

**Larval Trematodes of *Melanooides tuberculatus* (Müller, 1774)  
(Gastropoda: Prosobranchia) in a Brackish Spring,  
United Arab Emirates**

NAIM S. ISMAIL, FLS AND ARIF M.S. ARIF

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**Abstract**

Seven forms of cercariae were encountered from *Melanooides tuberculatus* snails collected from a brackish spring in United Arab Emirates. Of these, one form is the cercaria of *Philophthalmus gralli* and one is identical to *Cercaria asiri* VI. The remaining cercariae are considered as new forms and are named *Cercaria emirati* I through V. *Cercaria emirati* I is a xiphidiocercaria belonging to *Cercaria Armatae* group. It has three pairs of penetration glands, 26 flame cells, and develops within a sporocyst. *Cercaria emirati* II is a gymnocephalous cercaria which has 34 flame cells and develops within a redia with a long intestine. *Cercaria emirati* III is a pleurolophocercous cercaria. It has 7 pairs of penetration glands, 22 flame cells, and develops within a redia with short intestine. *Cercaria emirati* IV is a trioculate monostome cercaria with two lateral adhesive pockets. It develops within a redia with two lateral processes. *Cercaria emirati* V is an ocellate apharyngeal brevifurcate cercaria. It has three pairs of penetration glands, 12 flame cells in the body, two flame cells in the tail, and develops within an elongated sporocyst. Other details on the morphology, behavior, and development of these forms are presented.

**Key words:** *Melanooides tuberculatus*; Cercaria; United Arab Emirates; Desert Oasis

**Introduction**

*Melanooides tuberculatus* Müller, 1774 is one of the most commonly found snails in the Middle East and the Arabian Peninsula (Alio, 1967; Brown, 1980). Thus, it is expected that this snail may act as an intermediate host for digenetic trematodes in these geographical areas. Several forms of cercariae have already been described from it (El-Gindy and Yousif, 1963; Gold and Lengy, 1974; Fahmy *et al.*, 1976, 1977; Khalifa *et al.*, 1977; Ismail and Saliba, 1985; Ismail *et al.*, 1988; Ismail, 1990). The present study reports seven forms of cercariae from *M. tuberculatus* snails collected from United Arab Emirates on the southeastern side of the Arabian Peninsula. Five of these cercariae are considered as new and are described and drawn.

**Materials and Methods**

*Melanooides tuberculatus* snails were collected from Al-Faydah spring during the period January to September 1990. This spring lies at about 130 km east of Abu-Dhabi, the capital city of United Arab Emirates, near Al-Ain city. A man-made pool of about 3000 m<sup>2</sup> is constructed at the spring for domestic geese. This pool attracted large number of wild birds and became heavily populated with *M. tuberculatus* snails. Preliminary measurements showed that water of this pool is slightly brackish (4–8 ‰) due to high air temperature which may exceed 50°C during summer.

Collected snails were individually placed in separate Petri dishes containing clean pool water, and examined for cercariae at least 24 hours later. All snails, whether or not had shed cercariae, were then crushed, dissected, and examined for developing larval stages. Cercariae were studied live, unstained or stained with vital stains.

Cercariae were fixed in hot 70% ethanol. Measurements were made on a minimum of 10 live and 10 fixed specimens.

### Results

Table 1 shows that 78.4% of the 2300 *Melanoides tuberculatus* snails examined were infected with larval trematodes. Seven forms of cercariae were encountered: One xiphidiocercaria, three gymnocephalous cercariae, two pleurolophocercous cercariae, and one brevifurcate cercaria. Of these, one form is the cercaria of the eye fluke *Philophthalmus gralli* as described by Ismail and Issa (1987), and one is identical to *Cercaria asiri* VI (Ismail, 1990). The remaining cercarial forms are considered as new and are provisionally named as *Cercaria emirati* I through V until their life cycles are known.

Table 2 shows the morphometric measurements of fixed and live specimens of *Cercaria emirati* I through IV. The measurements of the brevifurcate *C. emirati* V is shown in Table 3.

#### *Cercaria emirati* I (Fig. 1)

Description: This is a relatively medium-sized xiphidiocercaria. The body tegument is about 2  $\mu$ m thick and has fine spines all-over. It is also provided with 4 sensory setae at the anterior end, and 4 on each side of the body. The tail is shorter than the body and is highly contractile. It is recessed into a 10 by 12  $\mu$ m depression at the body base. The oral sucker is 41–52  $\mu$ m in

diameter and is provided with a small 5 by 8  $\mu$ m stylet, but lacks the virgula organ. The stylet has a base and lateral enforcement. The ventral sucker is slightly smaller than the oral sucker and is located in the posterior half of the body. It is 39–48  $\mu$ m in diameter. The digestive system consists of a mouth and a 10 by 14  $\mu$ m pharynx. The excretory bladder is Y-shaped and its two cornua run anteriorly until the anterior margin of the ventral sucker. Each cornu gives rise to an excretory duct that descends posteriorly before dividing into two collecting excretory tubules. The caudal excretory canal opens at the tip of the tail. Flame cells are arranged symmetrically in the body and are absent in the tail. The flame cell formula is  $2[(2+2+2+2)+(2+3)]=26$ . The glandular system is made of three pairs of penetration glands that empty their contents into ducts which open at both sides of the stylet. Moreover, the body is filled with relatively large cystogenous gland cells. The genital primordium consists of a mass of cells at the ventral sucker.

