

STUDIES ON SOME ECHINOSTOME CERCARIAL

by

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SUMMARY

During the course of an investigation on the cercarial fauna of the common snails found in the environs of the city of Lucknow, three new species of echinostome cercariae viz., *Cercaria granulosa*, *Cercaria triglandulata* and *Cercaria megacauda* were found and these are described in this paper. *C. granulosa* and *C. triglandulata* are tail-finned cercariae resembling *C. indica* XLVIII Sewell, 1922 and *C. nairi* Peter, 1955 respectively, while *C. megacauda* is a large-tailed form resembling *C. illecebrosa* Lee and Seo, 1959 and *C. reynoldsi* Etges, 1961.

Cercaria granulosa sp. nov., found parasitizing *Lymnaea acuminata*, (has aspinose body, four pairs of lobate penetration gland cells, gut composed of cells arranged end to end, cystogenous cells with granular contents and excretory system approaching "Echinata" type.

Cercaria triglandulata sp. nov., found infesting *Indoplanorbis exustus*, has aspinose body, three pairs of lobate penetration gland cells, cystogenous cells with bacilliform rods, and "Coronata" type of excretory system.

Cercaria megacauda sp. nov., found infesting *Gyraulus convenxiusculus*, has spinose body, cystogenous cells with rod-like contents, a large number of gland cells (penetration glands) located in the pharyngeal region, and a common opening of the main excretory canals into the excretory bladder.

INTRODUCTION

During the course of an investigation covering a period a little over a year (January 1974 to March 1975) on the cercarial fauna of the common snails (*Lymnaea acuminata*, *Indoplanorbis exustus* and *Gyraulus convenxiusculus*) found in pond in the outskirts of the city of Lucknow, three species of echinostome cercariae yet undescribed were found one in each and these form the subject matter of the present paper.

RESULTS

Cercaria granulosa sp. nov.

(Figs. 1, 2 & 3)

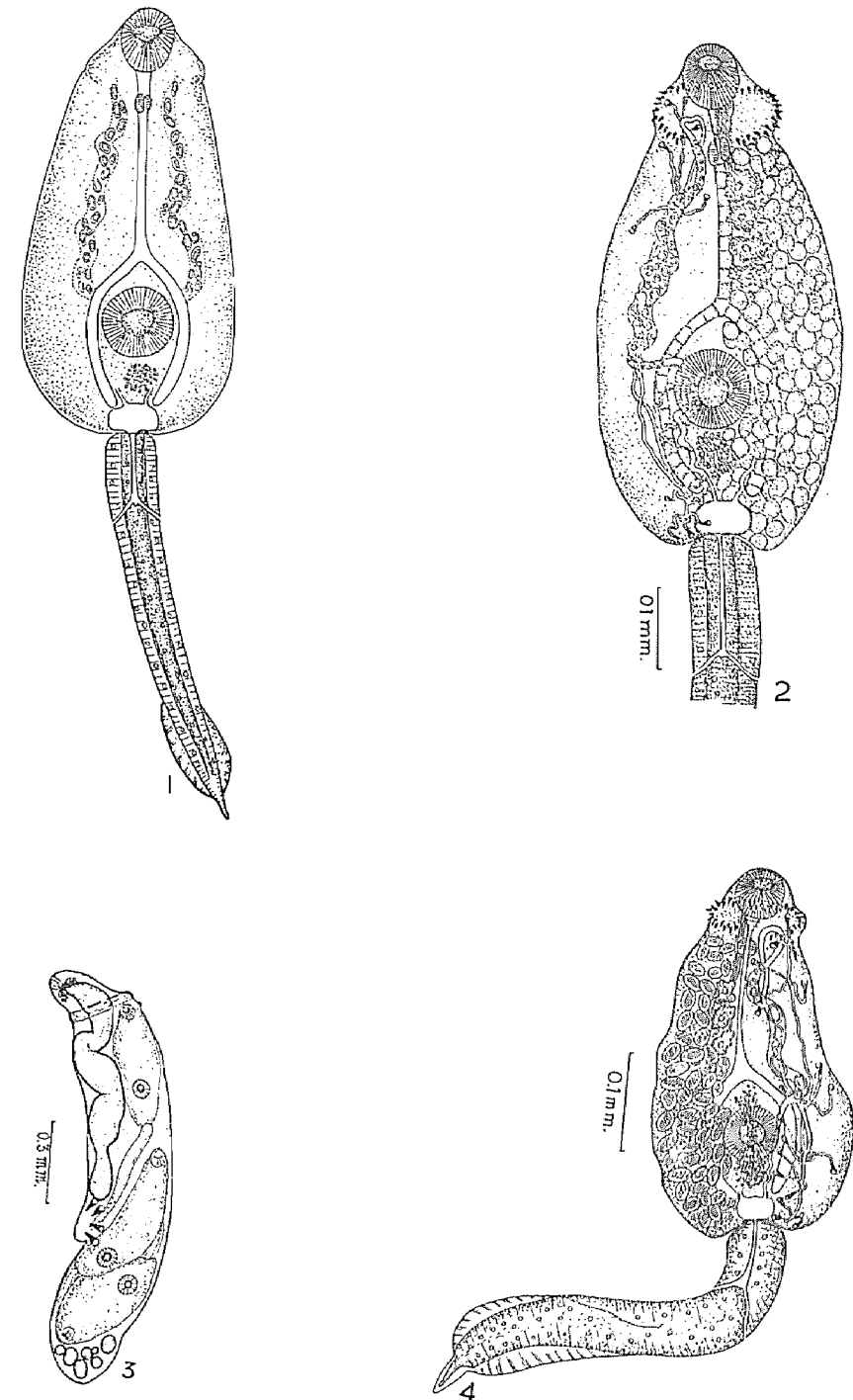
In all 233 specimens of *Lymnaea acuminata* (Lamarck) obtained from a pond located near Telibagh area about four miles from Lucknow city were examined during the course of the present investigation, but only four snails collected during the winter months (November and December, 1974) were found infected with this echinostome cercaria.

