1938, *P. isaitschikowi* Layman, 1930, *P. longisaccus* Fischthal & Kuntz, 1964 and *P. chrysophrys* Nagaty & Abdel-Aal, 1969 by Bray (1985); *P. pacificus* Yamaguti, 1938 by Reimer (1987); *P. pennelli* (Leiper & Atkinson, 1914) by Zdzitowiecki (1987); *P. japonicus* Yamaguti, 1938 and *P. macassarensis* Yamaguti, 1952 by Bray & Cribb (1989); *P. crassigula* (Linton, 1910) by Bartoli et al. (1989); *P. branchiostegi* Yamaguti, 1937 and *P. cynoglossi* Madhavi, 1975 by Bray (1990); *P. antarcticus* Kovaljova & Gaevskaya, 1974 by Zdzitowiecki (1990); *P. georgiana* Kovaljova & Gaevskaya, 1974 by Zdzitowiecki et al. (1992); and *P. mormyri* (Stossich, 1885) Yamaguti, 1971 by Bartoli et al. (1993).

In addition, several new species of *Macvicaria* have been described: *M. taksengi* from *Otolithes ruber* and *Sillago sihama* off Malaysia by Bray (1985); *M. selachophidii* from *Selachophidium guentheri* off Mozambique by Reimer (1987); *M. heronensis* from *Lethrinus chrysostomus* [now *L. miniatus*] and *Gymnocranius bitorquatus* off the Great Barrier Reef, Australia by Bray & Cribb (1989); *M. dampieri* from *Pseudorhombus jenynsi* off Western Australia by Bray (1990); *M. ophthalmolyci* from *Ophthalmolycus concolor* and *M. muraenolepidis* from *Muraenolepis microps* off Antarctica by Zdzitowiecki (1990); and *M. microtestis* from many fishes and *M. longibursata* from *Ophthalmolycus bothriocephalus* and *O. amberensis* in the Weddell Sea off Antarctica by Zdzitowiecki & Cielecka (1997).

Bartoli et al. (1989) amended the generic diagnosis of *Macvicaria*, and described a new species, *M. maillardi*, from the intestine of *Sparus auratus* in the Mediterranean Sea. They also transferred *Pachycreadium obovata* (Molin, 1859), *Allocreadium dubia* Stossich, 1905 and *Pachycreadium crassigula* (Linton, 1910) to the genus, and transferred *M. selachophidii* Reimer, 1987 to *Allopodocotyle* Pritchard, 1966, since in this species the vitelline follicles are confined to the hindbody.

According to the above review, 27 species have been included and are still recognised in *Macvicaria*.

Macvicaria chrysophrys (Nagaty & Abdel-Aal, 1969) Bray, 1985

Syn. *Plagioporus saoudi* Ramadan, 1985

Host: *Acanthopagrus bifasciatus* Forsskål (Sparidae).
Site: Intestine.
Locality: Red Sea, off Sharm El-Sheikh, South Sinai, Egypt.
Prevalence: 14/40 fishes examined; 35%.
Material: Voucher specimens are deposited in the Natural History Museum, London, 2004.11.30.16–19, and in the Helminthological Collection of the Red Sea Fishes, Marine Science Department, Faculty of Science Suez, Suez Canal University, Ismailia, Egypt.

Description (Figure 3)

[Based on 12 fully-gravid specimens.] Body elongate oval, robust, 3,169–5,600 × 1,086–2,074 (4,385 × 1,580). Forebody 1,071–1,763 (1,417) long, representing 31–43% of total body length. Tegument unarmed. Numerous gland-cells scattered in parenchyma of forebody. Oral sucker well developed, subterminal, slightly wider than long, 332–642 × 392–725 (487 × 559). Ventral sucker fairly large, transversely elongate, just pre-equatorial,

Figure 3. Macvicaria chrysophrys (Nagaty & Abdel-Aal, 1969) Bray, 1985 from *Acanthopagrus bifasciatus*, Red Sea. *Scale-bar:* 500 μm.

stout, with muscular fibres radiating from both sides into lateral fields of body, 452–910 × 633–1,015 (681 × 824). Sucker-width ratio 1:1.4–1.61 (1:1.50).

Prepharynx very short, 60–183 (122). Pharynx well developed, globular, 240–415 × 226–497 (328 × 362). Oesophagus very short, 38–45 (42). Intestinal bifurcation midway between suckers. Caeca simple, terminating blindly near posterior extremity.

Testes 2, oval, tandem, contiguous, midway between ventral sucker and posterior extremity, subequal, 301–456 × 392–808 (379 × 600). Cirrus-sac well developed, claviform, curved, overlaps anterior border of ventral sucker posteriorly, 495–684 ×152–210 (590 × 181), contains highly convoluted tubular seminal vesicle, short pars prostatica and relatively long ejaculatory duct. Genital pore sinistrally sublateral at level of intestinal bifurcation.

Ovary round, dextrally submedian, between ventral sucker and anterior testis, 283–311 (297) in diameter. Seminal receptacle situated just posterior to ovary. Laurer's canal present. Uterus relatively long, inter-caecal, passes between seminal receptacle and anterior testis, coiled mainly between anterior testis, ovary and ventral sucker, then passes along left margin of ventral sucker to genital atrium. Metraterm well differentiated. Eggs oval, moderately large, operculate, 64–78 × 35–48 (71 × 42). Vitelline follicles numerous, moderately large, occupy most of available space between posterior extremity and pharynx, confluent in forebody (dorsally) and in post-testicular region.

Excretory vesicle tubular, I-shaped, extends to near anterior border of anterior testis; excretory pore postero-terminal.

Discussion

As mentioned above, 27 species of *Macvicaria* are known, but there are likely be to other marine species attributed to *Plagioporus* which should be transferred to this genus. Even without these, the systematics of the genus is complex, with morphologically very similar species being recognised. The situation is exemplified by the work of Bartoli et al. (1989), who, when revising some forms from sparid fishes of the western Mediterranean, erected *M. maillardi*, a species almost identical to *M. crassigula* (Linton, 1910) [see also Bartoli et al., 1993, for the key features], while at the same

time suggesting that the latter species may represent a species complex (see also Jousson et al., 2000; Jousson, 2001). The present material, also from a sparid, resembles the description of *M. obovata* (Molin, 1859) given by Bartoli et al. (1989), but differs in that the vitelline fields are more extensive, especially ventrally, in the forebody. In fact these worms correspond very well with the original description of *Plagioporus chrysophrys* Nagaty & Abdel-Aal, 1969 given by Nagaty & Abdel-Aal (1969) from *Acanthopagrus* [= *Chrysophrys*] *bifasciatus*, the same host, in the Red Sea: this species was later transferred to *Macvicaria* by Bray (1985). The present material also corresponds well with *Plagioporus saoudi* Ramadan, 1985, which was collected from the type-host and locality of *M. chrysophrys* but not compared with this species (Ramadan, 1985). In fact, the two descriptions are very similar, there being no apparent specific differences. Consequently, the present material is referred to *M. chrysophrys* and *P. saoudi* is considered its synonym.

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