Behavior: *Cercaria emirati* I is an active swimmer. However, it does not reach the surface of the water. During rest periods the cercaria continues to contract its body and tail. This cercaria does not show positive or negative phototaxis.

Development: This cercaria develops in a thin walled sporocyst which was found embedded within the hepatopancreas of the snail. The sporocyst measures  $730 \pm 164$  by  $168 \pm 42$   $\mu$ m.

Table 1 Infection rates of 2300 *Melanoides tuberculatus* snails with various cercarial forms in Al-Faydah spring during January to September 1990

Cercarial form	Morphological type	Infection rate (%)
<i>Cercaria emirati</i> I	Xiphidiocercaria	29.7
<i>Cercaria emirati</i> II	Gymnocephalous	0.7
<i>Cercaria emirati</i> III	Pleurolophocercous	0.3
<i>Cercaria emirati</i> IV	Gymnocephalous	25.1
<i>Cercaria emirati</i> V	Brevifurcate	0.2
<i>Philophthalmus gralli</i> cercaria	Gymnocephalous	21.0
<i>Cercaria asiri</i> VI	Pleurolophocercous	1.4
Total		78.4

Table 2 Measurements of fixed (upper value) and live (lower value) specimens of *Cercaria emirati* I through IV. All numbers are in microns

Cercarial form	Body length	Body width	Tail length	Tail width
<i>C. emirati</i> I				
Mean	205	70	128	23
	187	92	124	23
S.D.*	24	13	29	2
	33	17	31	5
Range	173-242	55-100	76-173	20-24
	144-242	73-121	76-180	18-31
<i>C. emirati</i> II				
Mean	244	118	287	35
	245	125	243	37
S.D.	33	23	33	3.3
	49	29	54	4.3
Range	207-311	69-145	242-345	28-38
	173-345	69-155	166-293	31-41
<i>C. emirati</i> III				
Mean	135	72	398	22
	136	73	410	23
S.D.	11	10	15	2
	17	8	19	3
Range	107-141	59-86	375-413	21-24
	117-166	62-86	386-440	21-28
<i>C. emirati</i> IV				
Mean	349	177	345	57
	343	174	391	52
S.D.	105	23	106	14
	86	56	112	14
Range	333-453	133-213	200-480	40-80
	213-467	120-267	187-600	33-67

\* S.D. = one standard deviation.

### *Cercaria emirati* II (Fig. 2)

Description: This is a fairly large cercaria. The body and the tail are smooth, except for few spine at the tip of the tail and sensory setae on the body. Six pairs of these setae are concentrated at the anterior margin and 2 pairs on both sides of the body. The tail is filled with caudal bodies. The posterior three quarters of the body are densely packed with cystogenous matter. Cystogenous cells are of two types. First group of cells lie between the pharynx and the ventral sucker and contain fine rod-like cystogenous matter. The other group of cells lie posterior to the ventral

sucker and laterally on both sides of the body. These cells contain granular cystogenous matter. The oval oral sucker is 30 by 40  $\mu\text{m}$ . The ventral sucker lies in the posterior half of the body and is 33  $\mu\text{m}$  in diameter. The digestive system consists of a mouth that leads into muscular pharynx at about 30  $\mu\text{m}$  from the posterior border of the oral sucker. The pharynx measures 26 by 20  $\mu\text{m}$ , and connects to an oesophagus which bifurcates into two intestinal caeca. Each caecum diverges outwards and runs posteriorly to the end of the body. The excretory bladder is single-chambered and connects to two ascending ducts which dilate and run anteriorly to about the level of the

Table 3 Measurements of fixed (upper value) and live (lower value) specimens of *Cercaria emirati* V. All numbers are in microns

Morphometric measurements	Mean	S.D.*	Range
Body length	124	3.6	117–128
	99	18.5	80–130
Body width	42	3.2	38–48
	45	9.1	25–48
Tail stem length	207	9.1	193–221
	190	20.9	155–214
Tail stem width	25	1.1	24–28
	25	4.5	17–31
Tail furcus length	77	5.4	69–86
	86	4.5	79–93
Tail furcus width	10	0.9	9–10
	9	1.5	7–10

\* S.D. = one standard deviation.

pharynx. Each duct narrows and descends posteriorly to about the level of the ventral sucker before it bifurcates into two collecting excretory tubules. The dilated portion of the excretory duct is filled with large refractile excretory granules. The caudal excretory canal runs posteriorly and open in an excretory pore near the tip of the tail. Flame cells are arranged symmetrically in the body and are absent in the tail. The flame cell formula is  $2[(2 + 2 + 3) + (2 + 3 + 3 + 2)] = 34$ . The genital primordium consists of a small mass of cells behind the ventral sucker.

**Behavior:** This is an active swimmer cercaria. It swims continuously in water and shows no response to light. Within 12 hours of emergence from the snail some of the cercariae develop into metacercariae. However, this encystment was not successful because all metacercariae were found dead and decomposed within 24 hours.