Cercariae emerged from the snails at noon when it is comparatively hot during the winter months. They lived, under the laboratory conditions, for a short period, not exceeding four to five hours. At the end of their active life, they settled at the bottom of the container, crawled for a while, and eventually died.

During active life, the cercariae swim vigorously by the lashing movements of their tail, and the curves ventrally while swimming. The cercariae appear to be positively phototactic as majority of them were found to crowd in the container towards the source of light. The cercariae crawl on the substratum with the help of their suckers which are alternately attached and detached. Occasionally a cercaria, while adhered to the substratum by its suckers, elevates and briskly vibrates its tail.

Cercarial body aspinose and elongate-oval, with a blunt anterior and a broad posterior end. It measures, in live specimens, 0.557-0.651 mm. in length and 0.278-0.285 mm. in maximum breadth in the region of ventral sucker, while in fixed specimens 0.225-0.251 mm. in length and 0.140 mm. in maximum breadth. Tail aspinose and tapers posteriorly; it has, at its distal third, a dorsal as well as a ventral fin fold. The tip of the tail has a small invaginable process. In live cercariae, tail is almost as long as the body, measuring 0.610-0.643 mm. in length and 0.078 mm. in breadth at its base; but in fixed specimens, it appears longer than the body and measures respectively 0.462-0.532 mm and 0.043 mm.

Oral sucker is somewhat longer than broad, and measures lengthwise 0.071-0.075 mm. and breadthwise 0.054-0.059 mm. in live specimens, while 0.034-0.037 mm. and 0.029-0.031 mm. respectively in



Figs. 1-3.—*Cercaria granulosa* sp. nov.; 1, ventral view; 2, ventral view (drawn from a well-extended specimen); 3, redia.
Fig. 4.—*Cercaria triglandulata* sp. nov., ventral view.

All figures are drawn from live specimens. Penetration gland cells, cystogenous cells and excretory canals are shown only on one side for clarity

fixed specimens. Ventral sucker larger than oral sucker, situated approximately in the middle of the posterior half of body and measures about 0.085 mm. in diameter in live and 0.040-0.043 mm. in fixed specimens. Cephalic collar well-developed and prominent, and supports 43 spines arranged in two alternate rows. No spines are found arranged in groups at the ventro-lateral corners of the collar.

A distinct prepharynx measuring about 0.041 mm. in length is readily distinguishable in live specimens. A mass of tiny spine-like bodies is present at the beginning of the prepharynx. Etges (1961) has described, in his account of *Cercaria reynoldsi*, a mass of spines at the corresponding place. The exact function of this mass of spines is difficult to interpret but it appears to guard the entrance of the digestive canal which, as mentioned later, is cellular and lacks a lumen. A somewhat similar case is presented by the cercaria of *Echinoparyphium recurvatum* (Linstow, 1873) as is evident from Kuntz's (1953) statement "A plug of cells remains at the base of the oral sucker so that the gut even in the mature cercariae may not communicate with the outside".

Prepharynx is followed by a pharynx which is lengthwise oval and measures about 0.027 mm. in length and 0.015 mm. in width in live specimens. Oesophagus quite long and measures 0.175 mm. in length in live specimens. Oesophageal bifurcation lies in front of the ventral sucker, and the intestinal caeca extend posteriorly up to the level of the excretory bladder. The interesting feature about the oesophagus and intestinal caeca being that they are composed of a number of coarsely granular cells arranged end to end and appear to be non-functional. Oesophagus is composed of nine or ten such cells, while each intestinal caecum of fourteen or fifteen cells.

Four pairs of lobate penetration gland cells, each with fine granules and a large round nucleus in its cytoplasm, are found arranged along the sides of oesophagus. The ducts of these gland cells open separately at the anterior margin of the mouth opening.

The lateral regions of the body, from the pharyngeal level up to the posterior end, are packed with numerous round or oval cystogenous cells, each containing a round nucleus and fine granules in its cytoplasm; these granules are, however, not rod-like—this is rather characteristic of the present cercaria. These cystogenous cells fairly obscure the penetration gland cells of the body.

A small mass of germ cells, representing the germinal primordium, is located behind the ventral sucker.