**Development:** *Cercaria emirati* II develops within sausage shaped rediae which vary greatly in size. There seemed to be two types of rediae, large and small: Large rediae measure 467–733 by 173–267  $\mu\text{m}$ , and are provided with a relatively small pharynx (73 by 59  $\mu\text{m}$ ), and a

rhabdocoel gut that runs to about two thirds of the redial length. Small rediae measure 227–506 by 133–266  $\mu\text{m}$ , and are provided with a relatively large pharynx (84 by 65  $\mu\text{m}$ ) and a long rhabdocoel gut. Both types of rediae are provided with anterior and posterior lateral processes. The large redia has a birth pore near its posterior extremity. Developing cercariae were seen only within large rediae.

### *Cercaria emirati* III (Fig. 3)

**Description:** This is a relatively small pleurolophocercous cercaria. The body is covered with fine spines which are more concentrated at the anterior third. A single row of stronger curved spines is present at the outer edge of the protrusible organ. More curved spines are present between the protrusible organ and eye spots. Longer straight spines are also present at the interior edge of the protrusible organ. Eight sensory setae are distributed on each side of the body. The tail, about three times body length, is provided with 10–12  $\mu\text{m}$  wide finfolds along its entire length. The anterior third of the tail has lateral finfolds, while the remaining part has dorsoventral finfolds. Two eye spots are located at about 60  $\mu\text{m}$  from the anterior body extremity. They are darkly pigmented and measure roughly 8 by 10  $\mu\text{m}$ . The oral sucker is modified into a protrusible organ and measures 31 by 38  $\mu\text{m}$ . The digestive system consists of a mouth and a rudimentary pharynx at about the level of eye spots. The pharynx is 13 by 8  $\mu\text{m}$ . The excretory system is conventional. The bladder is relatively large and measures 31 by 41  $\mu\text{m}$  with 6–7  $\mu\text{m}$  thick wall. It receives two ascending ducts which bifurcates into anterior and posterior collecting tubules at about the level of the pharynx. The caudal excretory canal opens into an excretory pore near the tip of the tail. Flame cells are arranged symmetrically in the body and are absent in the tail. The flame cell formula is  $2[(1 + 3) + (2 + 2 + 3)] = 22$ . The glandular system consists of seven pairs of penetration glands which empty their contents into two outer and two inner bundles of penetration gland ducts. The outer bundle consists of three ducts, while the

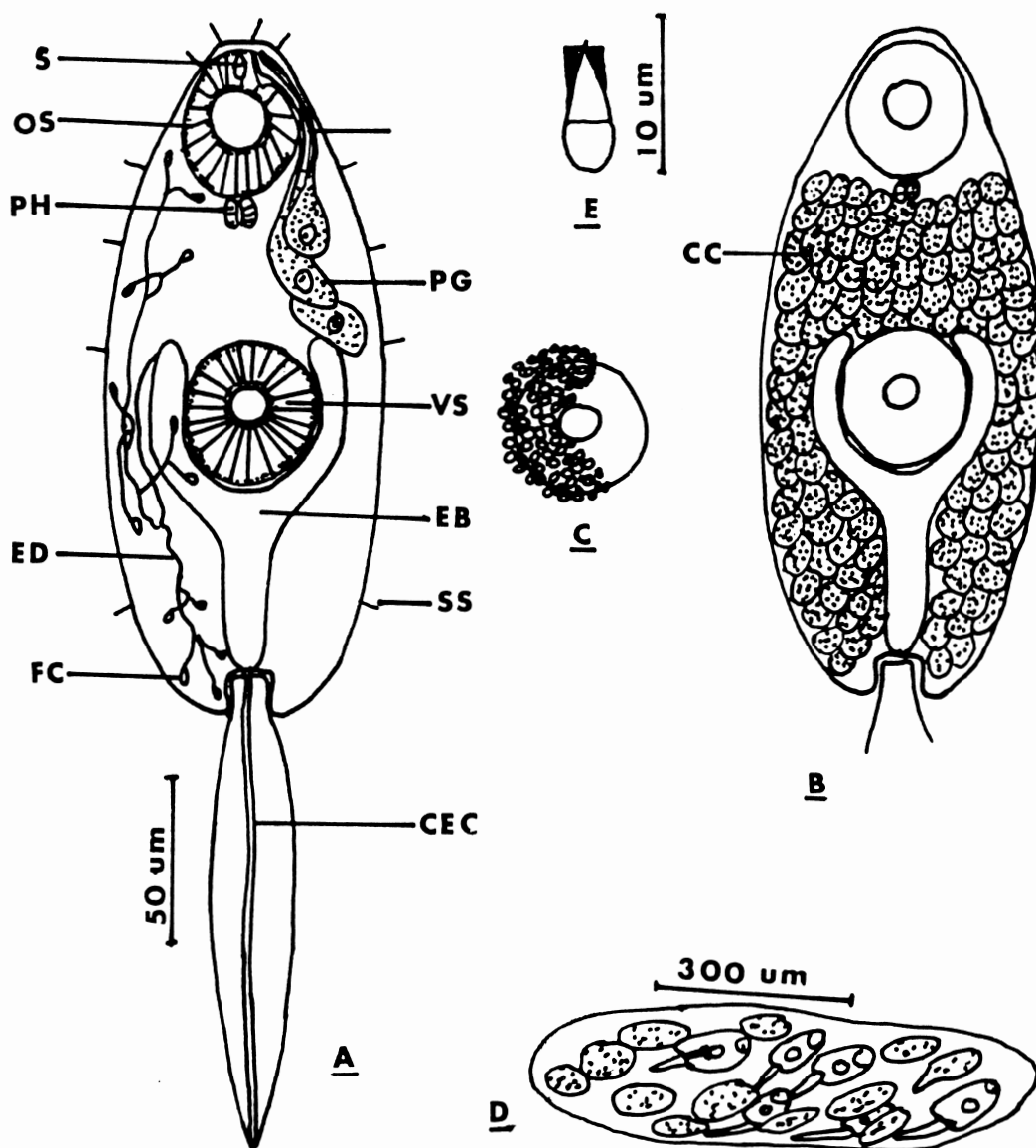


Fig. 1. *Cercaria emirati* I. A, entire specimen showing penetration glands and the excretory system. B, distribution of cystogenous cells. C, genital primordium. D, sporocyst. E, stylet.