Excretory bladder appears, in live specimens, as an oblong structure placed transversely at the posterior end of body. Two main excretory canals, which have a sinuous course, open separately into the anterior side of the bladder. Each excretory canal runs forward, as the ascending limb, as far as the prepharynx wherefrom it turns back forming a loop, and runs posteriorly, as the descending limb, in a sinuous way up to a point much beyond the ventral sucker but roughly midway between the posterior border of ventral sucker and the hind end of body where it divides into two secondary branches—the anterior and posterior collecting canals. Evidently excretory system is not of "Echinata" type, but may be said to approach it. Of these two collecting canals, the anterior one is much longer than the posterior one and appears as if is a continuation of the main excretory canal. The ascending limbs of the main excretory canals are much dilated in the preacetabular region—this is evidently due to the presence of a large number (80 to 90) of round refractile excretory corpuscles. The anterior as well as the posterior collecting canal of each side of the body have each two short tertiary branches connected with the capillaries of flame cells which are arranged in sets of three. Thus the flame cell formula is $2(3+3) + 2(3+3) = 24$. Although no flame cells were found in the body in front of the ventral sucker in the region of the oesophageal bifurcation, the writer is certain that he has not missed any flame cell in this region—even no isolated flame cell could be located here. A caudal excretory canal arises from the middle of the posterior side of excretory bladder and, after covering a distance of about one-sixth the length of the tail, appears to dilate somewhat before bifurcating into fine canals which run obliquely outward and backward and open outside by pores located at the margins of the tail.

Rediae: By crushing infected snails, parthenitae which are the rediae were obtained. Rediae appear transparent when young, but pale yellow when fully developed. They perform sluggish movements. Each redia is an elongated sac-like structure, almost of a uniform width, with a narrow anterior and a broad posterior end. Length of well-developed rediae varies from 1.421 to 1.643 mm., while maximum breadth is 0.347 mm. Collar situated about 0.150 mm. behind the anterior end. Birth pore located on one side behind the collar. Locomotory processes present about 0.350-0.491 mm. in front of the posterior end of the redial body.

Mouth terminal and leads into a subglobular pharynx measu-

ring 0.041 mm. in diameter. Pharynx leads into a long gut which has yellowish contents and extends posteriorly up to the level of the locomotory processes. Several unicellular gland cells open into the anterior part of the gut just behind the pharynx.

Three of four well-developed cercariae, besides a number of germ cells and germ balls, are present in each redia.

In young rediae, only four flame cells could be observed on each side at the level of the locomotory processes.

Discussion: Much has been said by different workers viz, Cort (3), Dubois (4), Chatterjee (2), Miller (13), Wesenberg-Lund (20) and Khan (9) on the classification of echinostome cercariae in general and on that devised by Sewell (19) and by Faust (7). Faust's classification, based on the pattern of the excretory system, appears to have received little attention - apparently due to the difficulties involved in tracing the excretory pattern of echinostome cercariae and consequently it has been practically dropped as being quixotic. Porter (17), too, in her monograph on South African cercariae, followed Sewell's classification but added three more groups of echinostome cercariae which she instituted to include certain forms not assignable to any of the groups established by Sewell (19). Byrd and Reiber (1) suggested a group "Magnacauda" for the reception of the large-tailed echinostome cercariae - tenability of this group is questionable in the light of Hedrick's (8) and Reimer's (18) works. Khan (9), apparently being unaware of the works of Hedrick (8) and of Lee et Seo (11), stated "The large-tailed Echinostome cercariae... undoubtedly form a compact natural group, which can easily be separated from other Echinostome cercariae".

The writer does not intend to enter into a critical discussion on Sewell's and Faust's schemes of classification. Suffice to say that existing schemes of classification of echinostome cercariae are unnatural. He feels a natural classification showing relationships between cercariae and adults must await further work on the life histories of echinostomes. At the present, the writer is constrained to follow Sewell's classification.

From India, to the best knowledge of the writer, the following echinostome cercariae are known;

1. *Cercaria indica* IV Sewell, 1922
2. *Cercaria indica* XII Sewell, 1922
3. *Cercaria indica* XX Sewell, 1922
4. *Cercaria indica* XXIII Sewell, 1922