#### Abbreviations

AO:	Adhesive organ	LP:	Lateral process
CC:	Cystogenous cells	LFF:	Lateral finfold
CEC:	Caudal excretory canal	OES:	Oesophagus
DC:	Developing cercaria	OS:	Oral sucker
DVFF:	Dorsoventral finfold	PH:	Pharynx
EB:	Excretory bladder	PG:	Penetration gland
ED:	Excretory duct	PGD:	Penetration gland duct
ES:	Eye spot	PO:	Penetration organ
FC:	Flame cell	SS:	Sensory setae
GP:	Genital primordium	S:	Stylet
INT:	Intestine	VS:	Ventral sucker

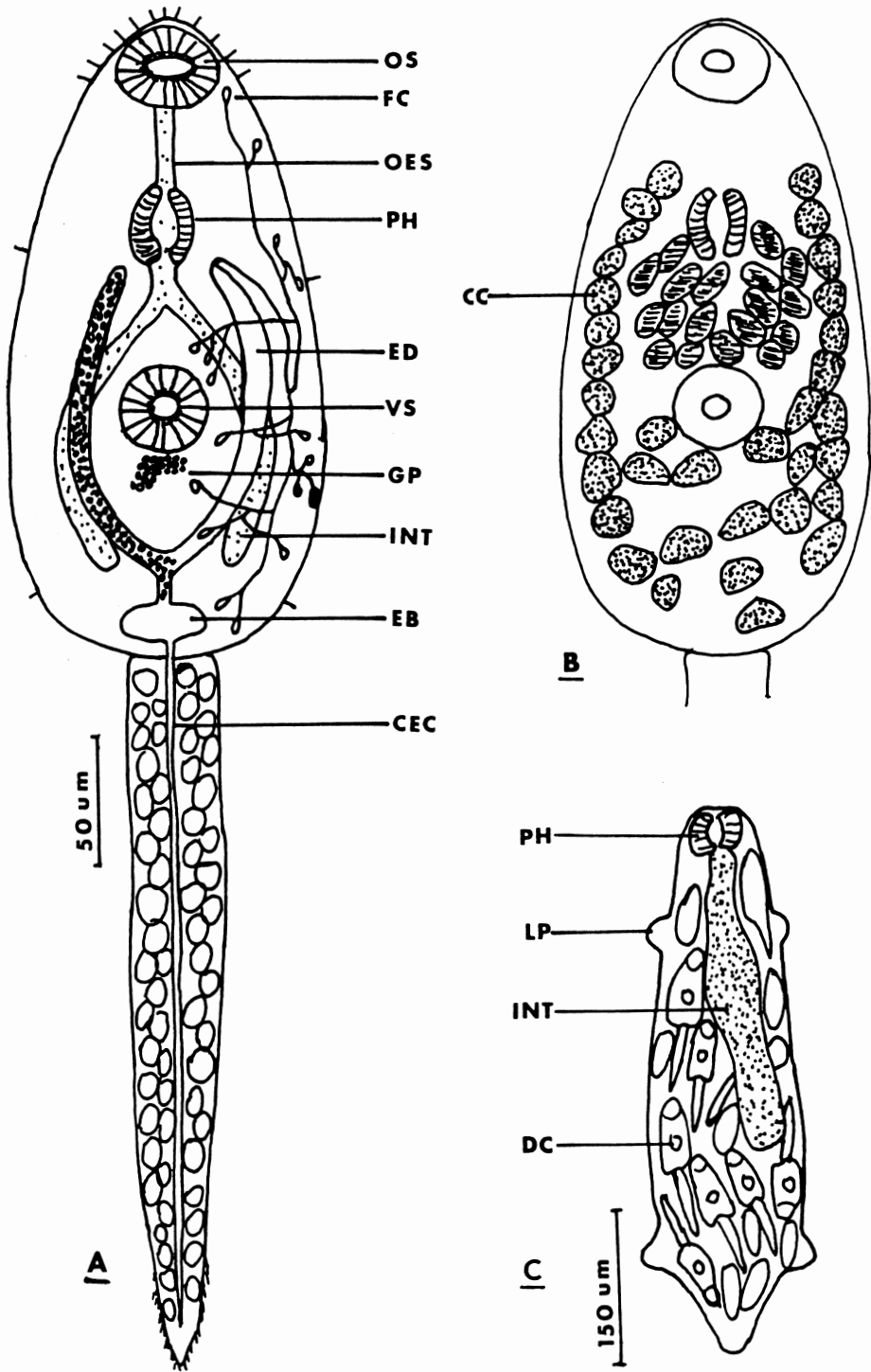


Fig. 2. *Cercaria emirati* II. A, entire specimen showing the digestive and excretory systems. B, distribution of cystogenous cells. C, redia.