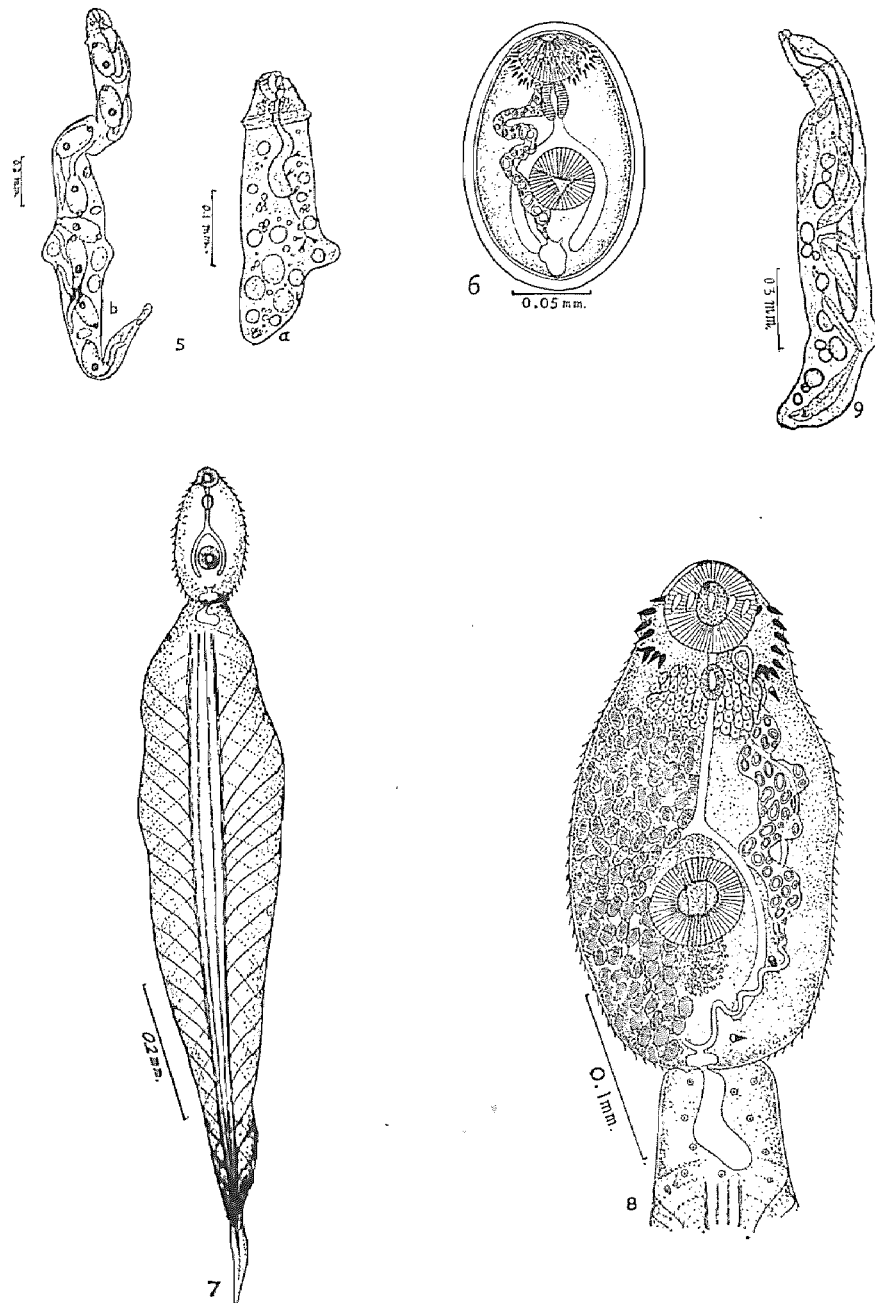
5. *Cercaria indica* XLVIII Sewell, 1922
6. *Cercaria mehrai* Faruqui, 1936
7. *Cercaria palustris* Chatterjee, 1932
8. *Cercaria nairi* Peter, 1955
9. *Cercaria echinostomi revoluti* Beaver, 1937
= *Cercaria* of *Echinostoma revolutum* (Froelich)
10. *Cercaria rithorensis* Mukerjee, 1963
11. *Cercaria mainpurensis* Pandey, 1965

Of all echinostome cercariae having caudal fins (Subgroup: Echinatoides) and four pairs of penetration gland cells, the present form greatly resembles *Cercaria indica* XLVIII Sewell, 1922 described from *Indoplanorbis exustus* in Wynaad, South India. Both have 43 collar spines. The present form can be distinguished from *C. indica* XLVIII by the relative size of its suckers: in the former ventral sucker is larger than oral sucker, while in the later they are equal. The ventro-lateral collar spines are not arranged in 'end-groups' in the present form, but they are in *C. indica* XLVIII. The oesophagus and intestinal caeca are cellular in the present form being composed of a column of cells placed end to end, but they are not so in *C. indica* XLVIII. Further, the cystogenous cells have granular contents in the writer's form in contrast to the rod-like contents found in *C. indica* XLVIII. Penetration gland cells are four pairs in both: they are lobate in the present species but pyriform in *C. indica* XLVIII. In the details of the excretory system, the two forms further differ. The redia of the present form differs from that of *C. indica* XLVIII in having a longer gut.

Cercaria triglandulata sp. nov.

(Figs. 4, 5 & 6)

30 out of 200 specimens of *Indoplanorbis exustus* Deshayes, obtained from a pond located in the vicinity of the village Purnea, about three miles from the city of Lucknow, were found infected with this echinostome cercaria. The infection was more prevalent amongst the snails collected during the winter months (November, December 1974 and January 1975), when about 15% specimens were found infected, than at other times of the year.



Figs. 5-6.—*Cercaria triplandulata* sp. nov.; 5a, a young redia; 5b, a mature redia; 6, encysted metacercaria.
Figs. 7-9.—*Cercaria megacauda* sp. nov.; 7 and 8, ventral views; 9, redia.

Cercariae emerged from the snail during morning and continued emerging till noon. They, too, were positively phototactic, like the other one described in the preceding pages. Swimming and crawling movements of this cercaria resemble those of *Cercaria granulosa* sp. nov., described in the present work.

Body large, aspinose, and pear-shaped with a bluntly pointed anterior and a broadly round posterior end, and measures, in live specimens, 0.352-0.365 mm. in length and 0.185-0.190 mm. in maximum breadth in the acetabular region. Tail is a tapering structure, devoid of spines, and measures, in live specimens, 0.379-0.397 mm. in length and 0.051 mm. in breadth at its base. A short conical caudal process, invaginable in nature, is present at the tip of the tail. Dorsal and ventral fin folds are present at the posterior half of the tail and they extend up to the tip of the tail. In fixed and mounted specimens, the body measures 0.172-0.220 mm. in length and 0.087-0.098 mm. in maximum breadth, while the tail measures 0.330-0.381 mm. in length and 0.031-0.038 mm. in breadth at its proximal part.

Terminal oral sucker measures 0.048-0.050 mm. in diameter in live specimens and 0.031-0.037 mm. in fixed specimens. Ventral sucker, situated in the middle of the posterior half of body, measures 0.049-0.056 mm. in diameter in live specimens and 0.036 mm. in fixed specimens. Collar prominent and armed with 41 spines arranged in two alternate rows. "End-group" spines absent.

Mouth opens, through a short prepharynx, into a subglobular pharynx. As described in case of *C. granulosa*, here, too, a mass of granules, which are, however, spherical and refractile in nature, is present at the entrance of prepharynx and possibly it performs a similar function. Prepharynx measures 0.018-0.020 mm. in length, while pharynx measures 0.010-0.018 mm. in diameter in live specimens. Oesophagus bifurcates, in front of ventral sucker, into intestinal caeca which extend almost up to the excretory bladder at the posterior end of body. A distinct lumen could not be seen in the digestive canal.

Three large and lobate penetration gland cells are present on each side of oesophagus. Each gland cell contains a large nucleus and finely granular cytoplasm. Ducts of these gland cells open separately at the anterior margin of mouth.

Numerous large and oval cystogenous cells are present on each side from the pharyngeal region up to the posterior end of body.

Each cystogenous cell contains a nucleus and a number of bacilli-form rods arranged in a parallel way.

Excretory system of "Coronata" type. Excretory bladder, situated at the posterior end of body, appears rectangular in outline. Two main excretory canals open separately at the antero-lateral corners of the bladder. Each excretory canal runs forward, as the ascending limb, in a tortuous course up to the prepharyngeal region wherefrom it turns backward forming a loop and runs, as the descending limb, in a sinuous course roughly up to the middle region of ventral sucker where it bifurcates into two secondary branches viz., the anterior and posterior collecting canals: of these, the anterior one is longer. Ascending limb of each excretory canal contains six to nine or, rarely, even ten large conspicuous refractile excretory corpuscles, and consequently greater part of it appears dilated. Some of these corpuscles appear to be compound in nature as they are composed of two partly fused corpuscles. Anterior as well as posterior collecting canal of either side have three short tertiary branches connected each with the capillaries of three flame cells. Thus the flame cell formula is $2(3+3+3) + 2(3+3+3) = 36$. A caudal excretory canal springs from the middle of the posterior side of the excretory bladder and enters into the tail wherein it runs backward and eventually, after covering a distance of about one-fourth of the entire length of the tail, forks into two fine branches which run obliquely outward and backward, and opening outside by pores located at the sides of the tail. Caudal excretory canal has no extension beyond its point of bifurcation in the tail.

Two masses of germ cells, one placed close to the anterior border and the other to the posterior border of the ventral sucker, constitute the germinal primordium. These two masses of germ cells are interconnected by an isthmus of similar cells running across the ventral sucker.

Rediae: Infected snails were dissected to obtain the parthenitae. On teasing the digestive glands of the infected snails in saline, numerous rediae in various stages of development were obtained. They performed slow movements. Young rediae (Fig. 5a) are transparent and small, whereas the older ones (Fig. 5b) are pale brown and quite long with a narrow aboral end. Young live rediae measure 0.683-0.710 mm. in length and 0.127-0.130 mm. in maximum breadth, while live mature ones 1.763-1.920 mm. in length and 0.186-0.220 mm. in maximum breadth. A collar is present around the body

about 0.093-0.110 mm. behind the anterior end. A small papilla with the birth pore at its tip is situated on one side just behind the collar. Locomotory processes are present towards the posterior region of the redial body, about 0.682-0.910 mm. in front of the hind end in fully developed rediae. Terminal mouth leads into a pharynx measuring 0.038-0.051 mm. \times 0.029-0.040 mm. Then follows the gut which, as compared with the body length of rediae, is quite short and extends behind for a short distance beyond the collar in fully developed rediae. Gut appears longer in young specimens—apparently due to the small size of the latter—and contains a brownish substance. A mass of gland cells surrounds the anterior part of the gut just behind the pharynx. A variable number of germ cells and germ balls, and developing cercariae are found within each redia; maximum number of well-developed cercariae found being 5 to 8 in mature rediae. Of the excretory system, only six flame cells could be seen on each side in young rediae; ; three located near the locomotory process and three in the region of the posterior part of the gut (Fig. 5a). They open on each side into a lateral collecting canal.