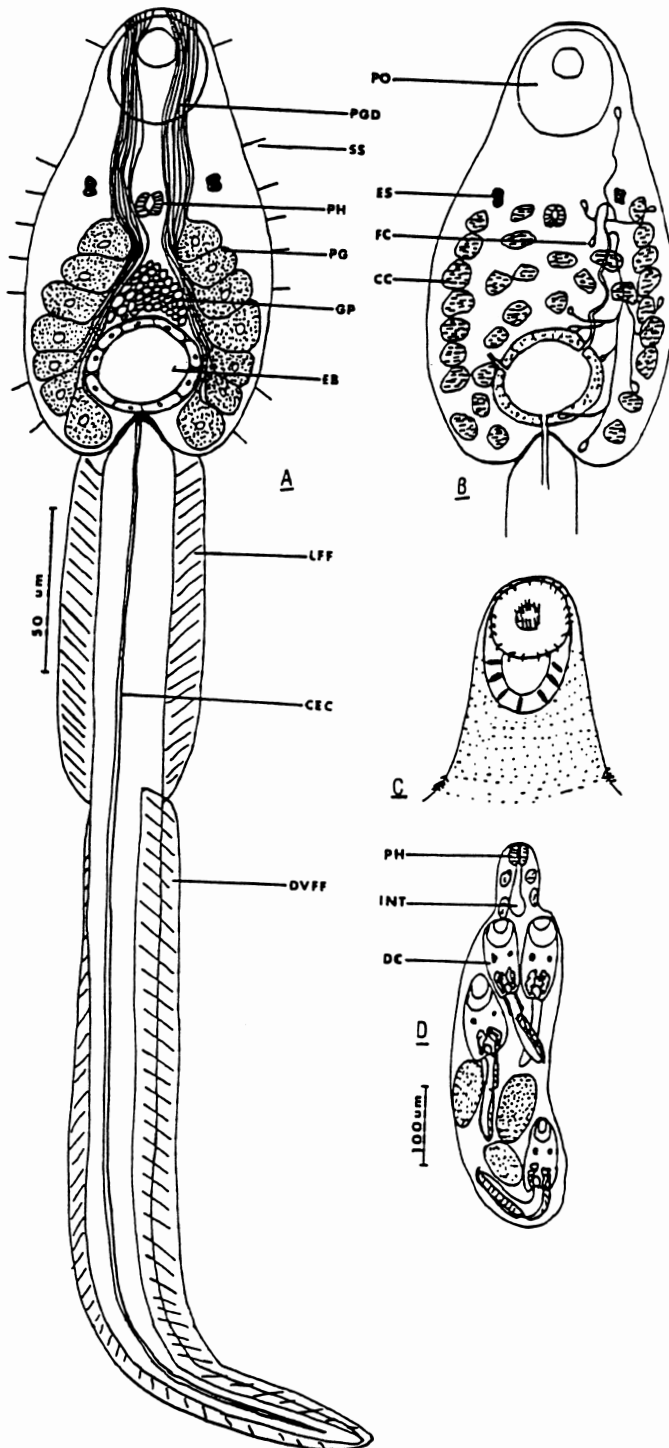


Fig. 3. *Cercaria emirati* III. A, entire specimen showing penetration glands and finfolds. B, distribution of cystogenous cells and flame cells. C, spines at the anterior end of the body. D, redia.

inner one consists of four ducts. These ducts open at the anterior edge of the protrusible organ. Moreover, the posterior two thirds of the body contains oval cells filled with rod-like cystogenous matter. The genital primordium consists of a mass of cells above the excretory bladder.

**Behavior:** This cercaria behaves as other types of the pleurolophocercous cercariae. It shows positive phototaxis and positive thigmotaxis. At rest, it assumes heart-shaped with body down on the bottom of the dish. It swims briefly but actively. It was noticed that cercariae cast off their tails within 24–36 hours post emergence from the snail and crawl on the bottom before they die.

**Development:** *Cercaria emirati* III develops within a sausage-shaped redia that measures 400–533 by 107–173  $\mu\text{m}$ . The redia has a relatively small pharynx (35 by 40  $\mu\text{m}$ ) and a short rhabdocoel gut.

#### *Cercaria emirati* IV (Fig. 4)

**Description:** This is a relatively large trioculate monostome cercaria. The body is smooth except for the fine spines at the anterior end. It has also 4 sensory setae on each side and is filled with cystogenous cells which contain thick rod-like cystogenous matter. The body is provided with one pair of postero-lateral 10–12  $\mu\text{m}$  long adhesive pockets and three darkly pigmented eye spots. The two lateral eye spots are prominent and are 23 by 10  $\mu\text{m}$ . The median one is smaller and consists of several darkly pigmented brown granules. The terminal oral sucker is 30 by 40  $\mu\text{m}$ . The digestive system consists of a mouth that leads into a long oesophagus which bifurcates into two intestinal caeca terminating near the posterior end of the body. The excretory bladder is relatively small measuring 25–30  $\mu\text{m}$  in diameter and connects to two ascending excretory ducts. These ducts dilate and run anteriorly to become re-connected at the level of eye spots. It was not possible to outline the finer excretory tubules and flame cells because the body is densely packed with cystogenous matter. The caudal excretory canal runs along the tail to open near the end of the tail.