Metacercariae: Cercariae, after emergence from the infected snails, lead an active life of about six to ten hours. Subsequently these cercariae encyst, apparently in the absence of other specimens of the molluscan host, in the same snail from which they emerged, as encysted metacercariae were obtained from the liver and mantle-edge of the infected snails placed singly in different glass jars.

Cyst is transparent, oval and measures about 0.170 mm. \pm 0.115 mm. in live condition. Collar spines of encysted metacercariae appear prominent. Refractile excretory corpuscles in the ascending limbs of the main excretory canals are more in metacercariae than they are in cercariae. Penetration gland cells are inconspicuous in the metacercariae. Some of the granules, forming the plug at the entrance of the prepharynx, appear to have been absorbed.

Discussion: The present cercaria closely resembles *Cercaria nairi* Peter, 1955, in having an aspinose body and tail, a collar set with 41 spines arranged in two alternate rows and three pairs of penetration gland cells, but it can be distinguished from *C. nairi* by several features: a mass of spherical granules at the entrance of the prepharynx is found in the writer's form but not in Peter's form. Penetration gland cells are lobate in the present form, but pyriform in *C. nairi*. It can be further distinguished from Peter's species by its well-developed caudal fins which extend posteriorly on the ven-

tral as well as dorsal side from the middle of the tail. In *C. nairi*, the caudal fin is described to be present only on the dorsal side at the posterior third of the tail. In the details of the excretory system, the two forms show marked differences. The two main excretory canals in the present form open independently into the excretory bladder which lacks an anterior chamber, whereas in *C. nairi* these canals join to form a short common trunk before opening into a small anterior chamber of the excretory bladder. In the flame cell formula, too, the two differ: the present species has the formula $2(3+3+3) + 2(3+3+3) = 36$, while *C. nairi* has $2(3+3) + 2(3+3+3) = 30$. In the present cercaria, there is no extension of the caudal excretory canal beyond its point of bifurcation in the tail, but in *C. nairi* such an extension has been described by Peter (16). Another distinctive feature of the present form is found in the genital rudiments - here, the two masses of cells, one lying anterior and the other posterior to the ventral sucker and respectively representing the anlage of the cirrus sac and gonads, are interconnected by an arcade of similar cells running over the ventral sucker, whereas in *C. nairi* the two masses of genital primordium are quite discrete.

Apart from *Cercaria nairi*, the writer's form bears some resemblance to *Cercaria mainpurensis* Pandey, 1965, from which it differs in having both dorsal and ventral fin folds on the tail, and in the number and arrangement of collar spines: in the present form collar spines are 41 and they are arranged in two alternate rows, while in *Cercaria mainpurensis* they are 48 and are arranged in a single row. The excretory bladder of the present form lacks an accessory chamber and, further, the main collecting canals open independently into the excretory bladder, while that of *C. mainpurensis* has an accessory chamber into which jointly open the main collecting canals. Lastly, in the present form the caudal excretory canal does not extend beyond its point of bifurcation in the tail, but in *C. mainpurensis* it does so.

***Cercaria megacauda* sp. nov.**

(Figs. 7, 8 & 9)

Out of 10 specimens of the snail, *Gyraulus convenxiusculus* (Hutton), collected on 25th September, 1974, from a pond located about six miles from Lucknow, only one was found liberating a

large-tailed echinostome cercaria. Unfortunately the snail died on the third day of its capture. Repeated attempts were made to obtain more infected snails and as many as 210 additional specimens of the said snails were subsequently examined from the same pond but none were found infected.

Cercariae emerged in large numbers during the early hours of the morning and they remained active throughout the day, became inactive towards the evening when they sank to the bottom of the container and eventually died.

Cercariae are large and perform wriggling movements. The active wriggling movements of the cercariae are punctuated by short periods of rest, during which they obliquely suspend themselves from the surface of water and then slowly sink to the bottom of the container. The wriggling movements are entirely due to the action of the huge tail, the body practically remains inactive during these movements. The cercariae are positively phototactic as they tend to crowd in the container towards the source of illumination.

Cercarial body appears as a mere knob at the broad anterior end of the large tail. It is spinose and when fully extended, oval in shape with a bluntly pointed anterior and a broadly round posterior end, and measures in live, under the pressure of cover glass, 0.270-0.324 mm. in length and 0.091-0.168 mm. in maximum breadth in the acetabular region. In fixed specimens, the body measures 0.158-0.180 mm. in length and 0.061-0.063 mm. in maximum breadth. Tail is long, massive and aspinose. In an extended condition, it is a lanceolate structure with an acuminate posterior end.