**Behavior:** This cercaria is an active swimmer. However, shortly after it emerges from the snail it crawls on the bottom and casts off its tail. The body encysts to form a metacercaria which is 165–180  $\mu\text{m}$  in diameter.

**Development:** *Cercaria emirati* IV develops within a relatively large redia which measures 100–200 by 670–1000  $\mu\text{m}$ . The redia has a 35 by 50  $\mu\text{m}$  pharynx and a rhabdocoel gut that extends to about half of the body. It is also provided with two posterior lateral processes. Rediae were found packed with several developing cercariae. No cercariae, however, were seen in younger rediae (130–170 by 400–650  $\mu\text{m}$ ). It's noteworthy that many of the young rediae emerged out from the infected snail during shedding of cercariae.

#### *Cercaria emirati* V (Fig. 5)

**Description:** This is a distome ocellate apharyngeal brevifurcate cercaria. The body and tail are covered with fine spines. Longer spines are concentrated at the anterior margin of the body. Four sensory setae are present on each side of the body at the level between the ventral sucker and the penetration organ. The tips of the tail rami are provided with 5  $\mu\text{m}$  long cuticular fin. The oral sucker is modified into a penetration organ which is 25–30  $\mu\text{m}$  in diameter. The ventral sucker, 10  $\mu\text{m}$  diameter, is located in the posterior half of the body. The two darkly pigmented eye spots are located in front of the ventral sucker in the middle of the body. The digestive system consists of a mouth that leads into a long and narrow oesophagus. The excretory system consists of a spherical excretory bladder which is 13–15  $\mu\text{m}$  in diameter. The bladder receives two primary excretory ducts. Each duct bifurcates into two secondary canals, one runs anteriorly to about the level of the penetration organ and the second runs posteriorly. The caudal canal runs along the tail stem and bifurcates into two canals which run along the tail rami to open in excretory pores near the tips of both rami. There are 6 pairs of flame cells arranged symmetrically in the body, and one pair in the tail near its base. The flame cell



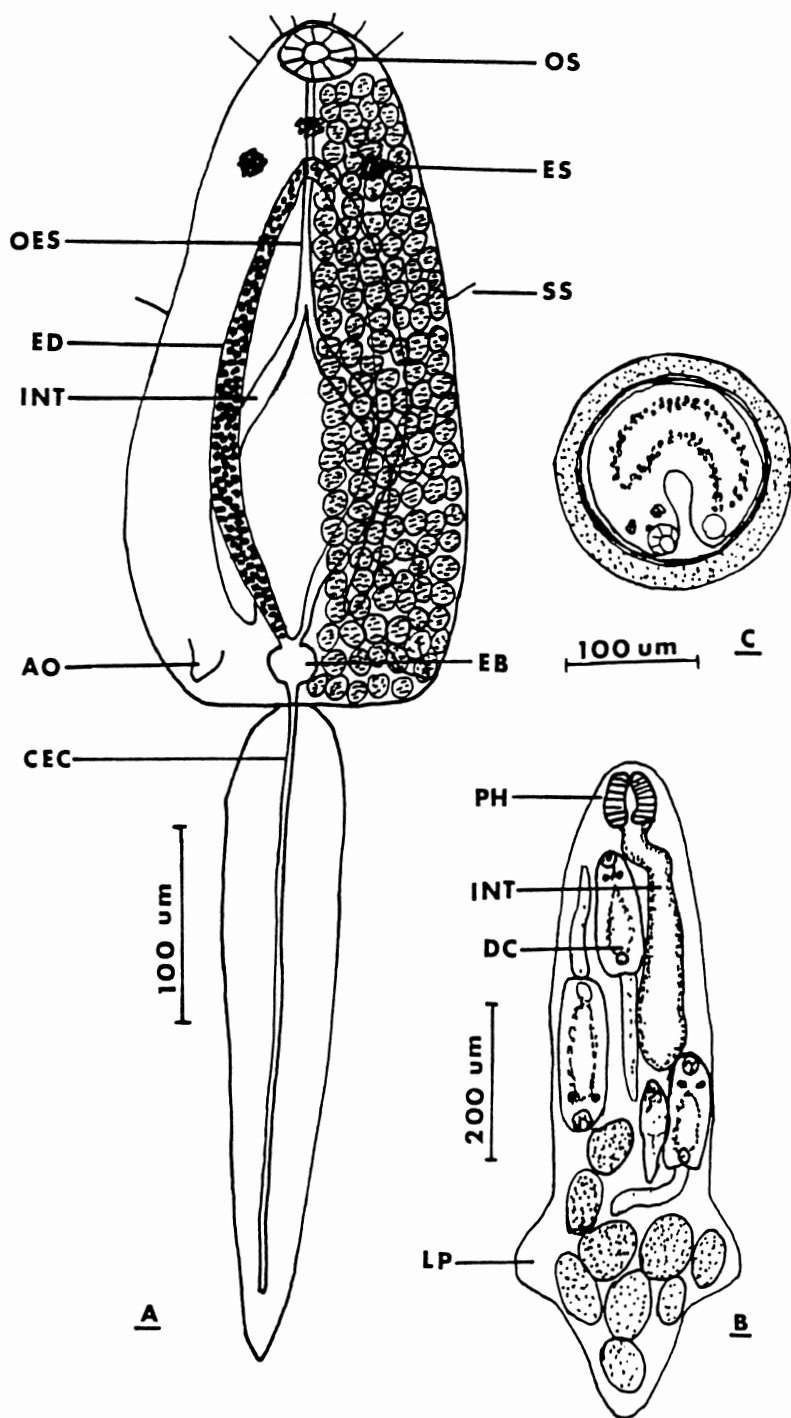


Fig. 4. *Cercaria emirati* IV. A, entire specimen. Cystogenous cells and the excretory granules are drawn each on one side of the body to show internal details. B, redia. C, metacercaria.