Musculature of the tail includes prominent longitudinal as well as diagonal bundles of muscle fibres. Longitudinal bundles are four in number, of which two appear to be dorsal and two ventral. They run through the middle of the tail, while the diagonal bundles of muscle fibres, of which quite a large number occur, run through the lateral regions of the tail. Nuclei are found interspersed with the diagonal bundles of muscle fibres.

Tail measures, when well-extended, 0.910-1.010 mm. in length and 0.210-0.247 mm. in maximum breadth in live specimens, but 0.385-0.421 mm. in length and 0.142-0.160 mm. in maximum breadth in fixed specimens.

Suckers aspinose and more or less equal in size. Oral sucker terminal roughly circular in outline, and measures in live specimens 0.052-0.058 mm., while in fixed specimens about 0.025 mm. in diame-

ter. Ventral sucker, situated in the posterior half of body, measures 0.056-0.058 mm \times 0.061-0.064 mm. in live and 0.025 mm \times 0.026 mm. in fixed specimens. A prominent collar, on which are set 22 collar spines in a single row, is present at the cephalic end of body.

Mouth leads through a short prepharynx into a subspherical or somewhat oval pharynx: the former measures 0.013 mm. in length, while the latter 0.019-0.021 mm. in diameter. No spines, as has been described by Etges (5) in case of *Cercaria reynoldsi*, could be observed in the initial part of the prepharynx in this form. Oesophagus is long and measures 0.079-0.081 mm. in length. Intestinal bifurcation occurs at about the middle, while intestinal caeca terminate near the posterior end of body. A dense mass comprising a number of small gland cells, whose number could not be ascertained due to their compactness, is present on each side in the region of pharynx: each gland cell has granular cytoplasm with a conspicuous nucleus. The ducts of these cells, which form the penetration glands, were not traceable.

Numerous cystogenous cells, which greatly mask the internal structures, are thickly present in the right and left halves of the body from behind the collar region. The bacilliform contents of these gland cells mask the nuclei and they are arranged in a parallel way.

Two compact masses of cells, one placed close to the anterior border while the other behind the posterior border of the ventral sucker, constitute the genital primordium. These masses of cells are interconnected by an isthmus of similar cells running over the ventral sucker.

Excretory bladder rectangular, located in the posterior end of body, and appeared to extend, through a narrow constricted region which seemed to mark the position of the excretory pore, into the basal part of tail as large and elongated excretory reservoir. Two main excretory canals open together in the middle of the anterior side of the excretory bladder. Each excretory canal runs anteriorly as the ascending limb up to the prepharynx wherefrom it flexes backward and runs posteriorly as the descending limb. The middle region of the ascending limb of each excretory canal is much dilated due to the contained refractile excretory corpuscles which, as usual in echinostome cercariae, are the most prominent structures. These corpuscles may be round, oval, or oblong. In fifteen cercariae selected at random, they were found to vary from 66 to 75 in each

excretory canal. Details of the excretory system could not be worked out due to the paucity of material caused by the death of the snail. A few flame cells were observed.

Rediae: When the dead snail was dissected, some live rediae were obtained from its liver. Evidently the snail had died shortly before. Rediae are elongated saccular structures with an attenuated oral end, and vary from 1.170 to 2.018 mm, in length. Mouth terminal and leads, through a muscular pharynx, into a long gut extending beyond the middle of the redial body, almost up to the locomotory appendages. A collar is present a short distance behind the oral end of redia. Birth pore is placed just behind the collar, approximately 0.163-0.210 mm. from the anterior end, while locomotory processes are located about 0.370 mm. in front of the posterior end of the redial body.

Discussion:

Over a dozen species of large-tailed echinostome cercariae are known. Nasir (14) listed the species known till 1960, and also described two additional species viz., *C. rashidi* and *C. titfordensis*. Subsequently Khan (9), Etges (5) and Mukherjee (12) described each one species of large-tailed echinostome cercaria. Leaving aside the species with uncertain number of collar spines, only two large-tailed echinostome cercariae are on record to date, viz., *C. illecebrosa* Lee and Seo, 1959 and *C. reynoldsi* Etges, 1961 which have, like the present species, 22 collar spines.

In *C. illecebrosa*, the crown of collar spines is discernible, according to its authors Lee and Seo (11) in the metacercarial stage; while in the present species, it is developed in the cercarial stage. Further, in *C. illecebrosa*, the crown of collar spines is interrupted mid-ventrally as well as mid-dorsally by a wide chasma, indicating that it is a larval form of some echinostome of the subfamily *Echinochasmidae* Odhner, 1910, and probably of the genus *Stephanophora* Odhner, 1902 as stated by Lee and Seo (11). In the present form, the crown of spines is interrupted only mid-ventrally—this evidently shows that it is not a larval form of any echinochasmid. The lanceolate tail is quite characteristic of the writer's form and easily distinguishes it from *C. illecebrosa*, and, further, it lacks the bristles which characterize the tail of the latter. The suckers of the present form are aspinose, while those of *C. illecebrosa* spinose. The present

species again differs from *C. illecebrosa* in the number of penetration gland cells which are certainly more than nine here. The genital primordium in the present form is quite extensive but not so in case of *C. illecebrosa*. The two main excretory canals in the writer's form have a common portal of entry into the excretory bladder, but in *C. illecebrosa* they have separate openings into the excretory bladder. These features suffice to show that the present form is distinct from *C. illecebrosa*.