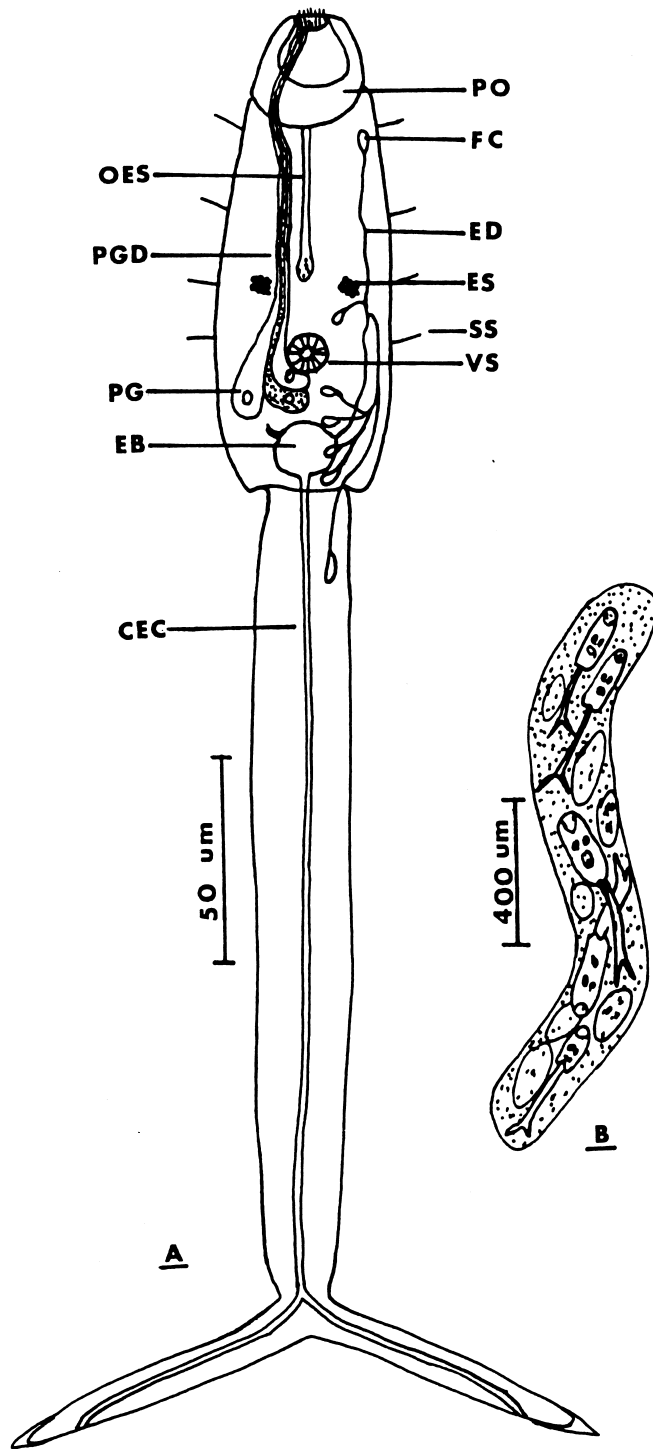


Fig. 5. *Cercaria emirati* V. A, entire specimen showing half of the flame cells drawn on one side and half of the penetration glands on the other side of the body. B, sporocyst.

formula is  $2[(1+1)+(2+2)+(1)]=14$ . The glandular system consists of three pairs of penetration glands around and posterior to the ventral sucker. Of these, one pair is coarsely granulated and two are finely granulated. Penetration gland ducts open at the anterior margin of the penetration organ. Besides these glands there is a sac which is usually filled with granular matter within the penetration organ. The genital primordium consists of a mass of cells near the ventral sucker.

**Behavior:** This cercaria is an active swimmer. It swims forward and backward by the action of its tail. It shows positive thigmotaxis and negative phototaxis.

**Development:** *Cercaria emirati* V develops within an elongated sporocyst measuring 70–100 by 210–480  $\mu\text{m}$ . Longer sporocysts measuring 250 by 2040  $\mu\text{m}$  were also isolated from infected snails. These sporocysts were found filled with developing cercariae and germ cells.

### Discussion

This is the first report on natural infection of *Melanoides tuberculatus* snails with seven forms of cercariae in United Arab Emirates. Five of these are considered as new and compared with closely related cercariae.

*Cercaria emirati* I belongs to Cercaria Armatae group of xiphidiocercariae (Lühe, 1909). This group includes distome cercariae with stylet, a tail lacking any finfold, acetabulum lying somewhat behind the middle of the body, and with a Y-shaped excretory bladder. The other form of cercariae which resembles *C. emirati* I in possessing similar Y-shaped excretory bladder, small sized stylet, and lacks intestinal caeca is Cercaria Levantina 12 (Gold and Lengy, 1974). However, the latter differs from *C. emirati* I in being larger in size and has 7 pairs of penetration glands instead of three. Although, *C. oiensis* (Reimer, 1971) has small stylet, it differs from *C. emirati* I in possession of a developed gut caeca. *Cercaria indica* XVI (Sewell, 1922) and *C. rumiensis* (Pike, 1967) have Y-shaped bladder, three pairs of penetration glands, and lack gut caeca as *C. emirati* I. However, these forms have

much bigger stylets. Moreover, *C. rumiensis* has lesser number of flame cells.

*Cercaria emirati* II is a distome cercaria, in which the tail is straight, slender, and narrower than the body. The absence of a stylet, collar spines, caudal fin folds, and eye spots, relate this cercaria to Lühe's (1909) group of gymnocephalous cercariae. Other cercariae which resemble *C. emirati* II are: *Cercaria sudanensis* No. 3 (Archibold and Marshall, 1931), *C. albinea* and *C. densacutis* (Khan, 1960), *C. sanlorenzensis* (Nasir and Acuna, 1964), *C. cytogenata* and *C. llangorensis* (Probert, 1965), *C. concilia* and *C. pseudoconcilia* (Nasir *et al.*, 1968), *C. barceloica* (Nasir, 1971), *C. stenophysae*, *C. armikuhniiani*, and *C. laurotraravassosi* (Nasir and Diaz, 1973), *C. leyteensis* no.39 (Ito and Blas, 1978), *C. pseudoalbinea* (Khan and Haseeb, 1980), and *C. asiri* V (Ismail *et al.*, 1988). *Cercaria emirati* II differs from *C. barceloica* and *C. sanlorenzensis* in having intestinal caeca running to posterior end of the body. The unbifurcated caudal excretory canal of *C. emirati* II differentiates it from *C. asiri* V, *C. leyteensis* no. 39, *C. densacutis*, *C. albinea*, and *C. llangorensis*. Being aspinose, *C. emirati* II differs from *C. sudanensis* no. 3, *C. armikuhniiani*, *C. laurotraravassosi*, and *C. cystogenata*. The presence of papillae in oral suckers of *C. concilia* and *C. pseudoconcilia* differentiates them from *C. emirati* II. *Cercaria stenophysae* has lesser number of flame cells. Similarly, *C. pseudoalbinea* has lesser number of flame cells than *C. emirati* II, but has bigger ventral sucker and lacks sensory setae.

The modification of the oral sucker into a penetration organ, the presence of tail finfolds, and the absence of a ventral sucker relate *C. emirati* II to the Pleurolophocerca pleurolophocerca group of Sewell (1922). The other forms of cercariae which resemble *C. emirati* III in possession of seven pairs of penetration glands and a tail with lateral and dorsoventral finfolds are: The parapleurolophocercous cercariae A and B of El-Gindy and Yousif (1963), *C. pinjorensis* (Gupta and Taneja, 1969), *Cercaria* sp. III Kerala (Mohandas, 1976), *Cercaria* of *Haplorchis pumilio* (Khalifa *et al.*, 1977), and *C. asiri* IV (Ismail *et al.*, 1988). *Cercaria emirati* III differs

from the parapleurolophocercous cercaria A, the cercaria of *H. pumilio*, and the *Cercaria* sp. III Kerala in being significantly smaller in size. Moreover, *C. emirati* III has a longer tail than the parapleurolophocercous cercaria B and *C. pinjorensis*. Although, *C. emirati* III closely resembles *C. asiri* IV, it has 22 flame cells instead of 26 in *C. asiri* IV, smaller body, smaller rediae, and 8 pairs of sensory setae instead of 5.

*Cercaria emirati* IV is a trioculate monostome cercaria. Other cercariae which resemble *C. emirati* IV are: Cercaria of *Notocotylus duboisi* (Stunkard, 1966), cercaria of *N. ephemera* (Pike, 1969), *C. pulchelli* (Mukherjee, 1963), *C. leyteensis* no. 22 (Ito, 1977), and *C. leyteensis* no. 3 (Ito *et al.*, 1977). Both cercariae of *Notocotylus* develop within rediae without lateral processes, while the redia of *C. emirati* IV has two lateral processes. In addition, the caudal excretory canal of *C. emirati* IV does not bifurcate as in both cercariae of *Notocotylus*. Similarly, *C. leyteensis* no. 22 has a bifurcated caudal excretory canal. *Cercaria leyteensis* no. 3 and *C. pulchelli* differ from *C. emirati* IV in the absence of adhesive pockets.

*Cercaria emirati* V is a distome ocellate apharyngeal brevifurcate cercaria. It comes nearest to *C. indica* XLVII (Sewell, 1922), *C. tuberculatusi* (Premvati, 1954), and *Cercaria* sp. II (Ismail *et al.*, 1988). It can be differentiated from *C. indica* XLVII by having 6 pairs of flame cells in the body instead of 4 pairs, and by the presence of eye spots near the ventral sucker. *Cercaria tuberculatusi* has 5 pairs of flame cells in the body, 4 pairs of penetration glands in the penetration organ, and has a longer tail stem measuring 340  $\mu$ m. Although, *Cercaria* sp. II is similar in size to *C. emirati* V, it differs in having 5 pairs of flame cells in the body, 5 pairs of penetration glands instead of 3 pairs in *C. emirati* V, and the presence of hair like sensory setae on the tail stem.

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