The present form differs from *C. reynoldsi* in having a spinose body but an aspinose tail. In the relative size of suckers, the two species differ: suckers isodiametric in the present species but ventral sucker larger than oral sucker in *C. reynoldsi*. The position of the penetration gland cells differs in the two - in *C. reynoldsi* they are placed close to the anterior border of the ventral sucker, but in the writer's species they are far forward in position and numerically they are more. In *C. reynoldsi*, the cystogenous cells are confined to the anterior half of body in front of the ventral sucker, but in the present form they extend into the post-acetabular region of body as well. In both, the excretory system is of stenostoma type, but in the present form, the main excretory canals turn back without bifurcation from the pharyngeal region of body, while in *C. reynoldsi* they bifurcate at the pharyngeal level. Further, the excretory bladder lacks corpuscles in the present species.

The writer feels that a comparison of his species with *C. rithorensis* Mukherjee, 1963, the only other large-tailed echinostome cercaria described from the same snail host in India, is rather indispensable. Besides the number of collar spines, the writer's form differs from *C. rithorensis* in having a spinose body and isodiametric suckers, in the extension of the intestinal caeca beyond the ventral sucker, in the absence of a mass of spines at the posterior part of the pharynx, and lastly in the point of entrance of the main excretory canals into the excretory bladder. The rediae of the two species can be distinguished by the extension of the gut which in the redia of the present form extends up to the locomotory processes, whereas in the other case it stops short before reaching the level of the said appendages. It appears that in the figure of the redia of *C. rithorensis*, as shown by the author (Mukherjee, 12), the collar is wrongly labelled as the locomotory appendage and, further, the position of the birth pore in front of the collar is rather unusual, if at all it is so.

RESUMEN

Durante una encuesta sobre la fauna de cercarias de los caracoles comunes hallados en medios ambientales de la ciudad de Lucknow fueron encontradas tres nuevas especies de cercaria de echinostoma, *Cercaria granulosa*, *C. triglandulata* y *C. megacauda*, que son descritas en este trabajo. Las dos primeras son cercarias de cola en aleta que recuerdan a *C. indica* XLVIII Sewell, 1922 y *C. nairi* Peter 1955, respectivamente, mientras *C. megacauda* tiene una cola larga y recuerda a *C. illecebrosa* Lee y Seo, 1959 y *C. reynoldsi* Etges, 1961.

Cercaria granulosa sp. nov., hallada parasitando *Lymnaea acuminata*, tiene el cuerpo carente de espinas, cuatro pares de células glandulares lobuladas de penetración, intestino compuesto por células dispuestas una a continuación de la otra, células cistógenas con contenido granular y sistema excretor próximo al tipo "Echinata".

Cercaria triglandulata sp. nov., hallada infectando *Indoplanorbis exustus*, tiene el cuerpo carente de espinas, tres pares de células glandulares lobuladas de penetración, células cistógenas con varillas baciliformes y sistema excretor del tipo "Ciconata".

Cercaria megacauda sp. nov., hallada infectando *Gyraulus convexiusculus*, tiene el cuerpo espinoso, células cistógenas con contenido parecido a varillas, un gran número de células glandulares (glándulas de penetración) localizadas en la región faríngea, y una apertura común de los canales excretores principales en la vejiga excretora.

ACKNOWLEDGEMENT

The writer is highly thankful to Dr. R. Gupta, Head of the Department of Zoology, J. N. Degree College, Lucknow, for providing him the material for his study.

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BIOQUIMICA DEL ASCARIS LUMBRICOIDES DEL CERDO. VII. EFECTO DE LA ADICION DE DIVERSOS NUTRIENTES AL MEDIO DE SOBREVIVENCIA SOBRE LOS COMPONENTES AZUCARADOS

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SUMMARY

The variations of some carbohydrates in several tissues of *Ascaris lumbricoides* cultured in media added with hemoglobin of pig and glucose are studied statistically.

Although many of the results per carbohydrate and tissue are statistically significant, no clear conclusions can be drawn from them in relation to the influence of the specified nutrients on the sugar content (glucose, trehalose, glycogen) of the nematode. The presence of nutrients in the media is only related to the total content of carbohydrates.

INTRODUCCION

En trabajos anteriores hemos estudiado algunos componentes del líquido perivisceral del *Ascaris* (3), realizando un estudio estadístico de su contenido en trealosa y glucosa (1) y de proteínas y hemoglobina (4). Posteriormente hemos analizado las variaciones que estos constituyentes sufren durante la supervivencia en ayunas, tanto en líquido perivisceral como en diversos tejidos (2). En el presente trabajo se estudian las variaciones que sufren los componentes azucarados de los tejidos durante la supervivencia en medios adicionales de nutrientes.

MATERIAL Y METODOS

Esencialmente son los descritos en los trabajos anteriormente citados.

* Not consulted in original.